

## User Manual

### EFOY Hydrogen Fuel Cell EFOY Hydrogen Controller



Thank you!

Congratulations on choosing an EFOY Hydrogen Energy Solution from SFC Energy AG. We hope you enjoy your new power supply.

The user manual contain the information required for the correct installation and operation of the two components, the EFOY Hydrogen Fuel Cell and the EFOY Hydrogen Controller. The following abbreviations are used in the user manual:

EFOY Hydrogen Fuel Cell	Short term: <b>Fuel Cell</b>
EFOY Hydrogen Controller	Short term: <b>Controller</b>

If you have any questions about installation, please contact your sales partner or the EFOY hotline. Please have the serial number of the unit ready; it is located on a small sticker below the left handle of the unit.

The operator is responsible for the permanent and correct installation of the EFOY Hydrogen Energy Solution, including its components.

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Specifications may be changed without prior notice. Revision 01/2022*

## Info on safe operation



**Read the user manual before commissioning. For your own safety, follow the instructions and warnings in the user manual. Keep the user manual safe, together with the components, preferably in the EFOY Hydrogen Cabinet.**



### WARNING



The Fuel Cell and the Controller are components of an EFOY Fuel Cell Energy Solution. They may only be installed as a complete system in a suitable cabinet that protects them against direct weather influences and in particular against penetrating moisture. Ensure sufficient ventilation.



Do not open the Fuel Cell or the Controller and avoid damage of any kind. Modifications to the Fuel Cell or the Controller endanger safety and lead to the voiding of the guarantee or warranty.



Only transport in an upright position.



Protect the Fuel Cell and Controller against direct sunlight. Observe the temperature stipulations for operation and storage.



The maximum temperature range for transportation and storage is between  $-40\text{ }^{\circ}\text{C}$  and  $70\text{ }^{\circ}\text{C}$ . Do not store or transport the Fuel Cell or Controller at temperatures below  $-40\text{ }^{\circ}\text{C}$  or above  $70\text{ }^{\circ}\text{C}$ . The ideal storage and operating temperature is between  $10\text{ }^{\circ}\text{C}$  and  $25\text{ }^{\circ}\text{C}$ .



Do not smoke when handling the Fuel Cell and Controller. Keep the Fuel Cell and Controller away from sources of heat and ignition, as well as flammable materials.

## Service and contact

SFC Energy AG  
Eugen-Saenger-Ring 7  
85649 Brunenthal  
Germany

Hotline: +49 (0) 89 673 592 555  
Toll-free number\*: 00800 732 762 78  
E-mail: [service@sfc.com](mailto:service@sfc.com)  
Web: [www.efoy.com](http://www.efoy.com)

*\*The toll-free number can be called free of charge from a landline telephone in the following countries: Austria, Belgium, Denmark, France, Germany, Great Britain, Italy, the Netherlands, Norway, Spain, Sweden and Switzerland.*

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## 1 Safety

### 1.1 Explanation of signal words



#### **DANGER**

Indicates a hazard with a high degree of risk which, if not avoided, will result in death or serious injury.

- ▶ Pay attention to the danger warning.



#### **WARNING**

Indicates a hazard with a medium degree of risk which, if not avoided, can result in death or serious injury.

- ▶ Pay attention to the danger warning.



#### **CAUTION**

Indicates a hazard with a low degree of risk, which, if not avoided, can result in minor or moderate injury.

- ▶ Pay attention to the danger warning.



#### **INFO**

Indicates an action that can cause material damage.

- ▶ Pay attention to the information provided.



Includes further information and tips on optimal use of the Fuel Cell and the Controller.

## 1.2 Safety instructions for the Fuel Cell and the Controller



### INFO

The Fuel Cell and the Controller form part of an EFOY Hydrogen Energy Solution (complete system). The system operator is responsible for adhering to the relevant guidelines, both prior to commissioning and during operation.



### INFO

Ensure that the Fuel Cell and the Controller are inspected by a qualified service technician at intervals of no longer than six months.



### INFO

The EFOY Hydrogen Energy Solution is safe guarded by internal sensors and alarm processing, which continuously query and monitor important data. If a critical value is exceeded, the Fuel Cells are switched off and the sensor values continue to be monitored by the Controller.



### DANGER

#### **Risk of electric shock!**

Conversions and modifications to the Fuel Cell or Controller can lead to general hazards (injury from escaping hydrogen, risk of injury from heavy parts, risk of death from electric shock).

- ▶ Do not perform any conversions or modifications on the Fuel Cell and Controller or on any individual components

**DANGER**

**Explosion!** Hydrogen is a colorless, odorless and flammable gas. Hydrogen is highly flammable and burns with a colorless flame. Leakage of hydrogen forms explosive hydrogen-air mixtures, which ignite quickly and can lead to severe burns.

- ▶ Observe the guidelines and local regulations for handling hydrogen.
- ▶ Ensure that the hydrogen supply is installed correctly and compliant with regulations.
- ▶ Follow the installation instructions, warnings and safety regulations for handling compressed hydrogen, as well as for handling hydrogen cylinders.
- ▶ Regularly inspect the hydrogen lines and fittings for leaks.
- ▶ Avoid heat in the vicinity of the system and the hydrogen source
- ▶ Do not smoke or use naked flames in the vicinity of the Fuel Cell.
- ▶ Avoid electrostatic charges.
- ▶ If gas escapes, keep your distance and keep flammable materials away.
- ▶ The Fuel Cell and the Controller may **not** be operated if a leak in the hydrogen line or an increased hydrogen concentration is identified.

The Fuel Cell regularly checks its internal lines and connectors for leaks using a self-test. If a leak is detected, the system shuts down and can **no longer** be operated.

**DANGER**

**Oxygen deficiency!** Leakage of hydrogen can reduce the oxygen content of the air and lead to breathing difficulties.

- ▶ Do **not** inhale hydrogen.

The Fuel Cell uses oxygen during operation.

- ▶ The Fuel Cell and the Controller may only be installed and operated in a well-ventilated environment.
- ▶ Ensure sufficient ventilation of the Fuel Cell and Controller and ensure that the openings for the incoming and outgoing air are not blocked by any objects.



**DANGER**

**Risk of electric shock!** High voltages may occur in the EFOY Hydrogen Fuel Cell, even when the system is shut down or disconnected from the mains. System components are connected to electrical energy storage media and are under voltage.

- ▶ The Fuel Cell and the Controller must be grounded.
- ▶ Before commencing servicing works, the energy storage media (batteries) must be disconnected, then check that the system is de-energized.

The Fuel Cell and the Controller are not waterproof. The combination of infiltrating water and electricity creates a risk of injury.

- ▶ Ensure that no water can penetrate the Fuel Cell or the Controller.
- ▶ Ensure that the Fuel Cell and the Controller are installed in a cabinet protected against water.
- ▶ Do not use the Fuel Cell or the Controller if any part of them has been submerged in water. A Fuel Cell or the Controller damaged by water is potentially hazardous. Any attempt to operate these damaged components may lead to fire or explosion. Contact the EFOY hotline to have a service technician inspect the Fuel Cell or the Controller and replace any parts of the gas control and electrical control system that have been wet.

## 1.3 Certificates

### 1.3.1 Declaration of conformity



The company SFC Energy AG, Eugen-Saenger-Ring 7, 85649 Brunnthal declares that the EFOY Hydrogen Fuel Cell and the EFOY Hydrogen Controller comply with the following EU directives and that the listed harmonized standards were adopted.

**2014/30/EU EMC** : electromagnetic compatibility

EN 61000-4-2:2009, EN 61000-4-3:2006+A2:2010, EN 61000-4-4:2012,  
EN 61000-4-5:2014, EN 61000-4-6:2014, EN 61000-4-8:2010, EN 61000-4-11:2004  
EN 61000-6-2:2019, EN 61000-6-4:2007+A1:2011

**2011/65/EU and 2015/863** Restriction on the use of certain hazardous substances in electrical and electronic equipment RoHS

**1907/2006** REACH Directive (EC)

### 1.3.2 Warranty

The warranty service is based on the warranty conditions of SFC Energy AG, valid at the time of purchase for the respective country. Observe the warranty conditions accompanying the product or available at [www.efoy.com](http://www.efoy.com)

## 1.4 Proper use

The EFOY Hydrogen Energy Solution was designed as a stationary power supply system with a nominal output voltage of 48 V DC.

The Fuel Cell or the Controller must not be used for the following applications

- Medical, life-sustaining and agricultural equipment
- Operation outside of the stipulated technical specifications
- Operation outside of the allowable operating environment
- Feeding the energy produced into the power grid
- Operation in areas subject to explosion hazards
- Operation with damaged or missing components

## 1.5 Transportation and disposal

Information on transportation can be obtained by calling the EFOY hotline. Please note the SFC Energy AG instructions for transportation

The Fuel Cell and the Controller are protected by packaging. All materials used are environmentally friendly and recyclable.



### WARNING

**Risk of suffocation** from films and folding boxes.

- ▶ Keep packaging and parts of packaging away from **children**.

We recommend keeping the packaging for any necessary storage. However, if you still intend to dispose of the packaging, please help and dispose the packaging of the Fuel Cell and the Controller in an environmentally friendly manner in accordance with local regulations. In accordance with EU Directive 2012/19/EU, the Fuel Cell and the Controller are registered under WEEE Reg. No. DE 85008411.

Old devices: Old electronic devices may not be disposed of with household garbage.



Contact the EFOY hotline in order to coordinate the return of the Fuel Cell and the Controller.

## 2 Design and specifications: Fuel Cell and Controller

### 2.1 Product contents

#### EFOY Hydrogen Fuel Cell 2.5 48 V

Description	Pcs.
EFOY Hydrogen Fuel Cell 2.5 48 V	1 to 4

Note: The Controller and up to four Fuel Cells are always required together for an EFOY Hydrogen Energy Solution. For this reason, only one set of the user manual has been compiled for the Fuel Cell(s) and the Controller.

#### EFOY Hydrogen Controller

Description	Pcs.
EFOY Hydrogen Controller	1
User manual (Fuel Cell and Controller)	1

### 2.2 Description and specifications

#### EFOY Hydrogen Fuel Cell 2.5 48 V

The Fuel Cell modules are designed to be directly connected to a 48 V DC system. An additional 48 V power storage device (battery) is required to supply the EFOY Hydrogen Energy Solution with starting power and to bridge this starting time.

All specifications obtained through testing under normal conditions. We reserve the right to make changes to the specifications.



### Data sheet: EFOY Hydrogen Fuel Cell

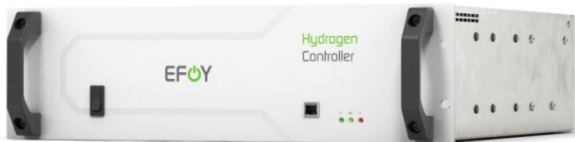
Specifications	EFOY Hydrogen Fuel Cell 2.5 48 V
Max. output power <sup>1</sup>	2.5 kW
Max. Power output after 5,000 h operation time	2.0 kW
Rated voltage	48 V DC
Supply voltage	41–57 V DC
Weight	28.5 kg
H <sub>2</sub> connection	1/4" NPT female connection
Fuel	Hydrogen
H <sub>2</sub> purity	3.0 or better
Inlet pressure at the Fuel Cell	0.5 bar
H <sub>2</sub> nominal consumption	0.06 kg H <sub>2</sub> /kWh
Leakage rate during operation <sup>2</sup>	Approx. 0.35 l H <sub>2</sub> / min.
Oxygen consumption	Approx. 335 l / kWh
Power consumption in standby mode	< 50 W
Operating temperature <sup>3</sup>	+3 °C to +50 °C

Specifications	EFOY Hydrogen Fuel Cell 2.5 48 V
Storage temperature	-40 °C to 70 °C Recommended: 10 °C to 25 °C
Altitude <sup>4</sup>	Up to approx. 3,000 m
Dimensions L x W x H	535 x 483 x 310 [mm]
IP protection class	IP 20
Data interface	Internal between Fuel Cell and Controller: CAN BUS

- <sup>1</sup> Only achievable with supply air temperatures < 30 C°
- <sup>2</sup> The leakage rate increases proportionally with the operation time of the fuel cell
- <sup>3</sup> When installed in a suitable cabinet with integrated heating. When used in the minimum ambient temperature, a base load of 1,000 W is required
- <sup>4</sup> With increasing altitude there is a reduction in power output

## EFOY Hydrogen Controller

The Controller is the control unit for the EFOY Hydrogen Fuel Cells. It controls the operation of all installed Fuel Cells and the parameters of the entire system. The Controller provides communications interfaces to other components (e.g., the energy manager) and an operating interface. The Controller is operated and connected to a computer using a Webtool, which must be installed (see Section 4). The RJ 45 plug connector on the front is for connecting to a computer to use the Webtool.



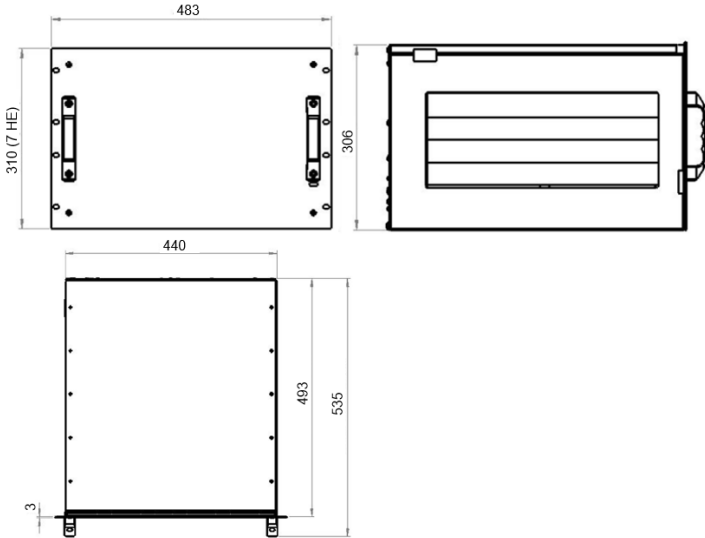
## EFOY Hydrogen Controller data sheet

Specifications	EFOY Hydrogen Controller
Supply voltage	36–57 V DC
Current consumption	Max. 2 A @ 48 V
Weight	7.6 kg
Operating temperature	+3 °C to 50 °C
Dimensions L x W x H	446 x 483 x 133 mm
Internal data interface	Between Controller and Fuel Cells: CAN BUS 2 x RJ 45 connector on the rear side
External data interfaces: Connectors / communication	<p>RJ 45 plug connector at the front side with the following interface</p> <ul style="list-style-type: none"> <li>• Ethernet for Web Interface (Ethernet: Firefox 44.0 and Java SE 8)</li> </ul> <p>6 x Sub D plug connector with the following interfaces</p> <ul style="list-style-type: none"> <li>• MODBUS RTU protocol via RS 485</li> <li>• Alarm contacts</li> <li>• Stop signal</li> <li>• Rectifier voltage reduction</li> <li>• Heating / ventilation</li> <li>• 24 V supply for external components.</li> </ul>

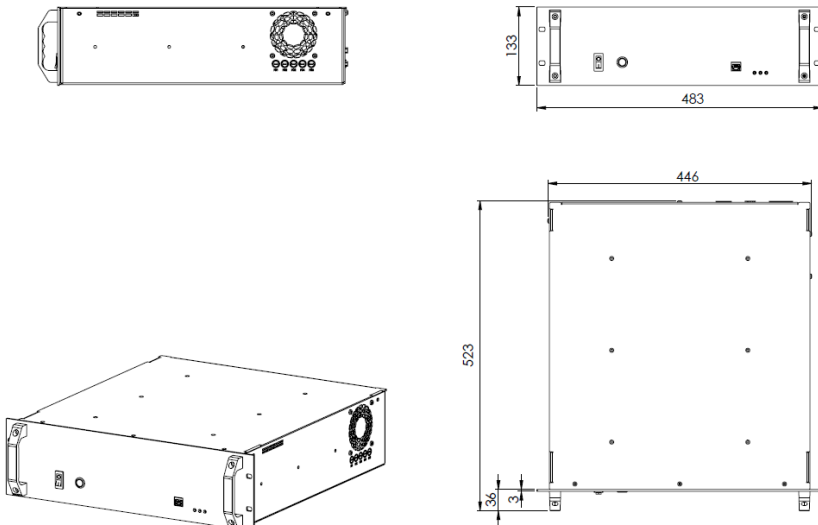
The RS 485 interface in the Controller is based on the ModBus protocol. A variety of data and settings is available via the Controller's ModBus. Detailed information on the ModBus parameters is available on request from SFC.

## 2.3 Dimensions

### EFOY Hydrogen Fuel Cell 2.5 48 V



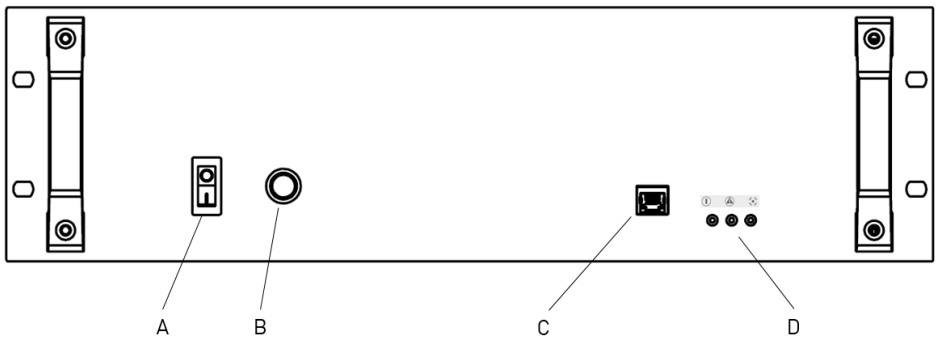
### EFOY Hydrogen Controller





## 3 Commissioning and operating the Fuel Cell and Controller

Normally, the EFOY Hydrogen Energy Solution (complete system) is already completely installed on site and is generally also initialized. The detailed description of the Fuel Cell and the Controller is therefore provided later in the user manual. The Fuel Cell(s) and the Controller can only be operated together. Operation and data transfer take place exclusively via the Controller. The following functional and information elements are located on the front of the Controller.



Controller front

Designation	Description
A	On-off switch
B	Push button with red LED
C	Ethernet connection (RJ45)
D	Status display with three LEDs (green, yellow, red)

The EFOY Hydrogen Controller is started using the on-off switch. The four LEDs (red, green, yellow from the status display and other red LED at the push button) show the operating status of the Controller and the Fuel Cell. They are explained in more detail in the Webtool description (Section 4). The Controller can be connected to a computer via the RJ 45 plug connector.

### 3.1 Initialization

The Controller initialization begins after switching on the Controller. Here, the Fuel Cell(s) present in the system are reset and, if necessary, sensors are heated up for operation.

The Fuel Cells are not yet ready for operation during initialization. During initialization, the green LED flashes quickly (approx. 0.5 sec. on; 0.5 sec. off). Initialization is carried out at every switching on and takes up to 90 seconds.

To increase efficiency, the anode side is purged after approx. 17 seconds and then regularly every 60 seconds. The hydrogen concentration is measured via a hydrogen sensor. One purge takes 300 milliseconds. The cathode side is cleaned by an induced short circuit. In this process, the "+" and "-" poles of the fuel cell stack are connected together for 300 milliseconds. 25 seconds after switching on, this process is carried out three times, and it is repeated three times every hour thereafter.

During the start-up process, an internal leakage test also takes place.

### 3.2 Standby

In standby mode, the Controller monitors the bus voltage (corresponds to the voltage on the energy storage device). The Controller remains in standby mode until the voltage falls below the switch-on thresholds defined in the system.

The green LED flashes slowly in standby mode (3 sec. on; 2 sec. off).

### 3.3 Normal operation

When the voltage falls below the **system on thresholds** defined (see Webtool, Section 4.3) defined in the system on the power storage device, the Controller starts the Fuel Cells. The power generated by the Fuel Cell depends on the voltage of the energy storage device (battery) and is between approx. 500 W and 2,500 W. The lower the voltage at the energy storage device, the higher the generated power. If several Fuel Cells are used, they are also started one after the other depending on the voltage on the energy storage device.

Before the Fuel Cell systems can deliver the required energy, an electrical energy storage device (battery) integrated in the Energy Solution must assume the power supply of the 48 V DC consumers. The Fuel Cell starting phase takes up to 2 minutes.

As long as the voltage remains below the **system on thresholds** defined on the bus voltage (voltage at the battery), the system remains in normal operation. Power is provided by the Fuel Cells present and the electrical energy storage device.

**The green LED is continuously lit during normal operation.**

If the necessary **system off threshold** on the 48 V DC bus voltage in the power supply system is achieved again, the Controller switches off the running Fuel Cells and goes into standby mode.

### 3.4 Testrun/Conditioning

The Controller automatically performs a test operation. The automatic test operation interval is 30 days. This can be increased manually to as much as 90 days. This can be changed, for example if, depending on the application, it is guaranteed that the Fuel Cells are operated every 30 days, even without a testrun. However, this change should only be carried out in collaboration with the service technician.

Independently of this, a test operation/conditioning can also be started manually using the Webtool (Section 4.3). A digital input, which is controlled via a potential-free contact, is provided for this purpose.



#### INFO

A load of at least 1,000 W is required for the testrun to allow the DC voltage to drop. Without the necessary load, the testrun is prematurely abandoned. The heating elements can be used as a load.

- ▶ When planning the all-in-one solution, ensure that there is a sufficient load to ensure a complete testrun in each case.

The testrun is terminated after 15 minutes, and the EFOY Hydrogen Energy System goes back to standby mode.

### 3.5 Service mode

The service mode can be activated manually in the Webtool (Section 4.4). In service mode, it is possible to switch valves and relays by hand, e.g., in order to purge the hydrogen lines or test the alarm outputs.

It is not possible to start the EFOY Hydrogen Energy Solution in this mode.

The three LEDs (green, yellow, red) flash quickly (0.5 sec. on, 0.5 sec. off) when the service mode is active.

## 4 EFOY Hydrogen Energy Solution Webtool

### 4.1 Description

The EFOY Hydrogen Energy Solution Webtool is an interface for monitoring the entire EFOY Hydrogen Energy Solution via an existing Ethernet connection. To achieve this, establish a connection from a computer to the Ethernet socket (RJ 45) on the front of the Controller. The Webtool requires the Firefox 44.0 internet browser and Java SE 8.

The Webtool includes the following individual functions:







- Operating status display
- Display and adjustment of system settings
- Displays important measured data and operating parameters
- Retrieval and storage of warning and alarm messages
- Service functions

The EFOY Hydrogen Energy Solution Webtool can generally be accessed at the following address:

- <http://192.168.11.175/WebIF4.html> → Home page

### 4.2 Menu icons

A variety of icons for controlling the Webtool are provided down the left margin. The icons have the following meanings:

Icon	Function
	Return to system overview
	Previous page
	To system settings
	Return to home page
	Open alarm list page
	To network settings (password protected)

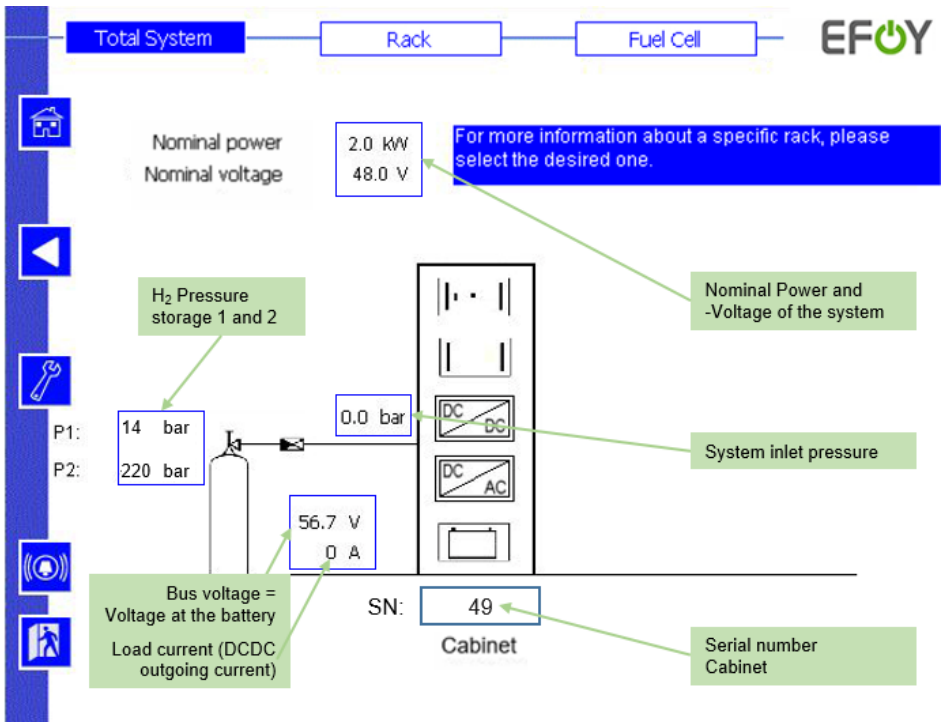
### 4.3 Settings

A welcome page briefly appears after starting the Webtool.

	The system overview can be accessed by clicking the welcome page or, if you are already on a different Webtool page, by clicking this button
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#### 4.3.1 System overview






The entire EFOY Hydrogen Energy Solution is displayed with the following elements: Tank system (hydrogen storage), a cabinet and the components contained therein, such as Fuel Cells, Controller, rectifiers, inverters and power storage device.



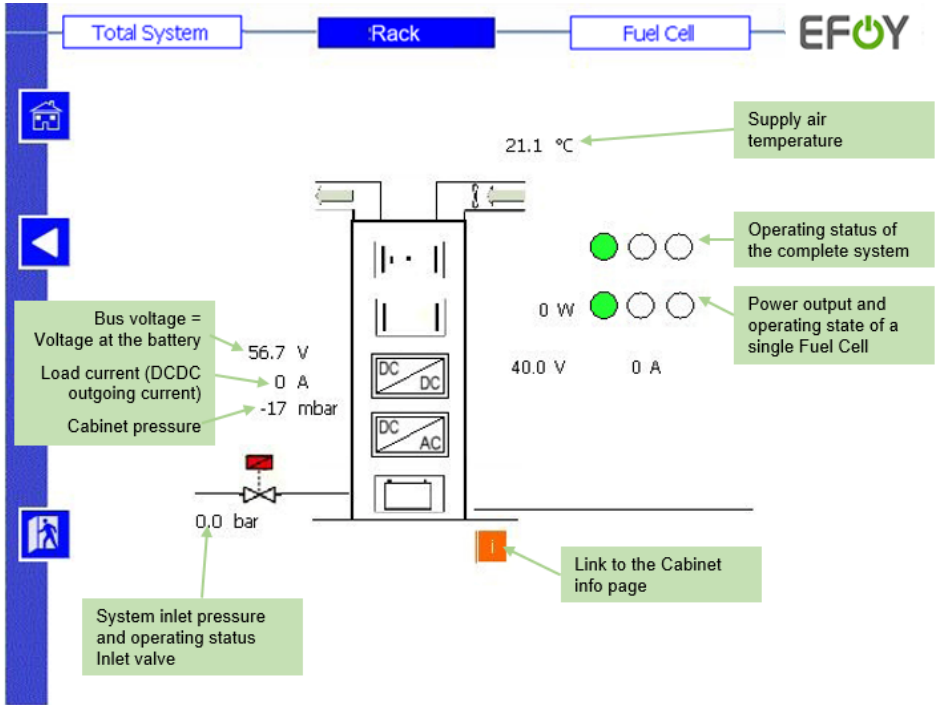
## EFOY Hydrogen Webtool overview page

Texts with a green background and the green arrows are shown in the user manual for explanation and do not appear in the Webtool.

### Meanings of icons used

Icon	Component
	EFOY Hydrogen Controller: Referred to as Controller in the Webtool
	EFOY Hydrogen Fuel Cell: Referred to as FC-Module in the Webtool
	Optional: Energy storage device (battery)
	Optional: DC/DC converter for converting the internal 48 V Fuel Cell voltage to the required output voltage
	Optional: Inverter for AC output

Clicking on the cabinet leads to the cabinet view, in which further details are shown






Cabinet view

Texts with a green background and the green arrows are shown in the user manual for explanation and do not appear in the Webtool.

The operating status display for the Controller and the Fuel Cells is shown next to the component in small circles using the three colors green, yellow and red. The meaning is similar to that of the LEDs on the front of the Controller (see Section 4) and is shown in the following table for both display options.

Symbols are also displayed above the green, yellow and red LEDs on the front of the Controller:

- Green: 
- Yellow: 
- Red: 

Operating status	Display		Meaning
	Front of Controller: LEDs	Webtool: Color	
<b>Operation</b>	Green: constant	Green	The entire system or the component is in normal mode
<b>Initialization</b>	Green: flashing quickly	Not available	The entire system is currently performing initialization
<b>Standby</b>	Green: flashing slowly	Not available	The entire system is in standby
<b>Warning</b>	Yellow: constant	Yellow	<p>A malfunction in the Fuel Cell or another component has been diagnosed. However, the component is still active. An error code is indicated on the alarm page in the Webtool. The warning disappears automatically as soon as the malfunction no longer exists.</p> <p>The yellow display appears in the Webtool in the case of an Fuel Cell that has been configured in the Webtool but is not (yet) installed</p>
<b>High H<sub>2</sub> concentration</b> <b>Stop signal</b>	Red LED of push button: constant	Not available	<p>If the red LED at the push button of the Controller lights up, this may have two causes:</p> <ol style="list-style-type: none"> <li>1. The hydrogen concentration measured by a sensor is too high (&gt; 0,08 Vol.% H<sub>2</sub> in the air), and the system is stopped. When the concentration drops again, this LED goes off, and the system can be restarted if necessary</li> <li>2. The system was stopped by an stop signal</li> </ol>



Operating status	Display		Meaning
	Front of Controller: LEDs	Webtool: Color	
<b>Alarm</b>	Red (status LED): constant	Red	A major malfunction has been diagnosed. The system is switched off and is in a safe condition. An error code and text are given on the alarm page in the Webtool. Malfunctions that the user can rectify can be reset using the reset function in the alarm list or by restarting the Controller (depending on the error).
<b>Service mode</b>	Green/yellow/red: flashing quickly	Separate pages in the tool	The system is in service mode, see Section 4.4

### 4.3.2 Cabinet info view

After pressing the small, orange "Info" button in the Webtool, information about the Controller and the installed Fuel Cell modules is displayed.

Total System
Rack
Fuel Cell

**Rack0**

S/N: 380 EA-Application-SW: EA\_Appl\_ 1 . 22 . 0\_ 500  
 EA-Booter-SW: EA\_Boot\_ 0 . 15 . 0\_ 0  
 EA-Parameter-RAM: EA\_Para\_RAM\_ 0 . 0 . 0\_ 0\_ 28  
 EA-Parameter-Flash: EA\_Para\_Flash\_255 .255 .255\_ 65535\_ 255

S/N: 51 EA-Application-SW: EA\_Appl\_ 1 . 22 . 0\_ 500  
 EA-Booter-SW: EA\_Boot\_ 0 . 15 . 0\_ 0  
 EA-Parameter-RAM: EA\_Para\_RAM\_ 0 . 0 . 0\_ 0\_ 28  
 EA-Parameter-Flash: EA\_Para\_Flash\_255 .255 .255\_ 65535\_ 255

TXT\_Rackinfo\_SC-App SC\_Appl\_ 20 . 3 . 0 . 0\_ 963

Info	Meaning
<b>SC application SW</b>	Version number of the installed application software on the Controller
<b>S/N</b>	Serial number of FC module: In this example: 51. In the Webtool, five digits are used for the serial number, whereby a "0" at the beginning of the number is omitted (SN 00051 => 51)
<b>EA application SW</b>	Version number of the installed application software on the FC module
<b>EA booter SW</b>	Version number of the installed booter software
<b>EA parameter RAM</b>	Version of parameter set in RAM
<b>EA parameter flash</b>	Version of parameter set in flash memory

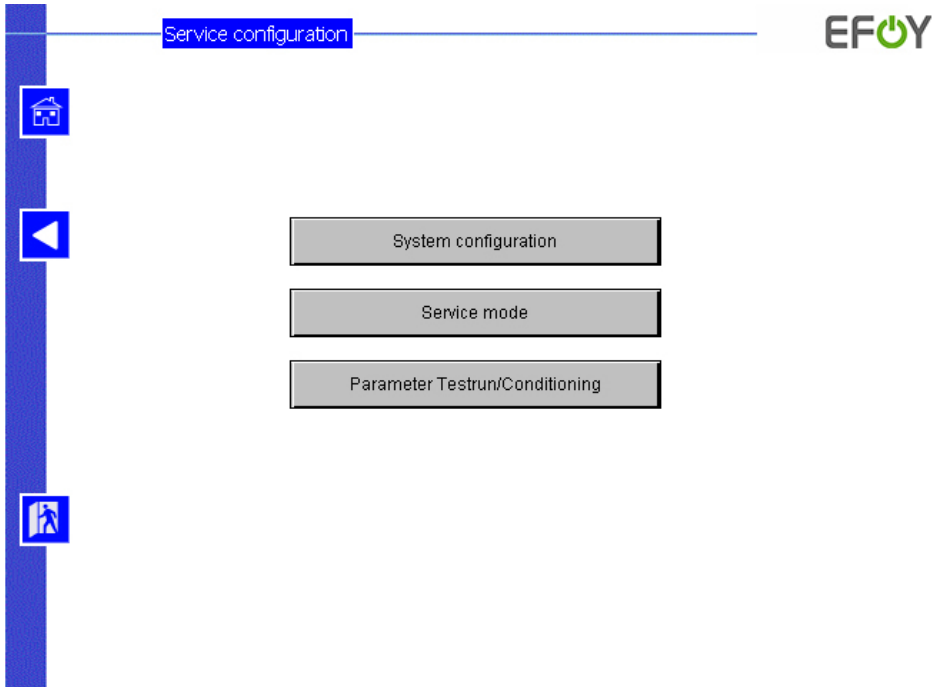
## 4.4 Service level



A click on the wrench button leads to the service level

Actions should only be performed on the service level after appropriate training or after consulting the EFOY hotline.

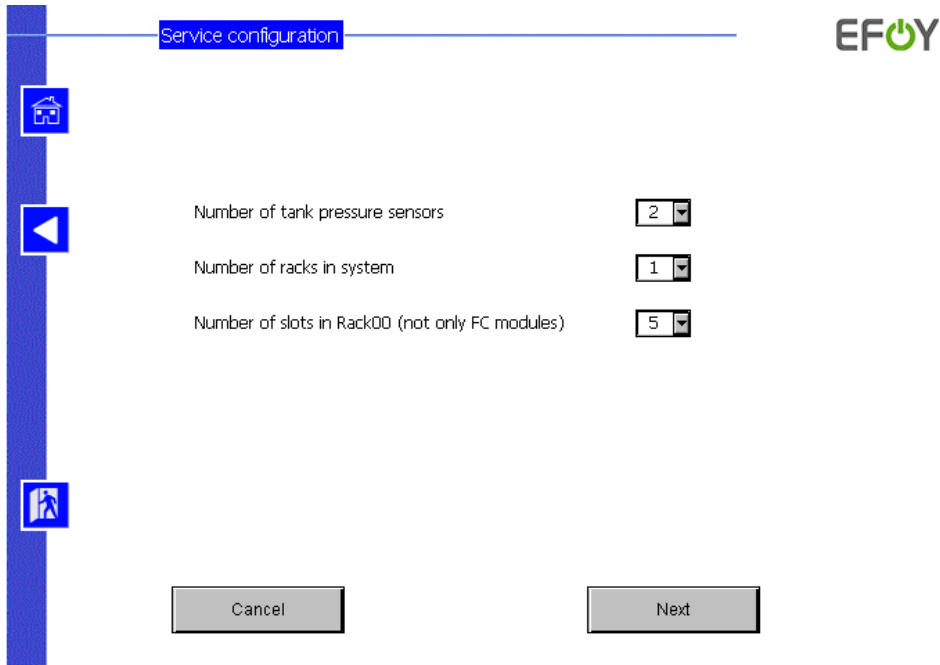
### 4.4.1 System settings



The following buttons can be clicked in the service level main menu:

- **System configuration:** Cabinet configuration
- **Service mode:** Open the service mode to switch valves or relays manually
- **Parameter Testrun/Conditioning:** Parameter settings for Testrun/Conditioning

## 4.4.2 System configuration



The screenshot shows the 'Service configuration' page of the EFOY webtool. The page has a blue sidebar on the left with three icons: a house, a left-pointing triangle, and a person. The main content area is white and contains three configuration items, each with a label and a dropdown menu:

- Number of tank pressure sensors: 2
- Number of racks in system: 1
- Number of slots in Rack00 (not only FC modules): 5


At the bottom of the page, there are two buttons: 'Cancel' on the left and 'Next' on the right. The EFOY logo is in the top right corner.

The number of tank pressure sensors installed in the system can be defined on the first page of the system configuration: The following values may be entered: 0, 1 or 2.

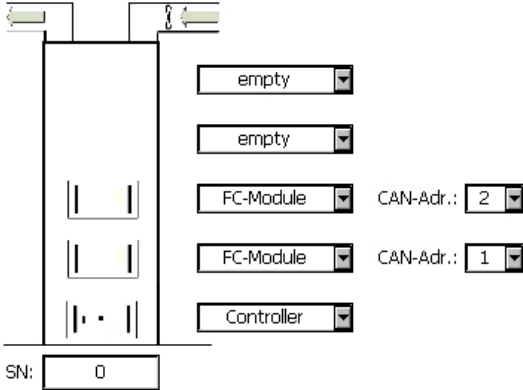
Additionally, the number of cabinets in the system and the number of slots in each cabinet can be defined. All slots count for the Fuel Cell, Controller and other modules. They are then configured further on the following page.

A click on **Next** leads to the next page

Service configuration



**Rack0**



The diagram shows a rack labeled 'Rack0' with five slots. To the right of the rack are configuration options for each slot: Slot 1: 'empty' dropdown; Slot 2: 'empty' dropdown; Slot 3: 'FC-Module' dropdown with 'CAN-Adr.: 2' dropdown; Slot 4: 'FC-Module' dropdown with 'CAN-Adr.: 1' dropdown; Slot 5: 'Controller' dropdown. Below the rack is an 'SN:' field with the value '0'. At the bottom are three buttons: 'Cancel', 'Back', and 'Next'.

On the second page of the system configuration, dropdown menus can be used to define which components are located where in the cabinet. In the case of slots with FC modules (Fuel Cells), another drop-down menu for specifying the CAN address appears on the right. Each Fuel Cell has its own CAN address. The Controller and the Fuel Cell communicate via this CAN address.


If a CAN address is allocated twice, the corresponding incorrect entry is marked in red and the **Next** button is hidden.


If more fuel cells are configured in the web tool than are actually installed, the system is in error and the yellow LED lights up. Since this is not a safety-relevant error, the system still works.


A click on **Next** leads to the next page

EFOY

Service configuration







Upper system on threshold	<input style="width: 90%;" type="text" value="52.000 V"/>
Delay upper system on threshold	<input style="width: 90%;" type="text" value="600 s"/>
Lower system on threshold	<input style="width: 90%;" type="text" value="49.500 V"/>
System off threshold	<input style="width: 90%;" type="text" value="55.500 V"/>
Correction factor busbar voltage measurement	
Single cable length load output to battery	<input style="width: 90%;" type="text" value="2 m"/>
Cable cross-section load output to battery	<input style="width: 90%;" type="text" value="75 mm&lt;sup&gt;2&lt;/sup&gt;"/>
Cable material load output to battery	<input style="width: 90%;" type="text" value="Copper"/>

Cancel

Back

Next

On the 3rd page of the system configuration, you can set the system on/off thresholds in the upper part.

There are two system switch-on thresholds. The voltage is measured at the bus voltage (voltage at the battery).

The **Upper system on threshold** is combined with a time delay. The fuel cell(s) is/are only started if the entered voltage is permanently below the set time **Delay upper system on threshold**. This means that short-term voltage fluctuations in the battery do not immediately cause the fuel cell(s) to start.

If the voltage falls below the **lower system on threshold**, the fuel cell(s) are started immediately.

When the **system off threshold** is exceeded, the fuel cell(s) are switched off again and go into standby mode.

The following table shows the default values (factory settings) and the respective minimum and maximum values.

	Default	Min.	Max.
Upper system on threshold (USOT)	50 V	> LSOT (41 V)	< SOT (57 V)
Delay upper system on threshold	300 sec.	0 sec.	10.000 sec.
Lower system on threshold (LSOT)	48 V	41 V	< USOT (57 V)
System off threshold (SOT)	55 V	> LSOT (41 V)	< SOT (57 V)

#### Important information:

- After switching on, an EFOY Hydrogen Fuel Cell 2.5 48V should run for at least 30 minutes. Short running times of the fuel cell should be avoided. This means that the intervals between the individual thresholds (see below) must be selected accordingly.
- The **Upper system on threshold** must be higher than the **Lower system on threshold**
- The **Upper system on threshold** must be lower than the **System off threshold**
- Changes should only be made after consultation with a service specialist

When using several fuel cells, a different switch-on threshold can be set for each fuel cell. This can be helpful depending on how quickly the voltage at the battery drops.

In the lower section of the page, you can enter the parameters for the compensation of long lines between the load output and the energy storage device. Compensation is achieved by reducing the measured bus voltage by the voltage drop in the line. If there is no intention to utilize the compensation, the line length must be defined as 0 m.

A click on **Next** leads to a page the individual components can be tested on.

Service configuration

Service mode activ

External stop activ

Service mode	Activ	<input type="button" value="switch off"/>
Tank valve	Closed	<input type="button" value="open"/>
Rack valve Rack00	Closed	<input type="button" value="open"/>
Rack heating	Off	<input type="button" value="switch on"/>
Rack ventilation	Off	<input type="button" value="switch on"/>
Alarmrelay "EPO"	Not activ	<input type="button" value="switch on"/>
Alarmrelay "Warning"	Not activ	<input type="button" value="switch on"/>
Statusrelay "System running"	Not activ	<input type="button" value="switch on"/>
Alarmrelay "Fuel_low"	Not activ	<input type="button" value="switch on"/>

At the very top of this page, you can first switch the Controller service mode on. Only after the service mode is switched on, additional buttons for manually switching valves and relays appear.

The Fuel Cells cannot be started when the service mode is active!

A red box with the info **Service mode activ** appears on the top right of all pages of the Webtool to signal that the service mode is active. In addition, the green, yellow and red LEDs on the front of the Controller flash quickly (0.5 sec. on; 0.5 sec off).

The operating status of each component (On, Off, Not active) is displayed to the left of each button for switching the components.

The following components can be switched manually when in service mode (not all of the components listed below must be connected to the Controller). Here, the functioning of the individual components can be examined.

- Tank valve in the system's hydrogen supply line
- Cabinet valve at cabinet inlet
- Cabinet heating



- Cabinet ventilation
- Alarm relay (potential-free contact) for EFOY Hydrogen EPO
- Alarm relay (potential-free contact) for EFOY Hydrogen warning
- Relay for operating display **Statusrelay “System running”** (potential-free contact)
- Alarm relay (potential-free contact) for **Alarmrelay “Fuel\_Low”**

On the **Service Settings** page you can click the **Parameter Testrun/conditioning** box to go to the following page:

The screenshot shows the 'Configuration' page of the EFOY webtool. The page has a blue sidebar on the left with icons for Home, Back, Settings, Network, and Help. The main content area is titled 'Configuration' and features the EFOY logo in the top right. The settings are as follows:

Parameter	Current Value	Target Value
Language	actual:  	
Conditioning time per module	300 s	<input type="text" value="300 s"/>
Conditioning	State: <span style="background-color: red; color: white; padding: 2px;">Off</span>	
H2 cylinder pressure, lower limit	20 bar	<input type="text" value="20 bar"/>

At the bottom of the configuration area, there are two buttons: 'Set Default' and 'Send'.


This page serves to define system settings. The following setting options are available:




- The Webtool language can be set to German or English by clicking the country symbol
- Setting the Conditioning time per module (from 1 sec. to 1,800 sec., default value: 900 sec)

- Starting the "**Conditioning**" and monitoring the current conditioning status. If conditioning mode is not possible in the system configuration, this setting is deactivated.
- Setting the H<sub>2</sub> cylinder pressure limit value: Up to two hydrogen supply strings can be monitored. The lower limit value initiates a notification for the provision of a new hydrogen storage device as soon as a hydrogen supply string falls below the defined limit value. If no tank pressure sensor is installed in the system, this alarm is deactivated.

A click on the **Send** button leads to the next page: "Service configuration".

Service configuration



Numbers of FuelCell-Modules for autom. Cond	2	<input style="width: 80px;" type="text" value="2"/>
Standbytime until conditioning request	30 d	<input style="width: 80px;" type="text" value="30 d"/>
Conditioning time per module	300 s	<input style="width: 80px;" type="text" value="300 s"/>

Set Parameter Testrun/Conditioning

Here, the following parameters can be defined:

- Number of Fuel Cell modules that must request "testrun/conditioning" to allow "testrun/conditioning" to start. The valid input range is between one module and the total number of modules in the system.

- **Standby time** of an FC module (Fuel Cell) after it requests "testrun/conditioning". The valid input range is between 30 and 90 days. This can be altered, for example if, depending on the application, it is guaranteed that the Fuel Cells are operated every 30 days, even without a testrun. However, this alteration should only be carried out in collaboration with the service technician, because it can negatively impact on the lifetime of the components.
- Duration of "testrun/conditioning" per Fuel Cell module (Fuel Cell). A module must run for at least this time continuously to allow it to reset its request for "testrun/conditioning". The valid input range is between 1 s and 1,800 s. Here, too, a change from the preset value of "900 s" should only be made after consultation with the service technician, as this can damage components.

The current settings can be seen to the left of the input boxes.

The new settings are adopted by clicking the

**Set Paramter Testrun/Conditioning** button. If a parameter lies outside of the allowable value range, the setting is not accepted, and the input box is reset to the current value.



Click this button to return to the system overview



Click this button to move from the system overview to the alarm/fault list

## Alarm/fault list

The screenshot shows the 'Alarmer' interface with a table of alarm history. The table has the following data:

TID	AlarmText	Time On	Time Off	ACK
201	EC_9901.EA_01 Kom. Störung	04.05.2021 11:15:25	--	NAK
161	EC_9901.EA_00 Kom. Störung	04.05.2021 11:15:25	--	NAK
22	EC_1112 BZ-Sys. nicht verfügt	04.05.2021 11:08:32	--	NAK
21	EC_1111 BZ-E Redundanz	04.05.2021 11:08:32	--	NAK
201	EC_9901.EA_01 Kom. Störung	04.05.2021 11:08:32	04.05.2021 11:15:24	NAK
161	EC_9901.EA_00 Kom. Störung	04.05.2021 11:08:32	04.05.2021 11:15:24	NAK

Below the table, the interface shows a 'Loaded / Total Entries' indicator with the value '40 / 40'. There are buttons for 'Load Alarms List', 'Save To File', and 'Reset'.

The controller's alarm list can be updated using the **Load Alarms List** button. Wait until the number of existing alarms is displayed in the **Loaded/Total Entries** box before pressing the **Load Alarms List** button for the first time. The alarm list does not update automatically. Press the **Load Alarms List** button again to display new alarms.

The alarm list contains the following information:

- **Alarm Text:** Error code plus short text allocated to the diagnosed malfunction. Also see Section 7 Troubleshooting.
- **Time On:** Time at which the warning/alarm occurred.
- **Time Off:** Time at which the warning/alarm was reset.
- **ACK:** Was the error confirmed.
  - AK: The error was confirmed
  - NAK: The error was not confirmed

Currently active warnings/alarms are marked in red in the list. Past warnings/alarms, which are no longer active, are marked in blue.

The last 250 warnings/alarms are stored in the alarm list.

The alarm list can be saved in a text file using the **Save To File** button if the Webtool is connected to a PC.

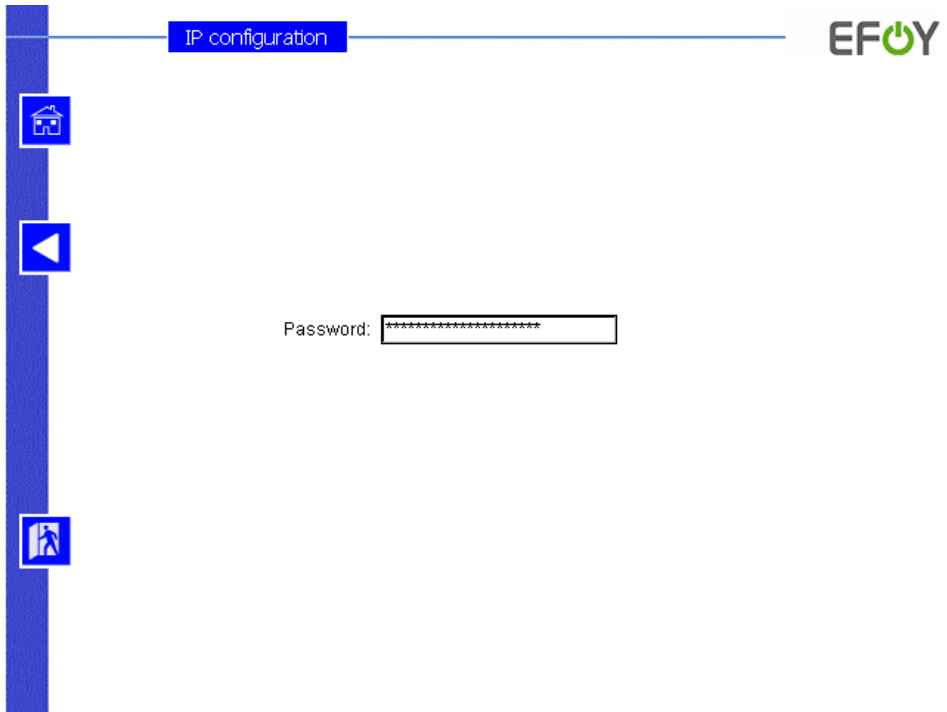
## 4.5 Network settings



The distributor button leads to the network settings

Changes to the network settings can only be made by the service personnel. Access to the network settings is therefore password protected.

## 4.5.1 Password page



You arrive at the following page after entering the password

## 4.5.2 Network settings

IP configuration

EFOY

IP-Adress  .  .  .

Subnet-Mask  .  .  .

Gateway  .  .  .

S-Bus Station Number

Set IP-Konfig

In **IP address**, **Subnet-Mask** and **Gateway**, new network settings can be defined. Only values between 0 and 255 may be entered. If a value lies outside of this range, a message appears in the line that the entry is invalid, and the settings cannot be adopted.




The controller address for the RS485 interface can be defined in the **S-Bus Station Number** box. Only values between 0 and 253 may be entered. If the value lies outside this range, a message appears in the line that the entry is invalid, and the settings cannot be adopted.


Clicking on the **Set IP-Konfig** button will open a dialog window in which you will be asked to examine your settings.

**CAUTION**

- ▶ The data given in **IP Address, Subnet-Mask, Gateway** and **S-Bus Station Number** do not show the current settings stored in the Controller. These are merely input boxes that are accepted by pressing the **Set IP Konfig** button.

### 4.5.3 New network settings confirmation page





**IP-Konfiguration**

Achtung: Das Ändern der IP-Konfiguration kann dazu führen, dass der Controller nicht mehr erreichbar ist!!!

Vor dem Schreiben der neuen Konfiguration bitte Eingaben prüfen und bestätigen.

<b>Aktuelle IP-Konfiguration:</b>	
IP-Adresse	192.168.10.162
Subnet-Mask	255.255.255.0
Gateway	192.168.10.1
S-Bus Station Number	162

<b>Neue IP-Konfiguration:</b>	
IP-Adresse	192 . 168 . 10 . 175
Subnet-Mask	255 . 255 . 255 . 0
Gateway	192 . 168 . 10 . 1
S-Bus Station Number	175

Abbrechen

IP-Konfiguration bestätigen

Use the information displayed to check your configuration and then confirm by pressing **Confirm IP Configuration**. By pressing **Cancel** you return to the configuration page.



The current IP address for opening the web interface is displayed on the subsequent page. Enter this address into your browser's address line to open the web interface.

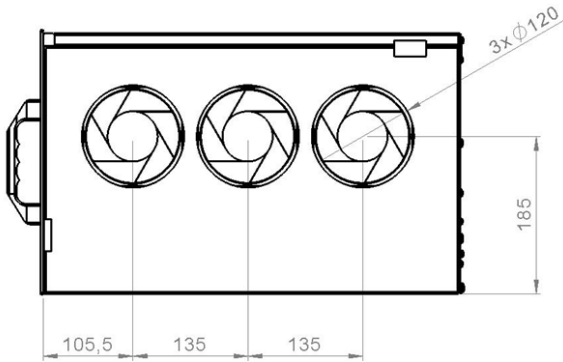
## 5 EFOY Hydrogen Fuel Cell

The Fuel Cell generates an unregulated DC voltage in the range from 41 V to 57 V DC by the chemical reaction of hydrogen with oxygen. The Fuel Cell is controlled via the Controller and can therefore only be operated together with a Controller. Up to four Fuel Cells can be operated for each Controller. The Controller is described in more detail in the following Section 6.

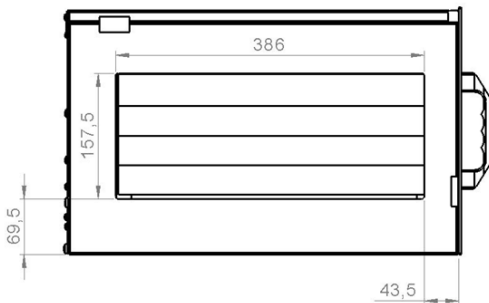
The Fuel Cell is air cooled and takes in the required cooling and reaction air via the integrated fan and discharges it again via the opposite outlet.

In order to ensure adherence to the Fuel Cell temperature limits, the interior of the system housing must be heated as required or cooled by an external fresh air supply.

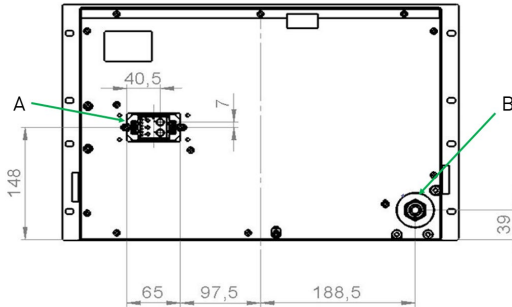
EFOY Hydrogen Fuel Cell 2.5 48 V



Right side elevation with the three fans: Air intake side



Left side elevation with the air outlet side



Rear elevation showing the PowerCom socket (power) and the hydrogen (H<sub>2</sub>) coupling for the hydrogen piping.

Designation	Description
A	PowerCom socket: power and communications connection
B	Hydrogen quick coupling socket

## 5.1 Function within the overall system

The Fuel Cells generate the electricity. The Controller switches the Fuel Cells on and off as a function of the voltage in the energy storage device (battery). The Fuel Cell is switched on when the voltage falls below predefined thresholds. Once the energy storage device has been charged and a predefined voltage value is exceeded, the Controller switches the Fuel Cell off again and puts it into standby mode.

## 5.2 Installing the Fuel Cell in a complete system (cabinet)

Installation and removal are simple but should nevertheless only be carried out by trained personnel. The Fuel Cell can be pulled out from the front and then pushed back in again, similar to a drawer, using a pre-installed slot system. Both the power and the hydrogen supply connections can be done without tools when fully inserted.

The PowerCom socket (see view above: A) provides the power and communications connection to the system cabinet. The Fuel Cell is supplied with hydrogen via the hydrogen quick coupling socket (see view above: B). The leakage rate at the hydrogen quick coupling socket is very low at approx. 0.0006 Nl / min

There can be one or two hydrogen supply strings within an Energy Solution (see EFOY Hydrogen Energy Solution user manual).

Both the PowerCom socket and the Hydrogen quick coupling socket carry out the complete, loss-free connection automatically. This allows fast Fuel Cell installation and removal.



## WARNING

The Fuel Cell may only be installed or removed when the entire system is switched off and the hydrogen supply is interrupted by closing the valve.

- ▶ When installing or removing the Fuel Cells, close the hydrogen valves and switch off the system.
- ▶ When installing a Fuel Cell, purging must be carried out by manually activating the quick coupling. This purging should be carried out by a specialist or after consulting the EFOY hotline.

## 5.3 Hydrogen and air supply

To facilitate fault-free Fuel Cell operation, it is necessary to provide a constant operating pressure of 0.5 bar at the Hydrogen quick coupling during operation. This is guaranteed by the Fuel Cell Hydrogen supply string (hereinafter referred to as the **H<sub>2</sub> string**).

### 5.3.1 H<sub>2</sub> string

The H<sub>2</sub> string components consist of a suitable pressure regulator, a shut-off valve and operating pressure monitoring sensors. The H<sub>2</sub> string is only available through SFC Energy AG.

The H<sub>2</sub> string is controlled and monitored by the Controller. It can supply up to four Fuel Cells with hydrogen.

### 5.3.2 Supply air

Each individual Fuel Cell includes an integral fan, which delivers the cooling and reaction air as a function of the current operating conditions.

Always observe the hazard warnings at the beginning of the user manual on page 2.

**INFO****Damage from soiled air**

The incoming air must have fresh air quality; in particular, it must be free of vapor and gaseous impurities and not be excessively soiled by dust.

- ▶ Use an F6 filter class inlet filter
- ▶ Replace the filter every six months

If several Fuel Cells are installed in an Energy Solution, it is possible for all devices to draw in fresh air from a common supply duct.

### 5.3.3 Outgoing air

The exhaust air from several Fuel Cells can be amalgamated into a joint outgoing air duct.

**DANGER****Risk of fire from escaping hydrogen!**

In a malfunction, the outgoing Fuel Cell air may contain small quantities of hydrogen. Escaping hydrogen may ignite.

- ▶ The outgoing Fuel Cell air may not escape into an enclosed room but must instead be led directly to the atmosphere.
- ▶ Ensure that the exhaust duct connection to the Fuel Cell's air outlet window is properly sealed

**INFO****Malfunction due to incorrectly designed air flow!**

The fans installed in the Fuel Cell must convey sufficient air for operation. Excessively small flow cross-sections or excessive pressure loss due to flow obstacles can impair operation

- ▶ The entire path, from the system housing air inlet to the system housing air outlet, must be designed in such a way that a pressure loss of 200 Pa is not exceeded for a maximum air flow of 700 m<sup>3</sup>/h per Fuel Cell.

### 5.3.4 Operating temperature

The Fuel Cell stack inside a Fuel Cell can be operated in a temperature range of +3 °C to +50 °C. The Fuel Cell is located in a system cabinet. At outside temperatures of -33 °C to 3 °C, a heater in the cabinet can heat the inside temperature to the minimum temperature required for the Fuel Cell to operate. If the temperature in the Fuel Cell becomes too high compared to the allowable outside temperature, fresh air for cooling can be supplied from the outside.

## 5.4 Removing the EFOY Hydrogen Fuel Cell 2.5 48 V



### WARNING

#### Malfunction or instable operation!

The Controller must be switched off to remove the Fuel Cell. Removing a Fuel Cell from an operating EFOY Hydrogen Energy Solution can lead to an inadequate power supply and instable operation.

- ▶ Switch off the Controller before removing the Fuel Cell.

To remove the Fuel Cell, undo the screws with the plastic washers at the front edge of the front panel and carefully remove the module from the system housing.

Thanks to the screwless connections on the rear of the Fuel Cell, it is not necessary to remove the gas supply and the electrical cables.



### WARNING

#### Electric shock and burns!

The Fuel Cell heats up during operation. It can remain warm even when switched off. Inside the equipment, the Fuel Cell may also be under voltage.

- ▶ Check that the Fuel Cell has cooled down prior to removal
- ▶ Do not open the Fuel Cell

**INFO****Damage to the Fuel Cell by frost or excessively high temperatures!**

The reaction between hydrogen and oxygen produces water which is located in the Fuel Cell and can cause damage in the event of frost. Excessively high temperatures can also damage the Fuel Cell.

- ▶ Ensure that the Fuel Cell's ambient temperature is between +3 °C and +50 °C. If necessary, the entire system must be provided with heating or additional fans.

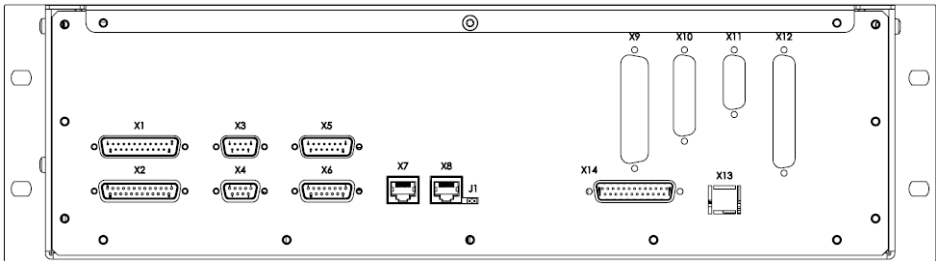
## 6 EFOY Hydrogen Controller

The EFOY Hydrogen Controller is the control and monitoring device for the EFOY Hydrogen Energy Solution. The Controller starts and stops the EFOY Hydrogen Fuel Cells as a function of the bus voltage (battery voltage) and controls the hydrogen supply. The Controller itself is not connected to either the hydrogen supply or to the electrical loads. As described in Section 4, the Controller represents the interface to a computer with an installed Webtool.

If required, an additional hydrogen monitoring board can be integrated into the controller. If the hydrogen concentration in the room is too high ( $> 0.08$  Volume%  $H_2$  in the air), an alarm is activated.

The red LED on the push button lights up, the controller sends a stop signal to all Fuel Cell(s) and all the magnetic valves close. The error "External stop active" appears in the alarm/fault list (Section 4.4) on the web tool. The Fuel Cell(s) and the Controller remain in standby mode. The alarm is active until the hydrogen concentration falls below the permissible value again and is switched off manually via the push button.

The Controller must be installed and removed by trained personnel, because correct wiring must be ensured. The connectors on the back of the controller are described in section 7.



Controller rear elevation



## 7 Troubleshooting

This section describes possible faults and warnings that can generally be rectified quickly and easily with the help of the instructions in the table below and using the separate list.

If the Controller displays a warning or a malfunction on the LEDs, the fault number is displayed on the Webtool's **Alarms** page.

**A detailed description and the fault rectification are given in the attached malfunctions list.**

Some malfunctions cannot be easily rectified. The system can no longer be started. In this case, please contact the EFOY hotline. This precautionary measure is only taken in the event of malfunctions that may pose a safety hazard to the customer, for example a hydrogen leak is detected or for a short circuit.

Description of malfunction	Possible cause	Rectification
The system does not start	Energy storage device drained	Check the energy storage device voltage, and recharge or replace batteries
	Battery not connected	Check battery connections and connect correctly
	Battery system fuse defective (short circuit)	Contact EFOY hotline
	Hydrogen tank empty, system inlet pressure <7 bar	Replace hydrogen tank or cylinders
LED yellow	Warning	Read the fault number in the Webtool (see Section 4.4.1) and consult the malfunction list
LED red (status display)	Fault alarm	Read the fault number in the Webtool (see Section 4.4.1) and consult the malfunction list for rectification

Description of malfunction	Possible cause	Rectification
Red LED on the button lights up	H <sub>2</sub> concentration in the room too high. For this, the optional H <sub>2</sub> monitoring board must be integrated in the Controller.	Find and eliminate the cause of the high hydrogen concentration. Then switch off the alarm using the button with the red LED.

## 8 Functions of the connectors of the Controller on the rear side

Plug connector	Version	Description
X1	SUB-D 25 pin Male connector	Power supply, H <sub>2</sub> string cabinet, heating/cooling
X2	SUB-D 25 pin Female connector	Solenoids, pressure sensors, H <sub>2</sub> sensors
X3	SUB-D 9 pin Male connector	Temperature sensors
X4	SUB-D 9 pin Female connector	ModBus interface
X5	SUB-D 15 pin Male connector	Alarm and warning contacts (potential-free)
X6	SUB-D 15 pin Female connector	External stop signal, H <sub>2</sub> sensors
X7/X8	RJ45	CAN connection: communications between Controller and Fuel Cell
JP1	Jumper RM 2.54	Jumper for terminating resistor CAN (120 Ω)
X9-X13		NC (not connected)
X14	SUB-D 25 pin Female connector	Hydrogen surveillance

Detailed PIN assignment of all connectors in the rear side of the Controller:

X1 (25-pin connector)	Description / Function
X1-1	PE
X1-2	NC (not connected)
X1-3	+UB
X1-4	+UB
X1-5	-UB
X1-6	-UB

X1-7	C_U_E_HV (Battery Voltage - Signal)
X1-8	VAR-OK
X1-9	Ventilation_Cooling_R0 (Signal for Ventilation)
X1-10	Heater_R0 (Signal for Heater)
X1-11	GR-SP-ABS-C0 (Test run +24 V) / Test run Start (24 V)
X1-12	C_I_L_+5V (Current sensor +5 V)
X1-13	C_I_L_REF (Current sensor Ref)
X1-14	PE
X1-15	NC (not connected)
X1-16	+UB
X1-17	+UB
X1-18	-UB
X1-19	-UB
X1-20	VAR-Return
X1-21	Ventilation_Cooling_R0_GND
X1-22	Heater_R0_GND
X1-23	Test run GND
X1-24	C_I_L_GND (Current sensor GND)
X1-25	C_I_L_SIG (Current sensor Signal)

<b>X2 (25-pin connector)</b>	<b>Description / Function</b>
X2-1	C_SV_H_R0_GND (Magnetic valve "-")
X2-2	C_SV_H_R0_FUSED (Magnetic valve "+")
X2-3	C_SV_H_T_GND (Tank valve GND)
X2-4	C_SV_H_T_SIG (Tank valve SIG +24V)
X2-5	C_P_H_RI_GND (Pressure sensor 1, GND)
X2-6	C_P_H_RI_+5V (Pressure sensor 1, +5 V)

X2-7	C_P_H_RI (Pressure sensor 1, Signal)
X2-8	C_P_H_R00_GND (Pressure sensor 2, GND)
X2-9	C_P_H_R00_+5V (Pressure sensor 2, +5 V)
X2-10	C_P_H_R00 (Pressure sensor 2, Signal)
X2-11	C_P_H_T_00_SIG (Tank pressure k Tank 0 SIG)
X2-12	C_P_H_T_00_+24 V_Fused (Tank pressure Tank 0 +24 V)
X2-13	C_P_H_T_01_SIG (Tank pressure Tank 1 SIG)
X2-14	C_P_H_T_01_+24 V_Fused (Tank pressure Tank 1 +24 V)
X2-15	LED_Fuel_Low_GND (LED Hydrogen empty GND)
X2-16	LED_Fuel_Low_Sig (LED Hydrogen empty Sig)
X2-17	Dig_IN_Test_GND
X2-18	Dig_IN_Test_SIG
X2-19	H <sub>2</sub> _Sensor_1_GND (H <sub>2</sub> Sensor 1)
X2-20	H <sub>2</sub> _Sensor_1_+24 V (H <sub>2</sub> Sensor 1)
X2-21	H <sub>2</sub> _Sensor_1_Signal (H <sub>2</sub> Sensor 1)
X2-22	H <sub>2</sub> _Sensor_2_GND (H <sub>2</sub> Sensor 2)
X2-23	H <sub>2</sub> _Sensor_2_+24V (H <sub>2</sub> Sensor 2)
X2-24	H <sub>2</sub> _Sensor_2_Signal (H <sub>2</sub> Sensor 2)
X2-25	Only for SFC test run

<b>X3 (9-pin connector)</b>	<b>Description / Function</b>
X3-1	C_T_A_R_GND (Supply air temperature GND)
X3-2	C_T_A_R_SIG (Supply air temperature SIG)
X3-3	C_T_RA_00_GND (Cabinet temperature GND)
X3-4	C_T_RA_00_SIG (Cabinet temperature SIG)

X3-5	C_T_P_00_GND (Pressure reducer temperature GND)
X3-6	C_T_P_00_SIG (Pressure reducer temperature SIG)
X3-7	C_T_E_GND (Temperature Battery GND)
X3-8	C_T_E_SIG (Temperature Battery SIG)
X3-9	NC (not connected)

<b>X4 (9-pin connector) Mod-Bus</b>	<b>Description / Function</b>
X4-1	RS485_SGND (Mod-Bus)
X4-2	NC (not connected)
X4-3	RS485_/D (Mod-Bus)
X4-4	NC (not connected)
X4-5	NC (not connected)
X4-6	NC (not connected)
X4-7	NC (not connected)
X4-8	RS485_D (Mod-Bus)
X4-9	NC (not connected)

<b>X5 (15-pin connector)</b>	<b>Description / Function</b>
X5-1	ALARM_CO (Potential-free contact - Alarm Common)
X5-2	ALARM_NC (Potential-free contact - Alarm Normally Open)
X5-3	ALARM_NO (Potential-free contact - Alarm Normally Closed)

X5-4	WARNING_NC (Potential-free contact - Warning Common)
X5-5	WARNING_NO (Potential-free contact - Warning Normally Open)
X5-6	WARNING_CO (Potential-free contact - Warning Normally Closed)
X5-7	FC_ON_CO (Potential-free contact – Fuel Cell in use Common)
X5-8	FC_ON_NO (Potential-free contact - Fuel Cell in use Normally Open)
X5-9	FC_ON_NC (Potential-free contact - Fuel Cell in use Normally Closed)
X5-10	FUEL_LOW_NC (Potential-free contact – Hydrogen empty Common)
X5-11	FUEL_LOW_NO (Potential-free contact - Hydrogen empty Normally Open)
X5-12	FUEL_LOW_CO (Potential-free contact - Hydrogen empty Normally Closed)
X5-13	NC (not connected)
X5-14	NC (not connected)
X5-15	NC (not connected)

<b>X5 (15-pin connector)</b>	<b>Description / Function</b>
X6-1	Stop_System_+24 V (External Stop signal +24 V) (NOT TEST RUN)
X6-2	Stop_System_Sig (External Stop signal Sig) (NOT TEST RUN)
X6-3	H <sub>2</sub> _Sensor_3_GND (H <sub>2</sub> Sensor 3)
X6-4	H <sub>2</sub> _Sensor_3_+24V (H <sub>2</sub> Sensor 3)
X6-5	H <sub>2</sub> _Sensor_3_Signal (H <sub>2</sub> Sensor 3)

X6-6	H <sub>2</sub> _Sensor_4_GND (H <sub>2</sub> Sensor 4)
X6-7	H <sub>2</sub> _Sensor_4_+24V (H <sub>2</sub> Sensor 4)
X6-8	H <sub>2</sub> _Sensor_4_Signal (H <sub>2</sub> Sensor 4)
X6-9	GND (at your free disposal)
X6-10	+24 V Fused (1 A) at your free disposal
X6-11	Reserved for sensor board 1
X6-12	Reserved for sensor board 2
X6-13	Reserved for sensor board 3
X6-14	Reserved for sensor board 4
X6-15	Reserved for sensor board 5

<b>X7 (RJ45)</b>	<b>Description / Function</b>
X7-1	CAN_GND
X7-2	NC (not connected)
X7-3	CAN_H
X7-4	CAN_GND
X7-5	CAN_+5V
X7-6	CAN_L
X7-7	NC (not connected)
X7-8	CAN_+5V
Schirm	PE

<b>X8 (RJ45)</b>	<b>Description / Function</b>
X8-1	CAN_GND
X8-2	NC (not connected)
X8-3	CAN_H
X8-4	CAN_GND



X8-5	CAN_+5 V
X8-6	CAN_L
X8-7	NC (not connected)
X8-8	CAN_+5 V

<b>X14 (25-pin connector)</b>	<b>Description / Function</b>
X14-1	H <sub>2</sub> _Sensor3_+24V
X14-2	H <sub>2</sub> _Sensor3_Signal
X14-3	H <sub>2</sub> _Sensor4_+24 V
X14-4	STOP_SYSTEM_SIG
X14-5	STOP_SYSTEM_SIG
X14-6	STOP_SYSTEM_SIG
X14-7	STOP_SYSTEM_SIG
X14-8	+24 V (Horn supply)
X14-9	+24 V (VAR-OK Vsupply)
X14-10	NC (not connected)
X14-11	NC (not connected)
X14-12	NC (not connected)
X14-13	-Ubattery
X14-14	H <sub>2</sub> _Sensor3_GND
X14-15	H <sub>2</sub> _Sensor4_Signal
X14-16	H <sub>2</sub> _Sensor4_GND
X14-17	GND
X14-18	GND
X14-19	GND
X14-20	GND
X14-21	Horn_Return

X14-22	VAR_Return
X14-23	NC (not connected)
X14-24	NC (not connected)
X14-25	+Ubattery
Housing	PE

## 9 Abbreviations

Analogous designations for the two components of the user manual

Designation	Short form	Designation in Webtool
EFOY Hydrogen Fuel Cell	Fuel Cell	FC module
EFOY Hydrogen Controller	Controller	Controller

Abbreviation	Meaning
A	Ampere
AC	Alternating current
Ah	Ampere hour
FC	Fuel cell
°C	Degrees Celsius
DC	Direct current
d	Day
Fuel Cell	EFOY Hydrogen Fuel Cell
Controller	EFOY Hydrogen Controller
h	Hour
H <sub>2</sub>	Hydrogen
IP	Protection class
kW	Kilowatt
kWh	Kilowatt hour
m	Meter

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mA	Milliampere
mbar	Millibar
NL / min	Norm Litre per minute. Specification for H <sub>2</sub> flow
Pa, kPa	Pressure in Pascal, or Kilopascal. 1 Kilopascal = 0,01 bar
V	Volt
VA	Volt ampere