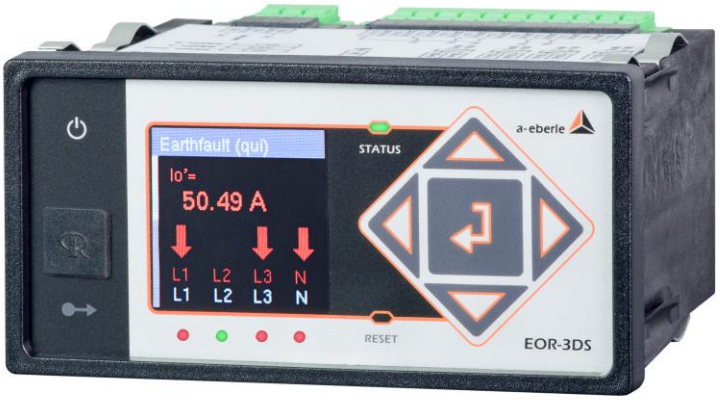
a-eberle

Operating instructions

EOR-3DS

Combined Earth Fault and
Short Circuit Indicator



03/2023
Firmware 2.1.3

GB

NOTICE!	Please note that these operating instructions may not always contain the latest information concerning the device. If, for example the firmware version has changed, then the present description may be incorrect in some points. In this case please contact us or use the current version of this document on our website (www.a-eberle.de)

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Table of Contents

1. User guidance

This User Manual is a summary of the information needed for the installation, commissioning and operating the product.

Read the User Manual in its entirety and do not use the product unless you have understood the User Manual.

1.1 Target group

The User Manual is intended for skilled technicians and trained and certified operators.

The contents of this User Manual must be accessible to people tasked with the installation and operation of the system.

1.2 Warnings

Structure of the warnings

Warnings are structured as follows:

⚠ SIGNAL WORD	**Nature and source of the danger.** Consequences of non-compliance. Actions to avoid the danger.

Types of warnings

Warnings are distinguished by the type of danger they are warning against:

⚠ DANGER!	Warns of imminent danger that can result in death or serious injuries if not avoided.

⚠ WARNING!	Warns of a potentially dangerous situation that can result in death or serious injuries when not avoided.

⚠ CAUTION!	Warns of a potentially dangerous situation that can result in fairly serious or minor injuries when not avoided.

NOTICE:	Warns of a potentially dangerous situation that if not avoided could result in material or environmental damage.

1.3 Tips

Tips on the appropriate device use and recommendations.

1.4 Other symbols

Instructions

Structure of the instructions:

➲ Instructions for an action.

↳ Indication of an outcome, if necessary.

Lists

Structure of unnumbered lists:

- List level 1
  - List level 2

Structure of numbered lists:

1) List level 1
2) List level 1
   1. List level 2
   2. List level 2

1.5 Applicable documentation

For the safe and correct use of the product, observe the additional documentation that is delivered with the system as well as the relevant standards and laws.

1.6 Storage

Keep the user manual, including the supplied documentation, readily accessible near the system.

1.7 Updated documentation

The most recent versions of the documents can be obtained at https://www.a-eberle.de.

2. Delivery scope

The delivery scope of EOR-3DS includes a display unit for indication and localization of short circuits and eath faults. Depending on the order characteristics ‘C’ and ‘U’ the device is delivered with different measurement cards and/or additional current and voltage adapters. In addition depending on the order characteristic ‘V’ the device has a RS485 interface. The following configrations are available:

Article number	Included components
119.841V.CCUU.xxx	Article number depending on order features: - V: order feature RS485 interface - CC: order feature current input - UU: order feature voltage input - xxx: customer specific order features T, P and K (software features)
119.8410.CCUU.xxx	EOR-3DS without RS485 interface
119.8411.CCUU.xxx	EOR-3DS with RS485 interface
119.841V.10UU.xxx	EOR-3DS with C10 current measurement input
119.841V.21UU.xxx	EOR-3DS with C21 current plug-on adapter
119.841V.25UU.xxx	EOR-3DS with C25 current plug-on adapter
119.841V.CC05.xxx	EOR-3DS with U05 voltage measurement input
119.841V.CC06.xxx	EOR-3DS with U06 voltage measurement input
119.841V.CC07.xxx	EOR-3DS with U07 voltage measurement input
119.841V.CC10.xxx	EOR-3DS with U10 voltage adapter
119.841V.2929.xxx	EOR-3DS with C29U29 current and voltage measurement input for ABB sensors (3x RJ45)
119.841V.3131.xxx	EOR-3DS with C31U31 current and voltage measurement input for Siemens SIBushing (3x RJ45)

Example: A device with RS485 interface, a C25 current plug-on adapter and a U10 voltage adapter with customer specific combination of the order characteristics T, P an K has the article number 119.8411.2510.123.

Adapter cable for connecting the EOR-3DS parallel to a voltage detecting system with order characteristic U05 is not included in the default delivery scope. (more information are included in the technical data sheet)

3. Safety instructions

- Observe the operating instructions.
- Always keep the operating instructions with the unit.
- Make sure that the device is never operated in a damaged or compromised condition.
- Make sure that only specialized personnel operate the unit.
- The device must be connected according to the manufacturer's installation instructions.
- Make sure that the device is never operated beyond its stated ratings.
- Do not install or operate the device in environments where explosive gases, dust or vapours may be present.
- Ensure that protective covers are always in place and are functional.
- Ensure that the five safety regulations according to DIN VDE 0105 are always observed.
- Clean the appliance only with commercially available detergents.

4. Technical Data

Please see the latest EOR-3DS data sheet for this data. The data sheet is available in the download center on our hompepage under www.a-eberle.de.

5. Intended use

The Earth Fault and Short Circuit Indicator EOR-3DS is intended for fixed installation and the continual measurement, monitoring and evaluation of voltages and currents.

The EOR-3DS is exclusively intended for use in electrical power engineering facilities and installations, where professsionals carry out the necessary work. Professionals are defined as people who are familiar with the installation, assembly, commissioning and operation of such products. They have qualifications that meet the requirements of their activities.

The earth fault and short circuit indicator EOR-3DS complies with the laws, rules and standards applicable at the time of delivery, in particular with relevant safety and health requirements.

In order to maintain this condition and ensure safe operation, the operator must follow all the instructions and warnings in the user manual and the technical data must be observed.

A. Eberle GmbH & Co. KG accepts no liability for damage resulting from unauthorized or improper modification or use of the product. Improper modifications of the product without consultation with A. Eberle GmbH & Co. KG can lead to personal injury, property damage and malfunctions.

6. Transportation and storage

The devices and spare components must be stored in rooms that are dry and clean.

The device and its replacement modules must be stored in a temperature -between -25°C to +65°C.

The relative humidity may not result in the creation of condensation or ice.

It is also recommended to connect the device to the auxiliary voltage before the device is commissioned. In extreme climatic conditions (in the tropics), this also 'preheats' the device and prevents condensation.

Before voltage is applied to the device for the first time, it should be left in the operating environment for at least two hours to equalize the temperature and prevent the creation of humidity and condensation.

7. Operation / Display

7.1 EOR-3DS housing

7.1.1 Overview EOR-3DS front side

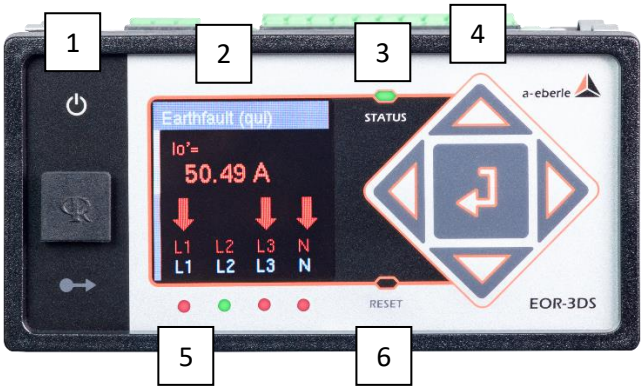


Figure 1: Front side EOR-3DS

1) Power LED
2) OLED colour display
3) Status LED
4) Operating keys
5) Signalling LEDs
6) Reset key

Figure 2: Front side EOR-3DS without service port plug

1) Service port

For the service port USB or Ethernet adapters are available. More information are included in the EOR-3DS data sheet.

7.1.2 Numbering of LEDs

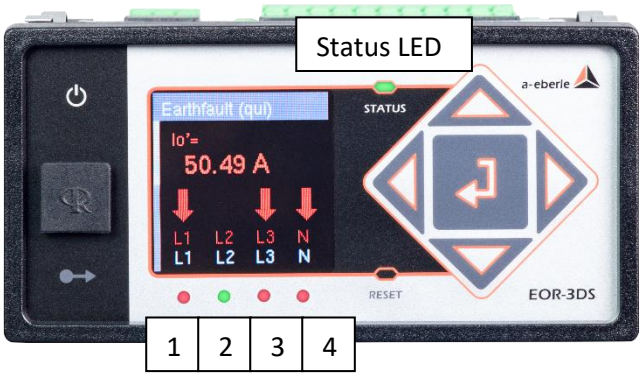


Figure 3: Numbering of LEDs from 1 to 4 and status LED

7.1.3 Overview EOR-3DS rear side

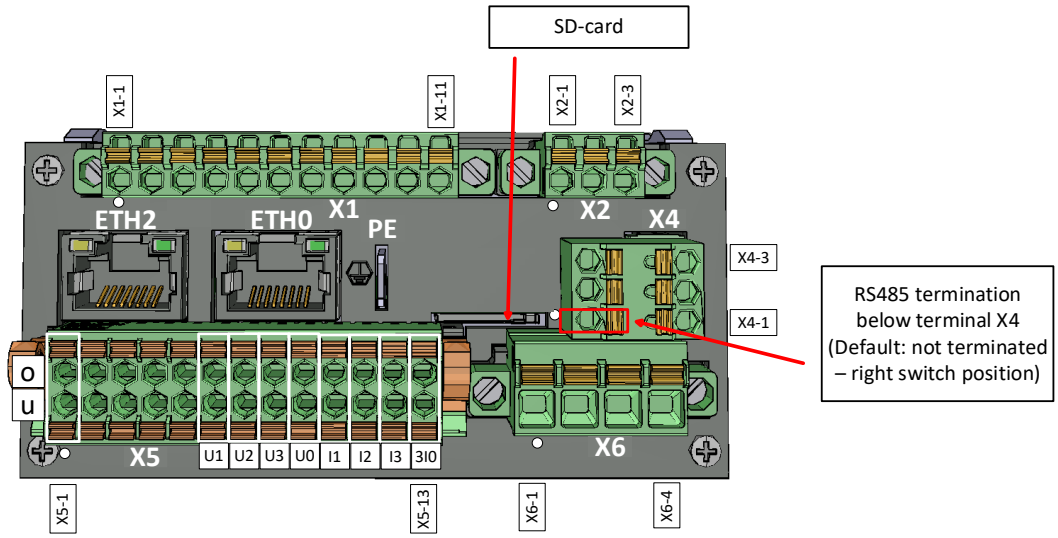


Figure 4: Current and voltage terminals, SD-card and RS485 termination switch

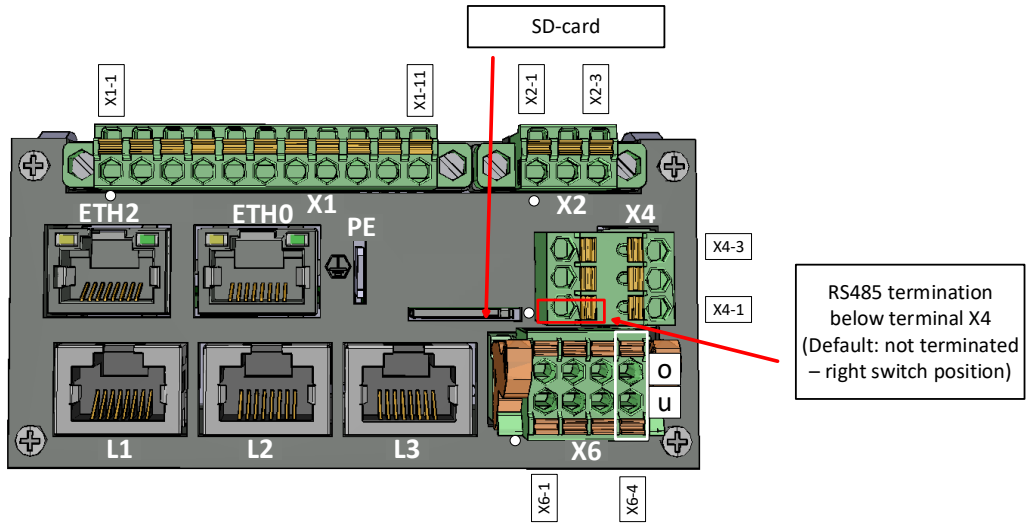


Figure 5: Current and voltage measurement via RJ45, SD-card and RS485 termination switch

X1	terminal strip binary outputs
X2	terminal strip power supply
X4	terminal strip RS485
X5	terminal strip voltage and current inputs as well as binary inputs
L1/L2/L3	RJ45 connection current and voltage sensors
X6	terminal strip binary inputs
ETH0	1. Ethernet interface
ETH2	2. Ethernet interface (optional: activatable via license)

There is no RS232 port avaiable for the EOR-3DS.

7.2 Menu control using control keys on the device

The local user interface comprises an LCD display, five function keys and 5 LED indicators as already described in chapter 7.1.1. The figure shows the start screen.

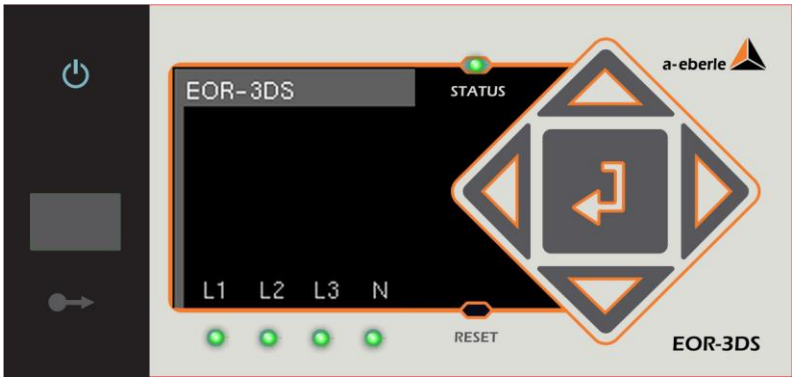


Figure 6: View of the display and user interface with the start screen

7.2.1 Brief description of the control keys

Key	Description	Function
	Up / Higher	1. Move up in the menu 2. Increase parameter value
	Down / Lower	1. Move down in the menu 2. Reduce parameter value
	Left	1. Switch to previous / higher level in the menu: ‘Back’ 2. For parameters with more than one number, move to the left (cursor) 3. 20 keystrokes in start screen → option for factory reset, see also chapter 11.2
	Right	1. Change to the next / lower level in the menu: ‘Forward’ 2. For parameters with more than one number, move to the right (cursor)
	Return / Enter	1. Jump to the menu from the start screen 2. Selection of a particular menu item 3. Confirmation of a changed parameter
	RESET	1. Quick press → Resetting of the signals 2. Long press (> 4 seconds) → warm start, see also chapter 11.3

7.2.2 Menu levels

The display of all operationally relevant measurement values and configuration or servicing takes place via three subordinate menu trees. The Display item provides quick access to the current operating measurement values. From the Setup menu tree it is possible to select all parameters and if necessary alter them. The Administration tree provides various service functions.

Further more via the selection Logout a logged in panel user or panel operator can be activly logged out, in case the user management for the panel is enabled.

Pressing the  key takes you from the start screen to the menu.

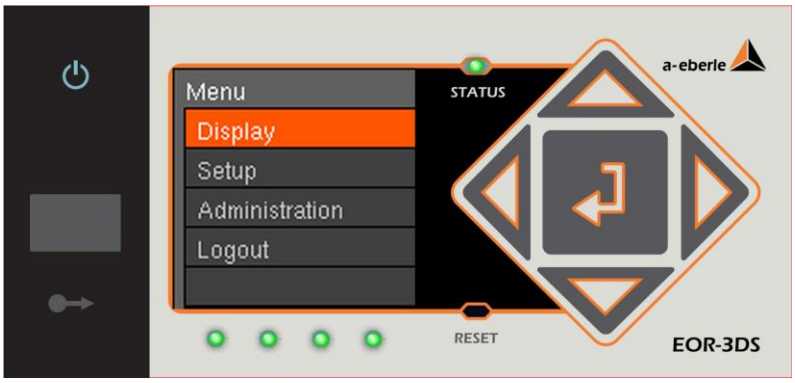
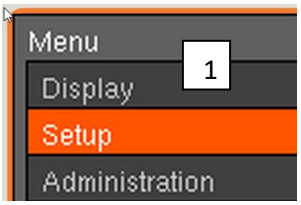


Figure 7: First menu level

Selection of the individual parameters takes place via the individual menu item. When scrolling through the menu tree, the top line of the LCD display indicates the current menu group (1).

The orange highlighted menu item is selected by pressing the enter key again



7.2.3 Changing to the measurement value view

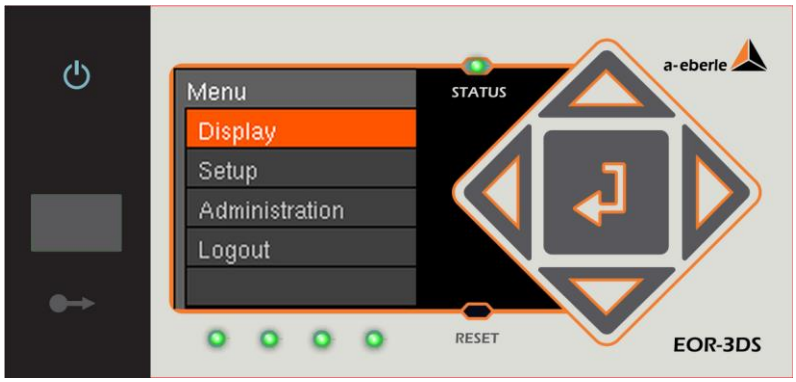


Figure 8:Display menu

- From the start screen change to the menu as described in 7.2
- Select the 'Display' menu item
- In the factory setting, nineteen pages are populated with the following measurement values

Setup ▸ Commissioning ▸ Display ▸ Measure-sequence

Paths	Parameter	PC Value	Comp. Value
Setup	Display pos. 1	01:Voltage secondary	
Commissioning	Display pos. 2	02:Current secondary	
General	Display pos. 3	03:Angle	
Status page	Display pos. 4	04:Voltage primary	
Display	Display pos. 5	05:Current primary	
Measure-sequ...	Display pos. 6	06:Voltage Ph-Ph	
LED_text	Display pos. 7	07:Activ power prim.	
Communication	Display pos. 8	08:Reactiv power prim.	
Telecontrol	Display pos. 9	09:Apparent power prim.	
Scriptserver	Display pos. 10	10:PQS prim.	
ConMaster	Display pos. 11	11:5th harm. prim.	
HW config	Display pos. 12	12:Frequency fx1	
Earthfault	Display pos. 13	13:State DI1-2	
Short Circuit	Display pos. 14	14:State DI3-6	
Recorder	Display pos. 15	15:State DO1-4	
Lua Variables	Display pos. 16	16:State DO5-8	
	Display pos. 17	17:Voltageadapter	
	Display pos. 18	18:Currentadapter	
	Display pos. 19	19:PT100 temperatures	

Figure 9:Parameterization of the measure-sequence with AEToolbox

The display '16:State DO5-8' does not exist for EOR-3DS, because the device has only 4 relays and the display automaically skipped therefor.

The display '19: PT100 temperatures' is only shown on devices with Siemens measurement cards (order characteristic C31/U31).

7.2.3.1 Navigation in the displays

Key	Description	Function
	Left	Change to the previous page of the measurement value display (from pages 1 to 19)
	Right	Change to the next page of the measurement value display (from pages 1 to 19)
	Return / Enter	Return to the first menu level

7.2.3.2 Displays

The six measurement value pages are followed by six pages with power values and values for harmonics and frequencies. The next six pages show the binary inputs and outputs as well as the terminal or adapter voltages and currents. On the last page the PT100 temperatures of the Siemens SIBushings are displayed, but only on devices with Siemens measurement cards C31/U31.

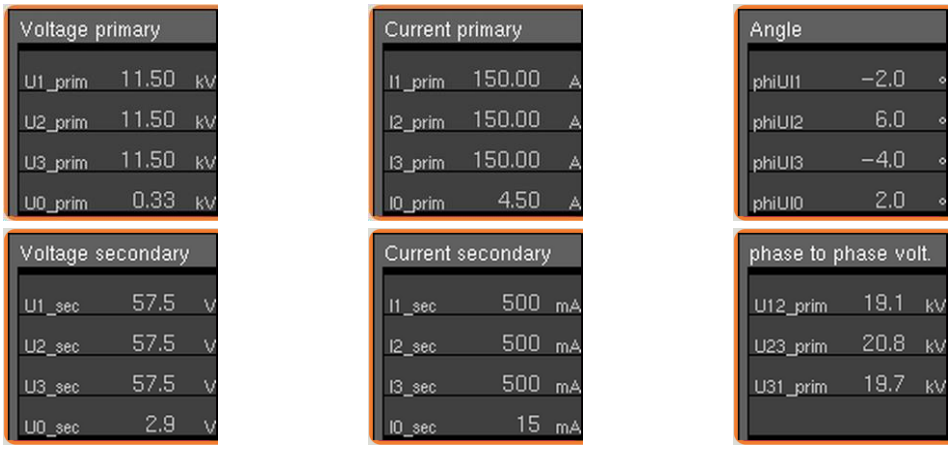


Figure 10: Displays for measurement values

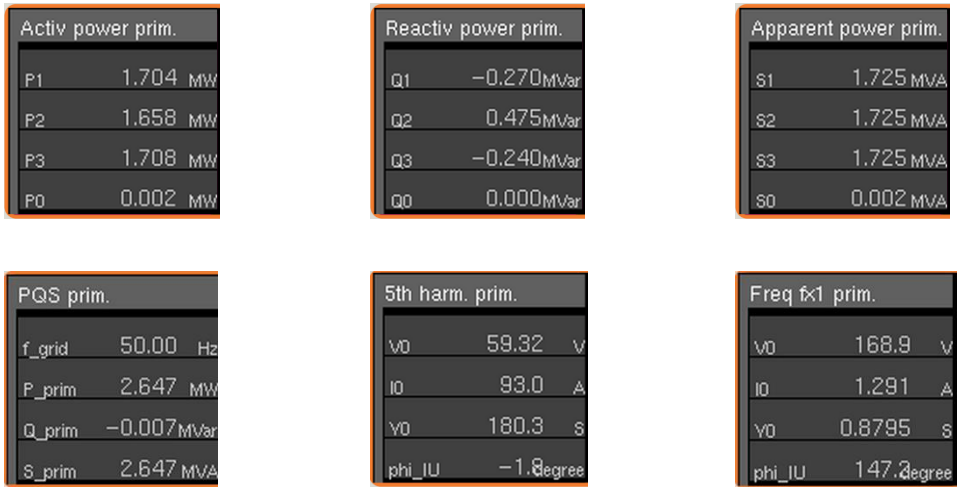


Figure 11: Displays for power values, harmonics and frequencies

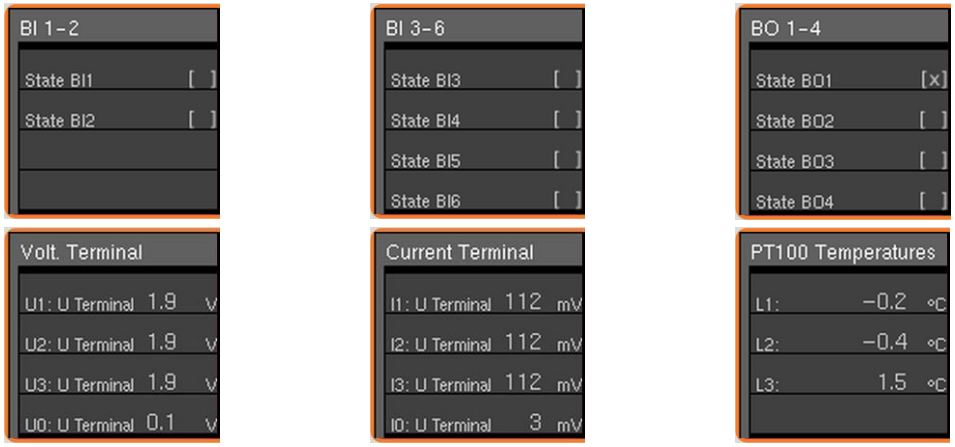


Figure 12: Displays for inputs and outputs, terminal voltages and current and PT100 temperatures

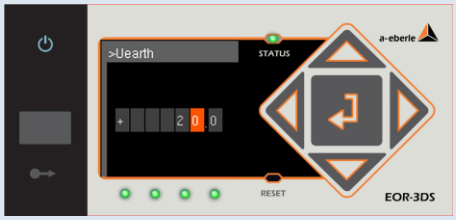
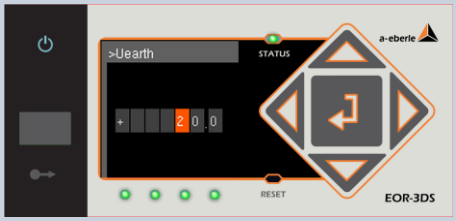
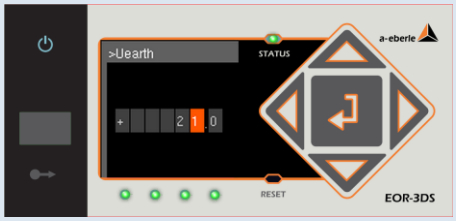
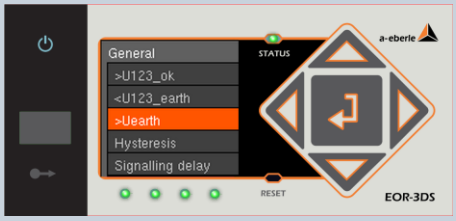
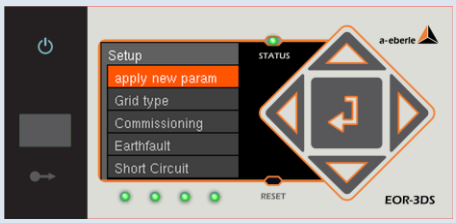
7.2.4 Changing of parameters directly on the device

All parameter can be changed directly via the user interface. There are two types of parameters:

- Pure numerical values, e.g. thresholds
- Fixed selectable values or functions

7.2.4.1 Changing numerical value parameters directly on the device

In the following example the earth fault threshold (>Uearth/>Uerd) is changed from 20.0 to 21.0.

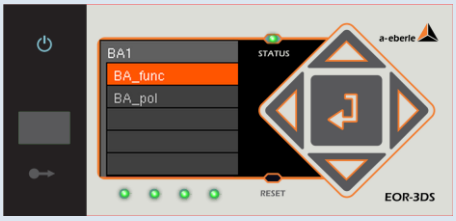
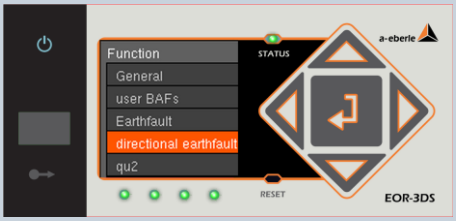
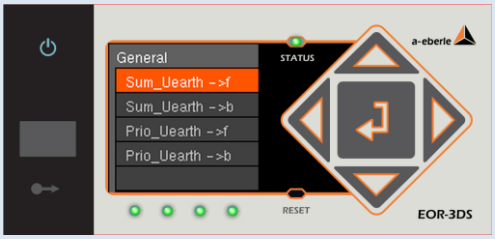
Operating step	Keys	Display view
1) Press the keys to select the desired parameter that is to be changed		
2) Pressing the input keys moves the cursor to the desired position		
3) The 'Up' / 'Down' keys are pressed to set the desired value		
4) Pressing the 'Enter' key confirms the value		
5) Then the function 'apply new param' must be selected in the menu tree		

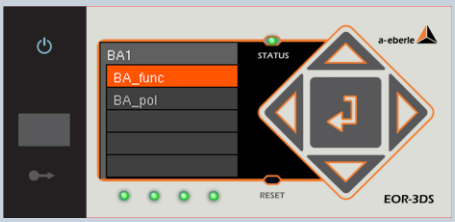
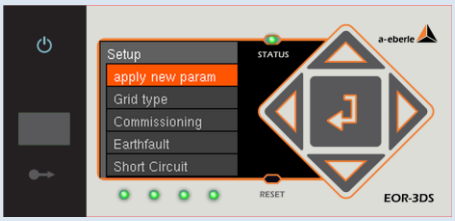
Operating step	Keys	Display view
6) This selection must be confirmed with the 'Enter' key. This finally saves the changed parameter		

Changed parameters must always additionally be confirmed with 'Apply new param' (Accept parameter)

7.2.4.2 Changing function value parameters directly on the device

In the following example the output function for Binary output 1 (Relay 1) is selected.

Operating step	Keys	Display view
1) Press the keys to select the desired parameter that is to be changed **I.e.** Binary output 1 (BA1)		
2) The 'Up' / 'Down' keys are pressed to select the desired value **I.e.** The directional earth fault signal should be applied to Binary output 1 → 'Directional earth fault		
3) Pressing 'Enter' takes you to the submenu. If there are further selection options for this value, they are displayed here **I.e.** Sum_Uerd→L (Total signal earth fault feeder direction)		

Operating step	Keys	Display view
4) Pressing the 'Enter' key assigns the selected function to the binary output. You are returned to the previous menu.		
5) Then the function 'apply new param' must be selected in the menu tree		
6) This selection must be confirmed with the 'Enter' key. This finally saves the changed parameter		

Changed parameters must always additionally be confirmed with 'Apply new param' (Accept parameter)

7.2.5 Displaying the logbook on the display (LCD logbook)

The EOR-3DS also provides the function of outputting a reduced logbook directly on the display. This logbook is called the LCD logbook, because for space reasons it cannot replace the logbook in the device.

Only locating signals are part of the LCD logbook (earth fault and short circuit). System messages (e.g. status) are stored in the internal logbook, which can be downloaded using the software AEToolbox.

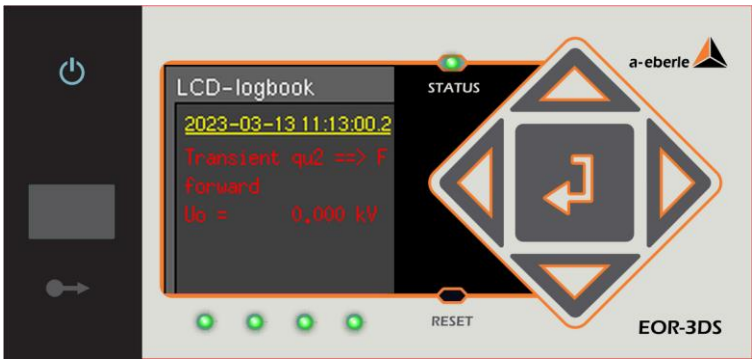
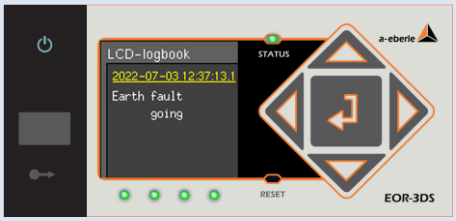
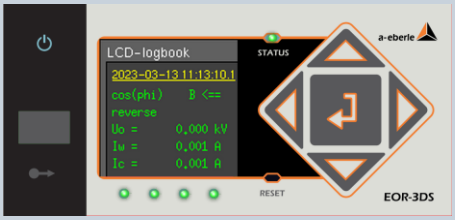
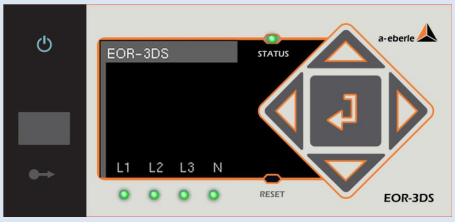


Figure 13: LCD logbook in the EOR-3DS

Operating step	Keys	Display view
1) From the start screen you access the LCD logbook directly by pressing the 'Up' key		
2) By pressing the 'Up' / 'Down' keys you can scroll through the log-book		
3) Pressing the 'Left' key returns you to the start screen		

- Faults in feeder direction **==> forward** are displayed in **red**
- Faults in busbar direction **<== backward** are displayed in **green**
- **Non-directional** indications (short circuit or pulse locating) are entered in **yellow**

7.2.6 Display of earth fault and short circuit indications

Beside measurement values also first information about a fault (earth fault or short circuit). is shown in the display. In this respect the display view contains information with the value of the fault current (mean value) and, when possible through the locating procedure used, directional information as well. A selective indication of the conductor affected is signalled by a corresponding arrow symbol above the respective phase.

The duration of the indication is controlled by the parameter ***signal duration LED/Disp***.

Here a differentiation must be done between earth fault and short circuit. The following time parameters apply:

- Earth fault: LED-Uerd – signal duration in chapter (9.3)
- Short circuit: LED – signal duration in chapter (9.4.1)

For continuous indications, the screen is overwritten by the next fault. The display can be reset either by pressing the reset key or through a binary input function.

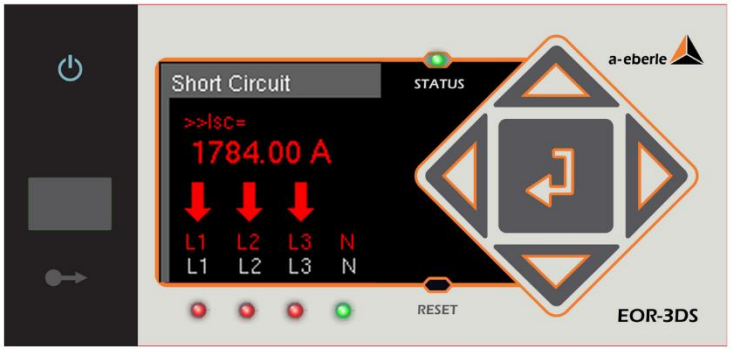


Figure 14: Earth fault display in the feeder direction

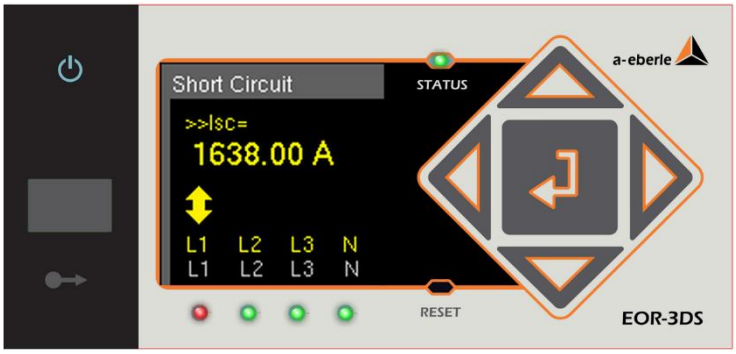


Figure 15: Non-directional short circuit display (3-pole)

- Faults in feeder direction **==> Forward** are entered in **red**
- Faults in busbar direction **<== Backward** are entered in **green**
- **Non-directional** indications (short circuit or pulse locating) are entered in **yellow**

8. Installation and commissioning

8.1 Applicability of the earth fault and short circuit location methods depending on the measurement

The following table shows the applicability of the different locationg methods of the EOR-3DS depending on the accuracy class of the used transformers and sensors.

Available trans-formers / sensors				Transient qu2	Restriking qui	sin(φ)	cos(φ)	Harmonics	Pulse	Short Circuit
I_0	$3 \cdot I_L$	U_0	$3 \cdot U_L$							
x									x	
x		x		x	x	x	x	x	x	
x	x								x	x
	x								x	x
	x		x	x	x	x	x	x*	x	x
	x	x		x	x	x	x	x	x	x
	x	x	x	x	x	x	x	x*	x	x
x	x		x	x	x	x	x	x*	x	x
x	x	x		x	x	x	x	x	x	x
x	x	x	x	x	x	x	x	x	x	x

Legend of minimum requirements for class of accuracy of transducers and sensors:		
		> cl. 1
		<= cl. 1
		<= cl. 0.5 + phase sensors / transducers preselected regarding error in amplitude and angle

* only applies for phase sensors/transducers, not for I_0 or U_0 sensors/transducers

8.2 Terminal assignment and connection power supply

A detailed describtion of the terminal assignment for the different characterisitics is included in the data sheet which is available on our homepage under www.a-eberle.de.

The connection of EOR-3DS power supply is identical for all devices, because there is only one power supply version (H23 feature) available. The EOR-3DS has a wide range DC power supply, that can be used in the range between DC 20 … 148 V. The power supply is protected again polarity reversal, i.e. a connection with revers polarity on terminals X2-1 and X2-3 in the range of the permitted operating voltage does not damage the device. The terminal X2 is located on the back of the device in the upper right corner, see also chapter 0.

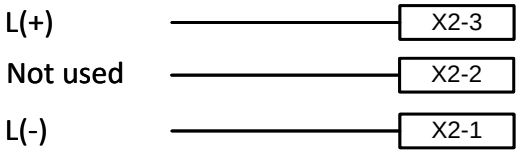


Figure 16: Power supply terminals X2

8.3 Connecting of low-power sensors and transformers

The EOR-3DS can be connected to low-power sensors and classic (inductive) transformers. The suitable analoge input is selected during order process (C and U feature). For the technical data of the different analog inputs please refer to the latest EOR-3DS data sheet.

The EOR-3DS has a maximum of four voltage inputs and four current inputs. With this, three phase voltages and three phase currents as well as the zero sequence voltage (Uen) and the zero sequence current (3Io) can be measured.

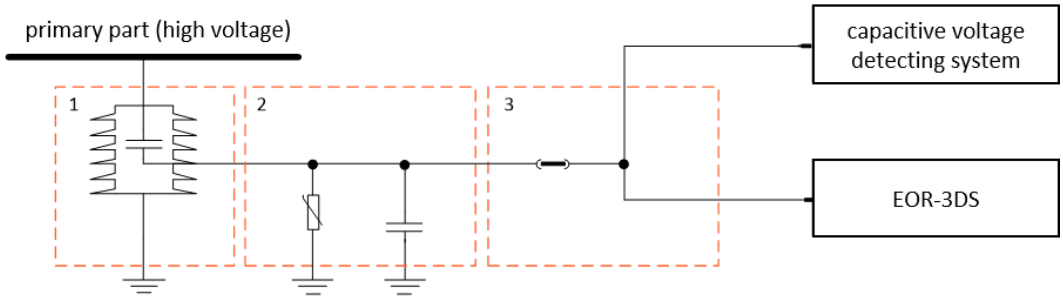
For classic transformers the connecting direction of the voltage and current transformers is given with the marking for the winding direction (in the pictures labeled with a dot).

- For all connection drawings for current transformers applies:
  P1 is directed to the busbar
  (Exception: SIBushing, see chapter 8.3.1.5)
- Conventional current transformers are connected to the devicet with a plug-on adapter on the top of the device (C21 or C25 adapter), see also chapter 8.3.2.1
- Conventional voltage transformers are connected via an external voltage adapter (U10 adapter) , see also chapter 8.3.2.1

8.3.1 Connection of low-power sensors and LR/LRM systems

8.3.1.1 Connecting of U05 for capacitive LR and LRM systems (incl. adapter cable)

With the EOR-3DS it is possible to measure the voltage parallel to a capacitive voltage detecting system.



1. Insulator with coupling capacitor
2. Interface cable (cable capacity) with overvoltage arrester
3. Adapter cable for parallel connection to a capacitive detection system

Figure 17: Principle schematic of connecting the EOR-3DS to capacitive transducer

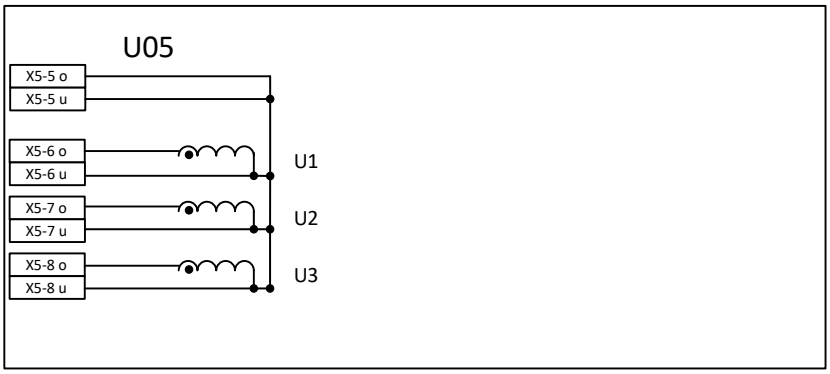


Figure 18: Terminal assignment for U05 characteristic

Adapter cable for connection to a capacitive voltage detection system

For the connection to the different valtage detecting systems there are several adapter cables available.

- Y-adapter cable for WEGA and CAPDIS (flat connector)

  With this adapter it is possible to connect with capacitive voltage detecting systems, that have a 4,8 mm flat connector (e. g. CAPDIS S1+/S2/IKI20a, WEGA1.2 (with flat connector), IVIS)

Figure 19: Y-adapter cable for WEGA and CAPDIS (flat connector)

1) Connection to the EOR-3DS
2) Connection to the capacitive voltage detecting system
3) Connection to the capacitive insulator

Figure 20: Example: EOR-3DS and WEGA1.2 connected with a Y-adapter cable for WEGA and CAPDIS

- Connection cable for WEGA and CAPDIS
  With this adapter cable it is possible to connect with capacitive voltage detecting systems that have a 4-pole AMP-plug (WEGA1.2c, WEGA1.2 (with AMP-connector)). In that case the capacitive insulator must be connected with flat connectors to the voltage detecting system.

Figure 21: connection cable for WEGA and CAPDIS

1) Connection to the EOR-3DS
2) Connection to the capacitive voltage detecting system

Figure 22: Example: EOR-3DS and WEGA1.2c connected with a connection cable for WEGA and CAPDIS

- Y-connection cable for WEGA and CAPDIS

  With this adapter cable it is possible to connect with a capacitive voltage detecting system, that have a 4-pole AMP-plug (WEGA1.2c ,WEGA1.2 (with AMP-connector)). In that case the capacitive insulator must be connected with the 4-pole AMP-plug on the Y-connection cable.

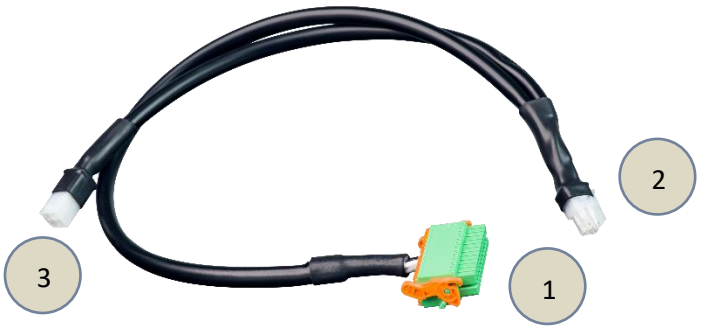


Figure 23: Y-connection cable for WEGA and CAPDIS

1) Connection to the EOR-3DS
2) Connection to the capacitive voltage detecting system
3) Connection to the capacitive insulator

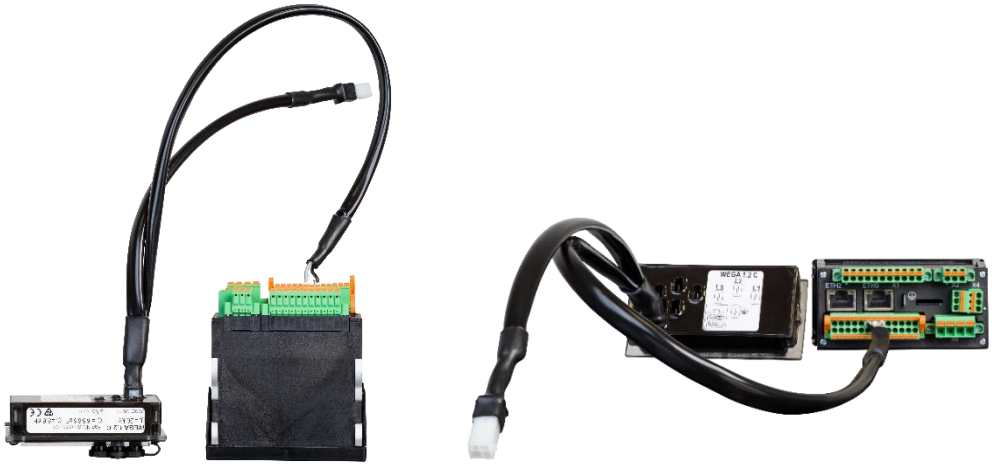


Figure 24: Example: EOR-3DS and WEGA1.2c connected with a Y-connection cable for WEGA and CAPDIS

More information for all adapters are included in the data sheet. The data sheet is available on our Hompage under www.a-eberle.de.

8.3.1.2 Connection of U06/U07 for low-power voltage sensors (rated burden 200 kΩ or 2 MΩ)

With the EOR-3DS it is possible to use low-power voltage sensors from different manufactures. Therefor the two different order order features are available. U06 for sensors requiring a rated burden of 200 kΩ and U07 for sensors requiring a rated burden of 2MΩ.

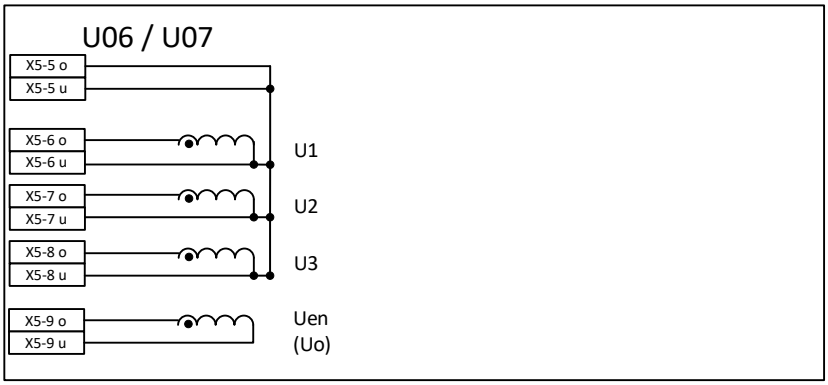


Figure 25: Terminal assignment for characteristics U06/U07

Normally Uen is not measured with low-power sensors. This means the paramter ‘calculate Uen’ must be activated in the EOR-3DS.

Figure 26: EOR-3DS connected with Zelisko voltage sensor

8.3.1.3 Connection of C10 for low-power current sensors

With the EOR-3DS it is possible to use low-power current sensors from different manufactures.

Figure 27: Terminal assignment for characteristic C10

Additional to the connection of the three phases it is possible to use a transformer with 3Io measurement and directly measure 3Io. For this the 3Io measurement must be set on 'measured' in the EOR-3DS.

Figure 28: EOR-3DS connected with Zelisko current sensor

8.3.1.4 Connection of C29/U29 for low-power sensors from ABB

With the EOR-3DS it is possible to use low-power voltage and current sensors from ABB. A combi sensor or separate voltage and current sensor with Y-adapter can be connected.

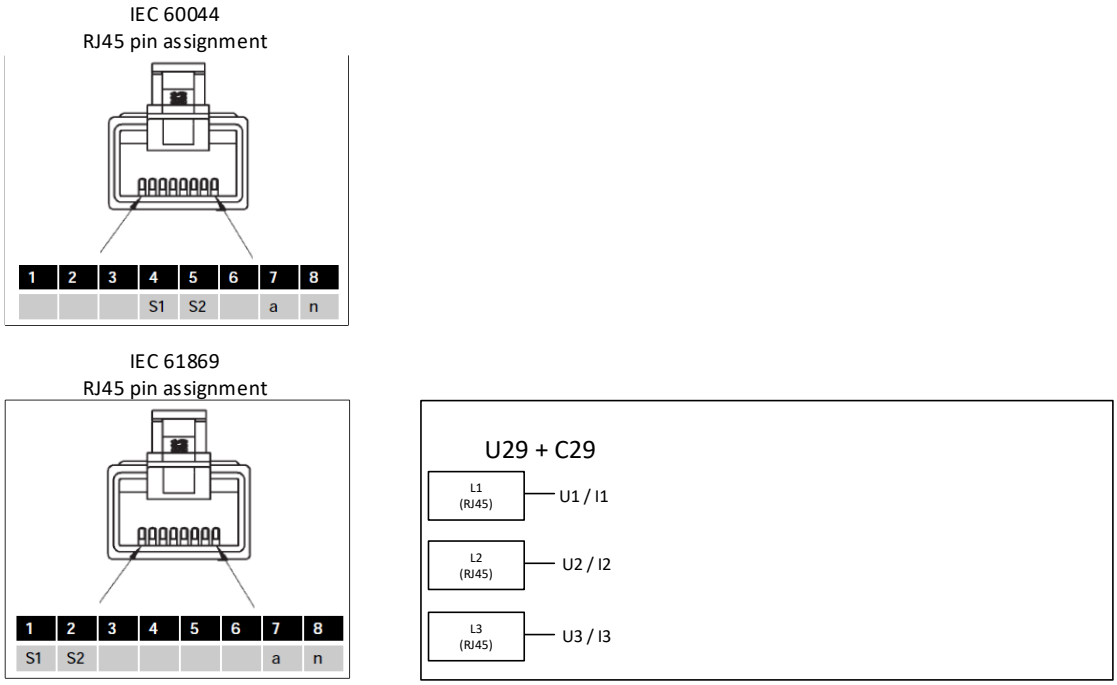


Figure 29: Terminal assignment for characteristic C29/U29

Figure 30: EOR-3DS connected with ABB combi sensor for current & voltage measurement

Figure 31: EOR-3DS with connected ABB voltage and current sensor with the help of a Y-adapter

8.3.1.5 Connection of C31/U31 for low-power sensors from Siemens

With the EOR-3DS it is possible to use Siemens low-power combi sensors (SIBushing) to measure voltage and current.

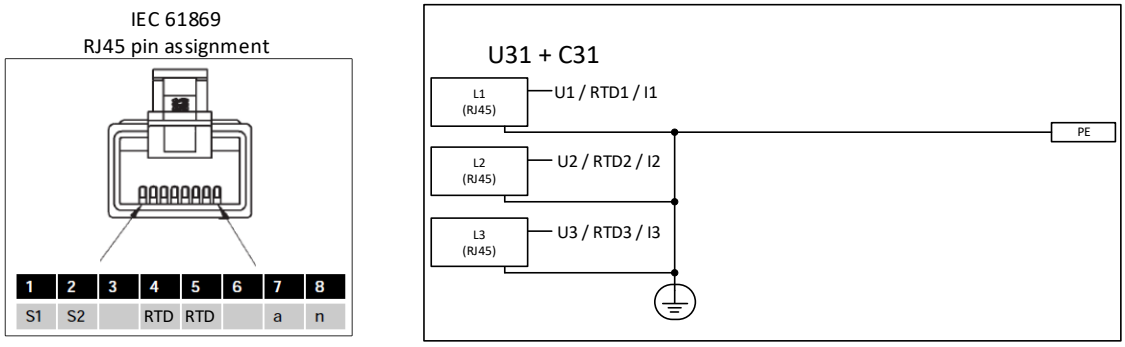


Figure 32: Terminal assignment for characteristic C31/U31

Figure 33: EOR-3DS connected with Siemens combi sensor SIBushing for current & voltage measurement

Definition P1/P2 with measurement card C31U31 (Siemens SIBushing):
For Siemens SIBushing P1 is directed to the cable and P2 is directed to the busbar. The EOR-3DS considers this fact automatically with the measurement card C31/U31. There is no need to invert the current measurement with the according parameters.

8.3.2 Connection of measurement transducers

8.3.2.1 Adapter module C21/C25 and U10

1) Adapter module for current transducer connection

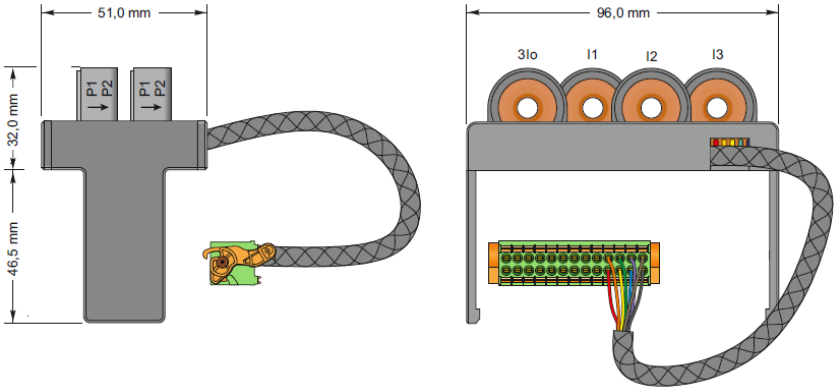


Figure 34: Plug-on adapter C21 for current transducers

The plug-on current adapter is used for measurement or converting the secondary measurement transducer currents. The secondary transducer cables must therefore be 'threaded' through the current transformer of the adapter according to the following connection diagrams.

There are two variants available. C21 for the phase currents as well as for the zero sequence current 3Io On the other hand C25 only for measuring the zero sequence current 3Io.

The suitable adapter must be specified upon ordering. Under **current input configuration**, please select the according feature C. The characteristics are listed in the technical datasheet.

2) Adapter module for voltage measurement

In addition to the sensors it is possible to connect conventional voltage transducers with the U10 voltage adapter.

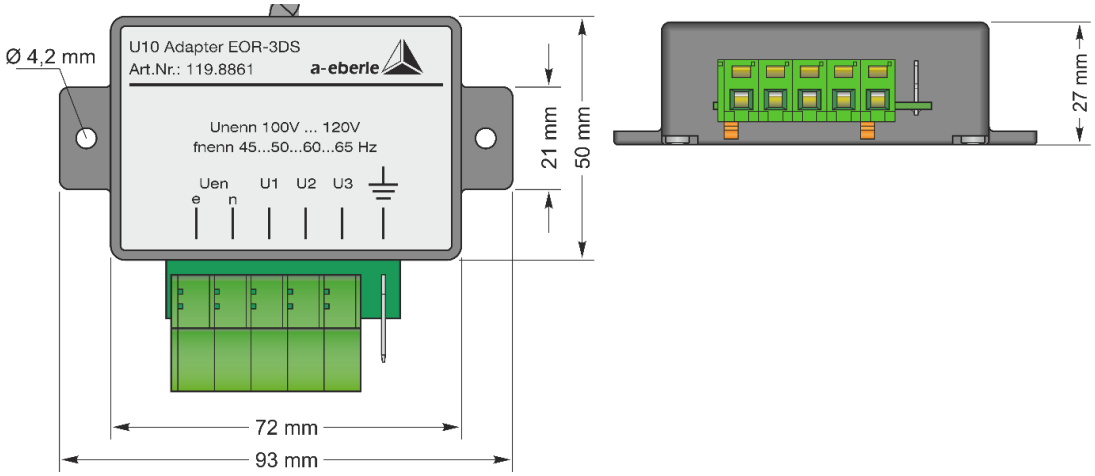


Figure 35: Dimensions for the adapter for voltage measurement on 100V / 110V measurement transducers, feature U10

The suitable adapter must be specified upon ordering. Under **voltage input configuration**, please select the according feature U. The characteristics are listed in the technical datasheet.

Figure 36: EOR-3DS with adapter for voltage measurement feature U10 and current plug-on adapter feature C21

The following example shows the connection of the wiring on the rear side Phoenix terminals for a binary input:

Connecting a wire to a phoenix terminal

- Solid conductors can be inserted with some preasure in the Phoenix terminal
- Additionally press with a suitable tool (e. g. screwdriver) on the orange locking
- For flexibel conductors the terminal must be opened with the orange locking

To release a wire proceed in reverse order

- Loosen the locking of the spring-type terminal
- Pull out the wire or lead

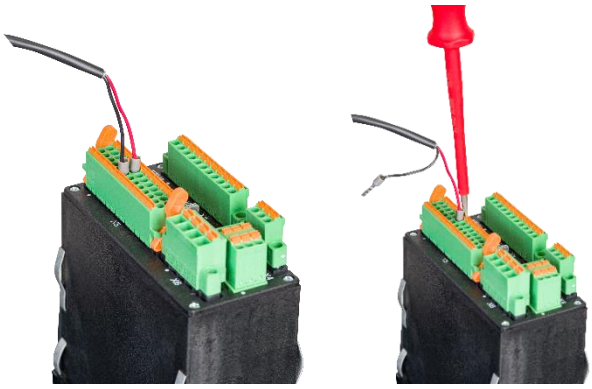
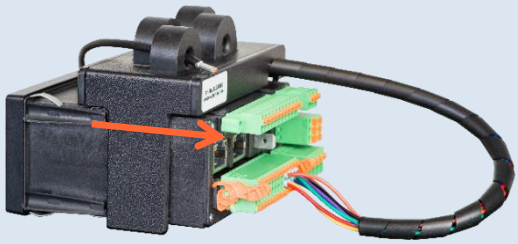
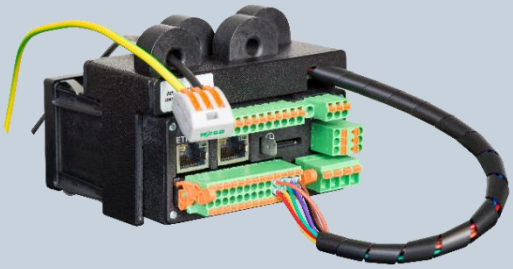


Figure 37: Removing of a conductor

The following example shows the connection of the 3Io current transducer to the EOR-3DS. Proceed in the same way with the connection of the phase current transducers.

EOR-3DS	Information
	Pull the secondary connecting cable (s1 or k) through the plug-on adapter in the direction of the arrow. Use the 3Io marked transducer.
	After pulling through the connecting cable, the transducer current circuit must be closed with the connection (s2 or l). It is recommended to do that on separate terminals.

8.3.2.2 Connection zero sequence voltage U_{en} and zero-sequence current $3I_o$

The connection of zero sequence voltage (referred to as Uen or also Uo) takes place via the so-called open delta winding. A core-balanced current transformer is used to measure 3Io.

In compensated networks, core-balanced current transformers mostly have transmission ratios of 100 / 1 A or 60 / 1 A.

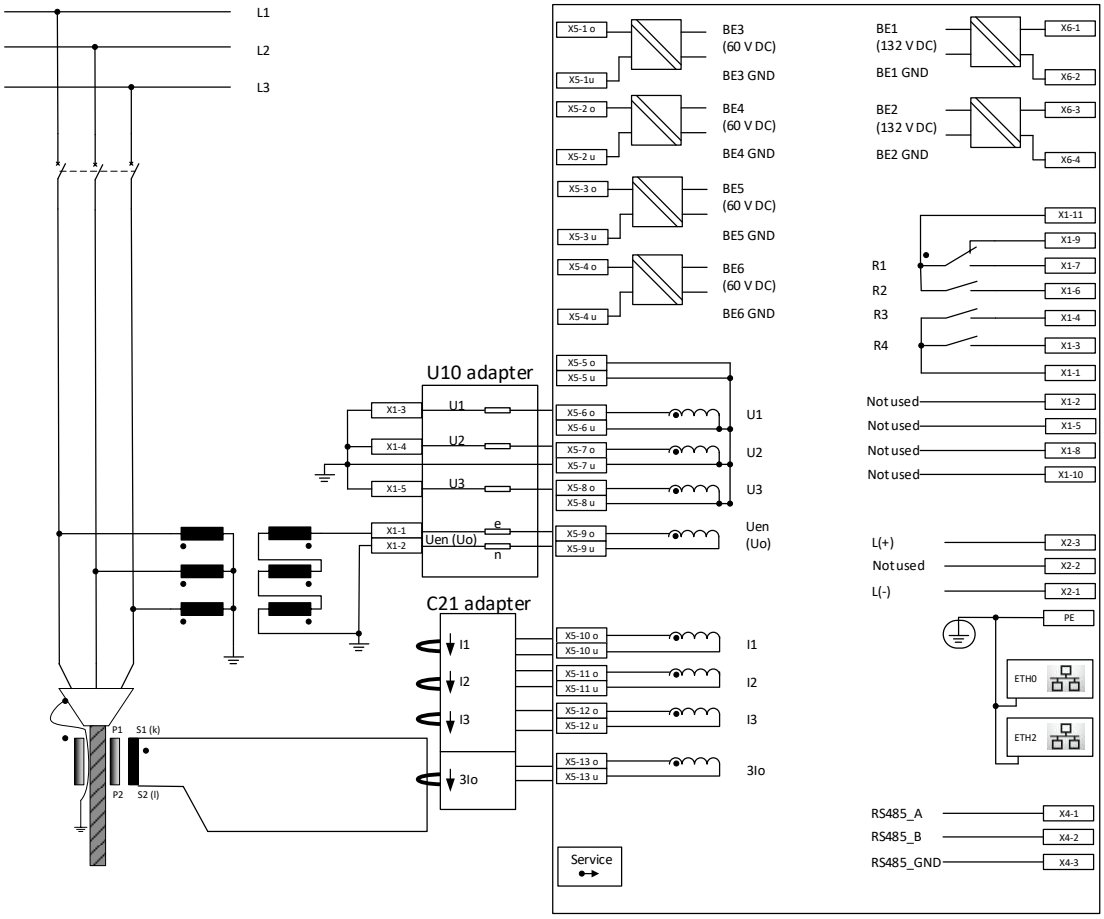


Figure 38: Connection of zero sequence voltage (Uen) and total current (3Io) to EOR-3DS

Note for terminal assignment in case of adapter U10 without connected phase voltages: In case only the Une measurement shall be used with the U10 adapter, a connection between the earthed Uen-connection and the short circuited phase voltage terminals incl. the PE terminal (ground connection of the U10 adapter) is mandatory.

The cos(φ) procedure (wattmetric) has demanding requirements in respect of the angular error for both current **and** voltage measurement. Class 1 rating transformers would fulfil these requirements, see the table in chapter 8.1 for an overview.

8.3.2.3 Connection of phase to earth voltages U_{L1}, U_{L2}, U_{L3} and phase currents I_{L1}, I_{L2}, I_{L3}

In the following example, only the phase voltages and the phase currents are connected to the EOR-3DS. This connection variant also limits the possible locating algorithms, see the table in chapter 8.1 for an overview.

The calculation of Uo and 3Io can be selected via the configuration on the EOR-3DS. In this way particular procedures are also possible for earth fault locating.

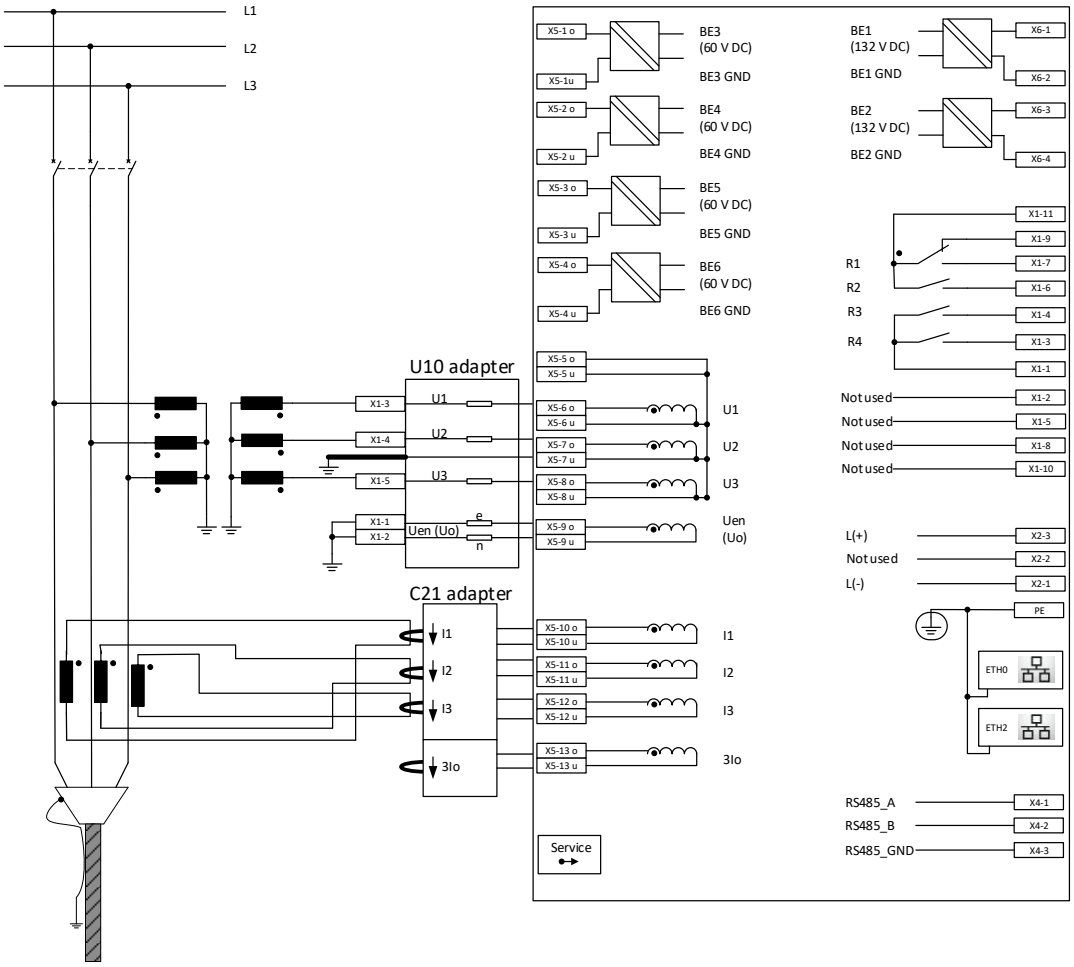


Figure 39: Connection of the phase voltages and phase currents to the EOR-3DS

The cos(φ) procedure (wattmetric) has demanding requirements in respect of the angular error for both current and voltage measurement, see the table in chapter 8.1 for an overview.

Depending on the angular error harmonics can circulate between the three single phase transformers. As a result in extreme cases an incorrect direction indicationcan result at the EOR-3DS. Therefore this procedure must not be used.

8.3.2.4 Connection to the busbar side neutral point of the current transducer

The voltage measurement identical as in chapter 8.3.2.3. However the current measurement is wired in a way, so that a connection from one transducer is combined with the other two current transducers. The sum of the three phase currents (i.e. 3Io) can consequently be measured at this 'node'.

Observe the direction of winding of the current transducers. If the transducers are installed the other way round, the direction of flow of the current is also reversed. Consequently, the 'threading direction' through the current transducer at the EOR-3DS must also be reversed.

In the configuration of EOR-3DS Uo is set to calculated. 3Io is measured.

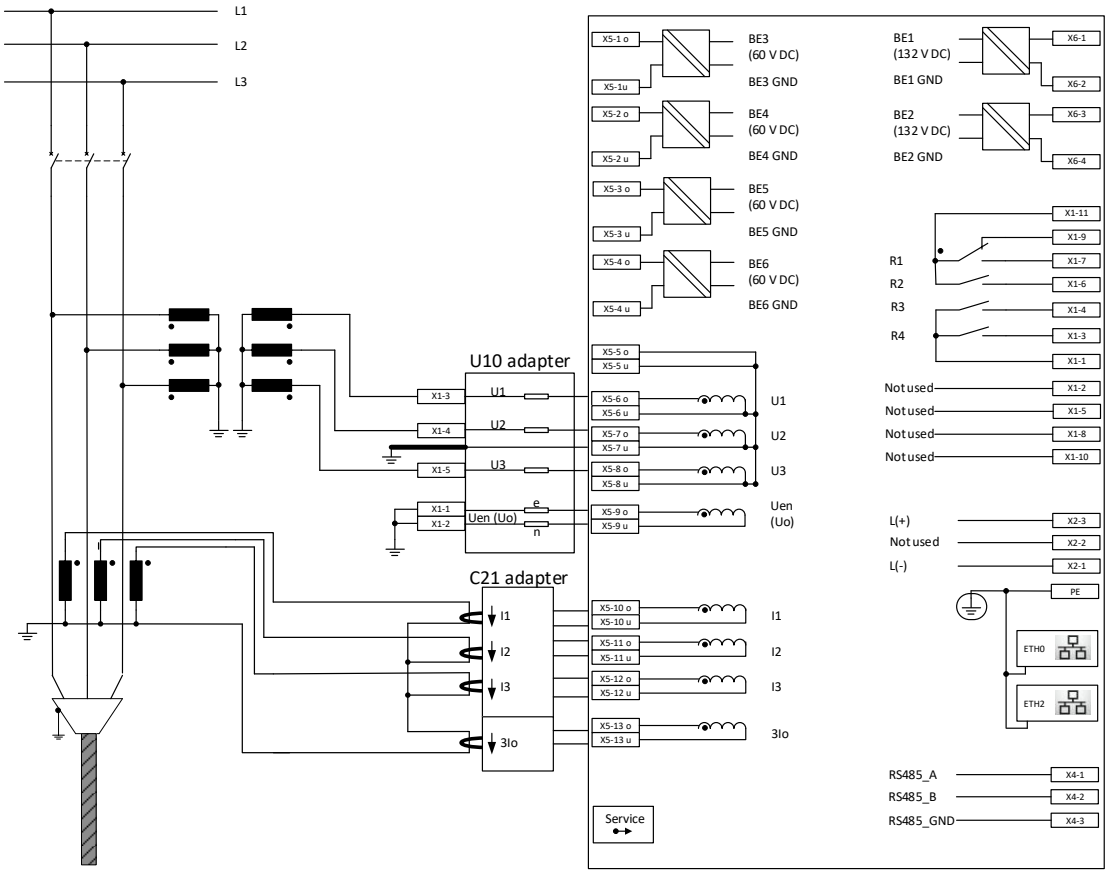


Figure 40: Connection of the phase voltages and phase currents with the neutral point in the direction of the busbar

The cos(φ) procedure (wattmetric) has demanding requirements in respect of the angular error for both current and voltage measurement, see the table in chapter 8.1 for an overview.

Depending on the angular error harmonics can circulate between the three single phase transformers. As a result in extreme cases an incorrect direction indicationcan result at the EOR-3DS. Therefore this procedure must not be used.

8.3.2.5 Connection to the conductor side neutral point of the current transducer

The voltage measurement identical as in chapter 8.3.2.4. However the current measurement is wired in a way, so that a connection from one transducer is combined with the other two current transducers. The sum of the three phase currents (i.e. 3Io) can consequently be measured at this 'node'.

Observe the direction of winding of the current transducers. If the transducers are installed the other way round, the direction of flow of the current is also reversed. Consequently, the 'threading direction' through the current transducer at the EOR-3DS must also be reversed.

In the configuration of EOR-3DS Uo is set to calculated. 3Io is measured.

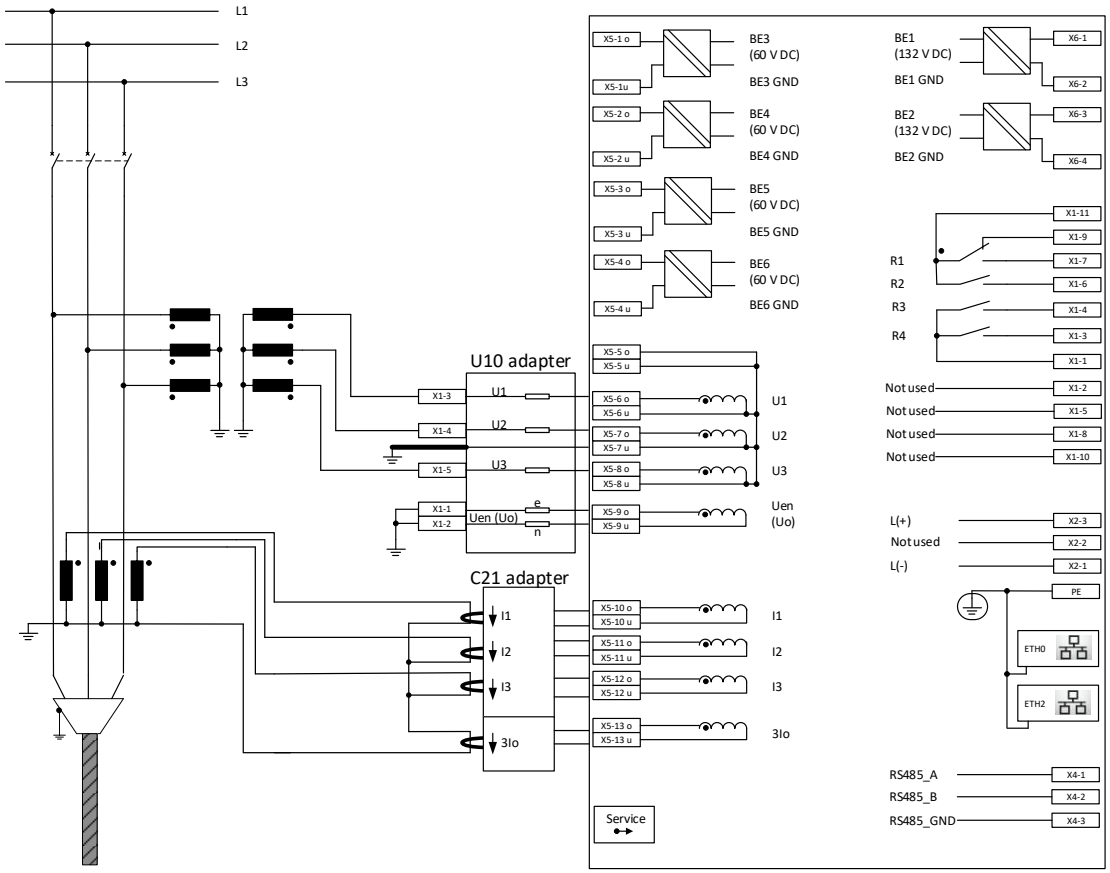


Figure 41: Connection of the phase voltages and phase currents with the neutral point in the direction of the feeder

The cos(φ) procedure (wattmetric) has demanding requirements in respect of the angular error for both current and voltage measurement, see the table in chapter 8.1 for an overview.

Depending on the angular error harmonics can circulate between the three single phase transformers. As a result in extreme cases an incorrect direction indicationcan result at the EOR-3DS. Therefore this procedure must not be used.

8.3.2.6 Separate connection of phase voltages / currents, zero sequence voltage / current

Beside the measurements for phase voltages and phase currents, measurements also exist for the zero sequence voltage (Uen) and zero-sequence current (3Io).

Observe the direction of winding of the current transducers. If the transducers are installed the other way round, the direction of flow of the current is also reversed. Consequently, the 'threading direction' through the current transducer at the EOR-3DS must also be reversed.

In the configuration of EOR-3DS Uo and 3I0 is set to not calculated. Both values are measured.

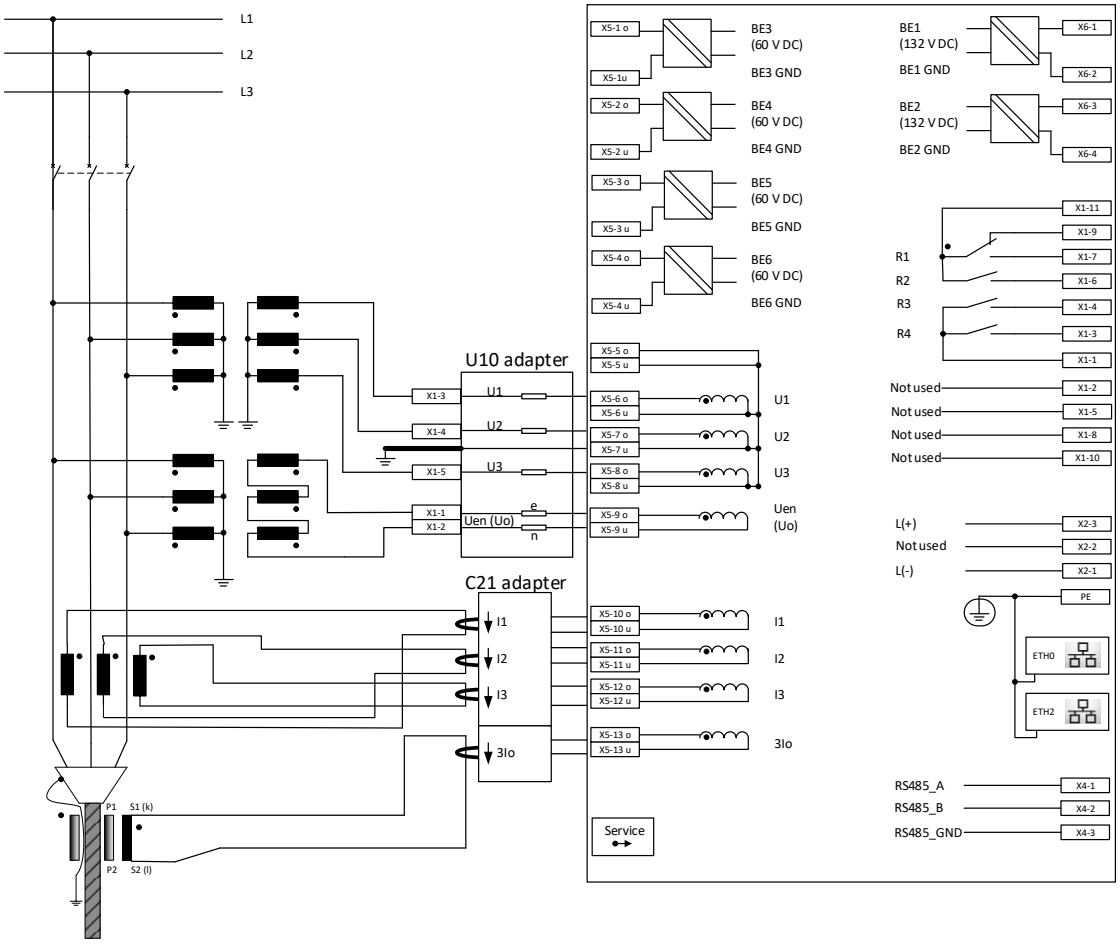


Figure 42: Connection of the phase voltages and phase currents with the neutral point in the direction of the feeder as well as the zero-sequence voltage and current

In this configuration all algorithms can be selected. The condition for the cos(φ) procedure is as before good angular accuracy in respect of Uo and 3Io.

8.4 Commissioning with parameterization software AEToolbox

The parameterization and project software AEToolbox is used to parameterize and commissioning the EOR-3DS. The AEToolbox also supports other devices from A. Eberle.

Further informaton for the parameterization of the EOR-3DS with help of the AEToolbox and informations about other functions of the AEToolbox are listed in the specific manuel. The manual is installed with the software and available under www.a-eberle.de in the downlaod center.

8.4.1 Calling online help for AEToolbox

The AEToolbox has an integrated online help, which is opened with the button F1 in the sotware.

When you are over a particular area of the AEToolbox GUI with the mouse cursor, press F1. You receive the help text for this area.

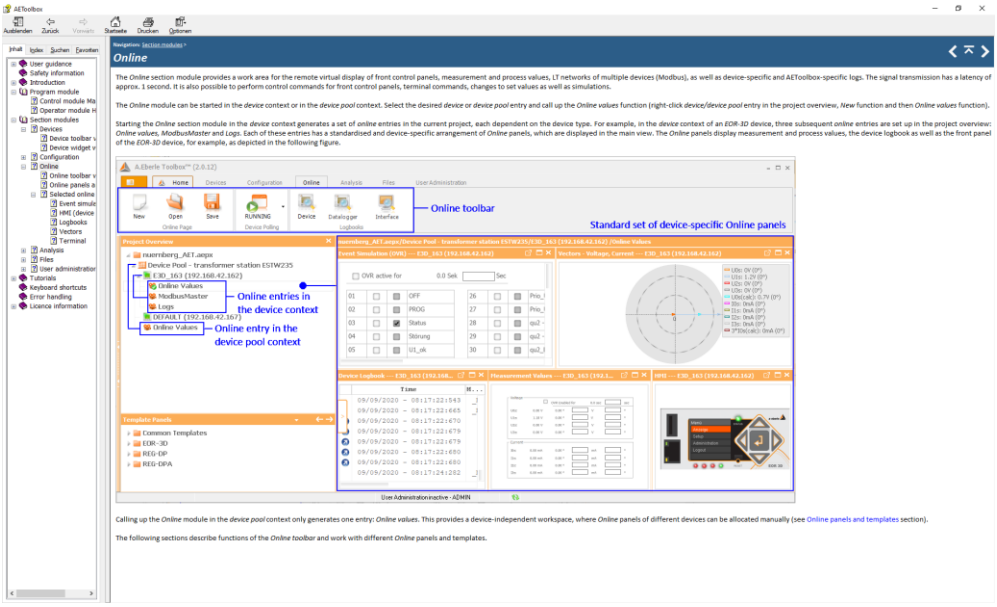


Figure 43: Online help of the AEToolbox using F1

Also, the complete user manual for the AEToolbox as PDF is available under the path **Menu/Help/Manual (PDF)**.

8.4.2 Set up the connection to the device

8.4.2.1 Setting the IP address directly at the EOR-3DS

To set up the connection between the parameterization software AEToolbox and the EOR-3DS, it may be necessary to change the settings of the used Ethernet port. The current IP setting of the used port is shown in the menu and can be changed on the device.

The default settings for the three available ports are:

ETH0 (1. ETH port): 10.15.55.129 / 24 (subnet mask 255.255.255.0)

ETH2 (2. ETH port): 10.16.55.129 / 24 (subnet mask 255.255.255.0)

ETH1 (via service adapter): 10.17.55.129 / 24 (subnet mask 255.255.255.0)

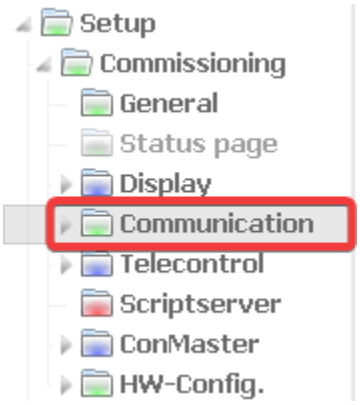
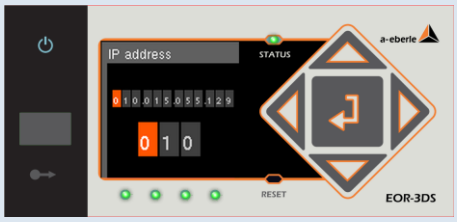
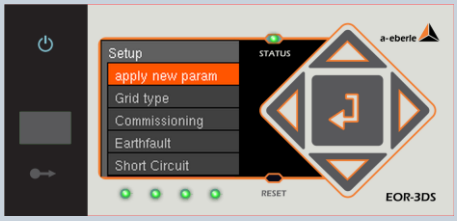


Figure 44: Menu item 'Communication' in the EOR-3DS

Display on the EOR-3DS	Information
	Change the IP-address, subnet mask and if needed the gateway for your needs.  The changing of parameters with numerical values is described in chapter 7.2.4.1.
	 Changings in the IP-address and subnet mask are applied directly, without the separate selection of 'apply new param'. To set the gateway it may be necessary to restart the device, if the address was not 0.0.0.0.

8.4.2.2 Connection with the EOR-3DS and adding to device pool

With the AEToolbox in the tab ‘Devices’ it is possible to add a device with the button ‘Device+’. With the button ‘Device+’ the Device/Data connection wizard is opened. When the device was connected recently, it can be selected from the list of recently used devices. If this is not the case, the device must be selected manually.

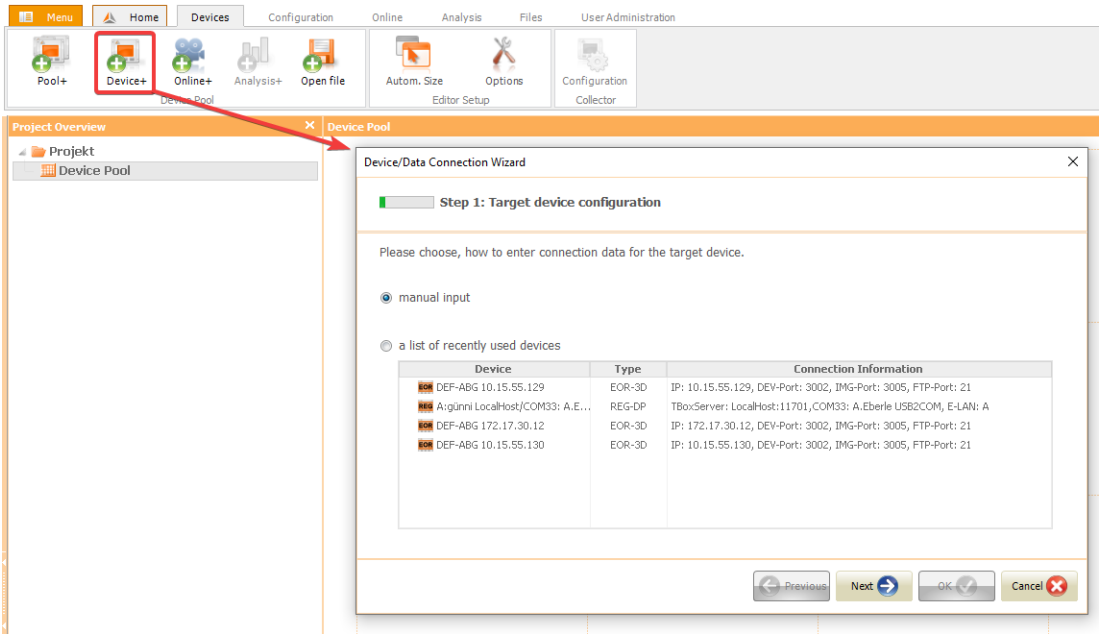


Figure 45: Step 1 Device/Data Connection Wizard: Target device configuration

In step 2 the device type is selected.

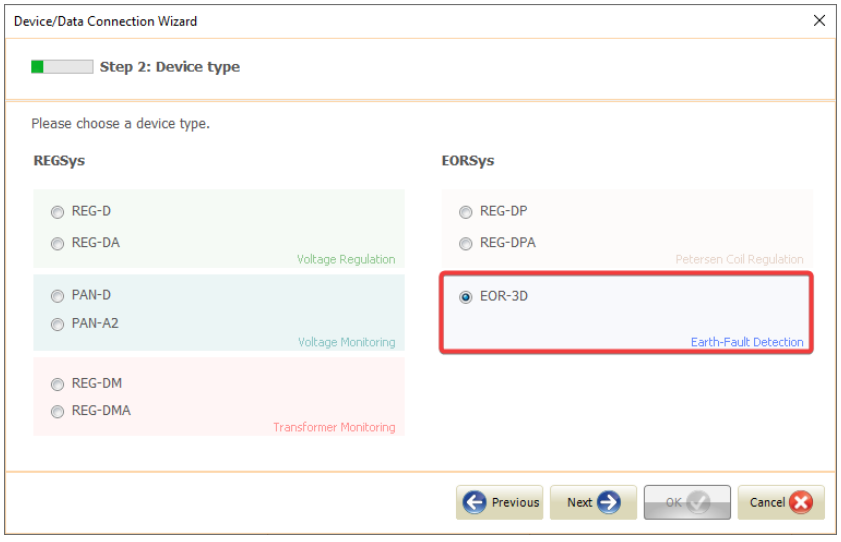


Figure 46: Step 2 Device/Data Connection Wizard: Device type

In step 3 the IP-address of the EOR-3DS can either be set directly (manually) or an automatic identification in the network with an UDP broadcast can be initiated.

For slow data connections for example GSM/LTE and connections via gateways (also the case for GSM/LTE connections) please choose the option ‘slow data connection’. The timeouts are increased and FTPS connections via gateways are possible.

For a succssful communication between AEToolbox and EOR.3DS the following ports on the used PC must be available:

- Port 3002 for TCP interpreter
- Port 3005 for GUI picture
- Port 21 for FTPS
- According FTP passive ports for FTPS: default 1024 to 1124

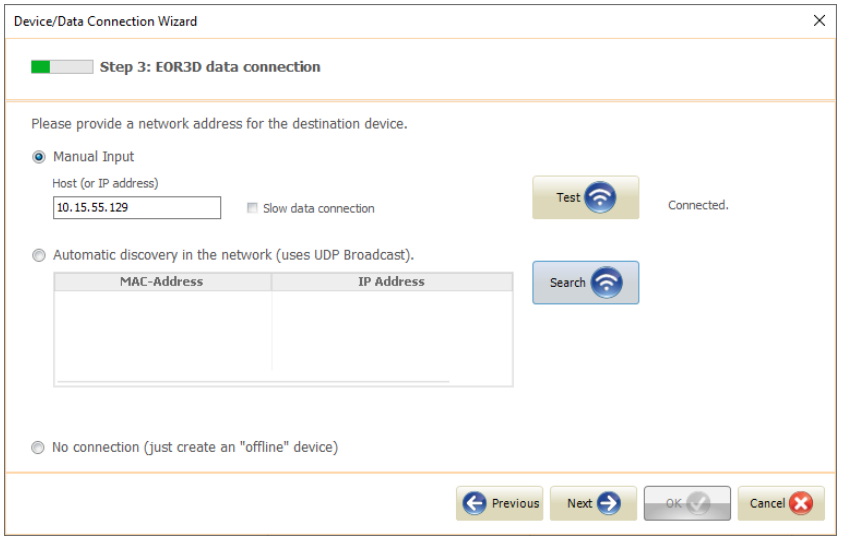


Figure 47: Step 3 Device/Data Connection Wizard: EOR-3DS data connection

In the last step the AEToolbox verifys the connection to the device and shows basic information of the onnected device, for example the serial number and firmware version.

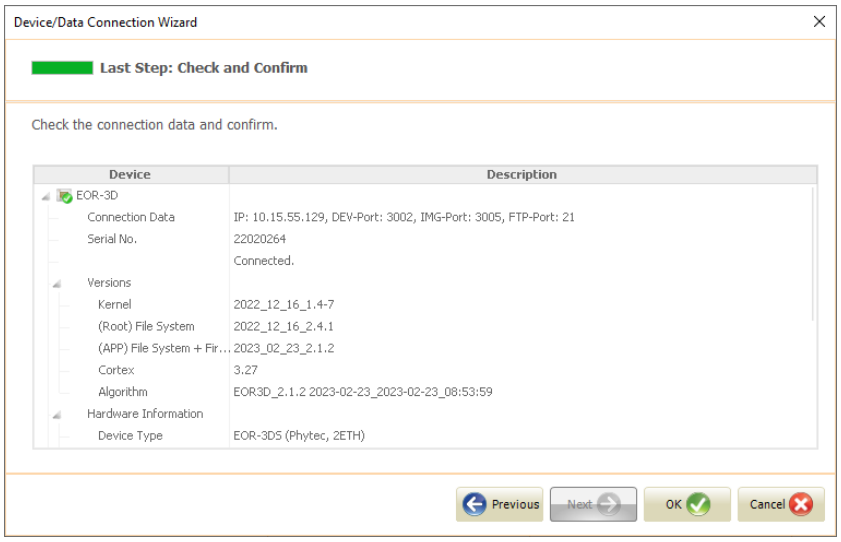


Figure 48: Last step Device/Data Connection Wizard: Check and Confirm

With a successful connection the device is added to the active device pool with 'OK'. A new device widget appears with the feeder and IP-address as device name incl. the serial number in the right bottom (SN: xxx).

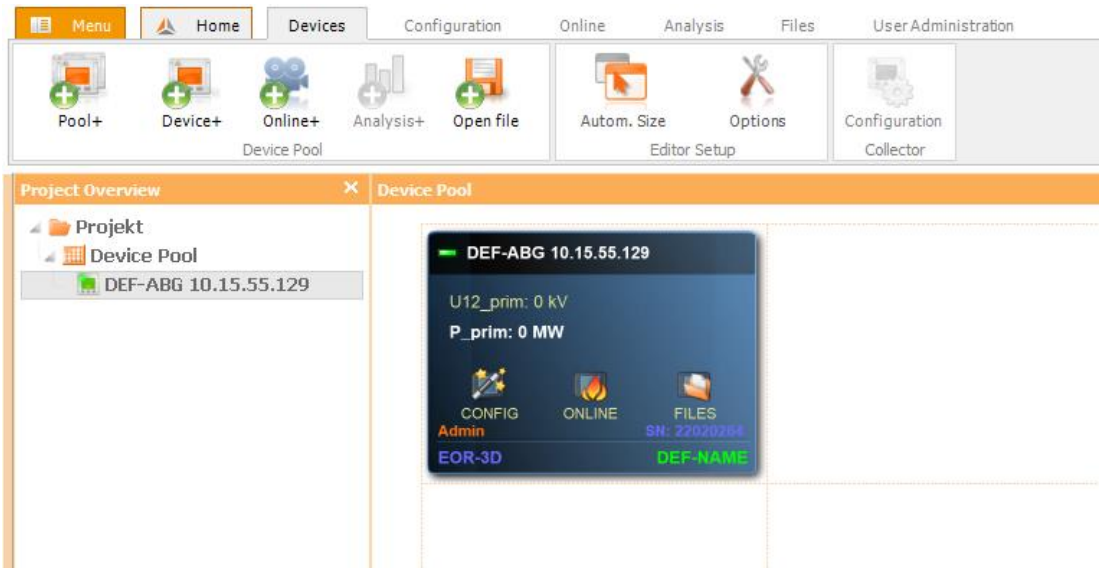


Figure 49: EOR-3DS device widget in the device pool

8.4.3 Open the parameter set

The parameter set is opened with the tab ‘Configuration’ or in the device pool over the icon ‘CONFIG’ in the device tile. When the parameter set is opened the first time, the device feature wizard appears.

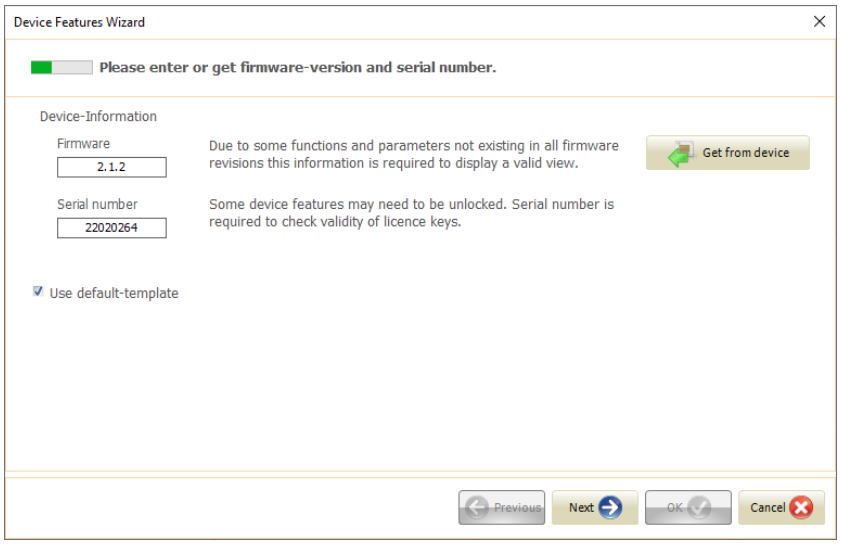


Figure 50: Device Features Wizard

On the second page of the device feature wizard the hardware characteristics of the device are set. When a device is connected the hardware type is set automatically, in case of an offline-device you have to choose the correct hardware version.

On the last page of the device feature wizard the software features for the device are set and the currently available licenses are displayed.

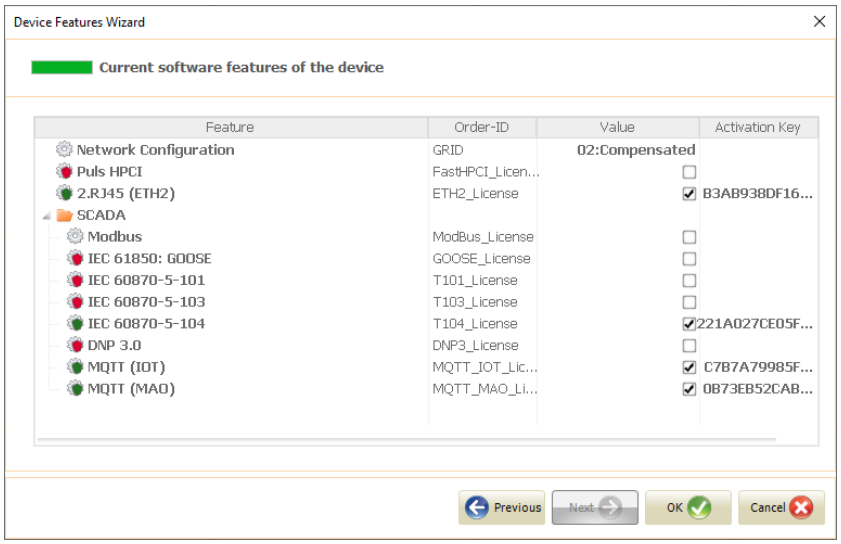


Figure 51: General settings for the Parameter view

Licensed features have a red (locked) or green (unlocked) symbol. The Modbus protocol is free to use. The licenses are, when ordered, activated when delivered. It is also possible to activate licenses afterwards. Also more than one license and protocol can be active and used at the same time. For questions please contact the A. Eberle headquarter.

The following functions are behind the individual items

General	Selection option	Function	
Network configuration	• Compensated • Isolated • Solidly earthed	Here you can make a preselection for the locating procedures that make sense with your network configuration	Depending on the network configuration, unsuitable locating methods are hidden. These methods are actively set to OFF in the background
2. RJ45 (ETH2)	• ON/OFF	Activation of the second rear side Ethernet port	The second Ethernet port is available on all devices and can be activated afterwards at every time.
SCADA	• ON/OFF	• None • MODBUS • DNP 3.0 • IEC 61850:GOOSE • IEC 60870-5-101 • IEC 60870-5-103 • IEC 60870-5-104 • MQTT (IOT) • MQTT (MAO)	All non-preselected protocols are actively set to OFF.

After that the tab ‘Configuration’ opens with a new parameter set depending on the selected features. The default parameter set for the device is included. With the ‘Download’ button the current parameter set of the connected EOR-3DS is loaded to the AEToobox.

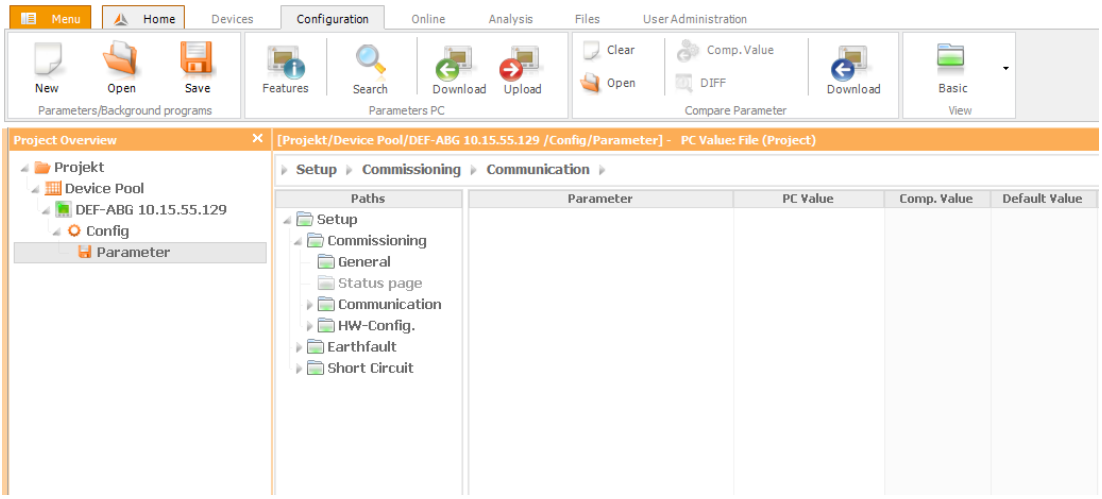


Figure 52: Tab ‘Configuration’

8.4.4 Sending parameters to the EOR-3DS

After opening an existing parameter set or changing parameters, the parameters can be uploaded to the device with the ‘Upload’ button.

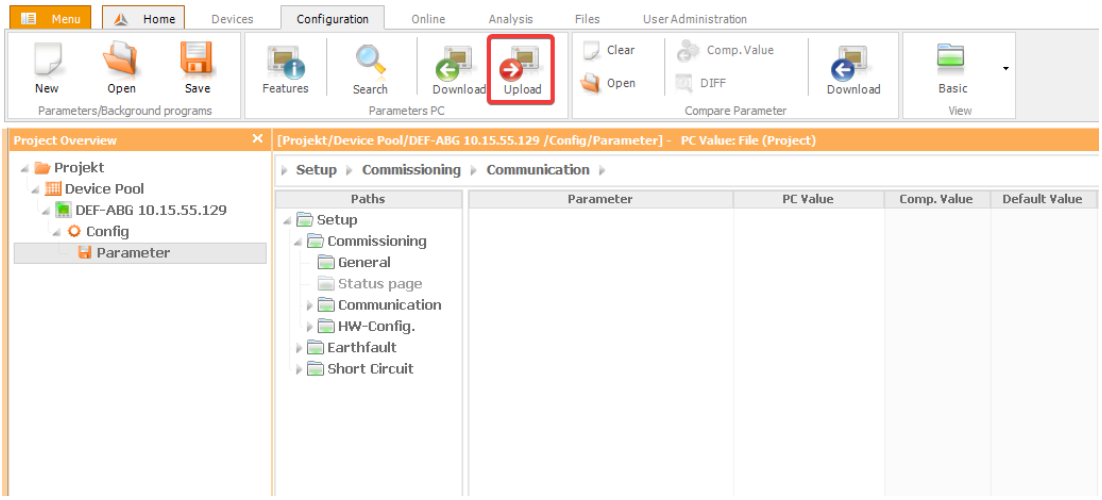


Figure 53: Upload parameters to the device

Then a dialog opens to select which data shall be transferred to the device.

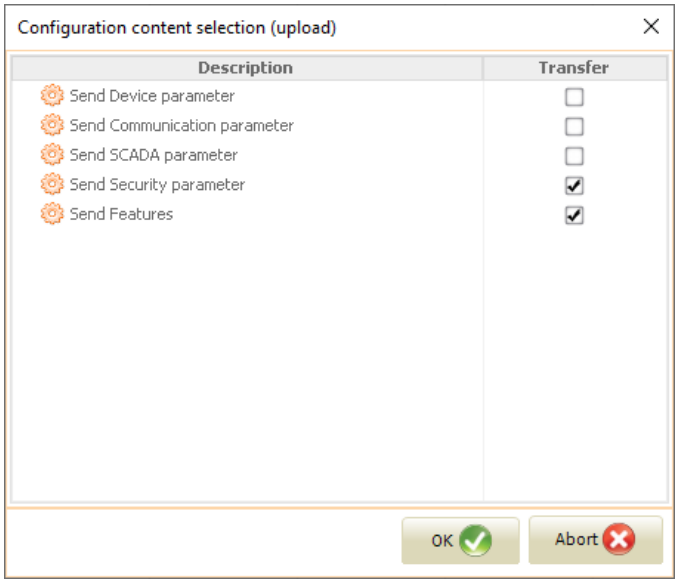


Figure 54: Selecting upload parameters

After that a comparision between the current parameters and the parameters on the device is displayed.

Further information for the parameterization of the EOR-3DS with help of the AEToolbox and information about other functions of the AEToolbox are listed in the specific manuel. The manual is installed with the software and avaiable under www.a-eberle.de in the download menu.

8.4.5 Transfer SCADA files

In the tab ‘Files’ in the path SCADA all SCADA files are listed, in which the individual indications and commands for every protocal are defined. Adress modifications and detailed settings for every data point can be done in the according CSV or XML file.

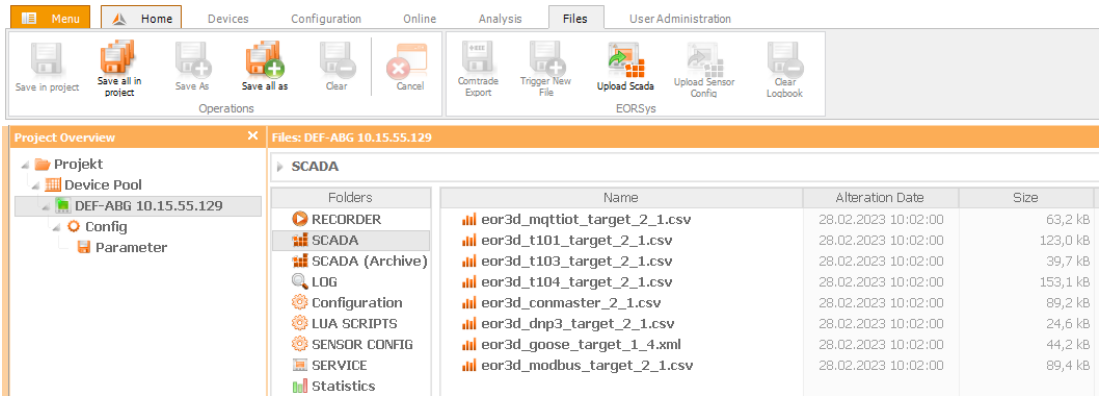


Figure 55: Overview file browser SCADA

The file names for the according SCADA files can be changed for versioning. The files must be in accordance with a given scheme and renamed according to the following table:

Default SCADA file	xxx for free versioning
eor3d_mqttiot_target_2_1.csv	eor3d_mqttiot_xxx.csv
eor3d_t101_target_2_1.csv	eor3d_t101_xxx.csv
eor3d_t103_target_2_1.csv	eor3d_t103_xxx.csv
eor3d_t104_target_2_1.csv	eor3d_t104_xxx.csv
eor3d_dnp3_target_2_1.csv	eor3d_dnp3_xxx.csv
eor3d_conmaster_target_2_1.csv	eor3d_conmaster_xxx.csv
eor3d_modbus_target_2_1.csv	eor3d_modbus_xxx.csv
eor3d_goose_target_2_1.xml	eor3d_goose_xxx.xml

Example:

The adjusted CSV for IEC protocol 60870-5-104 could be for example renamed to ‘eor3d_t104_ONS_Mozartstraße_V04.csv’.

When a new SCADA configuration is uploaded, the current file is moved to the SCADA (‘Archive’) folder.

After uploading a new SCADA file the SCADA protocol is restarted by the AEToolbox to apply the changes. This is done automatically. Furthermore the SCADA protocols can be stopped or started via the parameterization manually.

8.4.6 Downloading logbooks

In the tab ‘Files’ in the path ‘LOG’ it is possible to access the logbooks of the device. With the button ‘Save all in project’ the logs are downloaded from the device and are saved in the project overview. There they can be opened or saved as files.

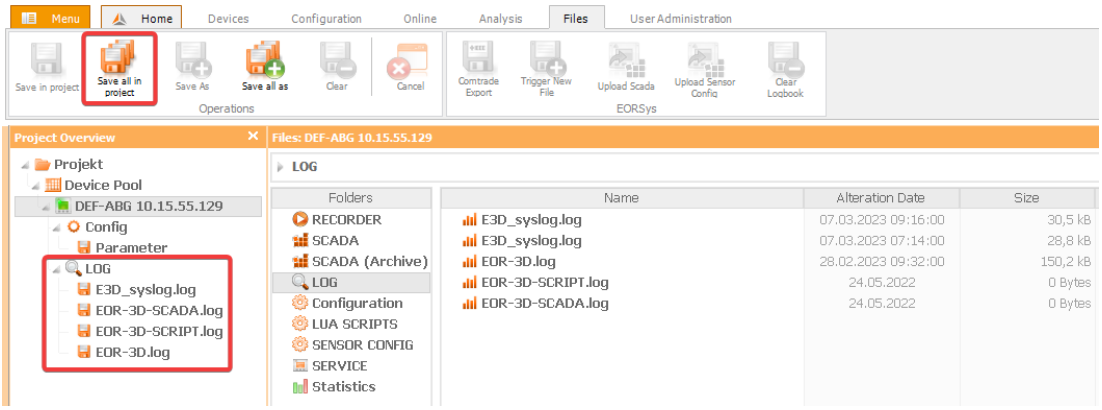


Figure 56: Logbooks in the AEToolbox

8.4.7 Firmware update EOR-3DS

With the AEToolbox it is possible to update the firmware on a EOR-3DS. For this the device must be selected with a right-hand click in the device pool. Under **Device Functions/Firmware Update** a dialog opens to select the firmware folder.

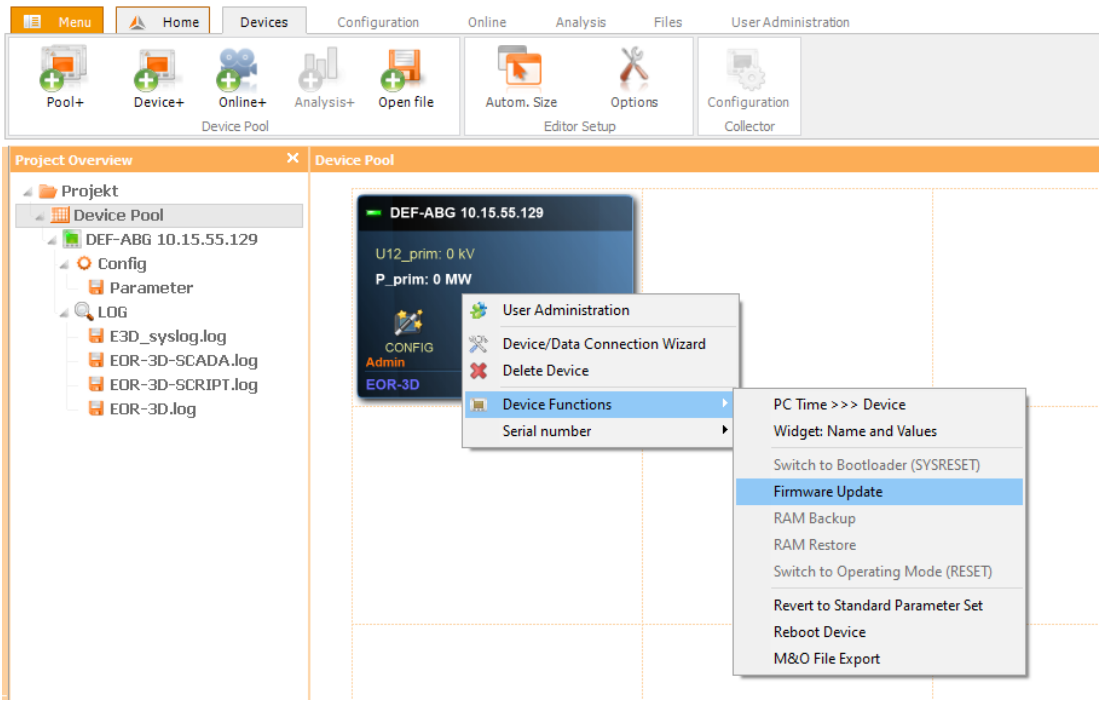


Figure 57: firmware Update with AEToolbox

The current firmware is available on our Hompage in the download center under www.a-eberle.de.

8.4.8 Create Management & Operations parameter files (M&O file export)

EOR-3DS devices can be managed centrally with a IoT Software (MQTT Management & Operations). This means firmware and parameter updates can be performed without the AEToolbox for a various amount of EOR-3DS devices at the same time.

The parameter files are created with the parameterization software AEToolbox and can be exported as Management & Operations files (M&O files). Afterward a M&O file is loaded in ZIP format into the IoT software and is distributed to all devices which are connected to the IoT software.

To create the M&O file the device is selected with right-hand click in the device pool. Under **Device Functions** the **M&O File Export** mus be selected. Afterwards a dialog comes up, to define the files for the M&O export.

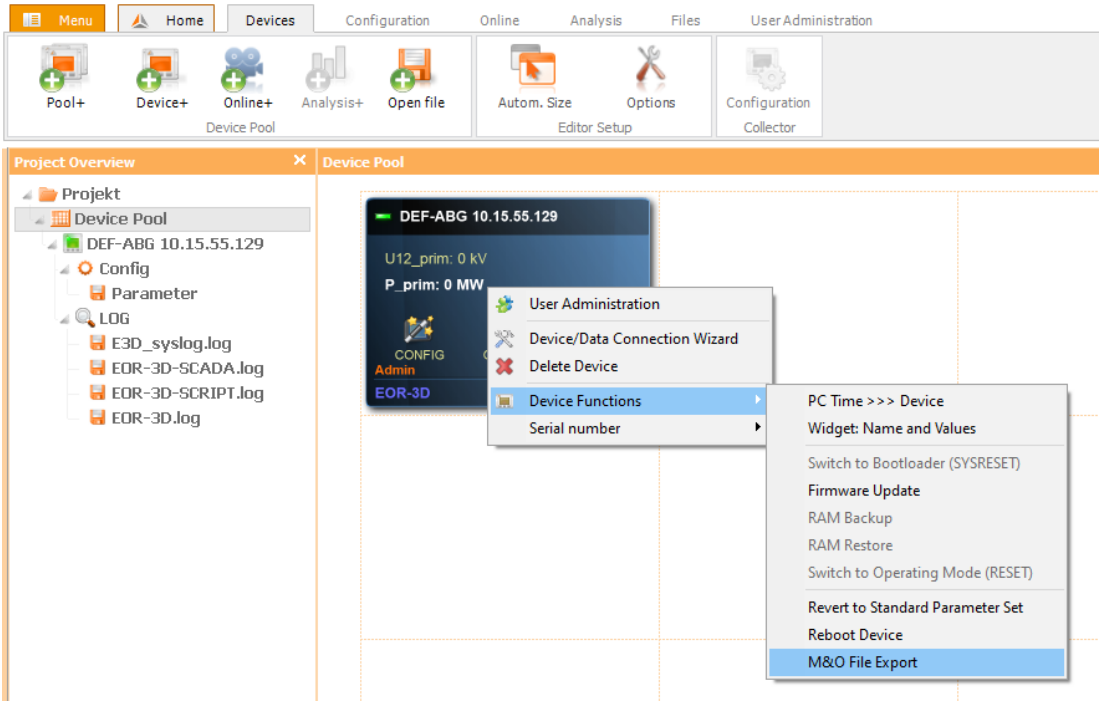


Figure 58: M&O File Export with AEToolbox

In the selection window of the 'M&O File Export' all or only individual files from the EOR-3DS device which are included in the project are selected. Only the files in the project, not the parameter settings of the connected device itself are used.

The M&O file export is only available when the connected device is online. Make sure, the firmware of the device which is connected to the AEToolbos has the same firmware, that the devices connected with the IoT Software have or shall get. This ensures the parameter scope of the parameter sets are identical.

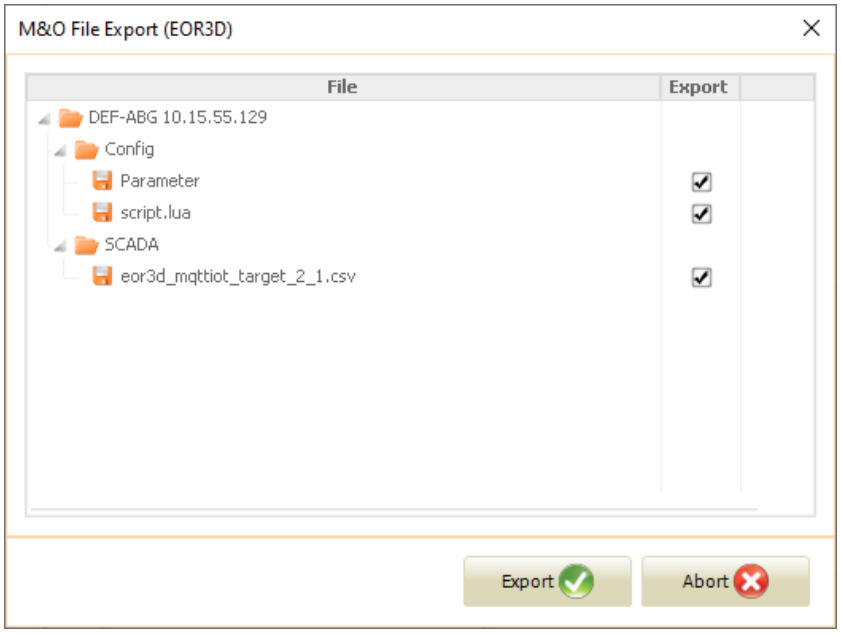


Figure 59: Selecting the files for M&O file export

9. Settings / Parameter detail view

This chapter describes the function of each individual parameter of the EOR-3DS device.

9.1 Setup

The EOR-3DS must be matched to the system or network in question through appropriate settings. The following section provides a description of the parameters, likewise tips are given for determining the setting data. The parameter sequence corresponds to the arrangement in the menu tree and in the configuration software AEToolbox.

Below the parameters are described as they occur in the configuration software environment.

The following function groups are found in the ‘Setup’ menu tree:

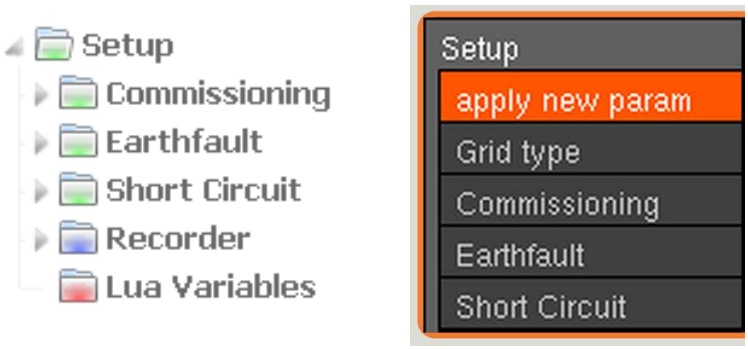


Figure 60: Setup menu in AEToolbox and on the device panel

On the device there is the additional point ‘apply new param’. With this option all changed parameters are applied (also see chapter 7.2.4). IP-adresses are applied directly after changing.

The grid type is selected in the AEToolbox in the device features wizard (last page ‘Software Features of the device’).

9.2 Commissioning menu

The function group ‘Commissioning’ includes general settings as well as the configuration of the communication settings, SCADA, Scriptserver, ConMaster (Modbus-Master) and the hardware configuration.

Figure 61: Commisioning menu in AEToolbox

9.2.1 General menu

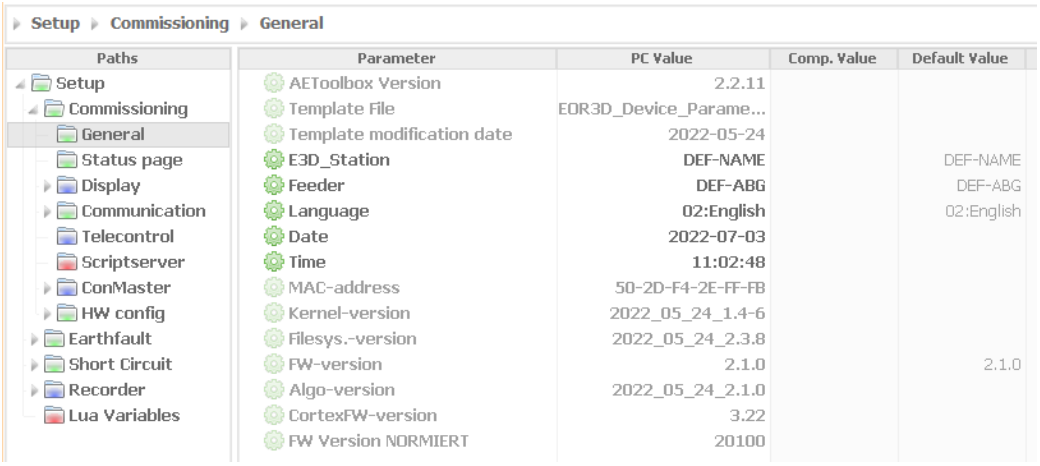


Figure 62: Menu general

E3D_Station
Specification of a station name is possible (Warning: only use Windows-conformant characters. Maximum 40 characters)
Feeder
Specification of a specific feeder, e. g. the field identifier J01
Language
Switching the device language (German or English)
Hardware information from the EOR-3DS (changeable)
Date
Time
Hardware and firmware information from the EOR-3DS (not changeable)
MAC-Address
Kernel-Version
Filesys.-Version
FW-Version
Algo-Version
CortexFW-Version
FW Version NORMIERT

9.2.2 Status page

Figure 63: Status page

Specific information from the EOR-3DS (not changeable)
Article No.
Serial No.
Order No.
Date
Inspector

9.2.3 Display

Under the menu item Display the settings that affect the displaying of measurement values can be found. The LED texts and the display timeout can also be adjusted here.

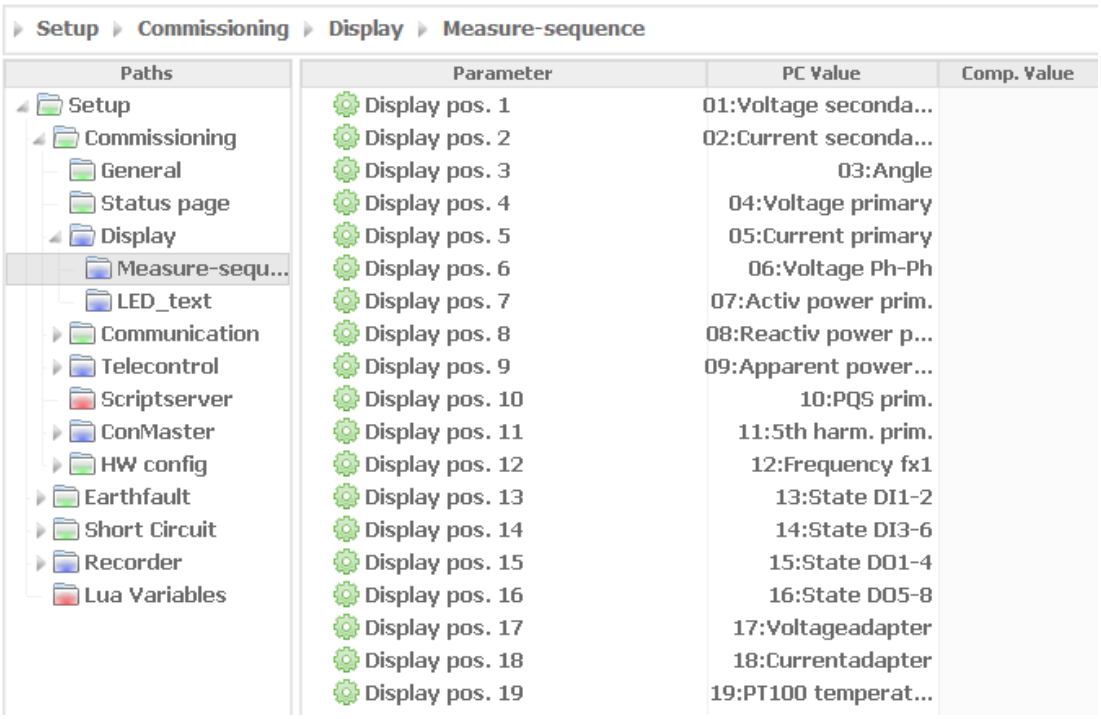


Figure 64: Parameter view Measure sequence

Measure sequence
Here the sequence of the measurement value pages in the device display view can be freely defined. When less measurement pages than the maximum amount of pages should be displayed, single display positions can be deactivated with '00:none'.

The display '16: State DO5-8' is not available on the EOR-3DS, because the device has only 4 relays. The display position is automatically skipped on the device.

The display '19: PT100' is only displayed on devices with Siemens measurement card (order characteristic C31/U31).

LED_Text

This parameter allows a freely configurable text to be entered for the 4 LEDs in the display. The text must not exceed 4 lowercase letters or 3 uppercase letters.

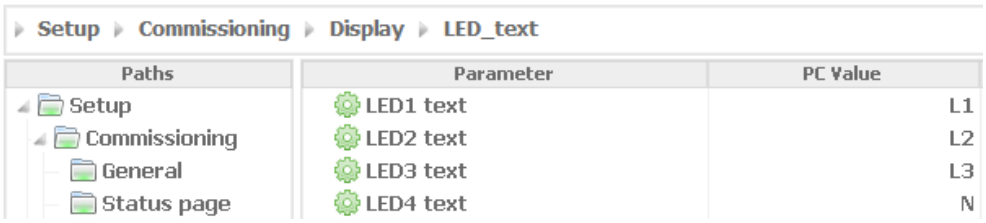


Figure 65: Configuration of LED texts

Display Timeout

This parameter allows to set the display timeout.

Figure 66: Display timeout

9.2.4 Communication

The communication settings for the EOR-3DS are made under this menu item. This relates to the IP-configuration of the Ethernet interfaces, the firewall settings, settings regarding time synchronization and parameters of the RS485 interface.

9.2.4.1 IP configuration

After changing of gateway adresses the EOR-3DS has to be restartet, in order to overtake all settings.

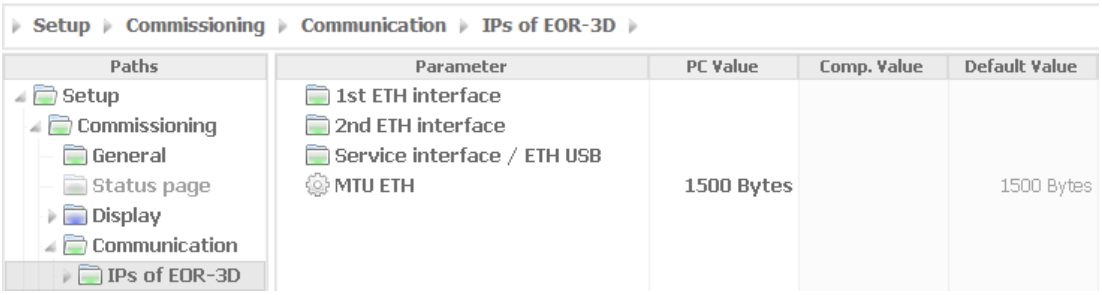


Figure 67: EOR-3DS IP configuration

1st ETH interface

Configuration of the 1. Ethernet inteface (ETH0) of the device.

IP address
Setting of the IP address for 1. backside network interface port (ETH0)
IP Mask
Configuration of the subnet mask
Gateway
Configuration of an Ethernet gateway

2. ETH interface

The 2. Ethernet interface (ETH2) for the EOR-3DS is activated with the order characteristic ‘P1’. It can also be acitvated afterwards with a license. For further information please contact the A. Eberle headquarter.

2nd ETH active
Activation of the second backside Ethernet port (ETH2)

2. ETH IP-Config

Configuration of the 2. Ethernet interface (ETH2) of the device.

IP address
Setting of the IP address for 2. backside network interface port (ETH2)
IP Mask
Configuration of the subnet mask
Gateway
Configuration of an Ethernet gateway

- **Service-Interface**

ETH service active
Activates the service Ethernet interface

Service-Interface IP-Config

Configuration of the Service-Interface of the device.

IP address
Setting of the IP address for frontside Ethernet interface
IP Mask
Configuration of the subnet mask
Gateway
Configuration of an Ethernet gateway

- **MTU ETH**

MTU
Configuration of the maximum transmission unit

- **IP DNS**

IP DNS
Configuration of IP DNS

9.2.4.2 Security

After changing parameters in the folder security the device must be restarted to apply all changed parameters.

Configuration of all paramters according to firewall, FTP-security and factory reset.

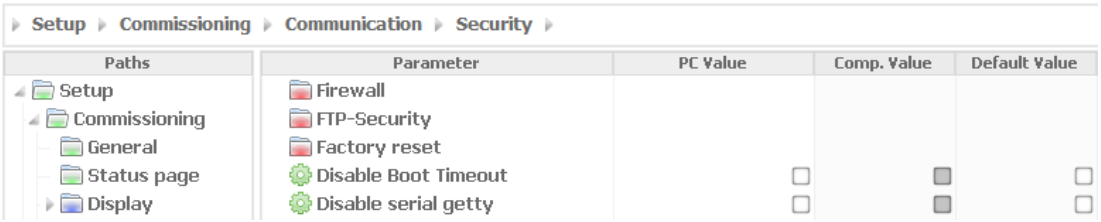


Figure 68: Security settings for EOR-3DS

Firewall

By default, the firwall should be deactivated to avoid connection problems.

Figure 69: Parameterization of the firewall

Disable firewall	Settings
Disable the firewall.	yes (default) / no

Firewall config

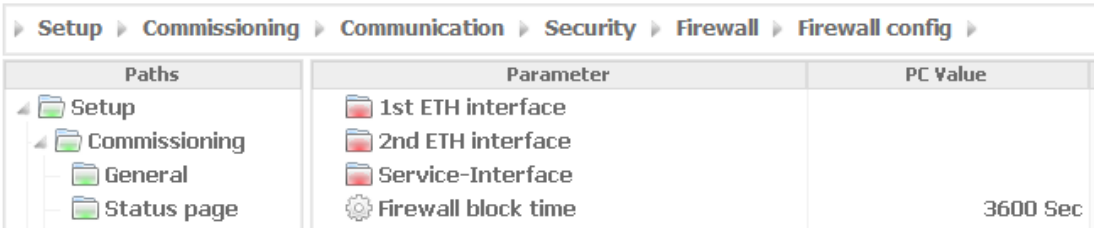


Figure 70: Parameterization of the firewall configuration

1st ETH interface / 2nd ETH interface / Service-Interface

Device communication allowed	Settings
Allows the device communication via the respective Ethernet interface	yes (default) / no
SSH allowed	
Allows communication over SSH	yes (default) / no
VNC allowed	
Allows communication over VNC	yes (default) / no
Modbus allowed	
Allows communication over Modbus	yes (default) / no
IEC 104 allowed	
Allows communication over IEC 104	yes (default) / no
DNP3 allowed	
Allows communication over DNP3	yes (default) / no

Network configuration

Network conf. active	Settings
Network configuration of firewall of respective Ethernet interface activation	yes / no (default)
FW network	
Allowed network address	0.0.0.0 (default)
FW Netmask	
Allowed netmask	0.0.0.0 (default)

Firewall block time

Firewall block time	Settings
Setting for the time for the deactivation of the network port in seconds in case of an registered attack.	0 to 86400 s 3600 s (default)

- **FTP-Security**

Disable PASV security check	Settings
Disable FTP PASV security check	yes / no (default)

- **Factory reset**

It is possible to define for the factory reset, whether the panel password is resetted or whether the panel password remains unchanged after a factory reset.

User password reset	Settings
The panel user (read-only user) password is resetted to the default value (‘0000’) or remains the set password after a factory reset, depending on the parameter.	yes (default → ‘0000’) / no
Operator password reset	
The operator user (read-write user) password is resetted to the default value (‘0000’) or remains the set password after a factory reset, depending on the parameter.	yes (default → ‘0000’) / no

- **Disable Boot Timeout**

Disable Boot Timeout	Settings
Disable the boot timeout, to interrupt the device while booting.	yes / no (default)

- **Disable serial getty**

Disable serial getty	Settings
Disable the serial service Ethernet.	yes / no (default)

9.2.4.3 Time configuration (time synchronisation of the EOR-3DS)

Time zone setting in the EOR-3DS takes place using Linux Syntax. I.e. the entry is made in plain text.

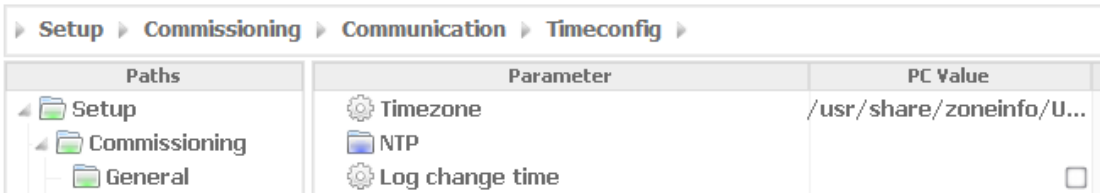


Figure 71: Time configuration

- **Time zone**

  Time zone setting in which the EOR-3DS is used. Below typical parameters are shown for various time zones.

You can find the complete list of time zones under
https://en.wikipedia.org/wiki/List_of_tz_database_time_zones

Time zone	UTC offset	UTC DST offset (daylight saving time)	Parameter (setting)
UTC	+00:00	+00:00	**/usr/share/zoneinfo/UTC (default value)**
Europe/Dublin	+00:00	+01:00	/usr/share/zoneinfo/Europe/Dublin
Europe/Berlin	+01:00	+02:00	/usr/share/zoneinfo/Europe/Berlin
Africa/Johannesburg	+02:00	+02:00	/usr/share/zoneinfo/Africa/Johannesburg
Europe/Helsinki	+02:00	+03:00	/usr/share/zoneinfo/Europe/Helsinki
Asia/Qatar	+03:00	+03:00	/usr/share/zoneinfo/Asia/Qatar
Iran	+03:30	+04:30	/usr/share/zoneinfo/Iran
Europe/Moscow	+04:00	+04:00	/usr/share/zoneinfo/Europe/Moscow
Asia/Dubai	+04:00	+05:00	/usr/share/zoneinfo/Asia/Dubai
Asia/Kabul	+04:30	+04:30	/usr/share/zoneinfo/Asia/Kabul
Asia/Tashkent	+05:00	+05:00	/usr/share/zoneinfo/Asia/Tashkent
Antarctica/Davis	+05:00	+07:00	/usr/share/zoneinfo/Antarctica/Davis
Asia/Kolkata	+05:30	+05:30	/usr/share/zoneinfo/Asia/Kolkata

Time zone	UTC offset	UTC DST offset (daylight saving time)	Parameter (setting)
Asia/Kathmandu	+05:45	+05:45	/usr/share/zoneinfo/Asia/Kathmandu
Asia/Dhaka	+06:00	+06:00	/usr/share/zoneinfo/Asia/Dhaka
Asia/Rangoon	+06:30	+06:30	/usr/share/zoneinfo/Asia/Rangoon
Asia/Bangkok	+07:00	+07:00	/usr/share/zoneinfo/Asia/Bangkok
Australia/West	+08:00	+08:00	/usr/share/zoneinfo/Australia/West
Australia/Eucla	+08:45	+08:45	/usr/share/zoneinfo/Australia/Eucla
Japan	+09:00	+09:00	/usr/share/zoneinfo/Japan
Australia/North	+09:30	+09:30	/usr/share/zoneinfo/Australia/North
Australia/South	+09:30	+10:30	/usr/share/zoneinfo/Australia/South
Australia/Queensland	+10:00	+10:00	/usr/share/zoneinfo/Australia/Queensland
Australia/Sydney	+10:00	+11:00	/usr/share/zoneinfo/Australia/Sydney
Australia/LHI	+10:30	+11:00	/usr/share/zoneinfo/Australia/LHI
Antarctica/Casey	+11:00	+08:00	/usr/share/zoneinfo/Antarctica/Casey
Pacific/Kosrae	+11:00	+11:00	/usr/share/zoneinfo/Pacific/Kosrae
Pacific/Norfolk	+11:30	+11:30	/usr/share/zoneinfo/Pacific/Norfolk
Pacific/Wake	+12:00	+12:00	/usr/share/zoneinfo/Pacific/Wake
New Zealand	+12:00	+13:00	/usr/share/zoneinfo/NZ
Pacific/Chatham	+12:45	+13:45	/usr/share/zoneinfo/NZ-CHAT
Pacific/Enderbury	+13:00	+13:00	/usr/share/zoneinfo/Pacific/Enderbury
Pacific/Apia	+13:00	+14:00	/usr/share/zoneinfo/Pacific/Apia
Pacific/Kiritimati	+14:00	+14:00	/usr/share/zoneinfo/Pacific/Kiritimati
Atlantic/Cape_Verde	-01:00	-01:00	/usr/share/zoneinfo/Atlantic/Cape_Verde
Atlantic/Azores	-01:00	+00:00	/usr/share/zoneinfo/Atlantic/Azores
Atlantic/South_Georgia	-02:00	-02:00	/usr/share/zoneinfo/Atlantic/South_Georgia
America/Buenos_Aires	-03:00	-03:00	/usr/share/zoneinfo/America/Buenos_Aires

Time zone	UTC offset	UTC DST offset (daylight saving time)	Parameter (setting)
America/Montevideo	-03:00	-02:00	/usr/share/zoneinfo/America/Montevideo
America/Puerto_Rico	-04:00	-04:00	/usr/share/zoneinfo/America/Puerto_Rico
Atlantic/Bermuda	-04:00	-03:00	/usr/share/zoneinfo/Atlantic/Bermuda
America/Cayman	-05:00	-05:00	/usr/share/zoneinfo/America/Cayman
America/Eastern Time	-05:00	-04:00	/usr/share/zoneinfo/EST
America/Regina	-06:00	-06:00	/usr/share/zoneinfo/America/Regina
US/Central	-06:00	-05:00	/usr/share/zoneinfo/US/Central
Mountain Standard Time	-07:00	-07:00	/usr/share/zoneinfo/MST
Canada/Mountain	-07:00	-06:00	/usr/share/zoneinfo/Canada/Mountain
Pacific/Pitcairn	-08:00	-08:00	/usr/share/zoneinfo/Pacific/Pitcairn
Pacific Time	-08:00	-07:00	/usr/share/zoneinfo/US/Pacific
Pacific/Gambier	-09:00	-09:00	/usr/share/zoneinfo/Pacific/Gambier
US/Alaska	-09:00	-08:00	/usr/share/zoneinfo/US/Alaska
Pacific/Marquesas	-09:30	-09:30	/usr/share/zoneinfo/Pacific/Marquesas
Hawaii Time Zone	-10:00	-10:00	/usr/share/zoneinfo/HST
America/Adak	-10:00	-09:00	/usr/share/zoneinfo/America/Adak
Pacific/Midway	-11:00	-11:00	/usr/share/zoneinfo/Pacific/Midway

- **NTP (NTP time synchronisation)**

  The EOR-3DS supports time synchronisation over NTP (***N***etwork ***T***ime ***P***rotocol). Up to two NTP servers can be configured.

NTP1
IP address of NTP server 1
NTP2
IP address of NTP server 2

- **Log change time**

Log change time	
Log change of system time	yes / no (default)

9.2.4.4 Configuration of the RS485 COM2 ports

The RS485 interface is configured under this menu item.

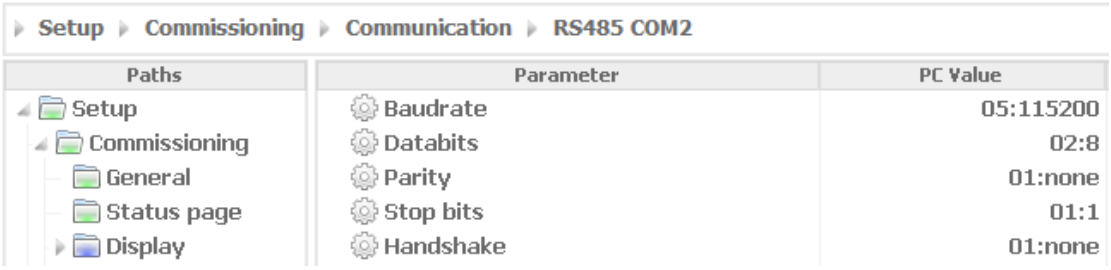


Figure 72: Configuring the COM ports

Baud rate
Baud rate for the RS485 interface (115200, 57600, 38400, 19200, 9600)
Data bits
Number of data bits 7 or 8
Parity
Parity setting: none, odd, even
Stop bits
Stop bit setting 1, 1.5 or 2
Handshake
Handshake setting: none, XON/XOFF (software), RTS/CTS (hardware)

9.2.5 Telecontrol

The menu item ‘Telecontrol’ contains the settings for the SCADA protocols of EOR-3DS. The following protocols are available for the user depending on the order characteristic ‘T’ and their activation in the device features wizard.

- Modbus
- IEC60870-5-101
- IEC60870-5-103
- IEC60870-5-104
- IEC61850 GOOSE
- DNP 3.0
- MQTT (IOT)
- MQTT (MAO – Management & Operations)

The SCADA protocols are linked to a licence key and are only displayed in the parameter menu when the according licence key is available and the protocol is activated in the feature wizard, as displayed in the picture below. The only exception is the Modbus protocol, which can be activated at every time without license.

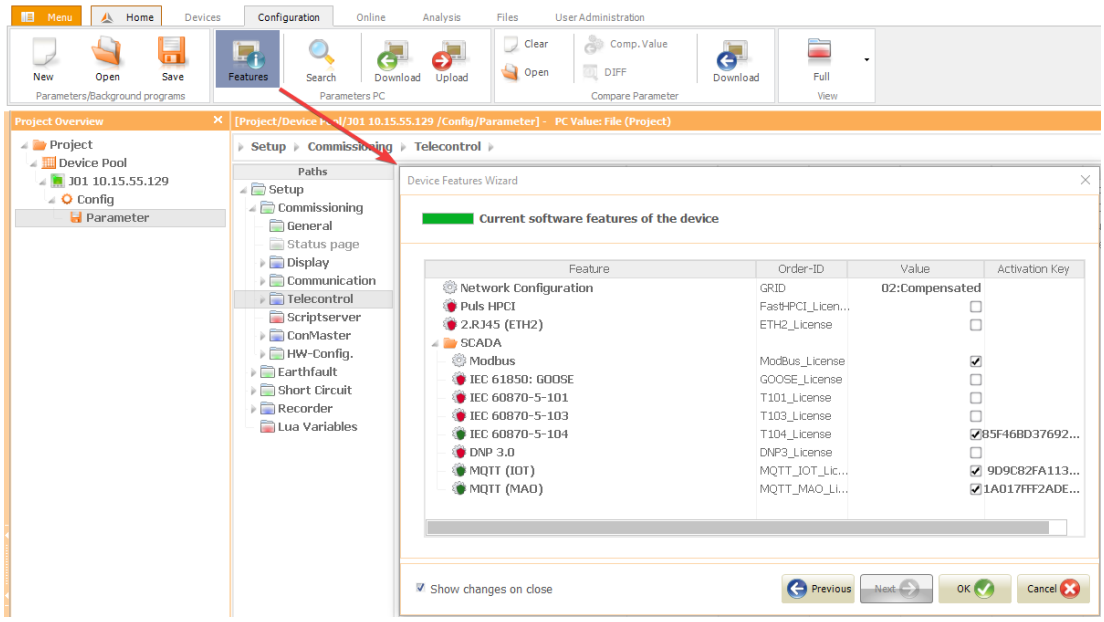


Figure 73: Device feature wizard with activated Modbus, -104, MQTT (IoT) and MQTT (MAO) protocol

Detailed description of the SCADA protocols, settings and the according CSV or XML SCADA files for describing the amount of data are available on out homepage under www.a-eberle.de.

9.2.5.1 Modbus protocol

Parameter	PC Value	Comp. Value	Default Value	Lower Limit	Upper Limit
Modbus active	☑	☐	☐		
Protocol	03:RTU RS48...		03:RTU RS485...		
TCP/IP-port	502		502	0	65.535
Slave-ID	11		11	0	247
Storage time	100 ms		100 ms	0	60.000
Reply delay time	10 ms		10 ms	0	10.000
Call monitoring time	10000 ms		10000 ms	0	600.000
Timesync monitoring time	24 h		24 h	1	24

Figure 74: Default settings SCADA protocol Modbus

Modbus active
Activation of the Modbus protocol
Protocol
This option is used to specify over which physical interface the protocol is transferred: OFF, TCP/IP, RTU RS485
TCP/IP port
TCP/IP port setting
Slave-ID
Slave-ID setting
Storage time
Storage time setting
Reply delay time
Reply delay time setting
Call monitoring time
Call monitoring time setting
Timesync monitoring time
Timesync monitoring time setting

9.2.5.2 IEC 6870-5-101 protocol

Parameter	PC Value	Comp. Value	Default Value	Lower Limit	Upper Limit
T101 active	☑	☐	☐		
T101 Port	02:RS485 CO...		02:RS485 COM2		
T101 STATION CA	1		1	0	65.535
T101 PI update	☐	☐	☐		
T101 config					

Figure 75: Default settings SCADA protocol IEC 60870-5-101

T101 active
Activation of the T101 protocol
T101 interface
This option is used to specify over which physical interface the protocol is transferred. OFF, RS485
T101 Station CA
Station address setting for the T101 protocol
T101 PI (Process Image) update
This parameter can be used to deactivate the deviation set in the control system file (*.csv).

▶ **T101 Config**

- T101 App.Layer

T101 COT Fieldl.
Setting for the Cause of Transmission (COT) field length: Selection: 1 / 2
T101 CA Fieldl.
Setting for the ASDU field length: Selection: 1 / 2
T101 IOA Fieldl.
Address length of the Information Object Address (IOA) Selection: 1/2/3

If the IOA address length is changed, the corresponding csv file (data point list) has to be changed as well.

- T101 Link Layer

T101 bal./unbal.
The type of data transfer is selected here: Unbalanced (unsymmetric), Balanced (symmetric)
T101 Dir Bit
This parameter is used to set the Direction Bit: 0: Balanced and unbalanced 1: Balanced
T101 Addr Fieldl.
This parameter is used to set the address field length. 0: Balanced 1: Balanced and unbalanced 2: Balanced and unbalanced
T101 Addr.
T101 address setting

9.2.5.3 IEC 60870-5-103 protocol

Parameter	PC Value	Comp. Value	Default Value	Lower Limit	Upper Limit
T103 active	☑	☐	☐		
T103 Port					
T103 STATION CA	1		1	0	255
T103 PI update	☐	☐	☐		

Figure 76: Default settings SCADA protocol IEC 60870-5-103

T103 active
Activation of the T103 protocol
T103 port
This option is used to specify over which physical interface the protocol is transferred: OFF, RS485
T103 Station CA
Station address setting for the T103 protocol
T103 PI (Process Image) update
This parameter can be used to deactivate the deviation set it the control system file (*.csv).

9.2.5.4 IEC 60870-5-104 protocol

Parameter	PC Value	Comp. Value	Default Value	Lower Limit	Upper Limit
T104 active	☑	☐	☐		
T104 Eth.(SYS/ETH USB)	01:System Et...		01:System Eth...		
T104 STATION CA	1		1	0	65.535
T104 TCP/IP Port	2404		2404	0	65.535
T104 timeo. param.					
T104 allowed IP	0.0.0.0		0.0.0.0		
T104 PI update	☐	☐	☐		
T104 IP bind	☐	☐	☐		
T104 redundancy					

Figure 77: Default settings SCADA protocol IEC 60870-5-104

T104 active
Activation of the T104 protocol
T104 Eth.(SYS/USB)
This option is used to specify over which Ethernet interface the protocol is transferred: System Ethernet (ETH0), Service-Ethernet (Front), 2. Ethernet (ETH2)
T104 Station CA
Station address setting for the T104 protocol
T104 TCP/IP Port
TCP/IP setting for the interface
T104 allowed IP
Setting of a T104 Client IP address
T104 PI update
This parameter can be used to deactivate the deviation set it the control system file (*.csv).
T104 IP Bind
When using a redundancy, this parameter must be set

T104 Timeo.Parameter

This parameter set contains specific parameters for the T104 protocol (link layer).

t0
This parameter determines how long the control centre waits for a connection
t1
This parameter determines how long the sender waits for an acknowledgement
t2
The telegram is acknowledged by the receiver no later than after this set time.
t3
After the configured time a test telegram is sent, provided there is no data traffic.
k
This parameter determines the maximum number of telegrams the sender transmits until it waits for the acknowledgement.
w
This parameter determines after how many telegrams the receiver sends an acknowledgement.

In the IEC60870-5-104 protocol, these parameters represent standard values, therefore they should not be altered.

- **T104 Redundancy 1 – 4**

The EOR-3DS has up to four parameterizable instances (slaves).

The parameters for the instances 1 – 4 are identical.

Red. TCP/IP Port
TCP/IP port for the redundancy (slave)
Red. x active
Activates the redundancy

- **Red IPs EOR-3DS**

Red. IP address
Permissible IP address for the respective redundancy. If an IP address is set to 0.0.0.0, then it causes a search in all networks.
Red. Mask
Subnetwork mask for one redundancy (slave)
Red. Gateway
Gateway IP address for one redundancy (slave)
Red.permitted IP
Permitted client IP address

9.2.5.5 DNP3 protocol

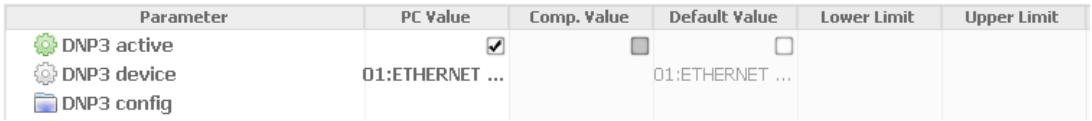


Figure 78: Default settings SCADA protocol DNP3

DNP3 active
Activation of the DNP3 protocol
DNP3 device
This option is used to specify over which physical interface the protocol is transferred. Ethernet UDP, Ethernet TCP, RS485

- **DNP3 config**

This parameter set includes the configuration parameter for the DNP3 protocol.

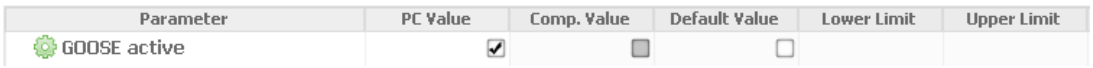
TCP/UPD Port
Setting the TDP/UDP port for the TCP or UDP port
Central stations (IP 1)
Settings of the IP address for the master device (1. IP)
Central stations (IP 2)
Settings of the IP address for the master device (2. IP)
Central stations (IP 3)
Settings for the IP address for the master device (3. IP)
Link address
Link address of the EOR-3DS device
Link address master
Link address of the master station

- **DNP3 Timeouts**

This parameter set includes the seperate timeoutparameter for the DNP3 protocol.

Timeout appl. conf.
Timeout for the apllication confirmation
Timeout Sel. Oper.
Timeout for ‘select and operate’ control (SBO – select before operate)
Timeout Serial
Timeout between two different characters
Time cold start
Time to restart after performing a cold restart

9.2.5.6 GOOSE protocol

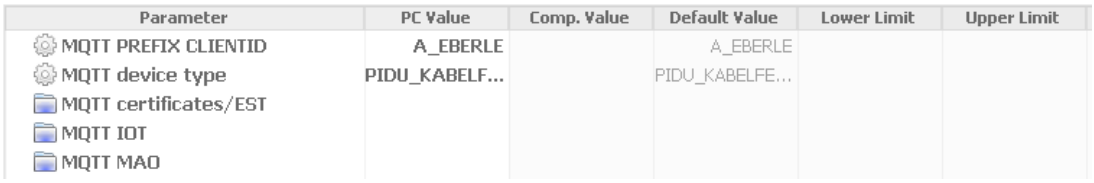


Parameter	PC Value	Comp. Value	Default Value	Lower Limit	Upper Limit
GOOSE active	☑	☐	☐		

Figure 79: default settings SCADA protocol GOOSE

GOOSE active
Activation of the IEC 61850 GOOSE protocol

9.2.5.7 MQTT



Parameter	PC Value	Comp. Value	Default Value	Lower Limit	Upper Limit
MQTT PREFIX CLIENTID	A_EBERLE		A_EBERLE		
MQTT device type	PIDU_KABELF...		PIDU_KABELFE...		
MQTT certificates/EST					
MQTT IOT					
MQTT MAO					

Figure 80: default settings for SCADA profile MQTT IoT and Management & Operations

MQTT Prefix ClientID
For the connection to the MQTT client a unique client ID is needed. A. Eberle is using for this a combination from 'MQTT Prefix Client ID' string, 'MQTT device type' string and the serial number of the device. Example: MQTT Prefix Client ID: A_EBERLE MQTT device type: PIDU_KABELFELD_01 Serial number SN: 123456 The complete Client ID is built with separators '-' (Prefix-device type-SN): A_EBERLE-PIDU-KABELFELD_01-123456
MQTT device type
See description MQTT Prefix Client ID

▶ **MQTT Zertifikate/EST**

EST server FQDN
Complete domain name (Full Qualified Domain Name)
EST server IP
IP address from the EST server
EST server cyclic CRL requests
Wait time for the cyclic request of the certificate revocation list

MQTT IOT

MQTT IOT avtive
Activation of MQTT IoT
MQTT IOT debug
Activates the debug output in the console or logbook
Logbook
Activates the logbook (EOR-3D-SCADA.log)

MQTT IOT config

MQTT IOT version
Selecting the MQTT version. Available are MQTTv311 or MQTTv5.
MQTT IOT dialect
Selection between the both implemented dialects JSON-Custom-V1 or Cumolocity-SmartREST
MQTT IOT URL/IP
URL or IP of the MQTT IoT installation
MQTT IOT connection login
Selection between the different login options: • Anonymous login • Login with username and password • Login with certificate • Login with certificate plus username and password
MQTT IOT user
Set the username for MQTT IoT login
MQTT IOT password
Set the password for MQTT IoT login
MQTT IOT Keepalive
The MQTT Keepalive signal is sent in the given interval (in seconds)

MQTT MAO (Management & Operations)

MQTT MAO active
Activation of MQTT MAO
MQTT MAO param versionsstring
Customer specific version string for parameter version for display in the IoT software
MQTT MAO debug
Activates the MQTT MAO debug output in the console and logbook
Logbook
Activates the logbook (EOR-3D-SCADA.log)

MQTT MAO config

MQTT MAO version
Selection between the MQTT MAO versions MQTTv311 or MQTTv5 (Cumolocity only supports MQTTv5 up to now)
MQTT MAO dialect
Currently only the dialect Cumolocity-SmartREST is available
MQTT MAO custom ext.
Enable to use customer specific Cumolocity-SmartREST templates
MQTT MAO URL/IP
URL or IP of the MQTT MAO installation
MQTT MAO connection login
Selection between the different login options: • Anonymous login • Login with username and password • Login with certificate Login with certificate plus username and password
MQTT MAO BOOTSTRAP user
Username for bootstrap process

MQTT MAO BOOTSTRAP password
Password for bootstrap process
MQTT MAO user
Username for MQTT MAO login
MQTT MAO password
Password for MQTT MAO login
MQTT MAO Heartbeat
Time in seconds in which the heartbeat is sent to the IoT software. The operating time in seconds is transmitted.
MQTT MAO cyclic values
Delay between cyclic transmissions in seconds, e. g. temperature, CPU capacity, RAM capacity and SD-card storage
MQTT MAO Keepalive
Delay between Keepalive signals in seconds

9.2.6 Scriptserver

Scriptserver active
Activation of the Scriptserver
Used script
File name of the used script, e. g. ‘eor3d_default.lua’
Sleep time
Sleep time until the script restarts repeating
Timeout time
Timeout for the script run, no timeout time is set with ‘-1’
Debug output
Activates the debug output for console and logbook
Logbook
Activates the logbook (EOR-3D-SCRIPT.log)

9.2.7 ConMaster

With the help of the ConMaster funtion, the EOR-3DS can be a Modbus Master and read in up to 6 Modbus slaves via Modbus RTU. The data can be transmitted with another protocol (e. g. IEC 60870-5-104, Modbus TCP, etc.). In this case the EOR-3DS is a gateway.

Furthermore it is possible to process the read out Modbus Master values to process them with a LUA script and transfer the calculated values to a superior SCADA system. For example the total power of the transformator field can be calculated with the power values from the cable fields.

ConMaster active
Activation of the ConMaster
Modbus debug
Activates Modbus debug output for console and logbook
Lua debug
Activates Lua debug output for console and logbook
Logbook
Activates the logbook (EOR-3D-SCRIPT.log)

▶ **ConMaster Modbus**

Modbus port
Selecting a port
Modbus polling
Cyclic updating of the Modbus variables, which are filled in the Lua script

▶ **ConMaster Lua**

Used script
Used script
Sleep time
Sleep time between script run
Timeout time
Timeout script run

9.2.8 HW_config

You can find the settings for the current and voltage channels under the menu tree of the hardware configuration (HW_config). Moreover, the configuration of the binary inputs, relay outputs and LEDs is part of the hardware configuration.

Also user-defined output functions, so-called uBAFs can be created here.

9.2.8.1 General

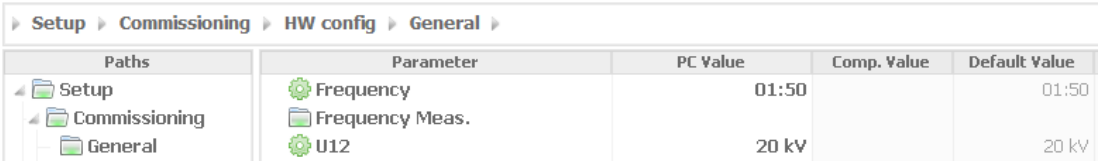


Figure 81: Hardware configuration menu tree / General

U12
Setting the phase-to-phase voltage of the grid. The parameter is used for the correct display of the primary values on the EOR-3DS.

Frequency
Setting of the network rated frequency 50Hz 16.7Hz (not currently used)

- **Frequency Meas.**
  - **U0 / U1 / U2 / U3**

Measurement active
Activation of the frequency measurement over the voltage

9.2.8.2 Voltage

The 4 voltage inputs can be configured under this menu tree.

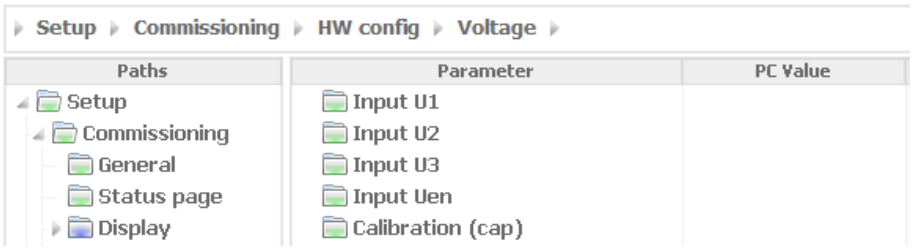


Figure 82: Configuration of the voltage inputs

Voltage input Ux

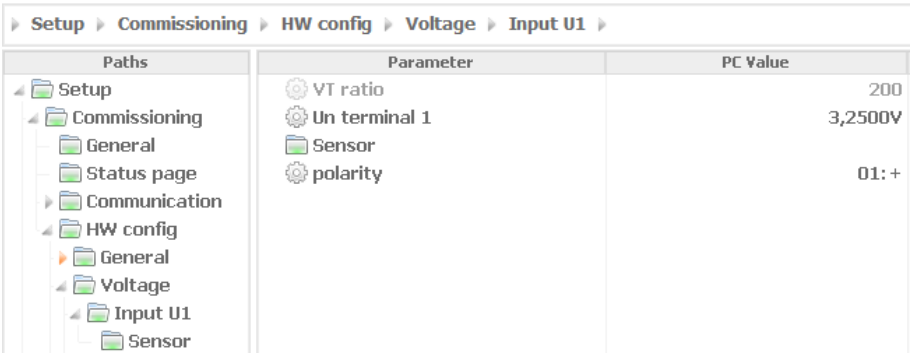


Figure 83: Configuration of the voltage input U1

Configuration of voltage input U1, U2, U3 and Uen

Un terminal x
Nominal value of the connected sensor, which is present at the sensor output and the terminals of the EOR-3DS in case the primary nominal voltage U12 of the network is applied.
Polarity
This setting is used to reverse the polarity of the voltage transformer input. This corresponds to a rotation of the signal by 180°

The default values of the Un terminal parameter depends on the ordered 'U' feature of the EOR-3DS according to the following table:

'U' feature	Un terminal default value
U05	10 V
U06/U07	3,25 V
U10	100 V
U29/U31	2,0 V

- **Additional parameter voltage input Uen**

Calculate Uen
If this parameter is activated, then the zero sequence voltage is calculated from the three connected phase to earth voltages

For the order characteristics C29/U29 and C31/U31 the parameter ‘calculate Uen’ is set fix to active, because the measurement input cards don´t have an Uen input.

- **Voltage input Ux / Sensor**

For low-power sensors the values for knuV (amplitude correction factor) and correction of angle are given on the type plate of the particular sensor or in the according sensor test report and can be parameterized in the EOR-3DS to optimize the measurement.

knuV
Parameter for the amplitude correction factor of the according sensor. Default value: 1

Correction of angle
Parameter for the correction of the angle of the according sensor. Default value: 0

For the order characteristics C31/U31 (Siemens measurement card ‘SIBushing’) the parameters knuV and correction of angle are read-only. The parameters are set by a sensor configuration file (‘SensorConfig File’), which is loaded in the production by Siemens on the EOR-3DS. So in this case there is no need to manually set the correction values.

Calibration (only needed for characteristic U05)

Under this menu point the adjustment of the voltage with capacitive voltage taps can be performed automatically. For an ideal measurement of the sensors it is necessary to readjust the inputs. Because of the production there are differeces between the coupling condensators.I n this case the voltage measurement of the sensors is readjusted automatically, this means the knuV factors are determined and set automatically.

Before the calibration the parameter 'Measuring Value U12' (grid voltage) must be set. (Default value: 20 kV)

The parameter 'Measuring Value U12' is a current (!) measurement value of the phase-to-phase voltages, e. g. voltage detecting unit in the same station with 20,1 kV. The parameter 'Measuring Value U12' has to be applied at first via 'apply new params' before the start of calibration should be performed.

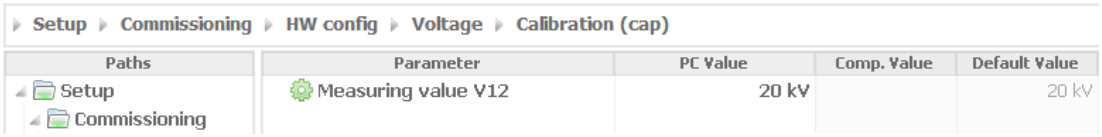


Figure 84: Parameterization for the calibration

Then the calibration can be started directly on the device display and is confirmed with return.

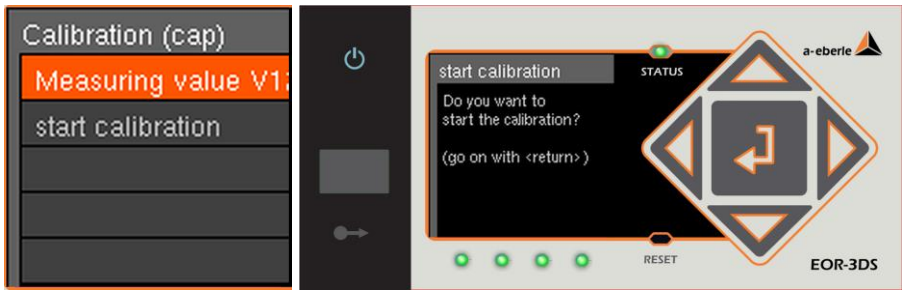


Figure 85: Menu navigation for calibration

The progress of the calibration is shown on the EOR-3DS panel. After finishing the calibration the locating methods are reactivated, a message is shown on the display.

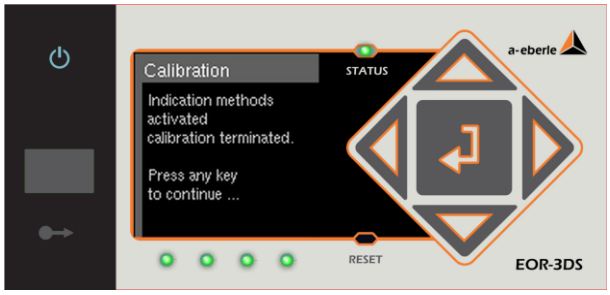


Figure 86: End of calibration

9.2.8.3 Current

The 4 current inputs can be configured under this menu item.

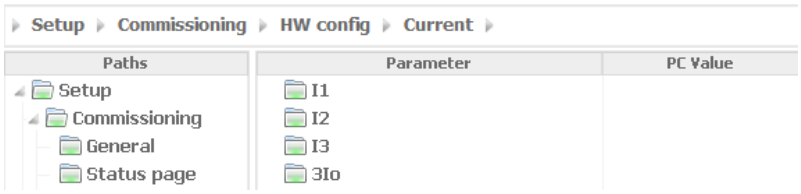


Figure 87: Configuration of the current inputs

▶ **Current input Ix**

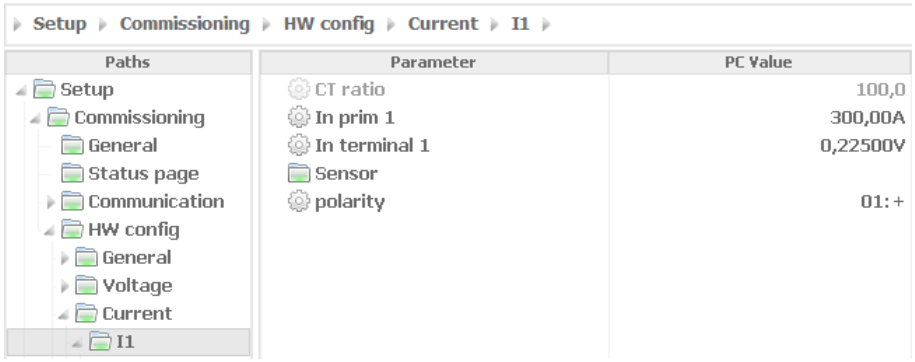


Figure 88: Configuration of the current input I1

Configuration of current inputs I1, I2, I3 and I0.

In terminal x
Nominal voltage of the connected value
In prim x
Primary value of the current measurement
Polarity
This setting is used to reverse the polarity of the current transformer input. This corresponds to a rotation of the signal through 180°

The default values of the In terminal parameter depends on the orderd ‘C’ feature of the EOR-3DS according to the following table:

‘C’ feature	In terminal
C10	0,225 V
C21/C25	1 A
C29	0,150 V
C31	0,0225 V

Additional parameter current input 3Io

Calculate 3Io
If this parameter is activated, then 3Io is calculated from the three connected phase currents.

For the order characteristics C29/U29 and C31/U31 the parameter ‘calculate 3Io’ is set fix to active, because the measurement input cards don´t have a 3Io input.

Current input Ix / Sensor

For low-power sensors the values for kniV (amplitude correction factor) and correction of angle are given on the type plate of the particular sensor or in the according sensor test report and can be parameterized in the EOR-3DS to optimize the measurement.

kniV
Parameter for the amplitude correction factor of the according sensor. Default value: 1

Correction of angle
Parameter for the correction of the angle of the according sensor. Default value: 0

For the order characteristics C31/U31 (Siemens measurement card ‘SIBushing’) the parameters kniV and correction of angle are read-only. The parameters are set by a sensor configuration file (‘SensorConfig File’) which is loaded in the production by Siemens on the EOR-3DS. So in this case there is no need to manually set the correction values.

9.2.8.4 Binary inputs

Binary inputs BI1 to BI6

Polarity
This setting can be used to change the polarity of the binary inputs: + : active with voltage - : active without voltage

9.2.9 Binary input functions (BI functions)

Functions are listed here (e.g. ‘Reset all2). They can be assigned to a binary input.
If more than one function is assigned to a binary input, the binary input status is used for each of the functions.

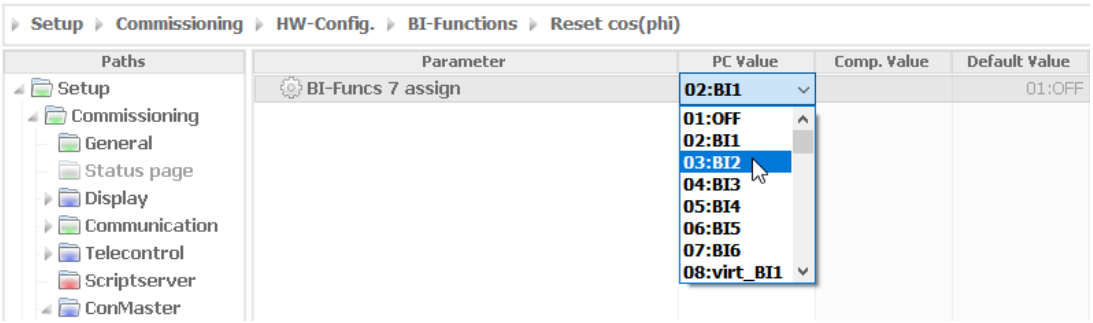


Figure 89: Assignment of a binary input function to a binary input

Binary input function	Description
OFF	No function
Reboot E3D	Restart EOR-3DS
Start recording	Triggers **fault recording** via a binary input that is linked with this function.
Reset all	Reset all signals on the EOR-3DS ● Location signals via the control system ● LED signals ● Indicators in the display
Reset LEDs	Resetting of ● LED indicators ● Indicators in the display
Reset qu2	Resets the signal of the transient procedure (qu2)
Reset cos(phi)	Resets the signal of the wattmetric procedure (cos(phi))
Reset sin(phi)	Resetting of the signal of the sin(phi) procedure
Reset OV	Resets the signal from the harmonic procedure (OV), i.e. of OV_250 and OV_fx1
Reset Pulse50	Reset the signal of the pulse locating procedure
Reset ShortCir	Reset the short circuit indications in the EOR-3DS

9.2.10 User-defined output functions (uBAFs)

So-called user BAFs are user defined output functions. Several so-called output functions can be created on one so-called user BAF. Configuration takes place using the numbers of the binary output function.

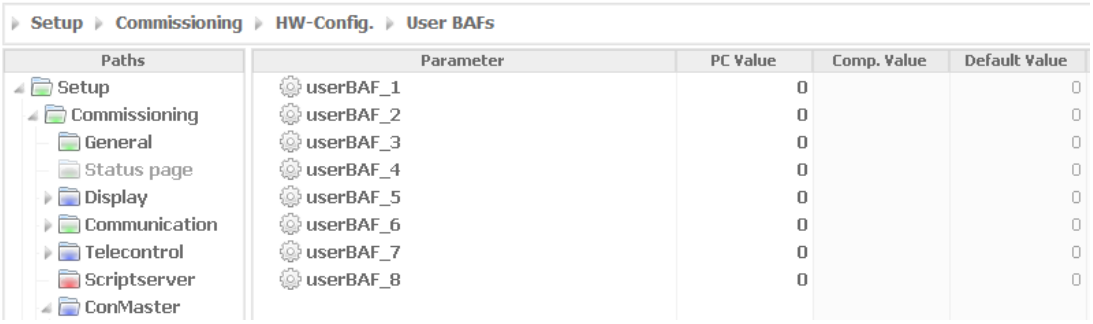


Figure 90: AEToolbox parameterization of userBAFs

A list with all user-defined output functions is provided in chapter 9.2.11.

If a user BAF is used with several output functions, it is always an OR relation (disjunction) of these output functions. The linking of output functions is implemented here using a semicolon ‘;’.

9.2.11 Binary outputs (BOs)

The binary outputs (BOs) of the EOR-3DS can be freely configured using the so-called output functions.

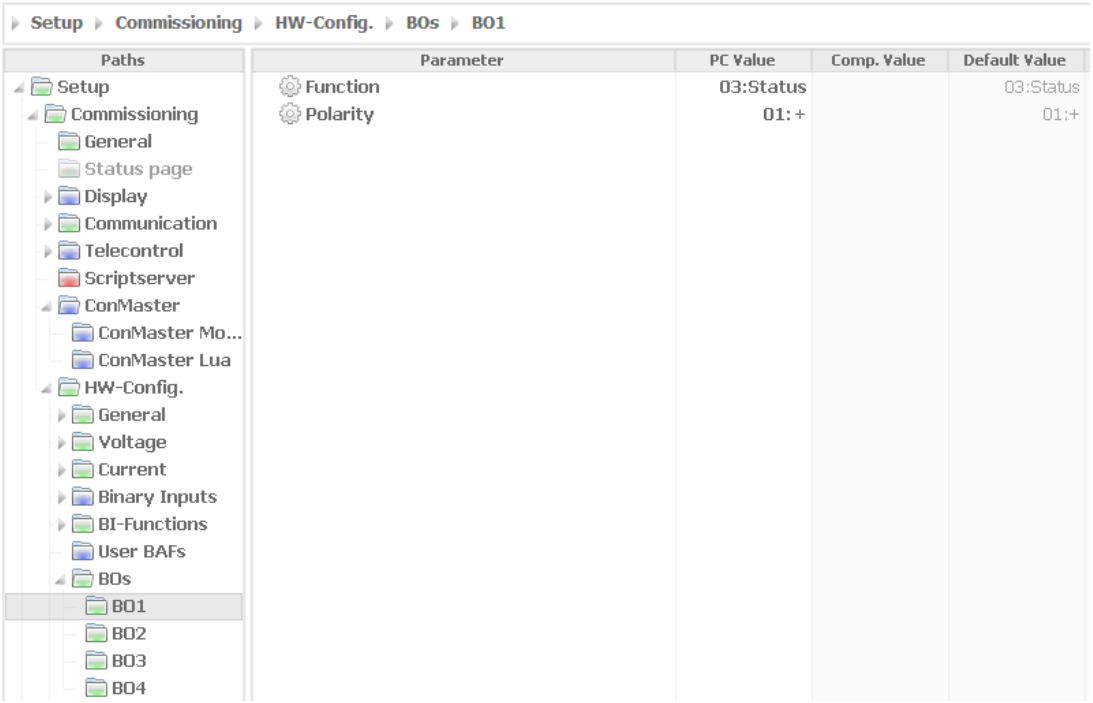


Figure 91: Selecting the output function for the binary output

The output function can be inverted using the 'Polarity' parameter.

A so-called user_BAF must be used for multiple assignment of a binary output to different output functions. The configuration is described in chapter 9.2.10.

The output functions are listed in the following table with a code designation. Next to this is an explanation.

Output function number	Binary output function (BAF) (parameter name)	Description
01	OFF	
02	PROG	Not currently used
03	Status	Status signal (live contact)
04	Failure	Fault signal
05	U1_ok	Phase to earth voltage U_{L1E} OK Measurement value is above the set threshold >U123_ok

Output function number	Binary output function (BAF) (parameter name)	Description
06	U2_ok	Phase to earth voltage U_{L2E} OK Measurement value is above the set threshold >U123_ok
07	U3_ok	Phase to earth voltage U_{L3E} OK Measurement value is above the set threshold >U123_ok
08	user_BAF1	User defined output function 1
09	user_BAF2	User defined output function 2
10	user_BAF3	User defined output function 3
11	user_BAF4	User defined output function 4
12	user_BAF5	User defined output function 5
13	user_BAF6	User defined output function 6
14	user_BAF7	User defined output function 7
15	user_BAF8	User defined output function 8
16	>Uerd	Earth fault threshold >Uerd exceeded
17	>Uerd_delay	Earth fault threshold >Uerd exceeded; delayed signal
18	Uerd_L1	Earth fault in L1 phase
19	Uerd_L2	Earth fault in L2 phase
20	Uerd_L3	Earth fault in L3 phase
21	Uerd_L1_d	Earth fault in L1 phase; delayed
22	Uerd_L2_d	Earth fault in L2 phase; delayed
23	Uerd_L3_d	Earth fault in L3 phase; delayed
24	Sum_Uerd ->L	Central earth fault signal forward
25	Sum_Uerd ->S	Central earth fault signal backward

Output function number	Binary output function (BAF) (parameter name)	Description
26	Prio_Uerd ->L	Prioritised forward earth fault signal
27	Prio_Uerd ->S	Prioritised backward earth fault signal
28	qu2 ->L	Forward earth fault transient
29	qu2 ->S	Backward earth fault transient
30	qu2_DE ->L	Earth fault transient with changeover to continuous earth fault (DE) forward
31	qu2_DE ->S	Earth fault transient with changeover to continuous earth fault (DE) backward
32	qui ->L	Intermittent forward earth fault
33	qui ->S	Intermittent backward earth fault
34	cos ->L	Cos(phi) (active power direction) forward
35	cos ->S	Cos(phi) (active power direction) backward
36	sin ->L	Sin(phi) (reactive power direction) forward
37	sin ->S	Sin(phi) (reactive power direction) backward
38	c_s ->L	Not currently used
39	c_s ->S	Not currently used
40	OV_250 ->L	Harmonic procedure 250Hz forward
41	OV_250 ->S	Harmonic procedure 250Hz backward
42	OV_fx1 ->L	Harmonic procedure free frequency 1 forward
43	OV_fx1 ->S	Harmonic procedure free frequency 1 backward

Output function number	Binary output function (BAF) (parameter name)	Description
44	OV_fx2+ ->L	Not currently used
45	OV_fx2+ ->S	Not currently used
46	OV_fx2- ->L	Not currently used
47	OV_fx2- ->S	Not currently used
48	Puls_50	Pulse locating signal
49	Puls_50c	Not currently used
50	Puls_50c->L	Not currently used
51	Puls_50c ->S	Not currently used
52	Puls50 LED	Not currently used
53	Puls_HPCI_50	Not currently used
54	Puls_HPCI_50 ->L	Not currently used
55	Puls_HPCI_50 ->S	Not currently used
56	Puls_HPCI_fx	Not currently used
57	>I	Central fault signal non-directional short circuit (1. Overcurrent level)
58	>I1	Non-directional short circuit phase L1 (1. Overcurrent level)
59	>I2	Non-directional short circuit phase L2 (1. Overcurrent level)
60	>I3	Non-directional short circuit phase L3 (1. Overcurrent level)
61	>>I	Central fault signal non-directional short circuit (2. Overcurrent level)
62	>>I1	Non-directional short circuit phase L1 (2. Overcurrent level)
63	>>I2	Non-directional short circuit phase L2 (2. Overcurrent level)
64	>>I3	Non-directional short circuit phase L3 (2. Overcurrent level)

Output function number	Binary output function (BAF) (parameter name)	Description
65	>I ->L	Central fault signal forward short circuit (1. Overcurrent level)
66	>I1 ->L	Forward short circuit phase L1 (1. Overcurrent level)
67	>I2 ->L	Forward short circuit phase L2 (1. Overcurrent level)
68	>I3 ->L	Forward short circuit phase L3 (1. Overcurrent level)
69	>>I ->L	Central fault signal forward short circuit (2. Overcurrent level)
70	>>I1 ->L	Forward short circuit phase L1 (2. Overcurrent level)
71	>>I2 ->L	Forward short circuit phase L2 (2. Overcurrent level)
72	>>I3 ->L	Forward short circuit phase L3 (2. Overcurrent level)
73	>I ->S	Central fault signal backward short circuit (1. Overcurrent level)
74	>I1 ->S	Backward short circuit phase L1 (1. Overcurrent level)
75	>I2 ->S	Backward short circuit phase L2 (1. Overcurrent level)
76	>I3 ->S	Backward short circuit phase L3 (1. Overcurrent level)
77	>>I ->S	Central fault signal backward short circuit (2. Overcurrent level)
78	>>I1 ->S	Backward short circuit phase L1 (2. Overcurrent level)
79	>>I2 ->S	Backward short circuit phase L2 (2. Overcurrent level)
80	>>I3 ->S	Backward short circuit phase L3 (2. Overcurrent level)

Output function number	Binary output function (BAF) (parameter name)	Description
81	>Ferro Res.	Not currently used
82	df_max	Not currently used
83	df_min	Not currently used
84	f_invalid	Not currently used
85	DynAdm ->L	Not currently used
86	DynAdm ->S	Not currently used
87	>I_E	Short circuit to earth non-directional
88	>I_E ->L	Short circuit to earth forward
89	>I_E ->S	Short circuit to earth backward
90	ind_L1	Earth fault or short circuit signal on phase L1
91	ind_L2	Earth fault or short circuit signal on phase L2
92	ind_L3	Earth fault or short circuit signal on phase L3
93	ind_N	Earth fault or short circuit signal on phase N
94	NC	
95	NC	
96	NC	

9.2.12 LED functions

The LEDs of the EOR-3DS can be freely configured with output functions. For every LED the colours red and green are parameterized with one function.

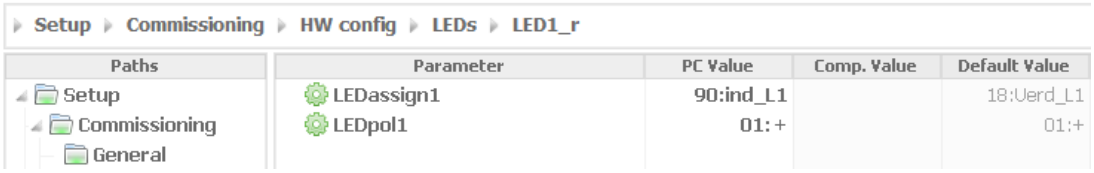


Figure 92: Selection of the output function for the LED

The output function can be inverted using the 'Polarity' parameter.

Logbook

Logbook
This parameter can be used to decide whether in addition to the normal signals of the locating procedure the LED signals are also entered in the logbook.

9.3 Earth fault

9.3.1 Processes of an earth fault event

The earth fault is characterised by one phase of the three-phase system being shorted to earth. Therefore the voltage of the faulty phase collapses. In the healthy phases the voltage increases in compensated and isolated grids. In solidly and low ohmic earthed grids the earth fault becomes an earth short circuit where high currents over earth occur. In all cases and types of neutral point treatment a zero sequence voltage (vectorial sum of phase voltages $\underline{U}_0 = \underline{U}_{1E} + \underline{U}_{2E} + \underline{U}_{3E}$) due to the imbalance occurs. Hence the zero sequence voltage often is used as the basic criterion for earth fault detection. The following three overlapping processes are distinguished:

- Discharging of the defective line via earth
- Charging of the healthy lines via earth
- Steady-state

In the following section these processes are discussed shortly at the example of an isolated grid with three feeders.

Discharging process of the faulty phase

First the capcities to ground of the faulty phase (in the faulty feeder as well as in the healthy feeders) are discharged.

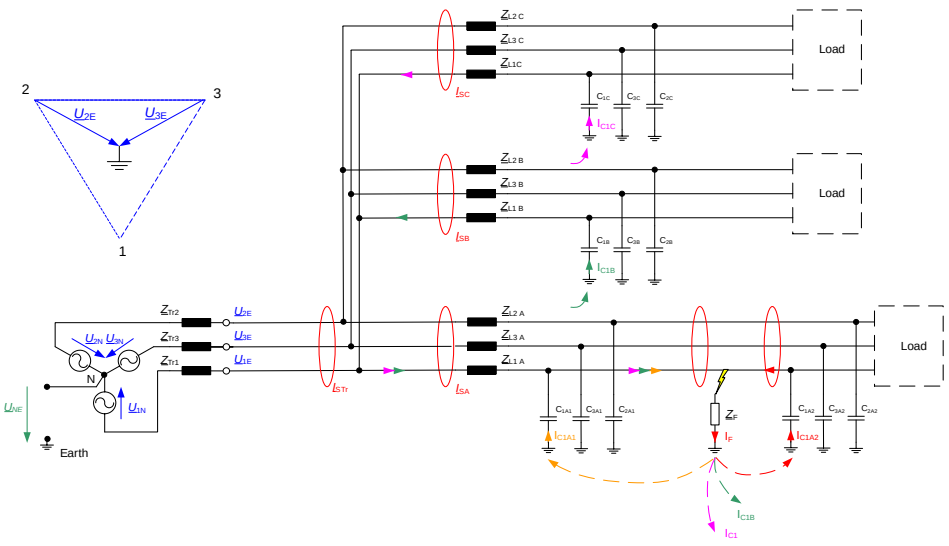


Figure 93: Discharging process for an isolated grid with three feeders

Important for the discharge process are:

- Capacity of faulty phase to earth
- Charging state of the capacity of faulty phase
- Line impedance to and in the other outgoing feeders
- Impedance of the faulty section itself or the earthing

The discharging process affects only the faulty phase and is independent of the neutral point treatment of the grid. The very high-frequency transient process depends on the length of the cables and its frequency gets higher as the cables get shorter. It is usually in the range of >10 kHz. Therefore the discharging process is not evaluated for the earth fault location.

Charging process of the healthy phases

In the second process the healthy phases are charged over earth. Caused by the charging the phase voltages of the healthy phases increase at maximum up to the value of the line-to-line voltage (depending on the fault impedance). This causes a neutral point shift.

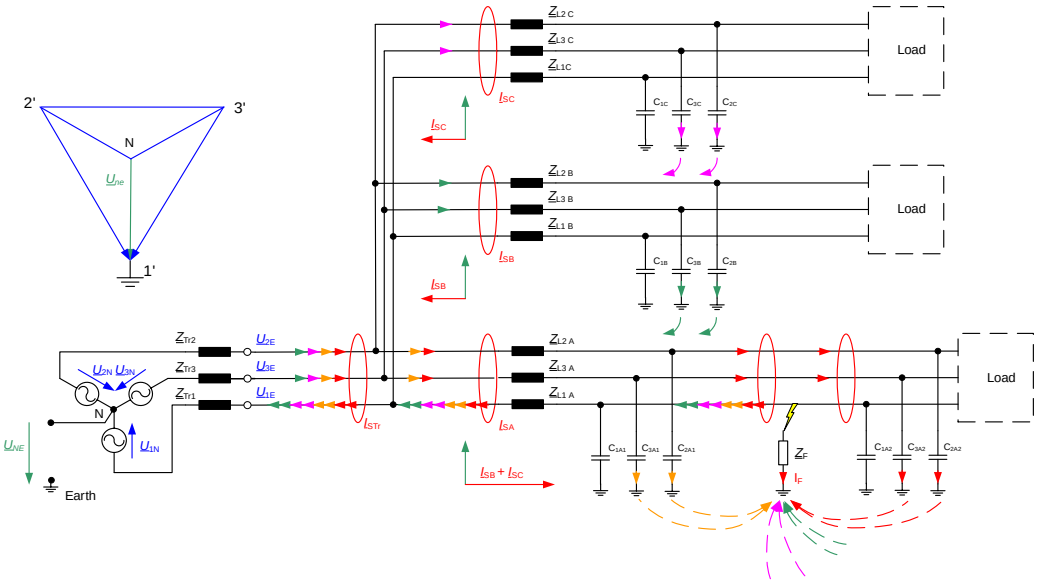


Figure 94: Charging process for an isolated grid with three feeders

Key for the charging process are:

- Capacitance of healthy phases to earth
- Charging state of the phases' capacitance
- Charging voltage
- Leakage inductance from the injecting transformer
- Line impedance from the faulty feeder to the injecting transformer
- Impedance of the fault itself or the earthing

The distribution transformers or the loads are only considered with a high impedance and can be neglected in the first approximation. The charge oscillation's limiting element remains the injecting transformer's relatively low impedance leakage inductance, and, if the faults are very far away, the transformer's inductance to the faulty section.

The charging process for the wye connection is displayed in the equivalent circuit in Figure 95. A possible transformer delta connection can be converted to the equivalent wye connection.

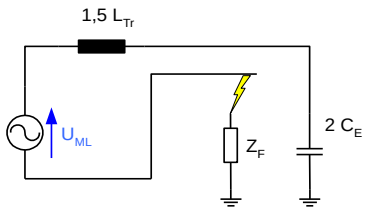


Figure 95: Equivalent circuit for the charging process

The frequency of the charge oscillation is calculated from

$$f_A = \frac{1}{2\pi}\sqrt{\frac{1}{L_{ers}C_{ers}}} = \frac{1}{2\pi}\sqrt{\frac{1}{3\,L_{Tr}C_E}} \qquad (0.1)$$

This formula for the charge oscillation frequency also applies when the inductance of the transformer L_{Tr} is added to the inductance of the line from the faulty section to the transformer. It reduces the frequency. An earth fault that is very far away delivers a lower charge frequency than an earth fault that is closer to a bus bar.

Estimation of the leakage impedance over the impedance voltage and the transformer's rated apparent power:

$$X_{Tr} = \omega\, L_{Tr} = \frac{u_s\, U_n^2}{100\, S_{Tr\,n}} \approx \frac{u_k\, U_n^2}{100\, S_{Tr\,n}} \qquad (0.2)$$

The initial amplitude of the charging current is given by:

$$\hat{I}_{ZA} = 2\,\omega\, C_E\, \hat{U}_{ML}\; c_\phi = \frac{2}{3}\hat{I}_{CE}\; c_\phi \qquad (0.3)$$

The impact of the switching moment (angle φ) is taken into account by the amplitude factor (in the formula, f = 50 Hz):

$$c_\phi = \sqrt{\cos^2\varphi + \left(\frac{f_A}{f}\right)^2 \sin^2\varphi} \qquad (0.4)$$

In the maximum of the earth-line voltage of the faulty line (φ = 90°)

$\hat{I}_{ZA} = 0{,}667\;\hat{I}_{CE}$ $\frac{f_A}{f}$ an the zero point of the earth-line voltage of the faulty line (φ = 0°) $c_\phi = 1$

and $\hat{I}_{ZA} = 0{,}667\;\hat{I}_{CE}$.

The above derivations have shown that the peak value of the charging current takes on at least the value $0{,}667\;\hat{I}_{CE}$ of the remaining grid (total grid minus faulty feeder).

Transient relays evaluate the charging process. The high frequency discharge oscillations are filtered out.

Steady state

In the steady state, the 50 Hz component of an isolated grid's capacitive current flows across the faulty section. The faulty voltage of the faulty phase remains zero while the voltages of the healthy phases remain on the increaed value of the phase to phase voltage (in case of a low ohmic fault). The steady state corresponds to the conditions in the charging process without charging oszillation as shown in Figure 94. In an isolated grid the capacitive earth fault current I_{CE} flows on the fault location.

9.3.2 The basics of resonant earthing

In medium and high voltage grids, Petersen coils are used to compensate the capacitive current across the faulty section by a similarly large counter-flowing inductive current when a single pole-to-earth fault occurs. This is done by setting the coil (in the grid's healthy state) to an inductive reactance X_L that corresponds approximately to the grid's capacitive reactance X_C. A real compensation coil additionally to the inductivity L_P shows an ohmic component G_P.

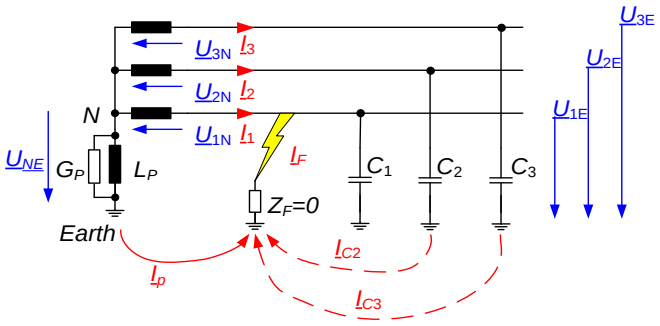


Figure 96: Equivalent circuit of a compensated grid (with only one feeder) with compensation coil und one-pole earth fault

When X_L equals exactly X_C only the so-called wattmetric residual current flows over the fault location. Normally the compensation coil is not exactly tuned to the resonance point (full compensation), but is slightly overcompensated.

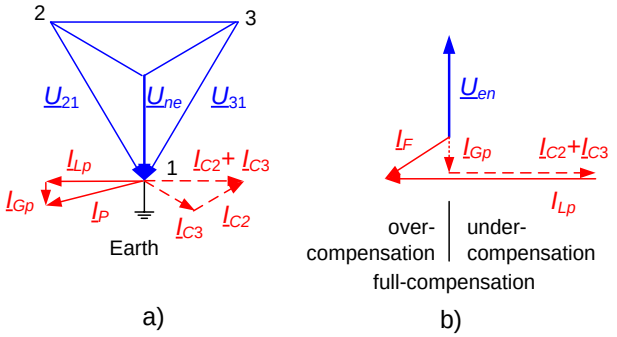


Figure 97: a) Vector diagram with earth fault in phase L1 (fault impedance = 0 Ω)
b) Influence of different positions of compensation coil on the fault current I_F

In compensated grids the zero sequence currents are significatly reduced compared to the isolated grid. Hence other methods for locating of earth faults have to be used. For the evaluation of the steady state in compensated grids the pulse detection can be used. The evaluation of the transient charging process via qu2-method can be used for both isolated and compensated grids and is therefore very flexible.

The parameterization of all eath fault localization methods is done in the menu tree.

9.3.3 General

9.3.3.1 Setting instructions

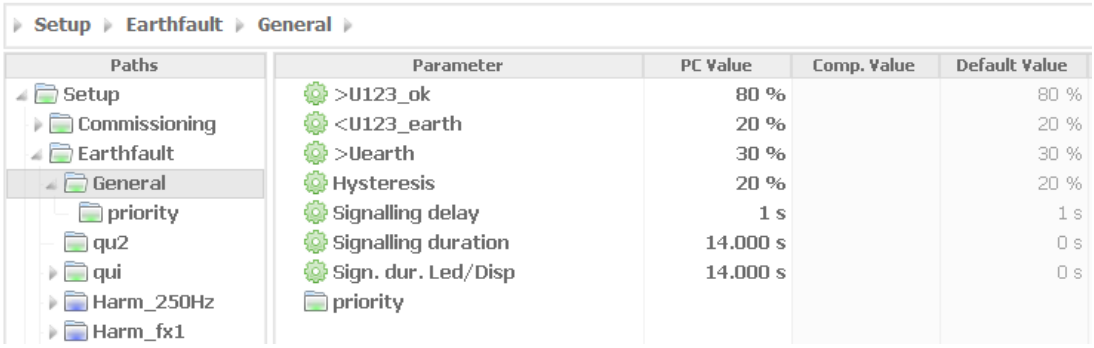


Figure 98: Overview of the general earth fault settings

>U123_ok
The three phase to earth voltages L1, L2, L3 can be monitored for an adjustable threshold. If the threshold is exceeded, a signal >U123_ok is issued.
<U123_erd
The three phase to earth voltages L1, L2, L3 can be monitored for an adjustable threshold. If the threshold is undershot, a signal <U123_erd is issued.
>Uerd
This parameter is used to set the earth fault threshold. If the threshold is exceeded, evaluation of the earth fault locating procedures is enabled. This parameter applies universally to all earth fault locating procedures.
Hysteresis
The earth fault threshold is reduced by the value of the hysteresis for releasing the earth fault signal.
Signalling delay
This adjustable time is used to delay the indication of the general earth fault signal Uerd.
Signalling extension
The output (relay, SCADA) of the general earth fault signal is extended by the adjustable time.
Sign. Dur. Led/Disp
If the Uerd signal is set to a LED, then the time set here applies for a signal extension. In addition the time also applies to the display indication.

9.3.3.2 Parameters General

Parameter	Value range	Presetting
>U123_ok	1 to 95%	80%
<U123_erd	1 to 95%	20%
>Uerd	1 to 90%	30%
Hysteresis	1 to 90%	20%
Signalling delay	0 to 90s	1s
Signalling extension	0 to 86400s 0 ≙ hold signal	0s
Sign. Dur. Led/Disp	0 to 86400s 0 ≙ hold signal	0s

Priority

The priority of the individual earth fault locating procedures to each other can be set here. This means that only the active earth fault locating procedure with the maximum priority can output a signal. For signalling the prioritised earth fault signales, the following two binary output functions are available:

- Prio_Uerd->L (feeder direction)
- Prio_Uerd->S (busbar direction)

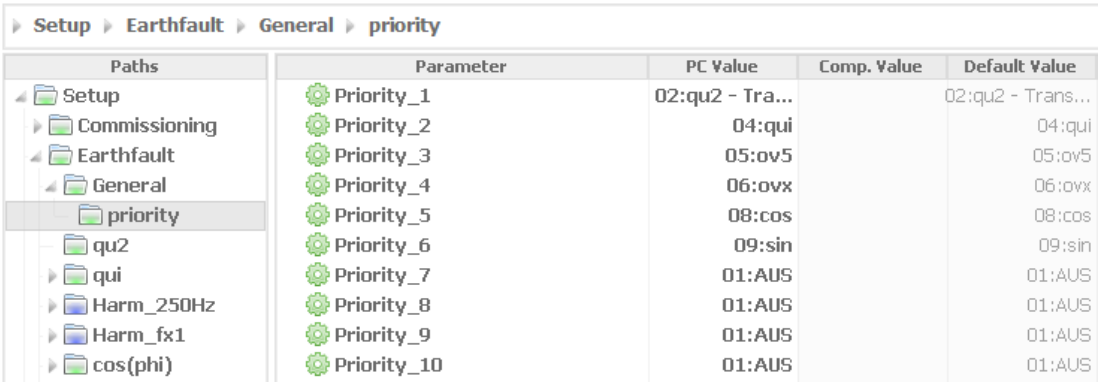


Figure 99: Priority list of the EOR-3DS

With the priority list it is for example possible to prevent a faulty signal from a stationary method like the wattmetric method during an re-igniting earth fault. For this, the qui method must be prior to the stationary methods in the priority list.

9.3.4 qu2 (transient earth fault)

9.3.4.1 Functional Description

The qu2-method (transient method) evaluates the recharging process (see also chapter 9.3.1) of the two healthy phases when an earth fault occurs.

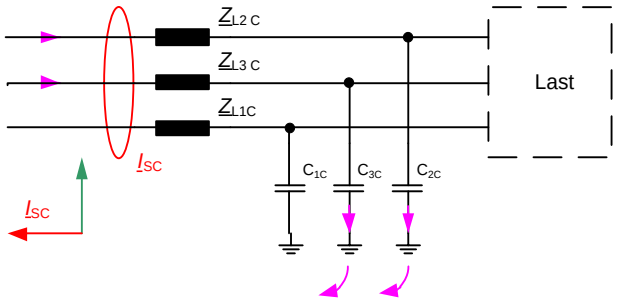


Figure 100: Recharging process of healthy feeder

The curve of the zero sequence voltage can be described in a simplified manner by the following equation: $u_0(t) = \frac{1}{C}\int_o^t i_o(\tau)d\tau$. It shows that the voltage does not occur until a current flows on the line-to-earth capacitance. This creates a current that leads the voltage by 90°. The integrated value of the current can be interpreted here as the applied charge q. This means that the voltage in a fault-free feeder is proportional to the charge. Plotting u_0 and q against in a diagram will always yield a straight line with a positive gradient for the fault-free feeder.

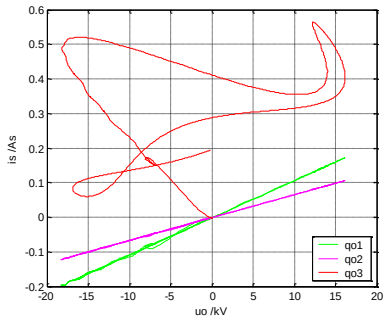


Figure 101: Direction evaluation qu2-methode (faulty feeder qo3)

Based on the fault resistance, the faulty feeder will yield a straight line with a negative gradient or the direction evaluation will be based on the rotation (corresponds to the surface or the curvature of the curve).

Fault-free feeder: Straight line with positive gradient

Faulty feeder: Straight line with negative gradient or rotation

The qu2-method compared to the conventional qu-method is additionally using a lineraization on the operating point and nonlinear filters. Therefore a reliable earth fault detection is also possible in meshed grids.

9.3.4.2 Setting instructions

Parameter descript for the qu2 procedure (earth fault transient)

Transient active
Activation of the qu2 procedure
Ice min
If the zero sequence voltage exceeds the threshold value, then a minimum current must also flow before the device generates a signal. This parameter is used to specify the minimum value for the fault-free residual network (primary value). The trigger value can be estimated from the uncompensated earth fault current: $I_{ce,min} = I_{CE} \cdot 0.05$
Rot./Grad.
The ratio Rotation / Gradient (Rot./Grad.) is determined when the rotation or the gradient is used for direction evaluation. If the quotient of Rotation / Grid is lower than the set value for Rot./Grad, then the gradient is used to determine the direction. The default value for this parameter is 50 and normally must not be changed. Changes should only be taken in consultation with A. Eberle.
Continuous EF after
If the zero sequence voltage remains higher than the triggering threshold for longer than the set time, then this is detected as a continuous earth fault. Accordingly the signal qu2_DE is indicated.

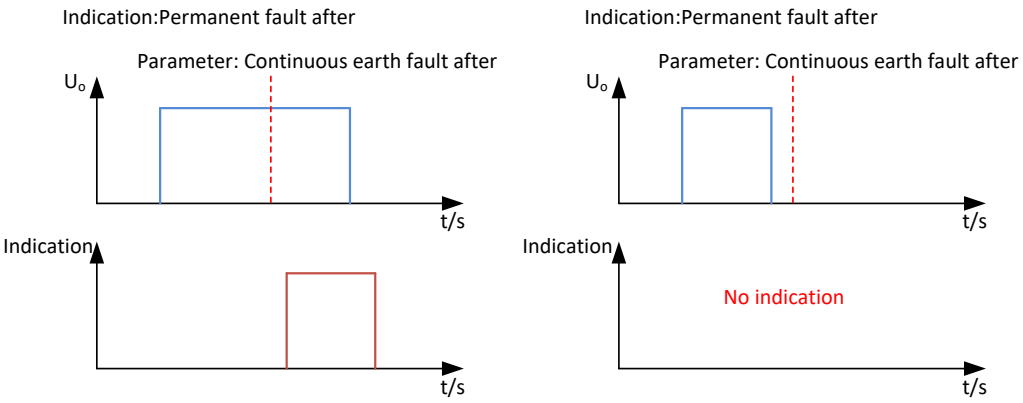


Figure 102: Earth fault transient signal with a continuous earth fault

Signalling duration
The earth fault transient signal is automatically reset after the set time has elapsed. Applies for binary outputs and SCADA signals.
LED signalling duration
If the earth fault transient signal is configured to an LED, then the LED indicator is automatically reset after the set time has elapsed.

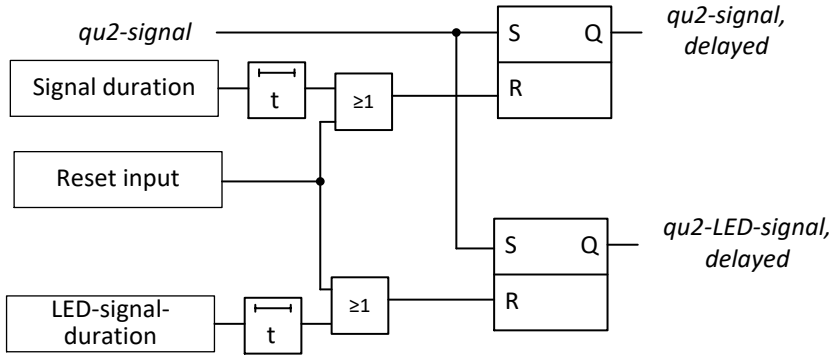


Figure 103: Signal extension qu2

A setting of 0s in the signal extension or LED signal extension causes a continuous signal with the qu2 procedure.

Signalling
This parameter specifies whether the qu2 signal is ● Retriggerable (the latest qu2 signal is always output) or ● Not retriggerable (first qu2 signal is saved until active resetting of the signal)
LCD_log active
This parameter enables entry of qu2 results in the LCD logbook. (Output via the display)

9.3.4.3 Parameters qu2

Parameter	Value range	Presetting
Transient active	Yes / No	Yes
Ice min	0 to 3000A	5A
Rot./Grad.	0 to 360	50
Cont. EF active	Yes / No	Yes
Continuous EF after	0 to 60 s	1 s
Signalling duration	0 to 90 s 0 ≙ Hold signal	2s
LED signalling duration	0 to 86400 s 0 ≙ Hold signal	2s
Reset message when EF turns off	Yes / No	No
Signalling	▶ **retriggerable** ▶ **not retriggerable**	retriggerable
LCD-log active	Yes / No	Yes

9.3.5 qui - re-igniting earth fault detection

9.3.5.1 Functional Description

In the qui procedure, the transient process is used for the re-igniting fault. It is essential that the zero sequence voltage no longer exceeds the trigger threshold. The increase in the zero sequence voltage due to the re-igniting represents only a fraction of the maximum zero sequence voltage. In this procedure there is also a correct display, if during the re-igniting fault network switching occurs; here the earth fault indication tracks the fault.

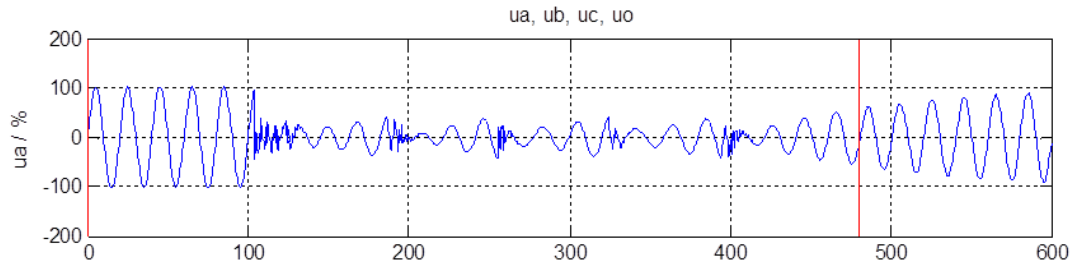


Figure 104: Phase to earth voltage U_{L1}

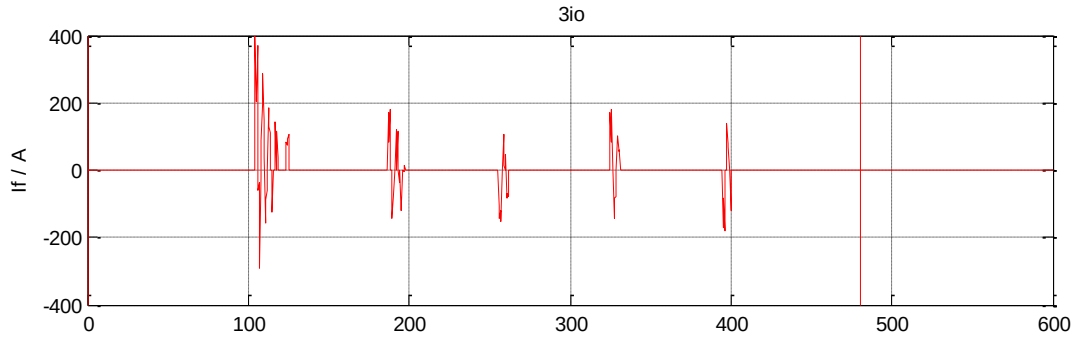


Figure 105: Fault current

Figure 104 shows the behaviour of a re-igniting fault. The phase to earth voltage UL1 is none-zero during the entire earth fault. The fault current itself is attenuated a few milliseconds after the current zero crossing. The network under consideration here is a compensated network, consequently the phase to earth voltage UL1 increases only very slowly. During this increase, the phase to earth voltage increases to a value of 2 - 6 kV, until a re-ignition recreates the fault path. The voltage upon re-igniting depends on various parameters and is not constant even during the earth fault.

Measurement value recording in SCADA systems normally determine a voltage mean value over 200 - 1000 ms. Consequently a re-igniting fault cannot be detected. This fault type would thus always be detected as a high-resistance, stationary earth fault.

9.3.5.2 Setting instructions

Parameter description for the qui procedure

qui active
Activating the qui procedure (intermittent earth fault)
Threshold dUo
With an intermittent earth fault, the zero sequence voltage must change by at least this adjustable threshold. Figure 106

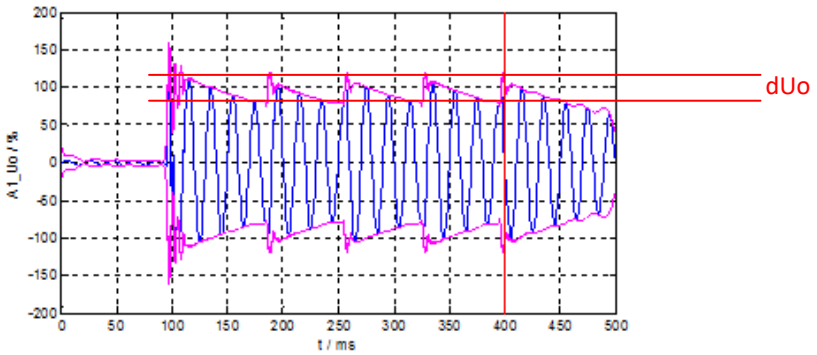


Figure 106: dUo threshold

Ice min.
Minimum current so that a direction decision or signal can be issued.
Supervision time
The number of igniting pulses is determined in the monitoring window. The number of igniting pulses must be reached for a direction indication.
Number of restrikes
Number of igniting pulses that must be reached for a direction decision.
Signalling duration
The qui signal is automatically reset after the set time has elapsed. Applies for binary outputs and SCADA signals.
LED signalling duration
If the qui signal is configured to an LED, then the LED indicator is automatically reset after the set time has elapsed.
LCD_log active
This parameter enables entry of qui results in the LCD logbook.

Cyclic log

The cyclic logbook entry is only active in earth fault cases, when a measurement value set is recorded in the logbook according to the configured time interval.

Cyclic log
Activates the cyclic logbook entry.
Time interval
Configurable time interval for the cyclic logbook entry.

9.3.5.3 Parameters qui

Parameter	Value range	Presetting
qui active	Yes / No	Yes
dUo threshold	0 to 150%	15%
Ice min.	0 to 300A	5A
Supervision time	200 to 1000ms	400ms
Number of restrikes	2 to 1000	2
Signalling duration	0 to 90 s	2s
LED signalling duration	0 to 86400 s	2s
LCD-log active	Yes / No	Yes
Cyclic log	Yes / No	Yes
Time interval	1 to 1000s	60s

9.3.6 Harmonic procedure OV_250Hz, OV_fx1

9.3.6.1 Functional Description

In the EOR-3DS, the harmonic procedure firstly evaluates the 5th harmonic (OV_250Hz), while on the other hand two parameter sets (OV_fx1, OV_fx2) are available for a free frequency. In this procedure, stationary earth fault conditions are prerequisite.

When monitoring the 5th harmonic, a compensated network can, as a first approximation, be considered as an isolated network, because the impedance of the electrical coil is increased by a factor of 5 ($X_{ESP}=\omega L_{ESP}$). Consequently the reactive power procedure can be used for earth fault locating or direction determination. The disadvantage is that the 250Hz zero sequence voltage does not underlie the 100% value rather time of day load fluctuations. This can be avoided through the feeding in of defined frequencies (e.g. ripple control installation).

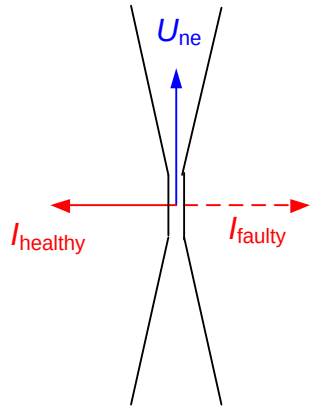


Figure 107: Direction determination procedure (OV_250,OV_fx1)

OV_250Hz and OV_fx1 are identical in their function. The difference is that in the OV_fx1 procedure the frequency is freely selectable.

9.3.6.2 Setting instructions

Parameter description for the harmonic procedure for the 5th harmonic

Harm_250Hz active
Activates the harmonic procedure for the 5th harmonic.
Uo_250_min
Minimum voltage for a direction decisison or signal. **Caution!** Refers to the voltage of the 5th harmonic.

Ice min.

Minimum current so that a direction decision or signal can be issued. **Caution**: Refers to the current of the 5th harmonic.

The following formula can be used as a basis for estimating the minimum current:

$$I_{fx} = I_{CE} \frac{f_{fx}}{f_{50hz}} \frac{U_{fx}}{U_{50}} U_{erd}$$

I_{CE}: capacitive network earth fault current at 50 Hz

f_{fx}: Frequency of the harmonic in Hz

$\frac{U_{fx}}{U_{50}}$: Ratio of harmonic voltage to fundamental voltage (phase to phase)

Angle min

Minimum angle that must be exceeded to ensure an indication is issued. This parameter is used to allow for angular errors of the current and voltage transducers.

Cycles (x10ms)

The same earth fault direction must be found for the specified number of measurement cycles, befor the signal is indicated definitely.

Signalling delay

The harmonic signal is only output once the set time has elapsed.

Signalling duration

The harmonic signal is automatically reset after the set time has elapsed. Applies for binary outputs and SCADA signals.

LED signalling duration

If the harmonic signal is configured to an LED, then the LED indicator is automatically reset after the set time has elapsed.

LCD_log active

This parameter enables entry of qui results in the LCD logbook.

Cyclic log

The cyclic logbook entry is only active in earth fault cases, when a measurement value set is recorded in the logbook according to the configured time interval.

Cyclic log
Activates the cyclic logbook entry
Time interval
Configurable time interval for the cyclic logbook entry.

9.3.6.3 Parameters OV_250Hz

Parameter	Value range	Presetting
Harm_250Hz active	Yes / No	No
Uo_250_min	0 bis 100 %	0,5 %
Ice min.	0 to 3000A	1A
Angle min	0 to 180°	5°
Measurement cycles	0 to 10	3
Signalling delay	0 to 90 s	0s
Signalling duration	0 to 90 s	0s
LED signalling duration	0 to 86400 s	2s
LCD-log active	Yes / No	Yes
Cyclic log	Yes / No	Yes
Time interval	1 to 1000s	60s

9.3.6.4 Setting instructions Harmonic procedure with free frequency OV_fx1

Parameter description for the harmonic procedure with free frequency OV_fx1.

OV_fx1 active
Activates the harmonic procedure for a free frequency.
Minimum voltage Uo_fx1
Minimum voltage for a direction decisison or signal. **Caution!** Refers to the voltage of the 5th harmonic.
fx1
This parameter is used to set the frequency to be detected.
Ice min.
Minimum current so that a direction decision or signal can be issued. **Caution**: refers to the current of the 5th harmonic. The following formula can be used as a basis for estimating the minimum current: $I_{fx} = I_{CE} \frac{f_{fx}}{f_{50hz}} \frac{U_{\mathrm{fx}}}{U_{50}} U_{erd}$ I_{CE}: capacitive network earth fault current at 50 Hz f_{fx}: Frequency of the harmonic in Hz $\frac{U_{fx}}{U_{50}}$: Ratio of harmonic voltage to fundamental (phase to phase)
Angle min
Minimum angle that must be exceeded to ensure an indication is output. This parameter is used to allow for angular errors of the current and voltage transformers.
Cycles (x10ms)
The same earth fault direction must always be specified for the specified number of measurement cycles.
Signalling delay
The harmonic signal is only output once the set time has elapsed.
Signalling duration
The harmonic signal is automatically reset after the set time has elapsed. Applies for binary outputs and SCADA signals

LED signalling duration
If the harmonic signal is configured to an LED, then the LED indicator is automatically reset after the set time has elapsed.
LCD_log active
This parameter enables entry of qui results in the LCD logbook.

- **Cyclic log**

The cyclic logbook entry is only active in earth fault cases, when a measurement value set is recorded in the logbook according to the configured time interval.

Cyclic log
Activates the cyclic logbook entry
Time interval
Configurable time interval for the cyclic logbook entry.

9.3.6.5 Parameters OV_fx1

Parameter	Value range	Presetting
OV fx1 active	Yes / No	No
fx1	0 to 500Hz	217Hz
Ice min.	0 to 3000A	1A
Angle min	0 to 180°	5°
Cycles (x10ms)	0 to 10	3
Signalling delay	0 to 90 s	0s
Signalling duration	0 to 90 s	0s
LED signalling duration	0 to 86400 s	2s
LCD-log active	Yes / No	Yes
Cyclic log	Yes / No	Yes
Time interval	1 to 1000s	60s

9.3.7 Wattmetric Cos(phi) procedure

9.3.7.1 Functional Description

In the cos(phi) procedure, the measured total current Io is projected to the zero sequence voltage Uo. Then the active component is calculated from the total current. Here the direction of this active current is decisive for signalling the earth fault in the forward or backward direction.

In this procedure it is also important that the measurement values Io and Uo are accurately measured. This is primarily dependent on the angular accuracy of the current and voltage transformers.

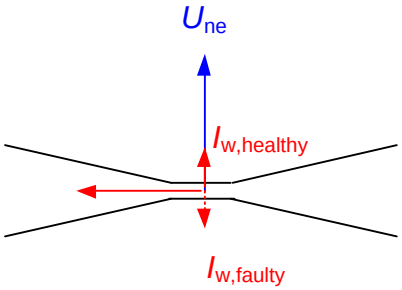


Figure 108: Direction determination cos(phi) procedure

9.3.7.2 Setting instructions

Parameter description for the cos(phi) procedure

Cos(phi) active
Activates the cos(phi) procedure
Iwatt min
Minimum resistive fraction of the total current at the output. Here the trigger value can be estimated using the following formula: Rule of thumb: $I_{w,min} = 0.25 \cdot 0.03 \cdot I_{CE,Netz}$ The total active component of the network can initially be estimated as 3% of $I_{CE,Netw}$, or e.g. read directly from the electrical coil controller. The trigger value is then determined by multiplying with a safety factor (f_A=25%).
Angle min
Minimum angle that must be exceeded to ensure an indication is output. This parameter is used to allow for angular errors of the current and voltage transformers. Example: I_{CE} = 100A → I_W = 3A With an angular error of 2° this gives an apparent active current of 3,5 A. This means that outputs with large, capacitive fractions can lead to incorrect displays because of angular errors.

Cycles (x10ms)
The same earth fault direction must always be specified for the specified number of measurement cycles.
Signalling delay
The cos(phi) signal is only output once the set time has elapsed.
Signalling duration
The cos(phi) signal is automatically reset after the set time has elapsed. Applies for binary outputs and SCADA signals
LED signalling duration
If the cos(phi) signal is configured to an LED, then the LED indicator is automatically reset after the set time has elapsed.
LCD_log active
This parameter enables entry of cos(phi) signals in the LCD logbook.

- **Cyclic log**

The cyclic logbook entry is only active in earth fault cases, when a measurement value set is recorded in the logbook according to the configured time interval.

Cyclic log
Activates the cyclic logbook entry
Time interval
Configurable time interval for the cyclic logbook entry.

9.3.7.3 Parameters Cos(phi)

Parameter	Value range	Presetting
Cos(phi) active	Yes / No	Yes
Iwatt min	0 to 1000A	1A
Angle min	0 to 90°	2°
Cycles (x10ms)	0 to 10	3
Signalling delay	0 to 90 s	0s
Signalling duration	0 to 90 s	0s
LED signalling duration	0 to 86400 s	2s
LCD-log active	Yes / No	Yes
Cyclic log	Yes / No	Yes
Time interval	1 to 1000s	60s

9.3.8 Sin(phi) procedure for isolated networks

9.3.8.1 Functional Description

This procedure is favoured for use in isolated networks. Here the sin(phi) procedure evaluates the fundamental of the zero sequence voltage and total current. In this procedure, stationary conditions are prerequisite.

In the isolated network there are, due to the high capacitive currents, unique conditions for measuring the direction of the fault. The advantage of this procedure is that the angular accuracy requirement for the current and voltage transformers is low. For a direction decision here only a 90° decision is made.

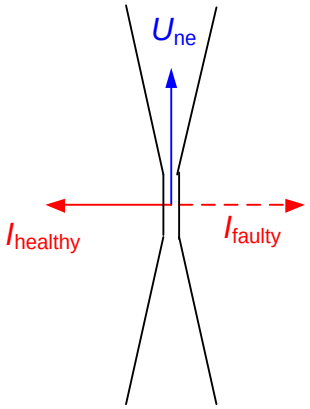


Figure 109: Direction evaluation sin(phi) - procedure

9.3.8.2 Setting instructions

Parameter description for the sin(phi) procedure

sin(phi) active
Activates the sin(phi) procedure
Ib min
Minimum current of the fundamental voltage so that a direction decision or signal can be issued. This value relates to the total, capacitive network earth fault current. Rule of thumb: $Ib_{min} = 0.05 \cdot I_{CE,net}$
Angle min
Minimum angle that must be exceeded to ensure an indication is output. This parameter is used to allow for angular errors of the current and voltage transformers.

Cycles (x10ms)
The same earth fault direction must always be specified for the specified number of measurement cycles.
Signalling delay
The sin(phi) signal is only output once the set time has elapsed.
Signalling extension
The sin(phi) signal is automatically reset after the set time has elapsed. Applies for binary outputs and SCADA signals.
LED signalling extension
If the sin(phi) signal is configured to an LED, then the LED indicator is automatically reset after the set time has elapsed.
LCD_log active
This parameter enables entry of sin(phi) signals in the LCD logbook.

- **Cyclic log**

The cyclic logbook entry is only active in earth fault cases, when a measurement value set is recorded in the logbook according to the configured time interval.

Cyclic log
Activates the cyclic logbook entry
Time interval
Configurable time interval for the cyclic logbook entry.

9.3.8.3 Parameters Sin(phi)

Parameter	Value range	Presetting
Sin(phi) active	Yes / No	No
Ib min	0 to 1000A	5A
Angle min	0 to 90°	5°
Cycles (x10ms)	0 to 10	3
Signalling delay	0 to 90 s	0s
Signalling duration	0 to 90 s	0s
LED signalling duration	0 to 86400 s	2s
LCD-log active	Yes / No	Yes
Cyclic log	Yes / No	Yes
Time interval	1 to 1000s	60s

9.3.9 Pulse locating

9.3.9.1 Functional Description

A pulsing current is produced by a clock system, which usually is on the power auxiliary winding of the Petersen coil, that can only be measured up to the fault location. By toggling capacitors, there is a current change towards full compensation. In this way, the total current at the faulty output is reduced and increased at the fault-free outputs.

During pulse locating a capacitor is switched on at a neutral point with a frequency of approximately 0.5Hz. This detuning changes the zero current through the neutral point. With low resistance faults, this current can only flow through the fault location. The voltage of the fault-free conductors relative to earth remains constant, so that the capacitive currents at the fault-free outputs also remain constant. Changing of the zero current with a 0.5 Hz rhythm can thus only be measured in the earth fault afflicted output.

With high resistance earth faults, a coupling to the fault-free outputs is created. By changing the current across the fault location the impedance Z_f changes as a result; the zero sequence voltage Une and consequently also the voltage relative to earth in the fault-free conductors also change. This results in the capacitive current to earth in the fault-free conductors also changing. Because of this relationship, with symmetrical pulsing and high-resistance earth faults, it is not possible to differentiate between faulty and good conductors.

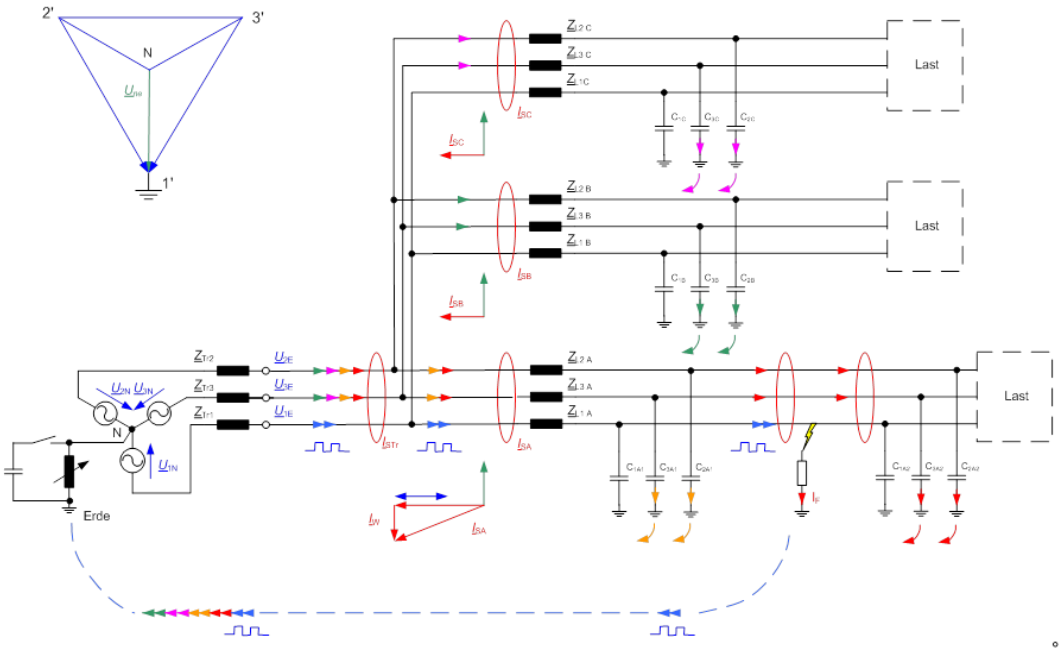


Figure 110: Pulse locating principle

Help is provided by asymmetric pulsing. In this type of pulsing, the capacitor is switched on for 1 second and off for 1.5 seconds (pulse interval ratio 1:1.5). This pattern can be repeated as often as necessary. It can easily be shown that with over-compensation the resulting current changes in the fault-free output are the inverse of the change in the faulty output. Consequently, even for high-resistance transition resistances in the faulty conductor, a criterion for differentiating between the faulty and fault-free conductors exists.

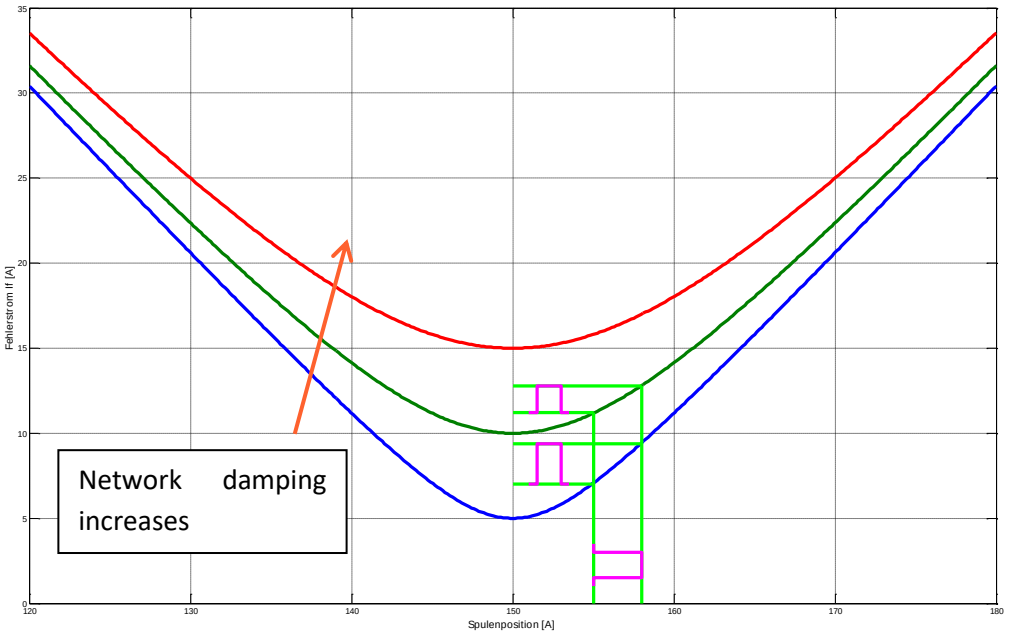


Figure 111: Pulse pattern with different damping ≙ I_w

Figure 111 clarifies again the influence of damping on the transferred pulse current. It can be seen that with increasing damping (V-curve becomes flatter) the transferred pulse becomes smaller. Consequently it is essential that when using pulse locating, appropriate detuning is selected.

9.3.9.2 Setting instructions

Parameter description for the pulse locating procedure

Pulse 50hz active
Activates the pulse locating procedure
Pulse Uen active
Evaluation of the pulse locating even without the zero sequence voltage being connected. This enables depth locating even in substations without voltage measurement.
Minimum dIe
This parameter is used to specify the necessary minimum current change of the pulse pattern.

The value is derived from earth fault engineering. As part of this activity, the cycle power must be matched to the network size. The pulse locating procedure does **not** evaluate any current pulses! (A spectrum is evaluated)

Pulse T_on (cap)
Switch on time of the detuning capacitor.
Pulse T_off (cap)
Pulse pattern off time interval. The detuning capacitor is switched off during this time.
Pulse min
This parameter, together with the pulse window, determines the sensitivity of the pulse locating procedure. A ratio values is obtained from the two values which can be applied to the know cycle current, e.g.: Pulse min = 3 Pulse window = 5 $\rightarrow \frac{3}{5} = 0.6$
Pulse window
The device searches in the immediate preceding seconds (moving monitoring window) for the pulse pattern.
Signalling duration
The pulse locating signal is automatically reset after the set time has elapsed. Applies for binary outputs and SCADA signals
LCD_log active
This parameter enables entry of pulse locating signals in the LCD logbook.

- **Cyclic log**

The cyclic logbook entry is only active in earth fault cases, when a measurement value set is recorded in the logbook according to the configured time interval.

Cyclic log
Activates the cyclic logbook entry
Time interval
Configurable time interval for the cyclic logbook entry.

9.3.9.3 Parameters Pulse locating

Parameter	Value range	Presetting
Pulse 50Hz active	Yes / No	No
Pulse Uen active	Yes / No	No
Minimum dIe	0 to 100 A	2A (prim)
Pulse T_on (cap)	0 to 10 s	1 s
Pulse T_off (cap)	0 to 10 s	15 s
Pulse min	0 to 10	3
Pulse window	0 to 10	5
Signalling duration	0 to 86400 s	0s
LCD-log active	Yes / No	Yes
Cyclic log	Yes / No	Yes
Time interval	1 to 1000s	60s

9.4 Short circuit

The EOR-3DS provides directional and non-directional short circuit indication and also the option for directional determination in a short circuit.

9.4.1 Non directional short circuit indication

9.4.1.1 Functional description

The methode for the non-directional short circuit indication (without directional determination) uses for in the detection of faulty conductor the exceeding of a selectable current threshold.

It is also possible to parameterize a two stage independent overcurrent protection characteristic. Two current stages ($I_>$ and $I_{>>}$) and the corresponding time delays ($t_>$ and $t_{>>}$) can be adjusted.

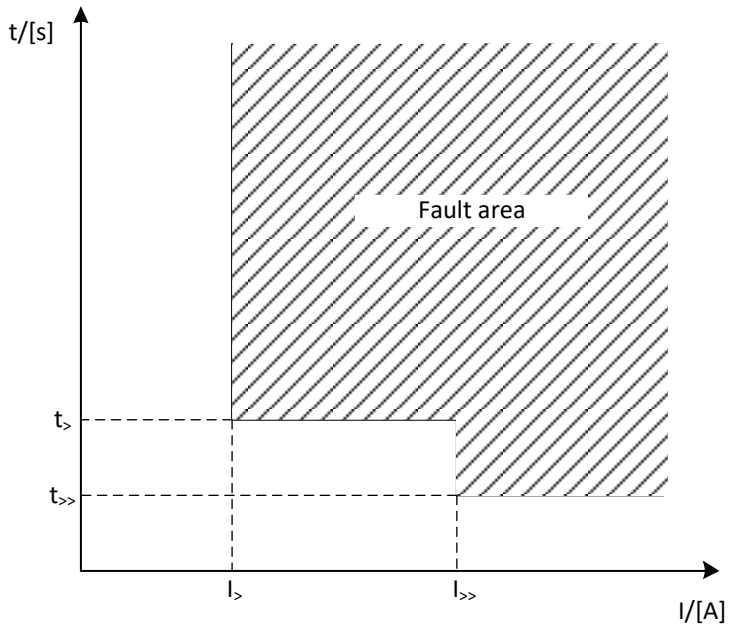


Figure 112: Two stage independent overcurrent thresholds for EOR-3DS

9.4.1.2 Setting instructions

Parameter description for the short circuit procedure

Short circuit
Parameterization non-directional over current indication
Udir. SC active
Activates the non-directional over current indication
Signalling duration
The short circuit indication can be extended by this time duration. Counts for binary outputs and SCADA indications.
Sign. Dur. Led/Disp
If the short circuit signal is set to a LED, then the time set here applies for a signal extension. In addition the time also applies to the display indication.

I> (1. threshold level)

I> active
Activates the first level
I_k min 1
Current treshold value. Set as primary value.
I_k hyst 1
Current threshold is reduced by the hysteresis for relesaing the signal in percent.
T min. 1
Time delay for I>. If I_kmin 1 is exceeded after the time T min. 1 the according signal (directed or non-directed) is indicated.

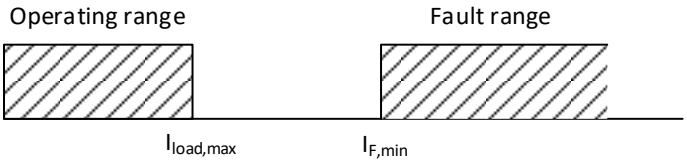
- **I>> (2. threshold level)**

I>> active
Activates the second level.
I_k min 2
Current treshold value. Set as primary value.
I_k hyst 2
Current threshold is reduced by the hysteresis for relesaing the signal in percent.
T min. 2
Time delay for I>>. If I_kmin 2 is exceeded after the time T min. 2 the according signal (directed or non-directed) is indicated.

- **I_E>**

I>E active
Activates the short circuit to earth indication.
I_k_E min
Current treshold value for short circuit to earth indication. Set as primary value.
I_k hyst E
Current threshold is reduced by the hysteresis for relesaing the signal in percent.
T min E
Time delay for short circuit to earth indication. After exceeding the threshold I_k_E min and the time T min E the according signal (directed or non-directed) is indicated.

The trigger level for the indication should be set with a security factor higher than the maximum load current (consider overload capability for parallel conductors). The lowest possible over current (short circuit current) must be taken into consideration on the other hand.



$$I_{min} = K_S \cdot I_{F,min}$$

I_{min} : *Response value EOR-3DS* $I_{F,min}$: *Minimum short cicuit current*

K_S : *Security factor* $I_{load,max}$: *Maximum load current*

To the message delay, the inherent time of the EOR-3DS must be added. It is 40 ms typically!

9.4.1.3 Parameters short circuit non-directional

Setting	Value range	Default setting
Udir. SC active	Yes / No	Yes
Signalling duration	0 to 86400s	10 s
Sign. Dur. Led/Disp	0 to 86400s	10 s
I> active	Yes / No	Yes
I_k min 1	10 to 10000A	500A
I_k hyst 1	1 to 20%	5%
T min. 1	0.2 to 2s	0.5 s
I>> active	Yes / No	Yes
I_k min 2	10 bis 10000A	700A
I_k hyst 2	1 to 20%	5%
T min. 2	0.02 bis 2s	0.1s
I>E active	Yes / No	No
I_k_E min	5 to 500A primary	100A primary
I_k hyst E	1 to 20%	5%
T min E	0,060s to 2s	0,1s

9.4.2 Directional short circuit indication

In this menu point it is possible to activate the directional short circuit indication. Therefor it is no need to set any further parameters. The settings for the current limits are taken from the non-directional short circuit indication.

For the directional overcurrent indication, the angle between fault voltage and fault current is used. Therefore, a voltage measurement of each phase is necessary.

The angle of triggering is set in the device and not adjustable. For suppression of a back and forth in the directional indication in borderline cases additionally a deadband is implemented. In the dead band area no direction is indicated. All short circuits in this area are evaluated as undirected.

The following areas are defined in the device:

Forward indicateion:	80° to -35°
Backward indication:	-100° to -215°
Deadband:	-35° to -100° and -215° to 80°

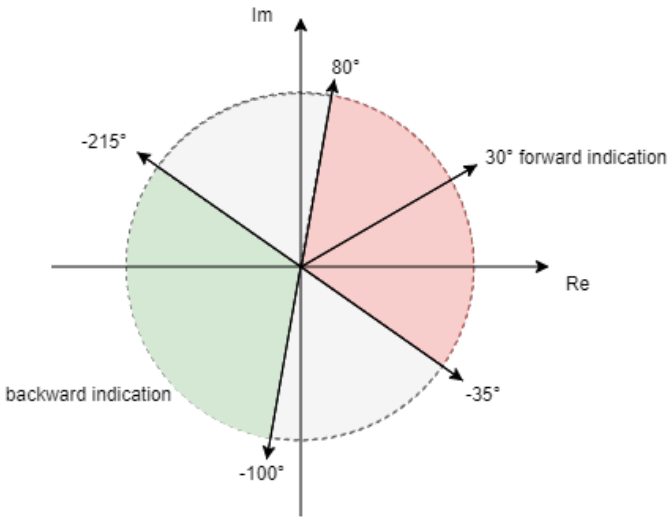


Figure 113: Definition of areas for the directional short circuit indication

In the EOR-3DS for evaluation of the short circuit the voltage *U* is placed on the real axis and therefore the angle of the current *I* is considered (analogue to the calculation of the angle $\varphi = \varphi_U - \varphi_I$ in the EOR-1DS). Electrical lines behave ohmic-inductive in case of a short circuit, which means for fault in cable direction (forward indication) the current lags compared to the voltage. Therefore the forward fault referring to the chosen angle definition in the EOR-3DS is found in the 1st quadrant and the backward fault in the 3rd quadrant.

9.4.2.1 Setting instructions

Dir. SC active
Activates the directional over current indication.
Signal forward at V123 = 0
Directional over current indication dispaly also when the phase to earth voltage was 0 V.

9.4.2.2 Parameters short circuit directional

Setting	Value range	Default setting
Dir. SC active	Yes / No	Yes
Sig. fwd. at V123=0	Yes / No	No

9.5 Recorder

Under the Recorder menu item, there are setting options for fault recording.

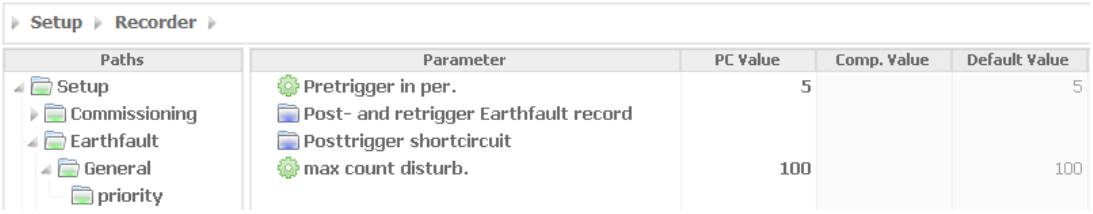


Figure 114: Fault recorder settings

Pretrigger in per.
This parameter specifies how many periods (n*20ms) prior to the trigger event (history) are displayed in the fault record.
Max count disturb.
Specifies the maximum number of fault records that can be saved on the SD card

▶ **Post- and retrigger Earthfault record**

Posttrigger in ms
Recording duration of the fault record
Retrigger interval in ms
This parameter is used to trigger a new trigger event (fault record) during a fault. This setting indicates at what intervals the renewed fault recording is triggered. The setting -1 deactivates the retriggering.
Regtrigger total duration in ms
This parameter indicates the recording duration of a fault record that has been triggered by a retrigger.

▶ **Posttrigger shortcircuit**

Posttrigger I_> (Sc1) in ms
Recording duration of a separate fault record for I_>
posttrigger I_>> (Sc2) in ms
Recording duration of a separate fault record for I_>>

9.5.1 Parameters Recorder

Parameter	Value range	Presetting
Pretrigger in Per.	1 to 11	3
Posttrigger in ms	1 to 35.000 ms	2000 ms
Retrigger interval in ms (-1 = OFF)	-1 to 999.000 ms	-1 ms
Retrigger total duration in ms	1 to 10.000 ms	1000 ms
Posttrigger I_> (Sc1) in ms	100 to 2.500 ms	200 ms
Posttrigger I_>> (Sc2) in ms	100 to 2.500 ms	200 ms
Max count disturb.	1 to 10.000	100

The -1ms entry for the parameter retrigger interval deactivates the retrigger function.

When 100 is selected for the fault recorder, then after the 100 fault record the oldest fault record is deleted.

9.6 Data transfer via USB stick

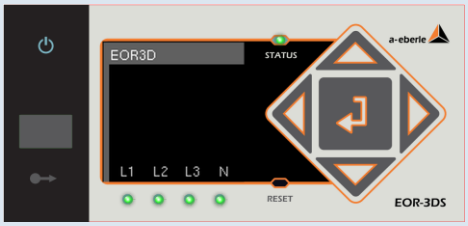
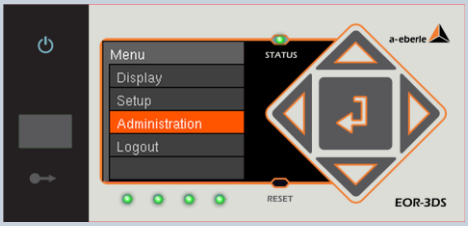
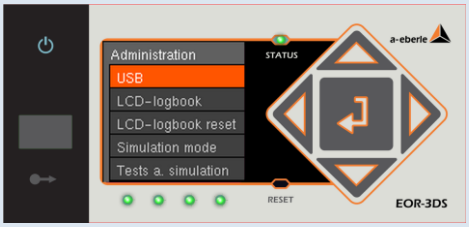
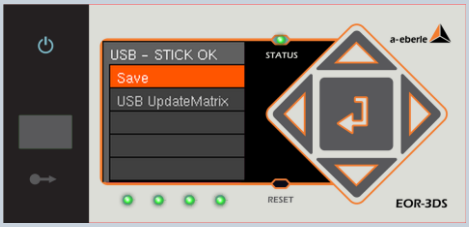
For data transfer via USB stick, a suitable adapter is needed.

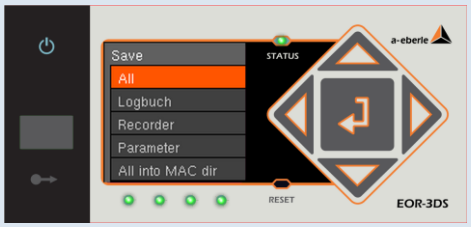
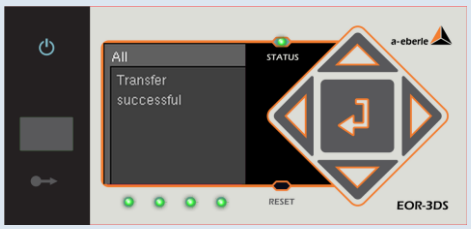
The EOR-3DS also supports transferring data via the USB stick (parameters, log files and fault records). The following files can be transferred:

- Logbook
- Recorder (fault record)
- Parameter files (ini)

Either all three categories or each category can be transferred individually.

The procedure for this is as follows:

Display	Information
	Plug the empty USB stick into the USB port Press the -key twice in a row
	Select Administration and confirm by pressing the -key
	Select USB and confirm by pressing the -key
	Select save and confirm by pressing the -key

	Select All and confirm by pressing the  -key
	Transfer starts
	Downloading of all files was successful / was completed

The files on the USB stick are structured after the station and feeder name.

10. Signal list (SCADA)

The following protocols are currently available for signals from the EOR-3DS to the control system:

- MODBUS
- IEC 60870-5-101
- IEC 60870-5-103 with fault record data transfer
- IEC 60870-5-104
- DNP 3.0
- IEC 61850 Goose
- MQTT IOT
- MQTT MAO (Management & Operations)

The SCADA connection is made directly from the EOR-3DS. No external device is necessary.

The following signals, commands and measurement values are available:

Binary output function (BAF) (parameter name)	Description
OFF	
PROG	Not currently used
Status	Status signal (live contact)
Failure	Fault signal
U1_ok	Earth conduction voltage U_{L1E} OK Measurement value is above the set threshold >U123_ok
U2_ok	Earth conduction voltage U_{L2E} OK Measurement value is above the set threshold >U123_ok
U3_ok	Earth conduction voltage U_{L3E} OK Measurement value is above the set threshold >U123_ok
user_BAF1	User defined output function 1
user_BAF2	User defined output function 2
user_BAF3	User defined output function 3
user_BAF4	User defined output function 4

Binary output function (BAF) (parameter name)	Description
user_BAF5	User defined output function 5
user_BAF6	User defined output function 6
user_BAF7	User defined output function 7
user_BAF8	User defined output function 8
>Uerd	Earth fault threshold >Uerd exceeded
>Uerd_delay	Earth fault threshold >Uerd exceeded; delayed signal
Uerd_L1	Earth fault in L1 phase
Uerd_L2	Earth fault in L2 phase
Uerd_L3	Earth fault in L3 phase
Uerd_L1_d	Earth fault in L1 phase; delayed
Uerd_L2_d	Earth fault in L2 phase; delayed
Uerd_L3_d	Earth fault in L3 phase; delayed
Sum_Uerd ->L	Not currently supported
Sum_Uerd ->S	Not currently supported
Prio_Uerd ->L	Prioritised forward earth fault signal
Prio_Uerd ->S	Prioritised backward earth fault signal
qu2 ->L	Forward earth fault transient
qu2 ->S	Backward earth fault transient
qu2_DE ->L	Earth fault transient with changeover to continuous earth fault (DE) forward
qu2_DE ->S	Earth fault transient with changeover to continuous earth fault (DE) backward
qui ->L	Intermittent forward earth fault
qui ->S	Intermittent backward earth fault
cos ->L	Cos(phi) (active power direction) forward
cos ->S	Cos(phi) (active power direction) backward
sin ->L	Sin(phi) (reactive power direction) forward

Binary output function (BAF) (parameter name)	Description
sin ->S	Sin(phi) (reactive power direction) backward
c_s ->L	Not currently used
c_s ->S	Not currently used
OV_250 ->L	Harmonic procedure 250Hz forward
OV_250 ->S	Harmonic procedure 250Hz backward
OV_fx1 ->L	Harmonic procedure free frequency 1 forward
OV_fx1 ->S	Harmonic procedure free frequency 1 backward
OV_fx2+ ->L	Not currently used
OV_fx2+ ->S	Not currently used
OV_fx2- ->L	Not currently used
OV_fx2- ->S	Not currently used
Puls_50	Pulse locating signal
Puls_50c	Not currently used
Puls_50c->L	Not currently used
Puls_50c ->S	Not currently used
Puls50 LED	Not currently used
Puls_HPCI_50	Not currently used
Puls_HPCI_50 ->L	Not currently used
Puls_HPCI_50 ->S	Not currently used
Puls_HPCI_fx	Not currently used
>I	Central fault signal non-directional short circuit (1. stage)
>I1	Non-directional short circuit phase L1 (1. over current stage)
>I2	Non-directional short circuit phase L2 (1. over current stage)
>I3	Non-directional short circuit phase L3 (1. over current stage)
>>I	Central fault signal non-directional short circuit (2. stage)

Binary output function (BAF) (parameter name)	Description
>>I1	Non-directional short circuit phase L1 (2. over current stage)
>>I2	Non-directional short circuit phase L2 (2. over current stage)
>>I3	Non-directional short circuit phase L3 (2. over current stage)
>I ->L	Central fault signal forward short circuit (1. stage)
>I1 ->L	Forward short circuit phase L1 (1. over current stage)
>I2 ->L	Forward short circuit phase L2 (1. over current stage)
>I3 ->L	Forward short circuit phase L3 (1. over current stage)
>>I ->L	Central fault signal forward short circuit (2. stage)
>>I1 ->L	Forward short circuit phase L1 (2. over current stage)
>>I2 ->L	Forward short circuit phase L2 (2. over current stage)
>>I3 ->L	Forward short circuit phase L3 (2. over current stage)
>I ->S	Central fault signal backward short circuit (1. stage)
>I1 ->S	Backward short circuit phase L1 (1. over current stage)
>I2 ->S	Backward short circuit phase L2 (1. over current stage)
>I3 ->S	Backward short circuit phase L3 (1. over current stage)
>>I ->S	Central fault signal backward short circuit (2. stage)
>>I1 ->S	Backward short circuit phase L1 (2. over current stage)
>>I2 ->S	Backward short circuit phase L2 (2. over current stage)
>>I3 ->S	Backward short circuit phase L3 (2. over current stage)
>Ferro Res.	Not currently used
50Hz –df	Not currently used
50Hz +df	Not currently used
50Hz n.a.	Not currently used
DynAdm ->I	Not currently used
DynAdm ->S	Not currently used

Binary output function (BAF) (parameter name)	Description
I_kE>	Short circuit to earth non-directional
I_kE> ->L	Short circuit to earth forward
I_kE> ->S	Short circuit to earth backward
ind_L1	Earth fault or short circuit signal on phase L1
ind_L2	Earth fault or short circuit signal on phase L2
ind_L3	Earth fault or short circuit signal on phase L3
ind_N	Earth fault or short circuit signal on phase N

Binary input function	Description
OFF	No function
Reboot E3D	Restart EOR-3DS
Start recording	Triggers **fault recording** via a binary input that is linked with this function.
Reset all	Reset all signals on the EOR-3DS ● Location signals via the control system ● LED signals ● Indicators in the display
Reset LEDs	Resetting of ● LED indicators ● Indicators in the display
Reset qu2	Resets the signal from the transient procedure (qu2)
Reset cos(phi)	Resets the signal from the wattmetric procedure (cos(phi))
Reset sin(phi)	Resetting of the signal from the sin(phi) procedure
Reset OV	Resets the signal from the harmonic procedure (OV) here OV_250 and OV_fx1
Reset Puls50	Resets the signal from pulse locating method
Reset Kurzschluss	Resets the signal from short circuit indication
Reset Statistik	Resets the statistic
Reset Puls HPCI	Resets the signal from fast pulse locating
Reset Adm2	Resets the signal from the admittance method
BEF nicht zugew-iesen	No function
BEF nicht zugew-iesen	No function

Measurement values	Description
UI_value_0	Absolute value Uo in V (secondary)
UI_value_1	Absolute value U1 in V (secondary)
UI_value_2	Absolute value U2 in V (secondary)
UI_value_3	Absolute value U3 in V (secondary)
UI_value_4	Absolute value Io in mA (secondary)
UI_value_5	Absolute value I1 in mA (secondary)
UI_value_6	Absolute value I2 in mA (secondary)
UI_value_7	Absolute value I3 in mA (secondary)
UI_angle_0	Angle Uo in degrees, phase angle Uo
UI_angle_1	Angle U1 in degrees, phase angle U1 (L1_N)
UI_angle_2	Angle U2 in degrees, phase angle U2 (L2_N)
UI_angle_3	Angle U3 in degrees, phase angle U3 (L3_N)
UI_angle_4	Angle Io in degrees, phase angle Io
UI_angle_5	Angle I1 in degrees, phase angle I1
UI_angle_6	Angle I2 in degrees, phase angle I2
UI_angle_7	Angle I3 in degrees, phase angle I3
UI_d_angle_0	Angle (Uo_Io) in degree / angle between Uo and Io
UI_d_angle_1	Angle (U1_I1) in degree / angle between U1 and I1
UI_d_angle_2	Angle (U2_I2) in degree / angle between U2 and I2
UI_d_angle_3	Angle (U3_I3) in degree / angle between U3 and I3
Up_0	Absolute value Uo in kV (primary) / primary value Uo
Up_1	Absolute value U1 in kV (primary) / primary value U1
Up_2	Absolute value U2 in kV (primary) / primary value U2
Up_3	Absolute value U3 in kV (primary) / primary value U3
Ip_0	Primary value I0 in A
Ip_1	Primary value I1 in A

Measurement values	Description
Ip_2	Primary value I2 in A
Ip_3	Primary value I3 in A
Us_0	Secondary value U0 in V
Us_1	Secondary value U1 in V
Us_2	Secondary value U2 in V
Us_3	Secondary value U3 in V
Is_0	Secondary value I0 in mA
Is_1	Secondary value I1 in mA
Is_2	Secondary value I2 in mA
Is_3	Secondary value I3 in mA
U12p_0	Absolute value U12
U21p_0	Absolute value U21
U31p_0	Absolute value U31
U12p_r_0	Real part voltage U12
U23p_r_0	Real part voltage U21
U31p_r_0	Real part voltage U31
U12p_i_0	Imaginary part voltage U12
U23p_i_0	Imaginary part voltage U21
U31p_i_0	Imaginary part voltage U31
wU12_0	Angle U12
wU23_0	Angle U21
wU31_0	Angle U31
dw_0	Angle between U0 and I0
dw_1	Angle between U1 and I1
dw_2	Angle between U2 and I2
dw_3	Angle between U3 and I3

Measurement values	Description
P_0	Active power Zero sequence component Po in kW
P_1	Active power Phase_1 P1 in kW
P_2	Active power Phase_2 P2 in kW
P_3	Active power Phase_3 P3 in kW
Q_0	Reactive power Zero sequence component Qo in kVar
Q_1	Reactive power Phase_1 Q1 in kVar
Q_2	Reactive power Phase_2 Q2 in kVar
Q_3	Reactive power Phase_3 Q3 in kVar
S_0	Apparent power Zero sequence component So in kVA
S_1	Apparent power Phase_1 S1 in kVA
S_2	Apparent power Phase_2 S2 in kVA
S_3	Apparent power Phase_3 S3 in kVA
Pg	Total active power (P1+P2+P3) in kW
Qg	Total reactive power (Q1+Q2+Q3) in kVar
Sg	Total apparent power (S1+S2+S3) in kVA
cosphi	Not currently used
f_grid	Not currently used
Umax_0	Not currently used
Umax_1	Not currently used
Umax_2	Not currently used
Umax_3	Not currently used
Umin_0	Not currently used
Umin_1	Not currently used
Umin_2	Not currently used
Umin_3	Not currently used
Uav_0	Not currently used

Measurement values	Description
Uav_1	Not currently used
Uav_2	Not currently used
Uav_3	Not currently used
Imax_0	Not currently used
Imax_1	Not currently used
Imax_2	Not currently used
Imax_3	Not currently used
Iav_0	Not currently used
Iav_1	Not currently used
Iav_2	Not currently used
Iav_3	Not currently used
Pmax_0	Not currently used
Pmax_1	Not currently used
Pmax_2	Not currently used
Pmax_3	Not currently used
Pmin_0	Not currently used
Pmin_1	Not currently used
Pmin_2	Not currently used
Pmin_3	Not currently used
Pav_0	Not currently used
Pav_1	Not currently used
Pav_2	Not currently used
Pav_3	Not currently used
Qmax_0	Not currently used
Qmax_1	Not currently used

Measurement values	Description
Qmax_2	Not currently used
Qmax_3	Not currently used
Qmin_0	Not currently used
Qmin_1	Not currently used
Qmin_2	Not currently used
Qmin_3	Not currently used
Qav_0	Not currently used
Qav_1	Not currently used
Qav_2	Not currently used
Qav_3	Not currently used
P_max_all_0	Not currently used
P_min_all_0	Not currently used
P_av_all_0	Not currently used
Q_max_all_0	Not currently used
Q_min_all_0	Not currently used
Q_av_all_0	Not currently used
S_max_all_0	Not currently used
S_av_all_0	Not currently used
U_LL_max_0	Not currently used
U_LL_max_1	Not currently used
U_LL_max_2	Not currently used
EvCnt_Qu2Fw_0	Not currently used
I_SC_0	Short circuit current L1
I_SC_1	Short circuit current L2
I_SC_2	Short circuit current L3

Measurement values	Description
I_SC_3	Maximum short circuit current

Virtual binary output vBA	Description
vBA_1	Free assignable virtual binary output
...	
vBA_96	Free assignable virtual binary output

Virtual measurement value vMWR	Description
vMWR_1	Free assignable virtual measurement value
...	
vMWR_96	Free assignable virtual measurement value

Virtual binary input vBE	Description
vBE_1	Free assignable virtual binary input
...	
vBE_96	Free assignable virtual binary input

Virtaul measurement value vMWW	Description
vMWW_1	Free assignable virtual measurement value
...	
vMMW_96	Free assignable virtual measurement value

11. Maintenance/Cleaning/Spare parts

The maintenance interval depends on the application and enviromental conditions and may be terminated by the customer. An interval of 5 years is recommanded. In a service case please use the service formular from the download center on our homepage under www.a-eberle.de.

11.1 Firmware Update

The firmware update can only be perforemd with connected supply voltage. The firmware update is performed with the AEToolbox, as described in chapter 8.4.7. The current firmware version is available in the download center on our homepage under www.a-eberle.de.

11.2 Factory reset

After pressing the left button 20 times on the start display, the option for a factory reset is displayed. After confirming the request with 'yes (reboot)' the device is restarted and reset. Please consider the saftey parameters for the factory reset as descriped in chapter 9.2.4.2.

11.3 Warm start

A warm start on the EOR-3DS is performed by pressing the reset button for at least 4 seconds. The device is restarted, parameters and real time clock are maintained. Use the warm start only in exeptional cases, because the warm start is a hardware reset and the operating system is not shout down before the reset.

11.4 Spare parts

It is possible to request spare parts by the A. Eberle GmbH & Co. KG.

11.5 Cleaning instructions

Use a soft, slightly damp, lint-free cloth. Make sure no liquid gets in the housing. Do not use window cleaner, household cleaners, sprays, dissolvent, cleaners that contain alcohol, ammonia solutions or abrasive cleaning agents.

If the inside is very dirty due to improper use, it may be best to send the device to the manufacturer. Dust that accumulates on the printed circuit board can cause the insulation coordination to fail.

Dust is generally hygroscopic and can bridge creepage distances, which is why it is advisable to operate a device with housing with the housing closed.

NOTE!	**Do not clean the device with unsuitable products!** This can damage the surface of the device and remove markings ➲ Please follow the cleaning instructions described above.

12. Norms and laws

- IEC 60255-1:2022 Measuring relays and protection equipment - Part 1: Common requirements
- DIN EN 61010-1:2020 Safety requirements for electrical equipment for measurement, control, and laboratory use - Part 1: General requirements
- DIN EN 61010-2-030:2022 Safety requirements for electrical equipment for measurement, control, and laboratory use - Part 2-030: Particular requirements for equipment having testing or measuring circuits
- DIN EN 61000-6-5:2016 Electromagnetic compatibility (EMC) - Part 6-5: Generic standards - Immunity for equipment used in power station and substation environment
- DIN EN 55032:2016 Electromagnetic compatibility of multimedia equipment - Emission Requirements (CISPR 32:2015)
- DIN EN 82079-1 Preparation of instructions for use - Structuring, content and presentation - Part 1: General principles and detailed requirements

13. Disassembly & disposal

⚠ **DANGER!**	**Danger to life due electric shock!**
	✋ Assemble/disassemble EOR-3DS indication unit and current sensors only in voltage free state of the facility
	✋ Consider the five safety rules!

Directive 2012/19/EU, better known as the WEEE2 Directive, deals with the return and recycling of waste electronic and electrical equipment in order to recover valuable raw materials. This concerns all A. Eberle products marked with the symbol of a waste garbage can shown.

➲ Our WEEE registration number is: **DE 37396879**

For old devices, please also note the information on our homepage:

https://www.a-eberle.de/en/about-us/take-back-recycling/

14. Warranty

We guarantee that every product of A. Eberle GmbH & Co KG is free from material and manufacturing defects under normal use.

The detailed conditions for the warranty can be found in our general terms and conditions of business under: https://www.a-eberle.de/en/general-terms/

Notes

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Edition of: 23.03.2023

Version: BA_EOR-3DS_EN_20230323.docx