Combined Earth Fault and Short Circuit Indicator

EOR-3DS

- **Panel mount housing EOR-3DS (B04)**
- **Designed for intelligent switch gear stations**

1. Application

The EOR-3DS combines earth fault and short circuit detection in a compact device. The advantages of different locating methods can be used and weighted by prioritization. The device is developed for the detection of a single feeder. By a variety of SCADA protocols, a PLC functionality, the use of monostable relays and IT-Security features the EOR-3DS is especially suitable for installation in intelligent switch gear stations.

1.1 Location method for use in compensated networks

- Transient earth fault detection using the qu2 and qui algorithms for
  - single faults
  - intermittent faults (qui)
  - fault in loops with large circul. currents (qu2)
- **Active power direction** or cos(φ) method (suitable transducers required)
- **Harmonics method** with measurement of the associated reactive power direction for a user selectable frequency
- Pulse location
- Directional or non-directional short-circuit indicator with configurable reset time

1.2 Location method for use in isolated networks

- Transient earth fault detection using the qu2 and qui algorithms for
  - single faults
  - restriking faults (qui)
  - fault in loops with large circul. currents (qu2)
- Reactive power direction or sin(φ) method
- Directional or non-directional short-circuit indicator with configurable reset time

1.3 SCADA connection

The EOR-3DS offers a lot of different SCADA protocols, that can be used stand alone or in parallel. By using protocols in parallel the EOR-3DS can be also used as a gateway or RTU.

Following protocols are available:

- IEC 60870-5-101 / 104
- IEC 60870-5-103 including fault log
- IEC 61850 GOOSE
- MQTT IoT / Management & Operations (incl. encryption with customer certificates)
- Modbus RTU (RS485, TCP/IP)
- Modbus Master for up to 6 devices
- DNP 3.0

1.4 PLC functionality

With the programming language LUA customer specific solutions can be implemented in the EOR-3DS. Therefore it is also possible to share information between several EOR-3DS via Ethernet and realize certain functions based on these shared information.

1.5 General Features

- Up to **32 GB** memory for event recorder & log book
- Network interface for configuration and data collection with **free software AEToolbox**
- Service interface on the front panel
- Local connection of the devices via network
- Data acquisition with **low-power sensors** or traditional **transducers** (adapters necessary)

1.6 IT-Security

The EOR-3DS connects **encrypted (TLSv1.2 + SFTP)** with the free parameterization software AEToolbox.

Via a user/role concept the devices can be set up **password protected**. The access via TCP (AEToolbox) and EOR-3DS front panel can be configured independently.

2. Characteristics

2.1 qu2 algorithm (transient)

With the qu2 algorithm, transient earth faults can be selectively detected to a few kΩ. In the zero sequence system the healthy outputs can be considered as capacitors. To obtain a voltage shift $u_{0(t)}$, these capacitors have to be charged. This charge is created with the null current $i_{0(t)}$ and results in the charge $q_{0(t)}$. With healthy outputs this yields the equation $q_{0(t)} = C_0\ u_{0(t)}$. When $u_{0(t)}$ is plotted on the x-axis and $q_{0(t)}$ on the y-axis of the qu-graph, this gives a straight line for healthy outputs. This behavior does not apply for faulty outputs. Figure 1 shows this behavior for a low impedance earth fault.

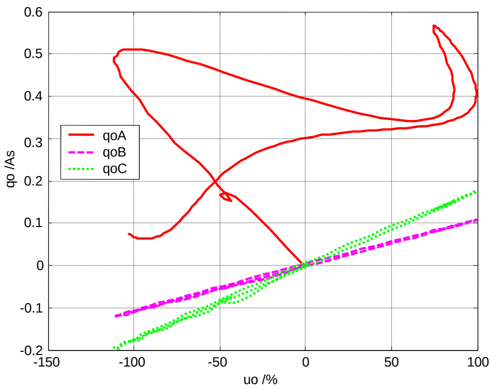


Figure 1: qu-graph for a low impedance earth fault

In parallel lines and meshed networks, circulating currents occur that can lead to an erroneous display. The improved qu2 algorithm eliminates this influence through linearization to the operating point and a downstream, non-linear filter. This algorithm is thus the first algorithm that really works in a meshed network and performs a successful, directional evaluation

This results in the following properties for the qu2 algorithm:

- Suitable for earth faults up to several kΩ
- The triggering threshold of the voltage shift u_{NE}
- The triggering current as an equivalent phase-earth capacitance
- Suppression of the earth fault in response to a selectable minimum duration of the earth fault (continuous earthing message)
- Suppression of the earth fault indication in the direction of the busbar is possible
- Reset of the indication by an external signal, automatically after a specified period or at the end of the earth fault
- For the evaluation, either the measured or calculated u_{NE} from the three phase-earth voltages can be used
- Recording of the transient events in the logbook
- Recording of the associated fault record with 10 periods of pre-event history and an adjustable post-event history length (several seconds)
- Errors due to higher-frequency signals are greatly reduced by integral evaluation
- The qu2 algorithm, in comparison with the standard transient method, uses a much larger time range for the evaluation of the fault direction

2.2 qui algorithm (restriking and intermittent earth faults)

Restriking faults occur especially in cable networks. Figure 2 shows the change in the voltage of the faulty phase and Figure 3 shows the corresponding change in the voltage shift. In the measurement, a mean value of the voltage over 10 periods is usually taken. As a result, this restriking fault is interpreted as a high-impedance fault and the failure location starts in the transmission line network, rather than in the area of the cable section. A further complication is that the usual stationary location methods, such as the cos(φ) method of stationary conditions would lead to the fault location and this non-linear method for the restriking cannot be properly evaluated. The corresponding directional indications are arbitrary and do not help with the fault location.

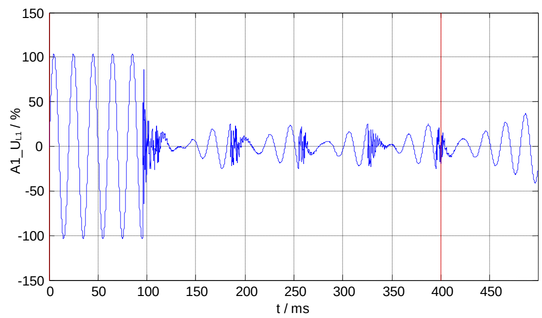


Figure 2: Voltage of the faulty conductors

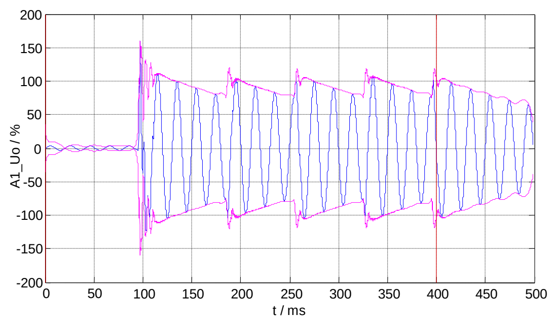


Figure 3: $u_0(t)$ with a restriking fault

The qui algorithm is based on the proven qu algorithm and is adapted to the intermittent fault only in terms of the parameter. A modified parameter set is required when, for example, the shift voltage no longer falls below the threshold value for the earth fault detection.

This results in the following essential properties for the qui algorithm:

- Directional indication also during restriking and intermittent earth faults
- The indication tracks the fault, i.e. if the faulty segment changes while creating the open connection in the circuit to the other output, with the qui method the indication also changes
- Fault location can already be performed during the restriking error
- Fault location can already be started on the faulty cable output because there is no misinterpretation of a high-impedance fault
- The recording of the events in the log book (coming, going) is configurable
- A cyclic record of the measured values in the log book during the fault can be configured for subsequent evaluation

2.3 Reactive power direction method for isolated networks: sin(φ)

- The trigger thresholds for the voltage shift U_{NE} and the total current $3I_0$ are configurable
- For the evaluation, either the measured or calculated U_{NE} from the three phase-earth voltages can be selected. The same applies for the total current $3I_0$
- In the reactive power direction method, the requirements for the accuracy of the angle between current and voltage transformers are less
- Suppression of the earth fault indication in the direction of the busbar is possible
- The recording of the events in the log book (coming, going) is configurable
- A cyclic record of the measured values in the log book during the fault can be configured. Thus, a more detailed analysis of the fault is possible

2.4 Active power direction method for compensated networks: cos(φ)

- The trigger thresholds for the voltage shift U_{NE} and the total current $3I_0$ are configurable
- Selectable operating modes:
  - Fault tracking indication of the direction of the active power in the null system
  - Stored indication of the active residual current increase
- Reset of the indication by an external signal: automatically after a specified period or at the end of the earth fault can be selected and combined
- Suppression of the earth fault indication in the direction of the busbar is possible
- The recording of the events in the log book (coming, going) is configurable
- A cyclic record of the measured values in the log book during the fault can be parameterized for subsequent evaluation
- When using the active power direction method, the accuracy of the angle between current and voltage transformers must be monitored

2.5 Harmonics method

- The evaluation is made using the sin(φ) method, however the frequency can be freely selected
- The method can be used in both isolated and compensated networks
- The recording of the events in the log book (coming, going) is configurable
- A cyclic record of the measured values in the log book during the fault can be configured for subsequent evaluation

2.6 Pulse location

- The trigger threshold of the pulse amplitude of the total current $3I_0$ is configurable
- The stationary part of the null current is removed automatically during the recognition of the pulse pattern
- Reset of the indication by an external signal or automatically after a specified period can be selected and combined
- A simple depth positioning is possible due to the pulse location
- Symmetrical and asymmetrical pulsing can be configured

2.7 Non-directional short circuit

- Adjustable activation threshold
- Automatic indication reset after a set time or via a digital input

2.8 Directional short circuit

- Directional indication through evaluation of the phase-earth voltages
- Adjustable activation threshold
- Automatic indication reset after a set time or via a digital input
- Timing of LED and relay separately adjustable

2.9 Applicability of the methods

The following table shows the possible use of EOR-3DS, depending on the placement of the Analog Input board.

Available transformers / 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

2.10 SCADA connection

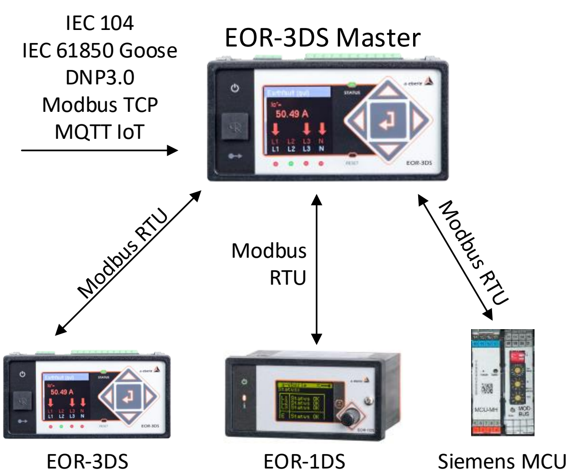
The EOR-3DS offers a lot of different SCADA protocols, that can be used stand alone or in parallel. By using protocols in parallel the EOR-3DS can be also used as a gateway or RTU.

Following protocols are available:

- IEC 60870-5-104
- IEC 60870-5-103 including fault log
- EC 60870-5-101
- IEC 61850 GOOSE
- MQTT IoT
  (incl. encryption with customer certificates)
- MQTT Management & Operations
  (incl. encryption with customer certificates)
- Modbus RTU (RS485, TCP/IP)
- Modbus Master for up to 6 devices
- DNP 3.0

2.11 Modbus Master functionality

With help of the Modbus Master functionality the EOR-3DS can connect up to 6 devices (independent from device vendor) via Modbus RTU and convert the data into another protocol. This way the EOR-3DS can work as a SCADA gateway or RTU.



For switch gears, where a motor control unit (MCU) is installed for switching of circuit breakers, this way it is possible to connect MCU units via Modbus.

Furthermore it is also possible to supervise in a switch gear one feeder with an EOR-3DS incl. RTU functionality and additional feeders with EOR-1DS.

2.12 PLC functionality

With the programming language LUA customer specific solutions can be implemented in the EOR-3D. Therefor it is also possible to share information between several EOR-3DS via Ethernet and realize certain functions based on these shared information.

Beside the serial connection via Modbus RTU there can be for example be a separate TCP/IP connection between two EOR-3DS established, without the necessity of a switch. In case of the customer specific function „cross calibration“, via a LUA background program, feeder 2 (capacitive voltage measurement cl. 3) can be periodically compared with and recalibrated by feeder 1 (resistive voltage measurement cl. 0.5).

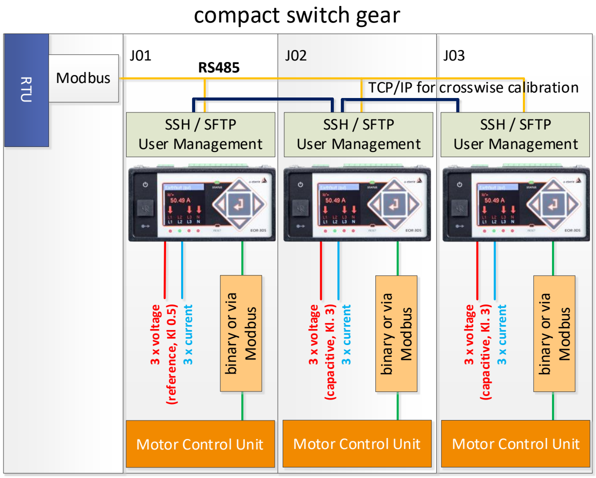


Figure 4: Cross calibration for one feeder

In case several feeders shall be cross calibrated by feeder 1, this can be realized by the additional use of a switch.

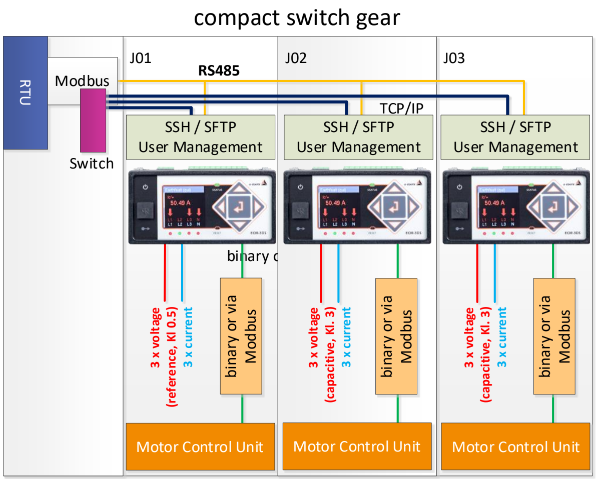


Figure 5: Cross calibration for several feeders

2.13 Fault recorder

- Recording with a sampling frequency ≥ 2 kHz
- Recording of all analogue channels, all digital inputs and relay outputs as well as all internal digital process decisions
- Due to >= 4 GB internal memory, very long periods can be monitored
- The recording is made in CSV format (Comma-Separated Values), and can be read directly
- The recordings can be converted using the operating software into COMTRADE format

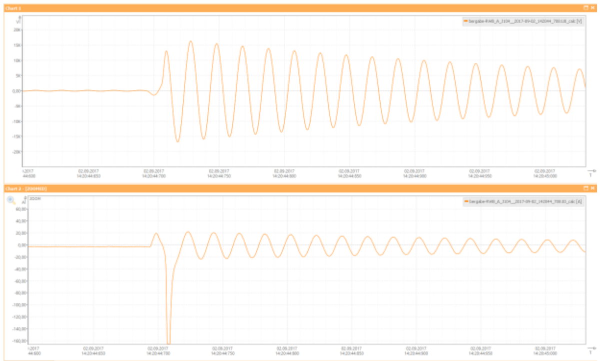


Figure 6: Fault record example Uo and Io

- The binary signals can be displayed as well

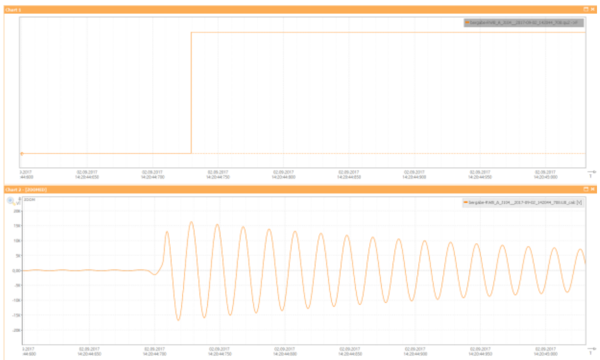
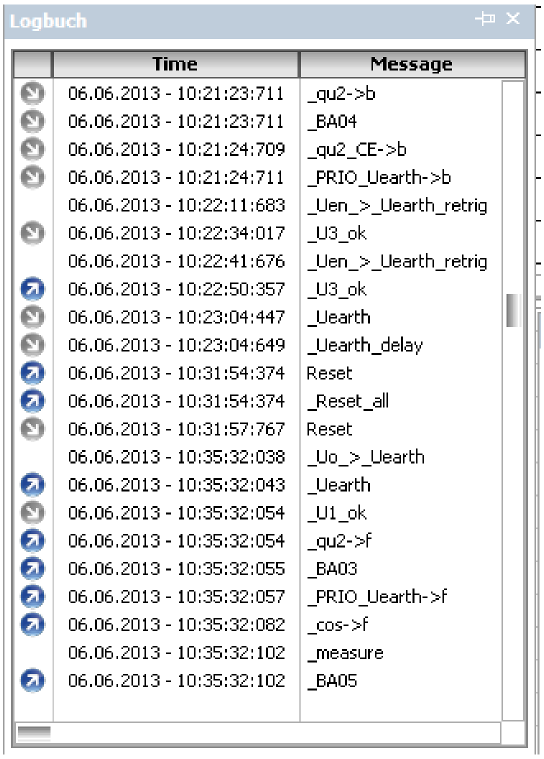


Figure 7: Fault record view incl. binary signal

- View the fault records directly in the software
- Comtrade file import via drag and drop

2.14 Log book

- Display of important signal directly at the EOR-3DS
- Detailed log book recording can be read via operating software AEToolbox
- Recording in ASCII format and directly readable
- Recordable events can be configured
- Cyclic input of measurement values during the fault possible
- Results of calculations e.g. I_{CE} at the outputs
- Parameterized mapping of the relay in plain text



Logbuch

	Time	Message
	06.06.2013 - 10:21:23:711	_qu2->b
	06.06.2013 - 10:21:23:711	_BA04
	06.06.2013 - 10:21:24:709	_qu2_CE->b
	06.06.2013 - 10:21:24:711	_PRIO_Uearth->b
	06.06.2013 - 10:22:11:683	_Uen_>_Uearth_retrig
	06.06.2013 - 10:22:34:017	_U3_ok
	06.06.2013 - 10:22:41:676	_Uen_>_Uearth_retrig
	06.06.2013 - 10:22:50:357	_U3_ok
	06.06.2013 - 10:23:04:447	_Uearth
	06.06.2013 - 10:23:04:649	_Uearth_delay
	06.06.2013 - 10:31:54:374	Reset
	06.06.2013 - 10:31:54:374	_Reset_all
	06.06.2013 - 10:31:57:767	Reset
	06.06.2013 - 10:35:32:038	_Uo_>_Uearth
	06.06.2013 - 10:35:32:043	_Uearth
	06.06.2013 - 10:35:32:054	_U1_ok
	06.06.2013 - 10:35:32:054	_qu2->f
	06.06.2013 - 10:35:32:055	_BA03
	06.06.2013 - 10:35:32:057	_PRIO_Uearth->f
	06.06.2013 - 10:35:32:082	_cos->f
	06.06.2013 - 10:35:32:102	_measure
	06.06.2013 - 10:35:32:102	_BA05

Figure 8: EOR-3DS logfile

2.15 Data logger

- Recording of measured operating values with adjustable sampling period
- The following are recorded: U, I, P, Q, S, 50 Hz

2.16 Digital inputs

- Binary inputs invertible
- Predefined functions, e.g. to acknowledge all indications at the same time or messages of single localization methods
- 6 binary inputs up to 60 V DC or partially up to 132 V DC

2.17 Digital outputs (relay)

- Signals can be inverted by software
- Multiple signals can be combined by software (OR-operation, invertible)
- 1 relays with changeover contact; monostable
- 3 relays with normally open contacts; monostable

3. Application software AEToolbox

The following functions are available in the application software.

3.1 Configuring of EOR-3DS

- Communication via TCP/IP
- System configuration
- Comparison of the parameterization and creation of difference lists
- Activation of the various earth fault and short circuit detection methods
- Setting the trigger levels
- Configuration of the signalling (LEDs, relays and combined signalling)
- Configuration of the EOR-3DS display sequence
- Configuration of the integrated SCADA

3.2 Support for easy commissioning

- Online service page
- Digital input and output testing
- Simulation of all input, output functions and analogue values for simple SCADA commissioning
- Display of all measurements:
  - U, I, P, Q, S, φ
  - 50 Hz and harmonics
- Graphic display of the measured values in a vector diagram

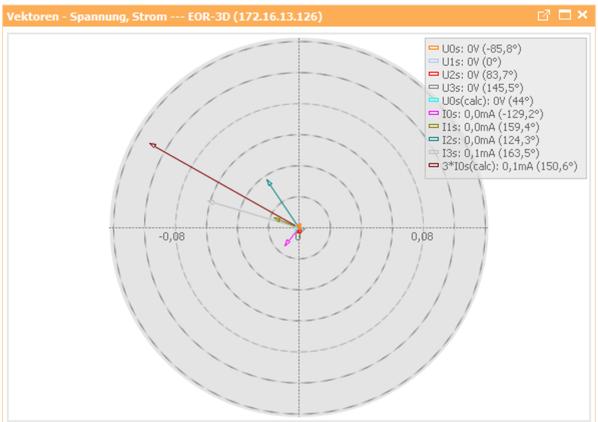


Figure 9: Vector diagram of the measurement values

- Primary examination of the direction of the power transformer in a healthy network with earth fault compensation during normal operation. This test requires no additional accessories.

3.3 IT-Security / User management

Since firmware 2.0 of EOR-3DS the parameterization software AEToolbox communicates **encrypted** with the devices (AEToolbox >= 2.0 necessary).

Via a user/role concept the devices can be set up **password protected**. The access via TCP (AEToolbox) and EOR-3D front panel can be configured independently.

The activation and configuration of the user/role concept is done in AEToolbx on the tab “User Management”. For the access via TCP the following roles are available:

- User (read only)
- Operator (read+write)
- Admin (r+w and security relevant parameters)

The user name and password are freely chooseable for TCP connections. It’s also possible to define several users in the same role.

For the access via panel of EOR-3DS only the users and roles User and Operator are available. The password is a four digit numeric code.

Single users can also explicitly be locked. This way it is possible to have e.g. read only access to the EOR-3D panels or to lock the panel completely.

3.4 Fault analysis

- Log book download and display
- Time synchronization of multiple log books
- Presentation of the events in digital traces
- Download of the recorded fault records
- Conversion of fault records into COMTRADE format
- Events in the fault record as binary traces

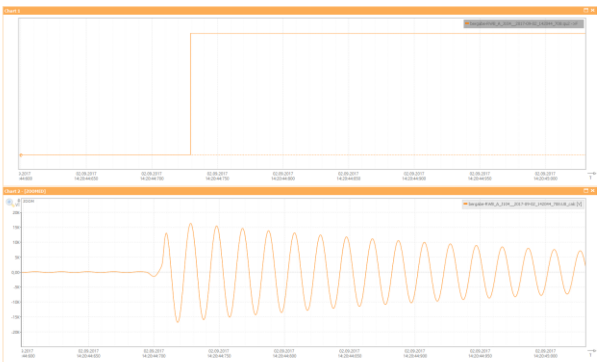


Figure 10: Fault record view incl. binary signal

3.5 AEToolbox projects for single devices and device pools

The software AEToolbox is project based. Each project can be saved as a project file in *.aepx format. But it is also possible to export single parameter setups or online pages.

Per project it is possible to have only one device or several devices in one device pool included. Furthermore it is possible to have several device pools and other A.Eberle devices included, e.g. REG-DP(A)s.

A detailed manual of the different functions of AEToolbox is available within the AEToolbox installation or on the A.Eberle homepage within the download center.

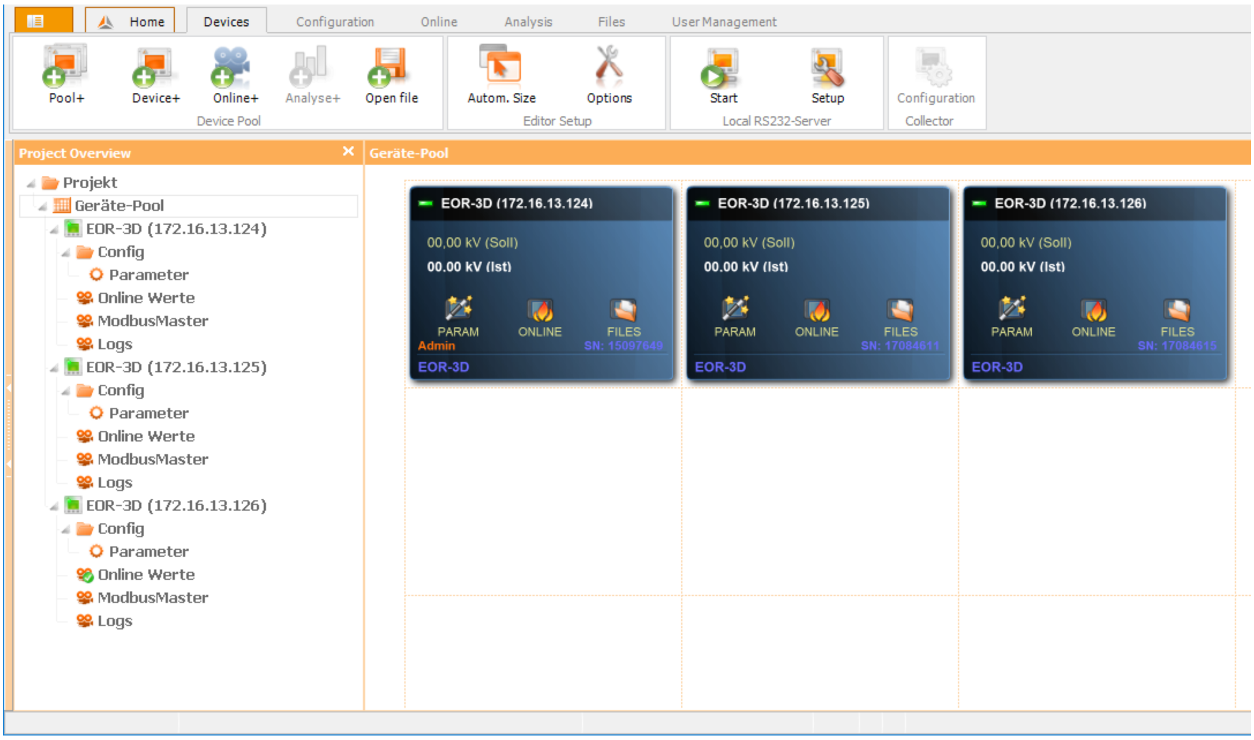


Figure 11: programming software AEToolbox

4. Technical specifications

4.1 Regulations and standards

IEC 60255-1:2022
DIN EN 61010-1:2020
DIN EN 61010-2-030:2022
DIN EN 61000-6-5:2016
DIN EN 55032:2016 (CISPR 32:2015)

CE

4.2 AC voltage input U05

Capacitive voltage tap-off on LR / LRM systems

Measuring voltage	0 ... 42 VAC
Shape of the curve	Sine
Frequency range of the fundamental wave	48 .. 52 Hz
Burden	110 pF
Accuracy	+- 1.0 %

4.3 AC voltage input U06

Low-power sensors with 200 kΩ rated burden and U_r = 3,25 V / $\sqrt{3}$ e.g. sensors from Zelisko, Greenwood Power, etc.

Measuring voltage	0 ... 4 VAC
Shape of the curve	Sine
Frequency range of the fundamental wave	48 .. 52 Hz
Burden	220 kΩ
Accuracy	+- 0.5 %

4.4 AC voltage input U07

Low-power sensors with 2 MΩ rated burden and U_r = 3,25 V / $\sqrt{3}$, e.g. sensors from ABB, Zelisko, Greenwood Power, etc.

Measuring voltage	0 ... 4 VAC
Shape of the curve	Sine
Frequency range of the fundamental wave	48 .. 52 Hz
Burden	2 MΩ
Accuracy	+- 0.5 %

4.5 AC voltage input U10

Classical voltage transducers with 100 V or 110 V; all values refer to the connection at the U10 adapter; AC voltage input at indicator itself like U06 feature

Measuring voltage	0 ... 150 VAC
Shape of the curve	Sine
Frequency range of the fundamental wave	48 .. 52 Hz
Burden	10 MΩ
Accuracy	+- 1.0 %

4.6 AC voltage input U29

Low-power sensors with 2 MΩ rated burden, e.g. ABB sensors acc. to IEC 60044 or 61869 with RJ45 plug

Measuring voltage	0 ... 8 VAC
Shape of the curve	Sine
Frequency range of the fundamental wave	48 .. 52 Hz
Burden	2 MΩ
Accuracy	+- 0.5 %

4.7 AC voltage input U31

Low-power sensors from Siemens (SIBushing) acc. to IEC 61869 with RJ45 plug (with sensor configuration file)

Measuring voltage	0 ... 8 VAC
Shape of the curve	Sine
Frequency range of the fundamental wave	48 .. 52 Hz
Burden	2 MΩ
Accuracy	+- 0.5 %

4.8 AC current input C10

Inductive low-power sensors with U_r = 225 mV, e.g. sensors from ABB, Zelisko, Greenwood Power, etc.

Measuring voltage	0 … 500 mVAC
Shape of the curve	Sine
Frequency range of the fundamental wave	48 .. 52 Hz
Burden	60 kΩ
Accuracy	+- 0.5 %

4.9 AC current input C21/C25

Classical current transducers 1 A / 5 A secondary

Measuring voltage	0 … 20 A
Shape of the curve	Sinus
Frequency range of the fundamental wave	48 .. 52 Hz
Internal consumption	≤ 0.1 VA
Accuracy	+- 1.0 %

4.10 AC current input C29

Low-power sensors ABB acc. to IEC 60044 or 61869 with RJ45 plug

Measuring voltage	0 … 4,69 VAC
Shape of the curve	Sinus
Frequency range of the fundamental wave	48 .. 52 Hz
Internal consumption	≤ 0.1 VA
Accuracy	+- 0.5 %

4.11 AC current input C31

Low-power sensors from Siemens (SIBushing) acc. to IEC 61869 with RJ45 plug (with sensor configuration file)

Measuring voltage	0 … 1.125 VAC
Shape of the curve	Sinus
Frequency range of the fundamental wave	48 .. 52 Hz
Internal consumption	≤ 0.1 VA
Accuracy	+- 0.5 %

4.12 Binary inputs

Inputs BI1 + BI2

Input voltage (valid for order codes C29/U29 and C31/U31)	DC 0 ...60 V
Input voltage (valid for order codes except C29/U29 and C31/U31)	DC 0 … 110 … 132 V
Curve shape, permissible	Rectangular
H – Level	DC 20 V
L – Level	DC 15 V
Input resistance	≥ 16 kΩ
Potential isolation	Impedance isolation

Inputs BI3 … BI6

Input voltage	DC 0 ...60 V
Curve shape, permissible	Rectangular
H – Level	DC 20 V
L – Level	DC 15 V
Input resistance	≥ 16 kΩ
Potential isolation	Impedance isolation

4.13 Binary outputs

max. switching frequency	≤ 1 Hz
Potential isolation	Isolated from all device-internal potentials
Contact load (maximum values with ohmic load)	AC 60 V / 1.0 A DC 30 V / 2.0 A DC 60 V / 0.5 A
Type of use	In secondary circuit, galvanic separated from line voltage
max. isolation voltage	DC 1500 V
min. switching load	100 mW
Switch. operations	> 10^6 electrical
BO 1	monostable relay with change over contacts
BO 2..4	monostable relays (normal open contacts)

4.14 Serial RS485 interface

Typ	2-wire RS485 interface
Potential isolation	galvanic separated
Connection	shielded cabel
120 Ω termination	via DIP switch on backside, see also figure 12

4.15 Supply voltage

Character-istic	Voltage range	Power consumption
H23:	DC: 20 .. 148 V protect. against polarity reversal	< 4 W (boot) < 3 W (operation) < 6 W (operation + service adapter)

4.16 Rated conductor cross section

Terminal X1 (digital outputs)	0,5 - 1,5 mm²
Terminal X2 (power supply)	0,5 - 1,5 mm²
Terminal X4 (RS485)	0,5 - 1,5 mm²
Terminal X5 (measurement inputs & binary inputs 3..6)	0,5 - 1,5 mm²
Terminal X6 (binary inputs 1&2)	0,5 - 2,5 mm²
Terminal X6 (binary inputs 1..6 - only with features C29/U29 or C31/U31)	0,5 - 1,5 mm²
PE flat connector (6.3 mm)	2,5 mm²

4.17 Measurement value recording

non-volatile	≤ 32 GB

4.18 Environment parameters

Reference temp.	23°C ± 1 K
Operation	-20 °C...+50 °C
Transport and storage	-25 °C...+65 °C
Relative humidity	5 %..95 % non-condensing
Altitude	Up to 2000 meters

4.19 Limit-value monitoring

Limit values	programmable
Response times	programmable
Alarm indicators	programmable: LED; Display

4.20 Weight

EOR-3DS B04	0.29 kg
EOR-3DS B04 with C21 adapter	0.41 kg
EOR-3DS B04 with U10 adapter	0.46 kg
EOR-3DS B04 with C21 & U10 adapter	0.58 kg

4.21 Electrical safety

DIN EN 61010-1:2020 DIN EN 61010-2-030:2022	
Degree of protection: Device front with attached service interface coverage Device back	 IP50 IP20
Protection class	I
Degree of pollution	2
Measurement category (only U10-adapter)	III/150 V
Measurement category (only U10-adapter)	II/300 V
Overvoltage category	II

Operating voltages

DC 50 V	RS485, Ethernet
DC 60 V	Binary inputs 1..6, measurement inputs
DC 132 V	Binary inputs 1+2 (except C29/U29 or C31/U31)
DC148 V	Power supply
AC 60 V	Binary outputs
AC 150 V	U10 voltage adapter

4.22 Electromagnetic compatibility

Immunity	DIN EN 61000-6-5:2016
Emissions	DIN EN 55032:2016 (CISPR 32:2015)

4.23 Installation location in compact switch gears and effects on relay contacts

⚠ WARNING!	**Compact switch gears: Switching commands and other security relevant commands allowed as double commands only!** Depending on the installation location of the EOR-3DS B04 in compact switch gear stations, during a switching operation in the own or near switch field high acceleration forces can affect the device. Due to the acceleration forces closed relay contact might open for a short time (time range typically 100 ms). Therefor switching commands and other security relevant commands via relay contacts of the EOR-3DS B04 have to be executed as double commands.

4.24 Back side EOR-3DS

- Network directly accessible on the back side → simple wiring in station
- RS485 directly accessible without adaptor; parallel bus directly on device; termination directly on device (note: RS485 interface only available with feature code V1)
- Memory card directly accessible
- EHT2 for process bus or remote access (optional; license required, feature code P1)
- Depending on the measurement input (feature code Cxx and Uxx) card sensors can be connected via 2-wire connection or via RJ45

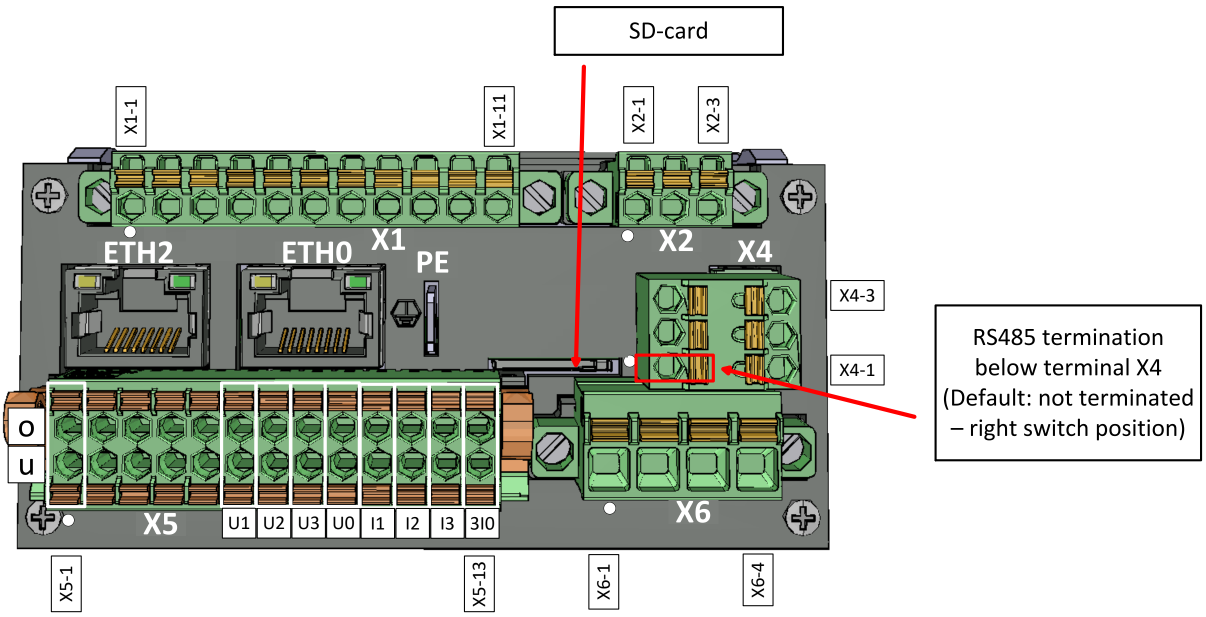


Figure 12: Terminal location for voltage and current inputs, SD-card and RS485 termination switch with features U05/U06/U07/U10 with C10/C21/C25

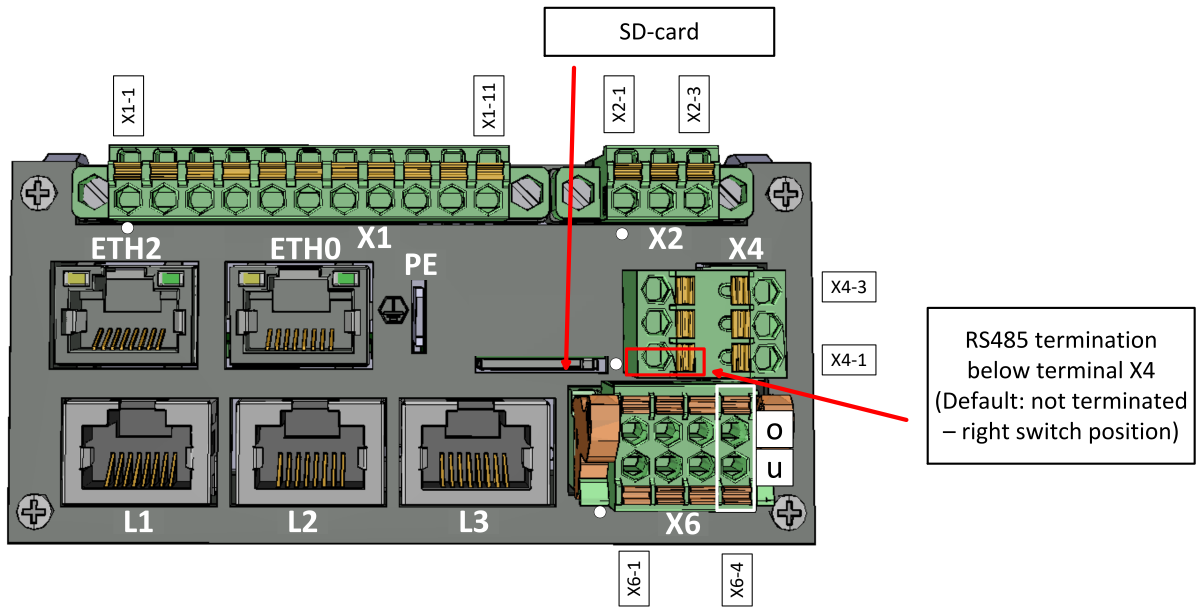


Figure 13: Voltage and current measurement inputs via RJ45, SD-card and RS485 termination switch with features C29/U29 or C31/U31

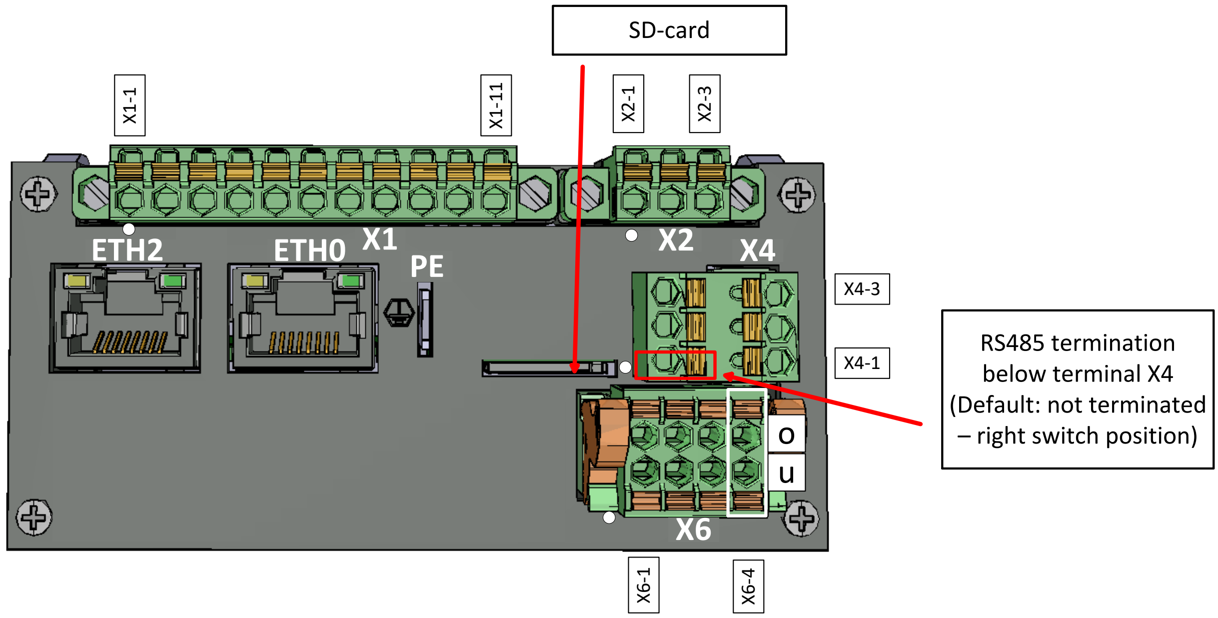


Figure 14: No voltage and current measurement inputs, SD-card and RS485 termination switch with features C00/U00

4.25 Indicator dimensions: features C10 with U05/U06/U07

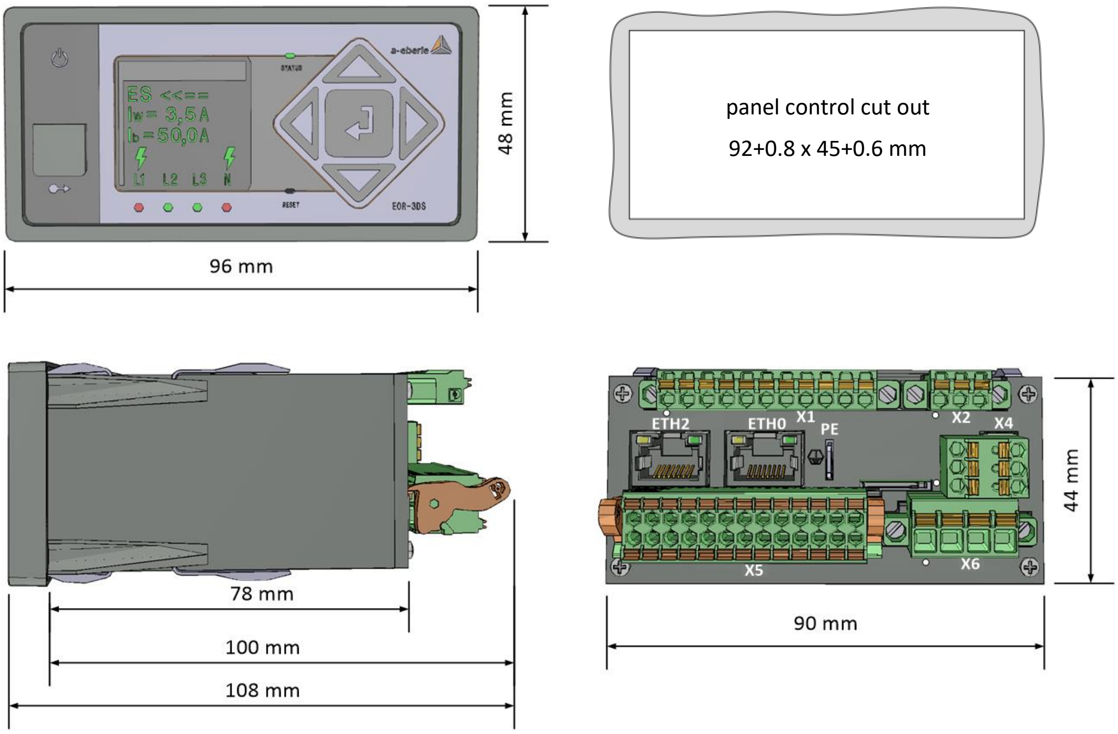


Figure 15: Dimensions EOR-3DS with feature U05/U06/U07 with C10

4.26 Indicator dimensions: features C29/U29 or C31/U31 or C00/U00

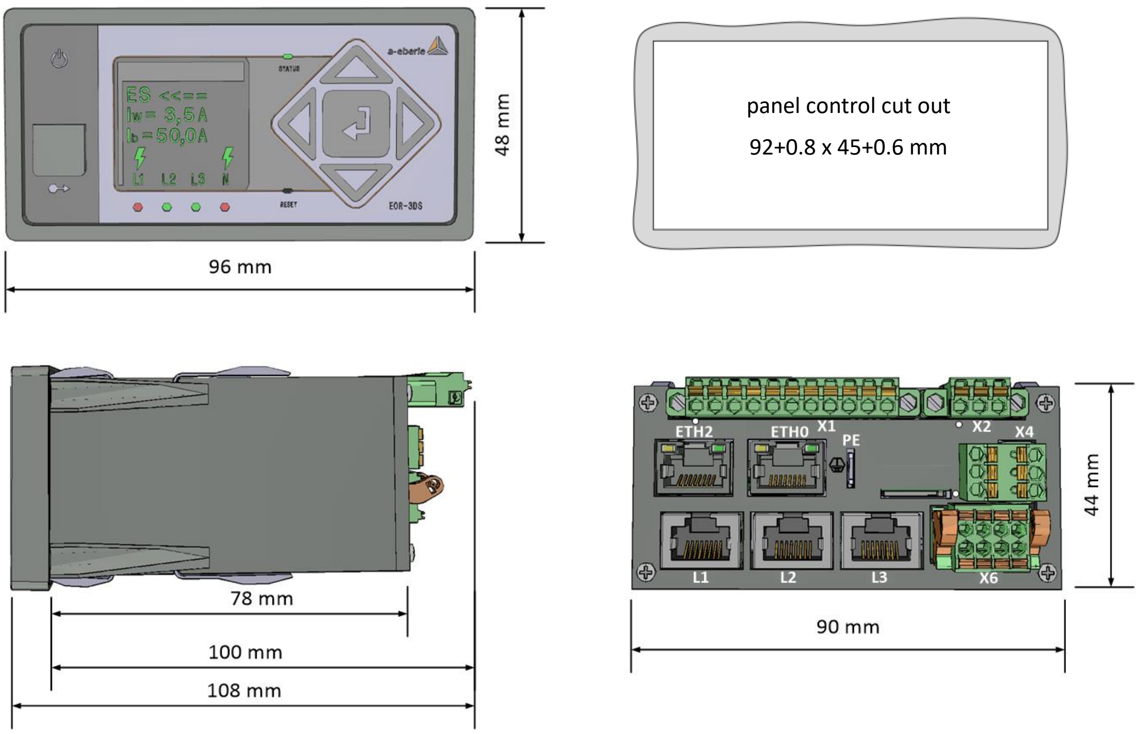


Figure 16: Dimensions EOR-3DS with feature C29/U29, C31/U31 or C00/U00

4.27 Dimensions current adapter C21/C25 and voltage adapter U10

The following picture shows the current adapter C21 for classical current measurement of 1 A / 5 A values. Feature C25 has in comparison with feature C21 only the $3I_0$ current transducer. The transducers for I1..3 are not available with this feature.

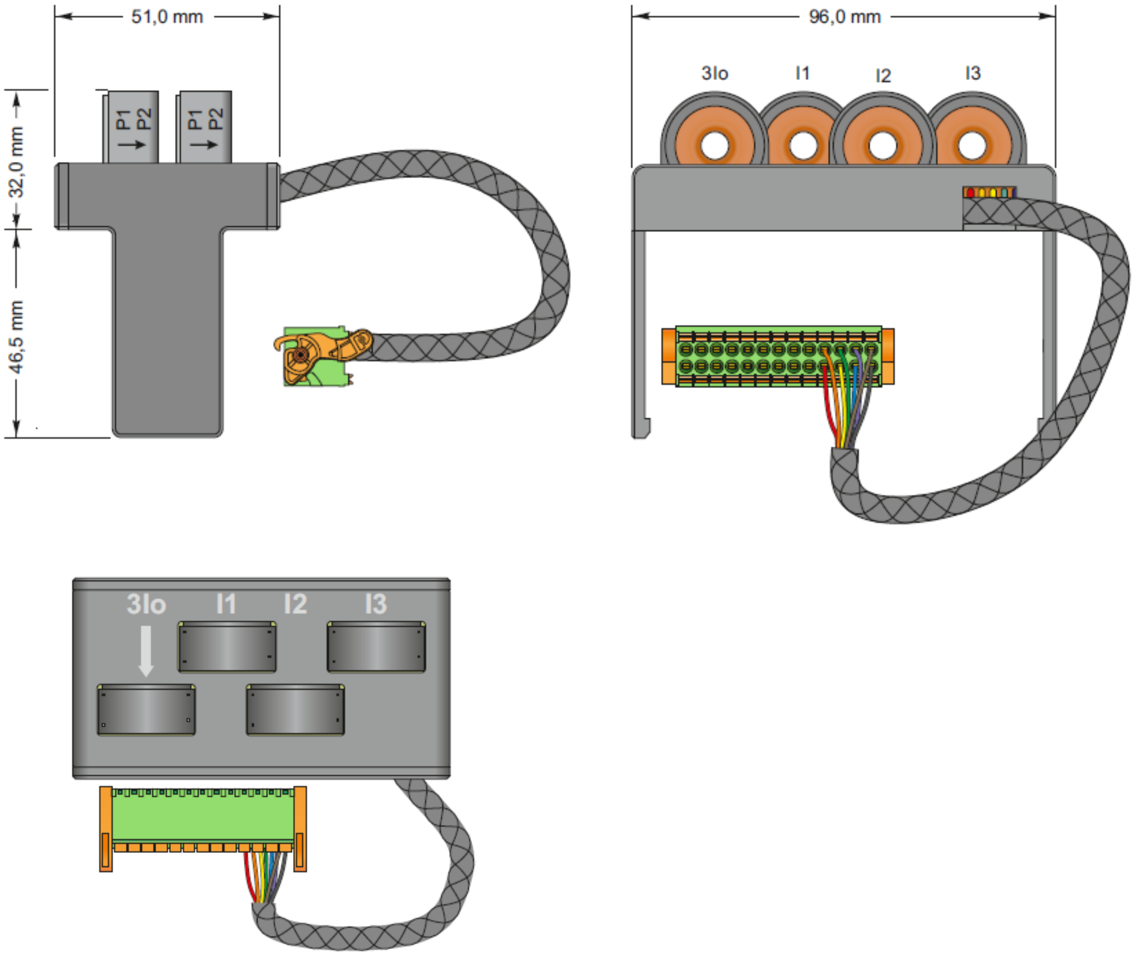


Figure 17: Dimensions of plug-on adapter for classical current measurement feature C21

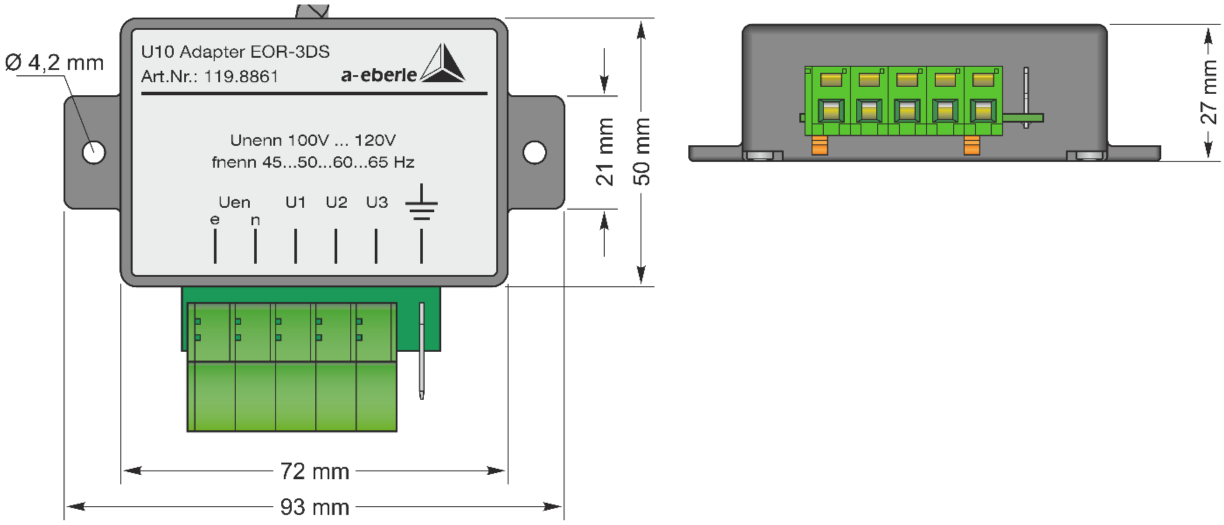


Figure 18: Dimensions of voltage measurement adapter for 100 V / 110 V transducers; order code U10

Figure 19: EOR-3DS mounted on DIN rail with current adapter C21 and voltage adapter U10

4.28 Terminal assignment for features C10 and U05

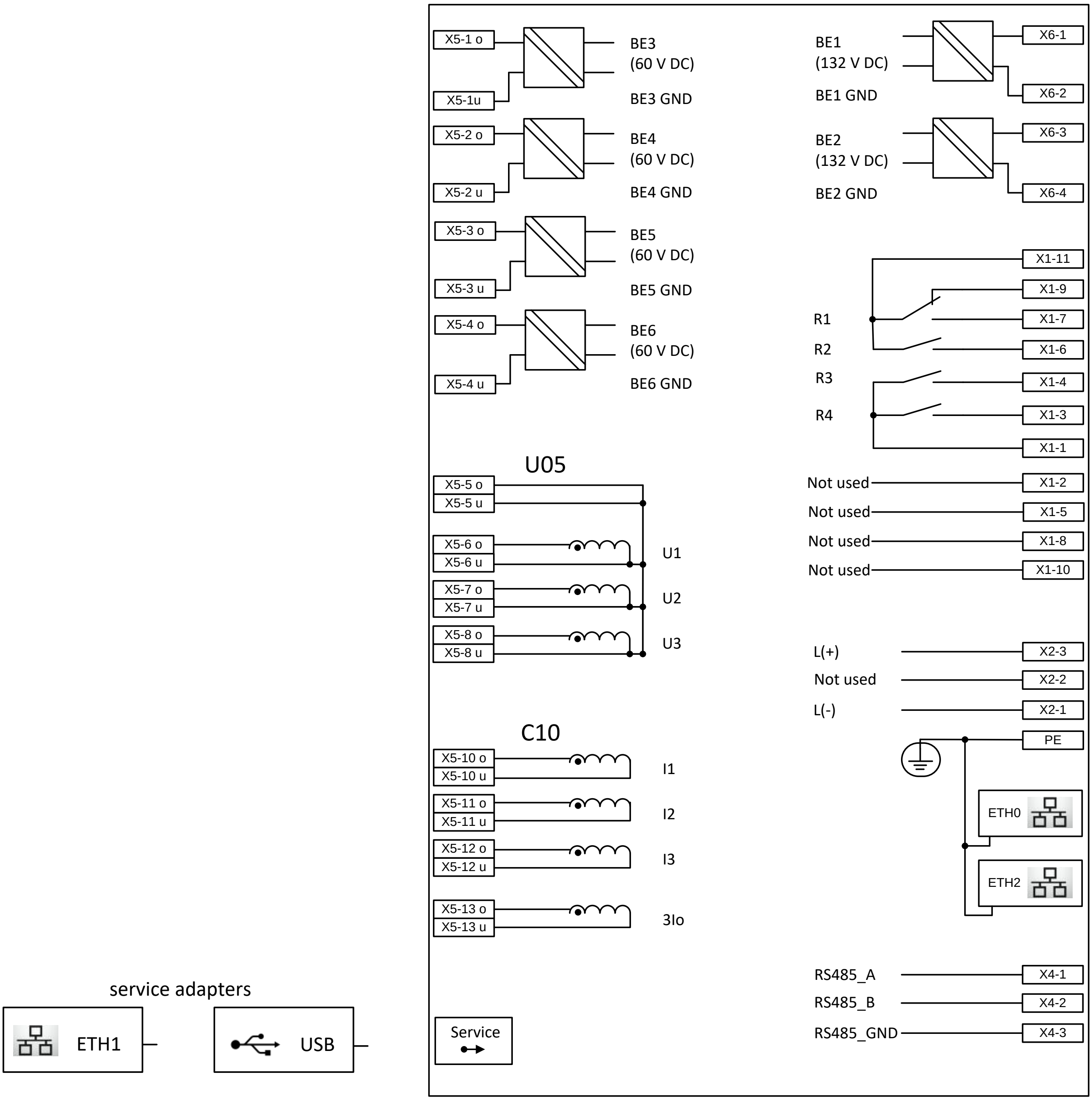


Figure 20: EOR-3DS terminal assignment for feature combination C10 and U05

RS485 terminals X4-1..3 only available with order code V1:
The order code V defines whether the device has the serial interface RS485. In case the EOR-3DS has the order code V0 the RS485 terminals X4-1..3 are not available.

4.29 Terminal assignment for features C21/C25 and U05

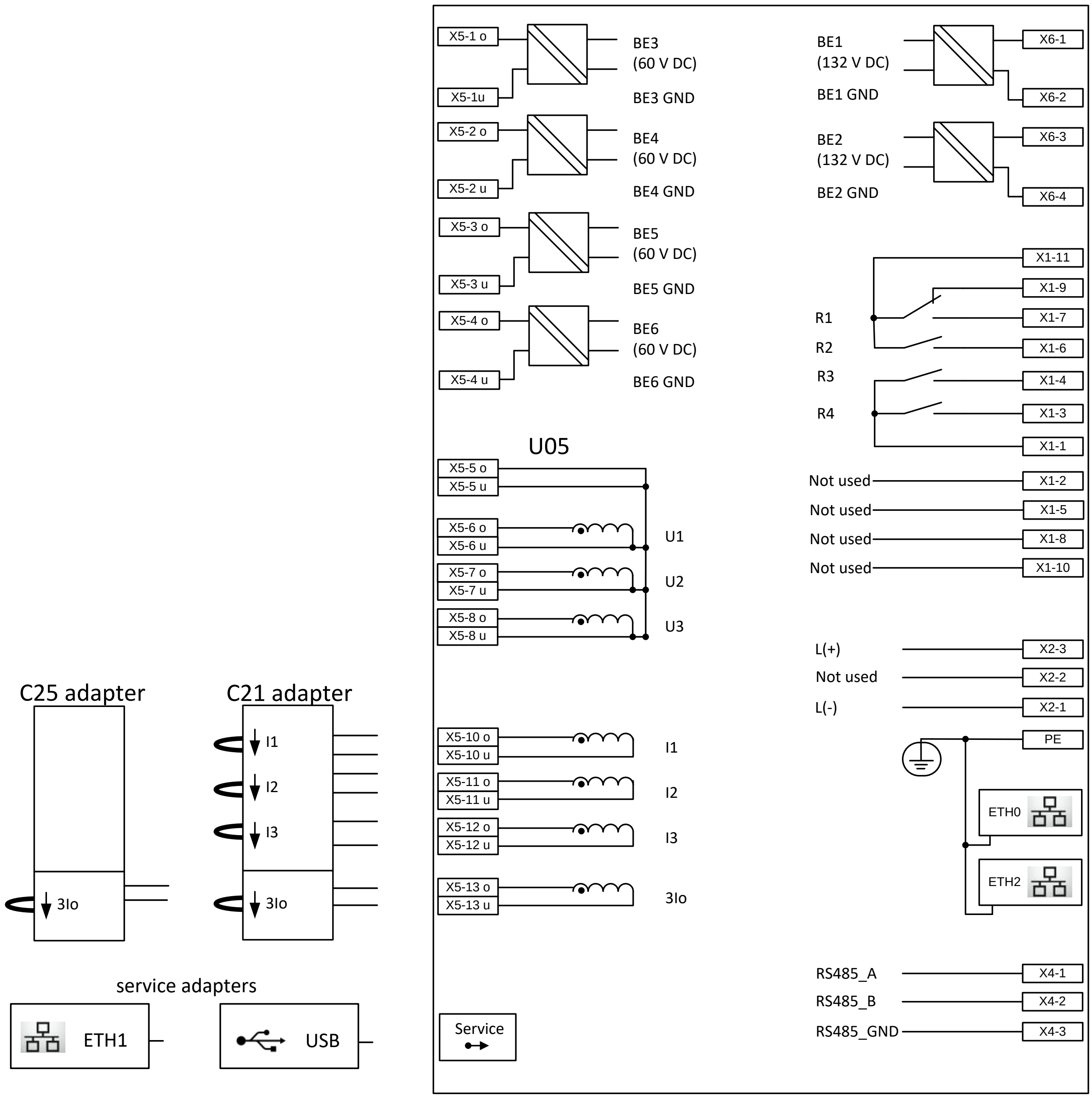


Figure 21: EOR-3DS terminal assignment for feature combination C21 or C25 and U05

RS485 terminals X4-1..3 only available with order code V1:
The order code V defines whether the device has the serial interface RS485. In case the EOR-3DS has the order code V0 the RS485 terminals X4-1..3 are not available.

4.30 Terminal assignment for features C10 and U06/U07

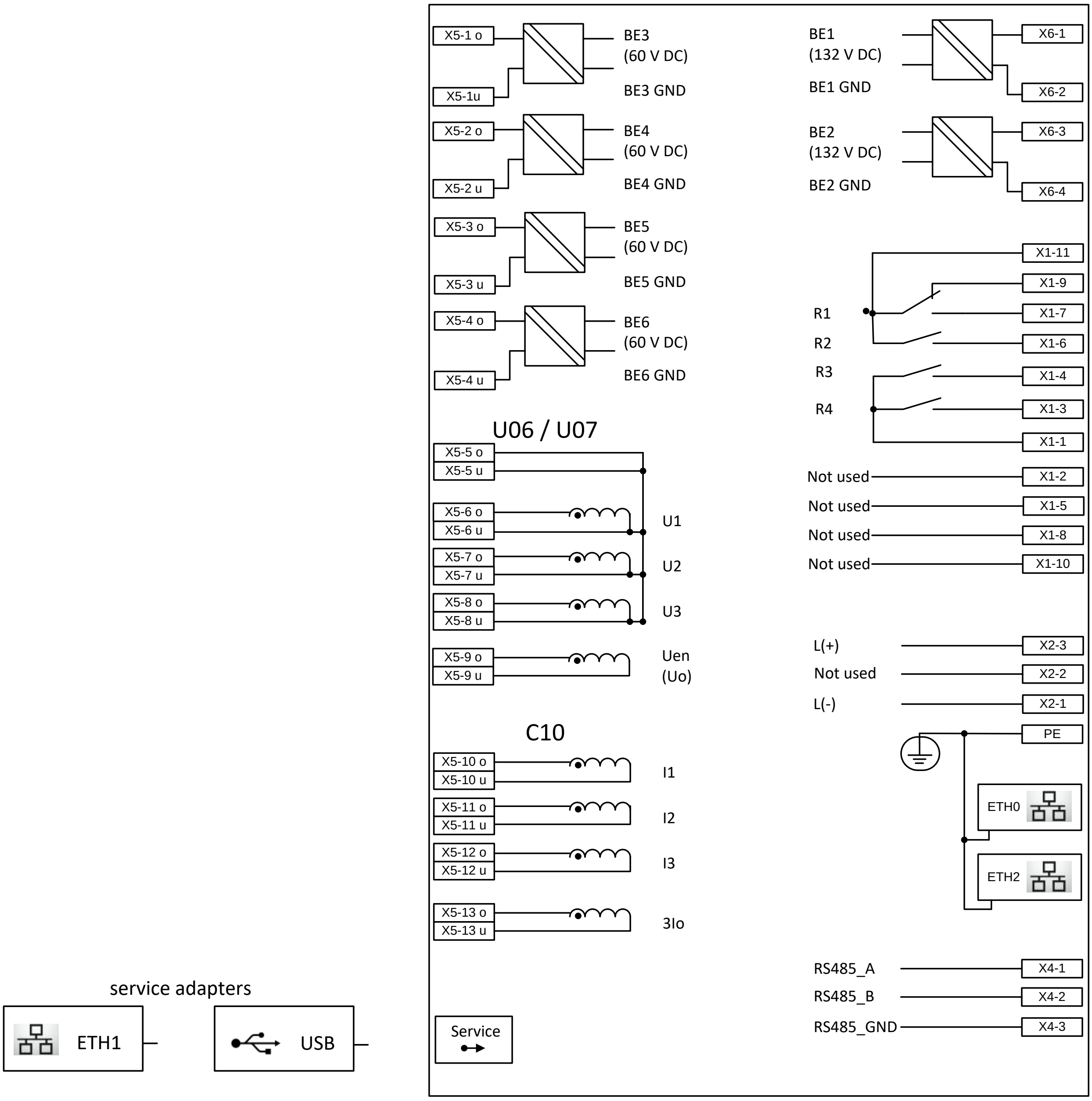


Figure 22: EOR-3DS terminal assignment for feature combination C10 and U06 or U07

RS485 terminals X4-1..3 only available with order code V1:
The order code V defines whether the device has the serial interface RS485. In case the EOR-3DS has the order code V0 the RS485 terminals X4-1..3 are not available.

4.31 Terminal assignment for features C21/C25 and U06/U07

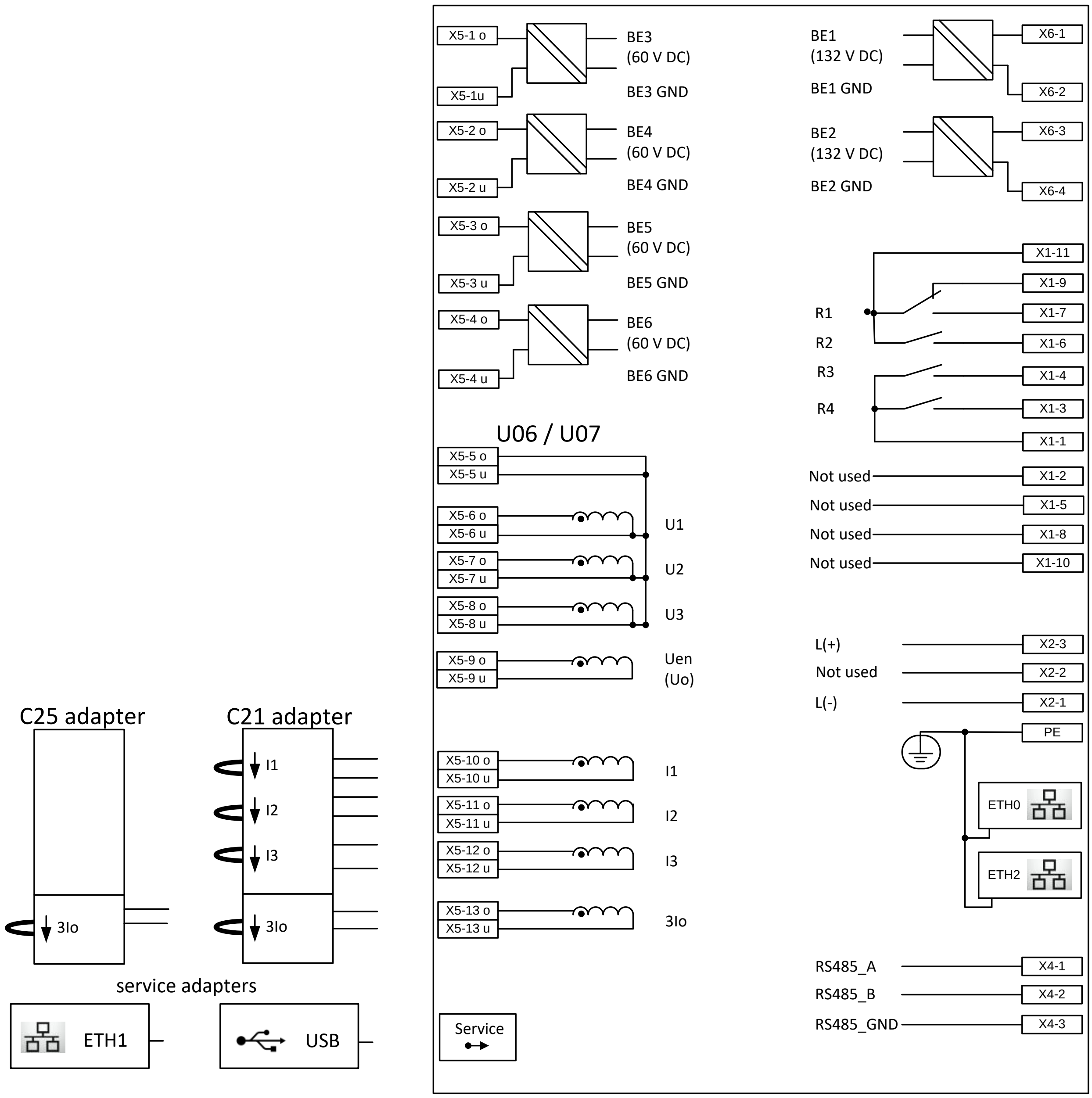


Figure 23: EOR-3DS terminal assignment for feature combination C21 or C25 and U06 or U07

RS485 terminals X4-1..3 only available with order code V1:
The order code V defines whether the device has the serial interface RS485. In case the EOR-3DS has the order code V0 the RS485 terminals X4-1..3 are not available.

4.32 Terminal assignment for features C10 and U10

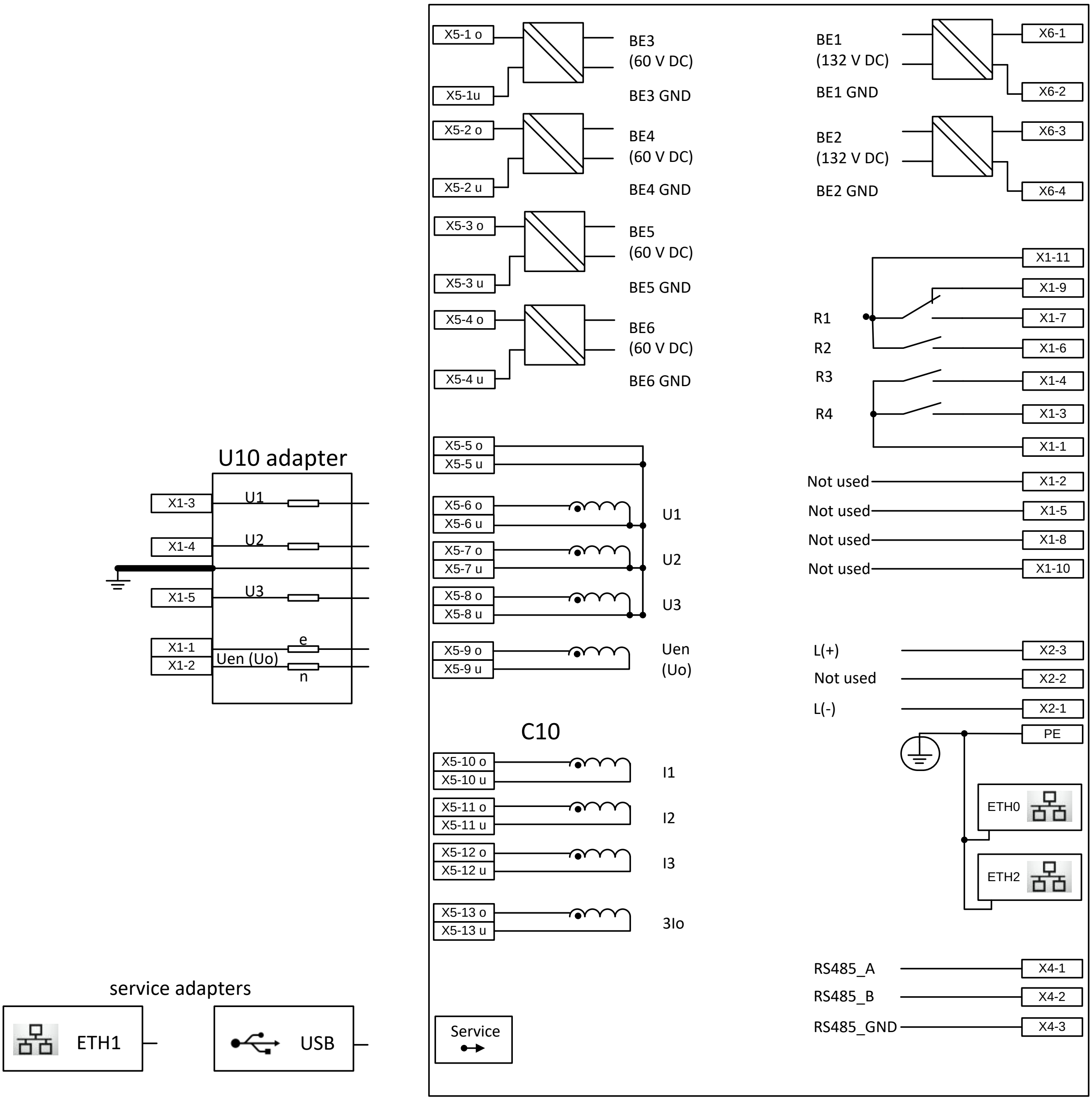


Figure 24: EOR-3DS terminal assignment for feature combination C10 and U10

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 Un-return conducter of the phase voltages (ground connection of the adapter) is mandatory.

RS485 terminals X4-1..3 only available with order code V1:
The order code V defines whether the device has the serial interface RS485. In case the EOR-3DS has the order code V0 the RS485 terminals X4-1..3 are not available.

4.33 Terminal assignment for features C21/C25 and U10

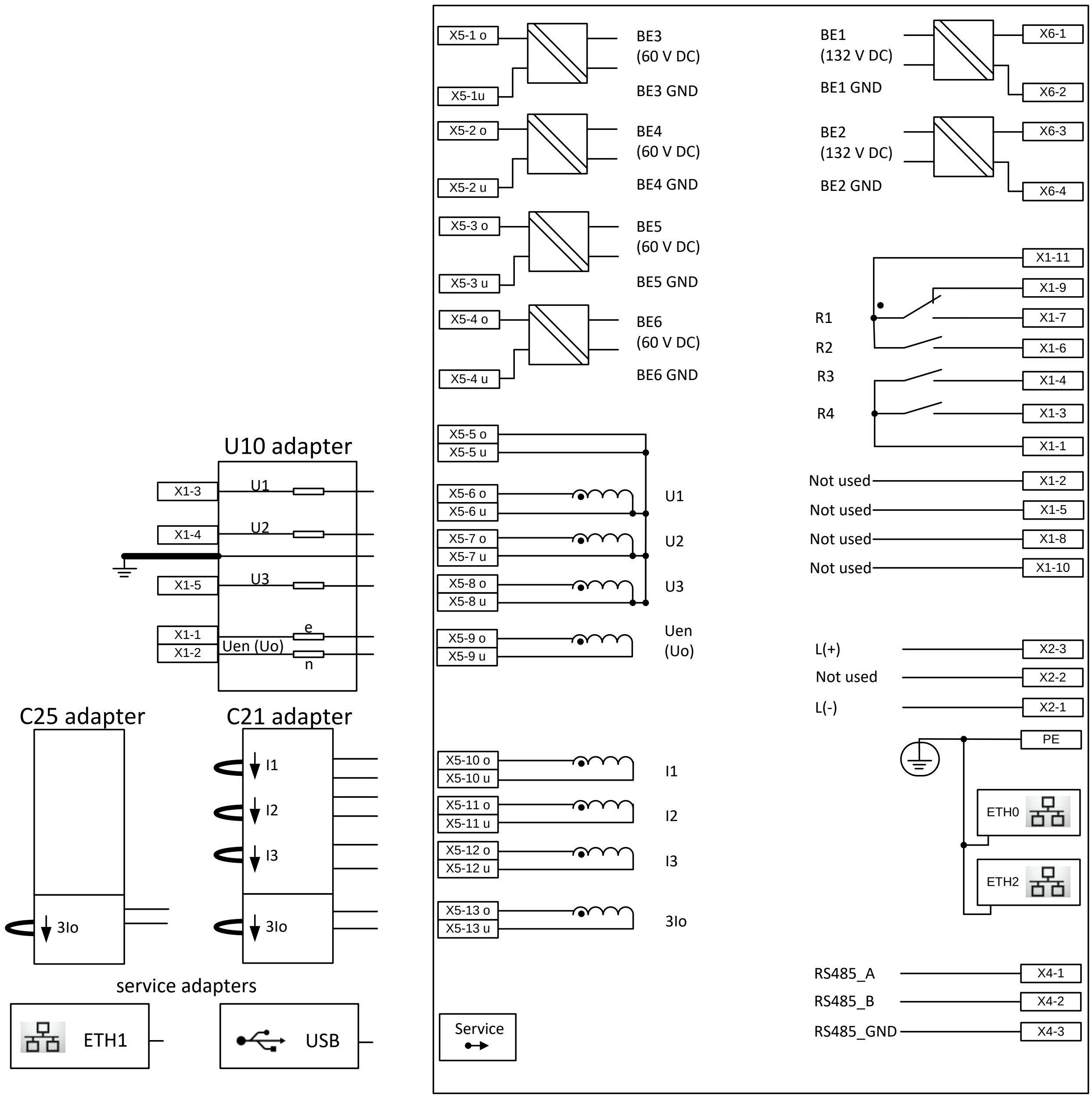


Figure 25: EOR-3DS terminal assignment for feature combination C21 or C25 and U10

Note for terminal assignment in case of adapter U10 without connected phase voltages:
In case only the Uen measurement shall be used with the U10 adapter, a connection between the earthed Uen-connection and the Un-return conducter of the phase voltages (ground connection of the adapter) is mandatory.

RS485 terminals X4-1..3 only available with order code V1:
The order code V defines whether the device has the serial interface RS485. In case the EOR-3DS has the order code V0 the RS485 terminals X4-1..3 are not available.

4.34 Terminal assignment for features C29 and U29

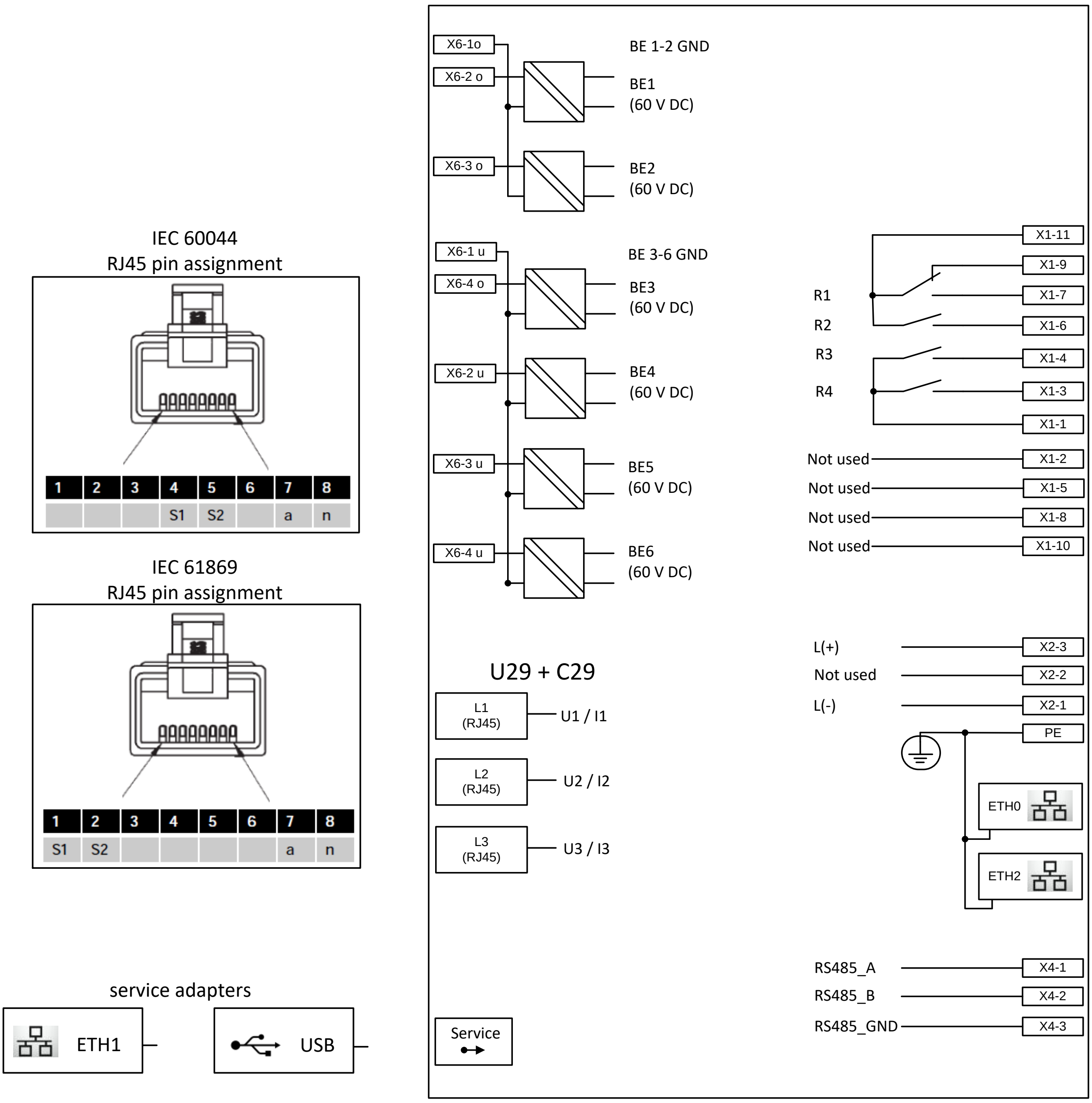


Figure 26: EOR-3DS terminal assignment for feature combination C29 and U29

RS485 terminals X4-1..3 only available with order code V1:
The order code V defines whether the device has the serial interface RS485. In case the EOR-3DS has the order code V0 the RS485 terminals X4-1..3 are not available.

4.35 Terminal assignment for features C31 and U31

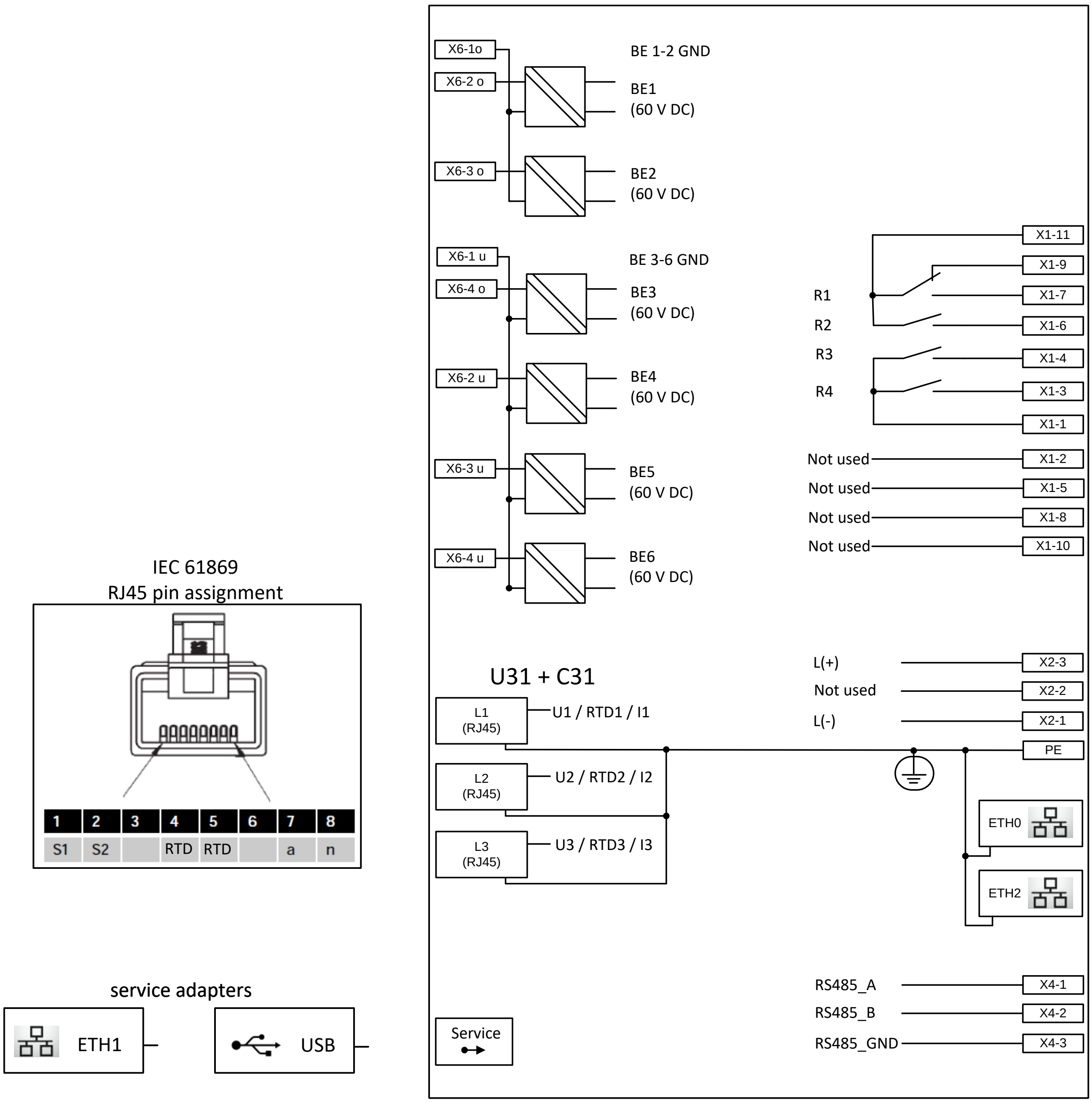


Figure 27: EOR-3DS terminal assignment for feature combination C31 and U31

RS485 terminals X4-1..3 only available with order code V1:
The order code V defines, whether the device has the serial interface RS485. In case the EOR-3DS has the order code V0 the RS485 terminals X4-1..3 are not available.

Definition of P1/P2 with measurement card C31U31 (Siemens SIBushing):
At Siemens SIBushing P1 is in direction of the feeder and P2 in direction of the busbar. The EOR-3DS automatically takes this into account with measurement input card C31U31. No inversion of current measurement has to be done via the corresponding parameters.

4.36 Terminal assignment for features C00 and U00

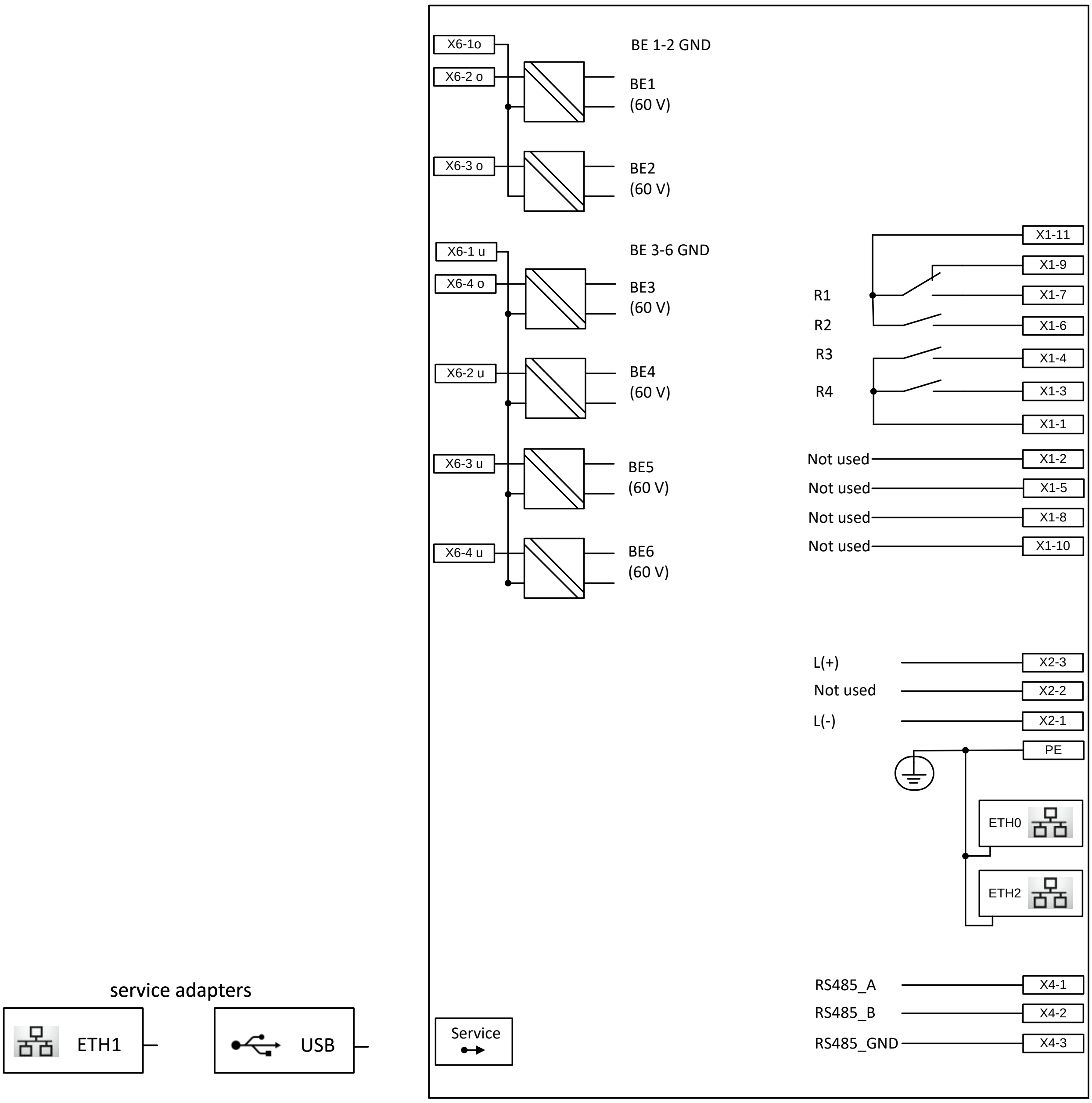


Figure 28: EOR-3DS terminal assignment for feature combination C00 and U00

RS485 terminals X4-1..3 only available with order code V1:
The order code V defines whether the device has the serial interface RS485. In case the EOR-3DS has the order code V0 the RS485 terminals X4-1..3 are not available.

5. Accessories for EOR-3DS

5.1 Housing adaptor for DIN rail mounting

With help of the housing adaptors the EOR-3DS B04 can be prepared for DIN rail mounting. Therefor at the back end of the device two appropriate housing adaptors are required.

Installation depth until DIN rail front edge: 132 mm

article number: 564.0490

5.2 sAdapter cables

There are different adapter cables for connection of capacitive or resistive dividers up to 60V for the combination with the measurement inputs card U24 available.

Y-adapter cable for WEGA and CAPDIS
(flat connector)
article number: 582.8014.xx

Y-connection cable for WEGA and CAPDIS
(4 pin connector)
article number: 582.8002.xx.03

Connection cable for WEGA and CAPDIS
(4 pin connector)
article number: 582.8011.xx

Connection cable for CAPDIS PI
(4 pin connector)
article number: 582.8012.xx

5.3 Communication adapters

The EOR-3DS has a frontal 10-pole service port, for which two service adapters are available:

- Service adapter for USB (article number 119.8920)
  For connection of a USB stick on the device, .e.g. to read out logbook, disturbance records or parameters from the device without software AEToolbox.
- Serviceadapter for ethernet (article number 119.8930)
  For connection to an Ethernet network, e.g. for parameterization via software AEToolbox.

5.4 Low power sensors

Zelisko sensor (split core type) 1 set (3 pcs.) for feature C10

Phase current sensor (split core type) for power and short circuit measurement 300 A / 0.225 V cl. 0.5 up to 200 % afterwards 5P10 for feature C10 (Inner-Ø: 55 mm). Also available as preselected set. Herewith the wattmetric cos(φ) method can be used without an additional CBCT.

Sensor type	Cable length	Article no.
SMCS/T-JW1002	3.7m	330.1510
SMCS/T-JW1002 preselected	3.7 m	330.1510.00

Zelisko sensor (closed ring core type) 1 set (3 pcs.) for feature C10

Phase current sensor (closed ring core type) for power and short circuit measurement 300 A / 0.225 V cl. 0.5 up to 200 % afterwards 5P10 for feature C10 (Inner-Ø: 82 mm). Directly mountable on the bushings of compact switch gears. Also available as preselected set. Herewith the wattmetric cos(φ) method can be used without an additional CBCT.

Sensor type	Cable length	Article no.
SMCS-JW1001	3.7m	330.1511
SMCS-JW1001 preselected	3.7 m	330.1511.00

Zelisko 3-phase (I1+I2+I3) + Core Balanced Current Sensor (3Io) multi-function sensor (closed ring core type) for feature C10

Phase current sensor for power and short circuit measurement 300 A / 0.225 V cl. 0.5 up to 200 % afterwards 5P10 for feature C10 (Inner-Ø: 84 mm).

Sensor type	Cable length	Article no.
SMCS3-JW1004	3.7m	330.1514

Zelisko sensor (split core type) Core Balanced Current Sensor (3Io) for feature C10

Core Balanced Current Sensor for 3Io measurement with a ratio of 60 A / 0.225 V; (Inner-Ø: 120 mm), cl. 0.5.

Sensor type	Cable length	Article no.
GAE120/SENS-JW1003	3.7m	330.1515

Zelisko combined current and voltage sensor (up to 12/24/36 kV) for open air facility for feature combination C10+U06

The open facility sensor combines the functions of a current and voltage sensor in one device. Due to the construction design and the special cast resin mixture the product can be used outdoors. The combined sensor is available up to an isolation level of 36 kV. (current sensor cl. 0.5 5P20 / voltage sensor cl 0.5 3P)

Sensor type	Cable length	Article no.
SMVS-K1112 (<= 12 kV isol. level)	-	330.1512.12
SMVS-K1112 (<= 24 kV isol. level)	-	330.1512.24
SMVS-K1112 (<= 36 kV isol. level)	-	330.1512.36

5.5 Current transducers with low nominal load

Phase current transformer für load current and short circuit detection ELEQ TQ50 (Inside-Ø: 42mm, rated burden 0,5 VA)

Transducer type	Length of cable	Article no.
250/1 A (Kl.1)	5.0 m	330.1502
300/1 A (Kl.1)	5.0 m	330.1503
400/1 A (Kl.0,5)	5.0 m	330.1504
500/1 A (Kl.0,5)	5.0 m	330.1505
600/1 A (Kl.0,5)	5.0 m	330.1506

6. Order specifications

For determining the order details:

- Only one unit can be ordered for codes with the same capital letter.

Characteristic	CODE
Combined earth fault and short circuit indicator EOR-3DS • 2 programmable binary inputs up to 60 or 132 V DC • 4 programmable binary inputs up to 60 V DC • 4 programmable relays • Service interface for front panel access via TCP/USB (adapter required) • Ethernet 10/100 MBits/s • Modbus TCP (for Modbus RTU and Modbus Master feature V1 necessary) • Log book and fault recorder for easy fault analysis • Energy storage for supply voltage interruption (up to 4s) • Including PC software, ethernet cable, SD card (>= 4 GB)	EOR-3DS
Model	
• Industrial housing WxHxD: 96 x 48 x 108 mm (installation depth 100 mm)	B04
Supply voltage	
• External DC 20 … 24 … 48 … 60 … 110 … 148 V	H23
Current input configuration (not comprising sensors or instrument transformers)	
• Without (only in combination with U00)	C00
• For 4 units current sensor (1 MΩ) 0.225 V / 300 A, e.g. for sensors from ABB, Zelisko, Greenwood Power, etc.	C10
• Incl. adaptor for 4 units current transformer for 1 A / 5 A (1 x 3I0, 3 x ILx)	C21
• Incl. adaptor for 1x current transformer for 1 A / 5 A (1 x 3I0)	C25
• For 3 pcs. ABB current or combi sensors acc. to IEC 60044 or IEC 61869 **via RJ45 connectors** (only in combination with U29)	C29
• For 3 pcs. Siemens current or combi bushing sensors SIBushing acc. to IEC 61869 incl. temperature supervision **via RJ45 connectors** (only in combination with U31)	C31

Characteristic	CODE
Voltage input configuration (not comprising sensors or instrument transformers)	
• Without (only in combination with C00)	U00
• 4 voltage inputs up to 60 V for capacitive LR and LRM systems (Capdis, WEGA, IVIS, etc.)	U05
• 4 voltage inputs (burden 220 kΩ) up to 60 V for low power sensors, e.g. sensors from Zelisko, Greenwood Power, etc. (Un = 3,25 V / √3)	U06
• 4 voltage inputs (burden 2 MΩ) up to 60 V for low power sensors, e.g. sensors from ABB, Zelisko, Greenwood Power, etc. (Un = 3,25 V / √3)	U07
• 4 voltage inputs up to 120 V for classical 100 V VT (incl. external adapter, burden 10 MΩ)	U10
• For 3 pcs. ABB voltage or combi sensors acc. to IEC 60044 or IEC 61869 **via RJ45 connectors** (only in combination with C29)	U29
• For 3 pcs. Siemens voltage or combi sensors acc. to IEC 61869 incl. temperature supervision SIBushing **via RJ45 connectors** (only in combination with C31)	U31
Communication	
• without additional communication protocol	T0
• IEC 60870-5-101	T1
• IEC 60870-5-103 with fault recorder supply	T3
• IEC 60870-5-104	T4
• MQTT IoT	T5
• MQTT Management & Operations	T6
• DNP 3.0 (RS485 or TCP)	T7
• IEC 61850 GOOSE light	T8
ℹ **Serial protocol requires V1 feature code:** For serial protocols like IEC 60870-5-101, IEC 60870-5-103, DNP 3.0 RS485, Modbus RTU and Modbus Master feature V1 is necessary!	
ℹ **Use of several protocol in parallel:** It is possible to use different protocols on the device at the same time, but at maximum one serial protocol and at maximum one instance of each protocol. This way it is possible e.g. to use the EOR-3DS as a SCADA gateway (e.g. Modbus-Master & IEC 60870-5-104) or e.g. beside IEC 60870-5-104 also the two MQTT protocols IoT and Management & Operations (feature T4+T5+T6=T456).	
License for second back-mounted RJ45 Ethernet port	
• Without	P0
• With	P1
RS485 interface (for all serial protocols e.g. Modbus RTU necessary)	
• Without	V0
• With	V1

Characteristic	CODE
Customer specific parameterization	
• Without	K0
• With	K1

ACCESSORIES	article number
Housing adaptor for DIN rail mounting (2 pcs.) (see also chapter 5.1)	564.0490
Adapter cables (see also chapter 5.2)	
• Y-adapter cable for WEGA and CAPDIS (flat connector)	
○ length of connection cable 0.3 m	582.8014.03
○ length of connection cable 1.5 m	582.8014.15
• Y-connection cable for WEGA and CAPDIS (4 pin connector)	
○ length of connection cable 0.5 m	582.8002.05.03
○ length of connection cable 1.0 m	582.8002.10.03
○ length of connection cable 1.5 m	582.8002.15.03
• Connection cable for WEGA and. CAPDIS (4 pin socket)	
○ length of connection cable 0.3 m	582.8011.03
○ length of connection cable 0.5 m	582.8011.05
○ length of connection cable 1.5 m	582.8011.15
• Connection cable for CAPDIS PI	
○ length of connection cable 1.5 m	582.8012.15
Service adapters (see also chapter 0)	
• Service adapter for USB (for connection of a USB stick on the front service port of the device, .e.g. to read out logbook, disturbance records or parameters from the device without software AEToolbox)	119.8920
• Serviceadapter for ethernet (for connection to an Ethernet network on the front service port of the device, e.g. for parameterization via software AE-Toolbox)	119.8930

ACCESSORIES	article number
Low power sensors (see also chapter 5.4)	
• 1 set (3 pcs.) sensors, split core type, for feature C10	
◦ Zelisko SMCS/T-JW1002, length of conn. cable 3.7 m	330.1510
◦ Zelisko SMCS/T-JW1002 vorsortiert, length of conn. cable 3.7 m	330.1510.00
• 1 set (3 pcs.) sensors, closed ring core type, for feature C10	
◦ Zelisko SMCS-JW1001, length of conn. cable 3.7 m	330.1511
◦ Zelisko SMCS-JW1001 preselected, length of conn. cable 3.7 m	330.1511.00
• 1x 3-phase (I1+I2+I3) + Core Balanced Current Sensor (3Io) multi-function sensor, closed ring core type, for feature C10	
◦ Zelisko SMCS3-JW1004, length of conn. cable 3.7 m	330.1514
• 1x Core Balanced Current Sensor (3Io), split core type, for feature C10	
◦ Zelisko GAE120/SENS-JW1003, length of conn. cable 3.7 m	330.1515
• 1x combined current and voltage sensor (up to 12/24/36 kV) for open air facility for feature combination C10+U06	
◦ Zelisko SMVS-K1112 (up to 12 kV isolation level)	330.1512.12
◦ Zelisko SMVS-K1112 (up to 24 kV isolation level)	330.1512.24
◦ Zelisko SMVS-K1112 (up to 36 kV isolation level)	330.1512.36
Current transducers with low nominal load (see also chapter 5.5)	
• Phase current transformer für load current and short circuit detection ELEQ TQ50 (Inside-Ø: 42mm, rated burden 0.5 VA)	
◦ ELEQ TQ50 250/1 A (cl.1), length of connection cable 5.0 m	330.1502
◦ ELEQ TQ50 300/1 A (cl.1), length of connection cable 5.0 m	330.1503
◦ **ELEQ TQ50 400/1 A (cl.0.5), length of connection cable 5.0 m**	**330.1504**
◦ ELEQ TQ50 500/1 A (cl.0.5), length of connection cable 5.0 m	330.1505
◦ ELEQ TQ50 600/1 A (cl.0.5), length of connection cable 5.0 m	330.1506

Notes

A. Eberle GmbH & Co. KG

Frankenstraße 160
D-90461 Nuremberg

Tel.: +49 (0) 911 / 62 81 08-0
Fax: +49-(0) 911-62 81 08 99
E-mail: info@a-eberle.de

http://www.a-eberle.de

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