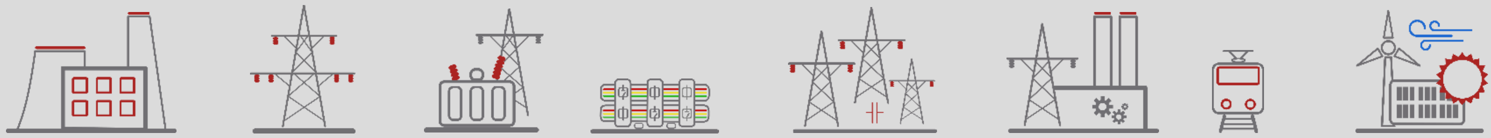

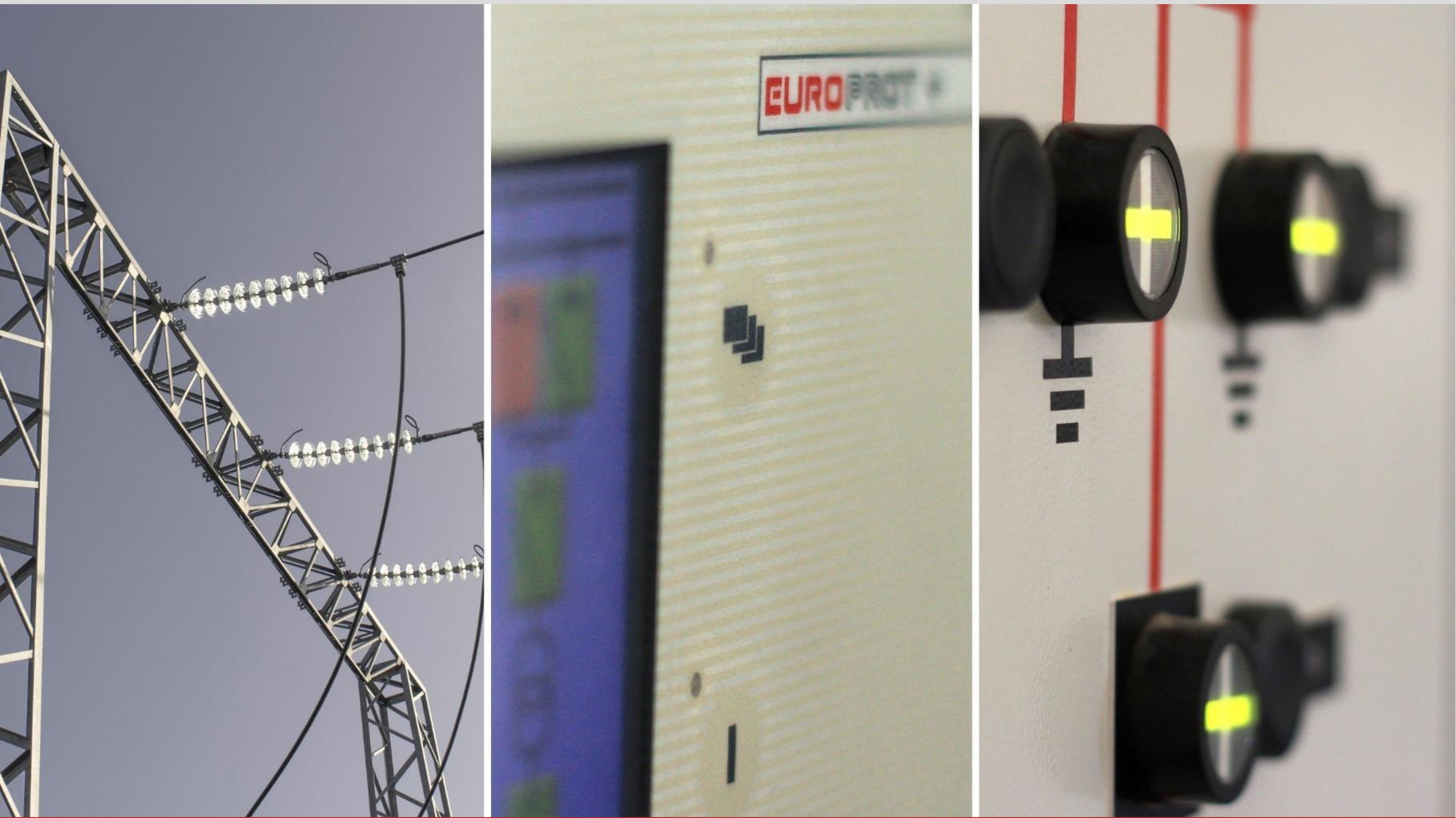

Manual

Busbar protection

EuroProt+/OGYD

Distributed busbar protection

DOCUMENT ID: OGYD-23-28 VERSION: 1.3 Date: 2023/09/17

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VERSION INFORMATION

NAME	DOCUMENT ID	VERSION	DATE
EuroProt+ Busbar type	PP-13-21887	1.0	2019-04-05
EuroProt+ Hardware description	PP-13-19958	2.0	2023-02-10
Distributed busbar differential and breaker failure protection function	PP-13-21320	1.1	2016-09-30
Line measurement Frequency measurement Voltage measurement Current measurement	PP-13-21168	2.3	2021-09-02
Average and maximum measurement function	PP-11-20109	1.0	2013-09-27
Metering function	PP-13-22238	2.1	2022-10-19
Voltage measurement selection function	VERSION 1.0	1.0	2013-02-06
Disturbance recorder	PP-13-20368	3.0	2017-06-02
Remote I/O (RIO) server description	PP-13-22346	1.0	2021-06-02
Technical notes on EOB interoperability	-	1.0	2011-06-27
Maintenance guide	PP-13-226045	2.0	2022-11-18
EP+ Installation manual	PP-06-22516	1.0	2022-03-09

Table of Contents

1. Introduction

The OGYD and DGYD product types are members of the ***EuroProt+*** product line, made by Protecta Co. Ltd. The ***EuroProt+*** complex protection in respect of hardware and software is a modular device. The modules are assembled and configured according to the requirements, and then the software determines the functions. This manual describes the OGYD/DGYD product type.

1.1. Application

The OGYD and DGYD products are designed for busbar protection applications.

The relays of this type support various primary bus systems that include:

- from single up to quadruple busbars
- breaker and a half or ring bus topologies
- bus couplers, bus sectionalizers with one or two current transformers
- transfer buses

One main scope of the function of the OGYD and DGYD types is to provide selective tripping in short time for internal faults. Only the bays of the faulty busbar section get disconnected, the others remain in continuous operation.

Second main scope is to remain to provide the highest possible stability for several situations, such as external faults with CT saturation. Special, adaptive characteristics are applied, check zone criteria is also implemented to increase stability. Voltage breakdown conditions can be applied optionally.

Third main scope is to follow the changes in the busbar. The busbar replica adapts dynamically to the actual states of the bays according to the disconnector signals; it is also possible to easily extend it when new bays are constructed.

The EuroCAP configuration tool, which is available free of charge, offers a user-friendly and flexible application for protection, control and measurement functions to ensure that the IED-EP+ devices are fully customizable.

There are two versions of busbar protections: decentralized (OGYD) and centralized (DGYD). In the decentralized version other individual protective devices of the bays (distance protection, overcurrent protection, etc., or potentially dedicated bay units) are involved in the busbar protection scheme as bay units. These devices perform the sampling of the currents and they have access to all information needed for the busbar protection system. This information is sent by a fiber optic link to the central unit. The calculation and decision are performed by the central unit (i.e. the OGYD type device) and the dedicated trip commands are sent back to the devices also via fiber optic links.

The centralized busbar protection (DGYD) measures the currents directly in each bay. If the number of bays connected to the busbar is limited (there are a maximum of 6 bays), the tasks related to the three-phase busbar differential protection function are performed within one device. If there are more bays, the tasks are divided among three independent devices. Each of them is responsible for the differential protection of one phase (L1, L2 or L3) of the busbar.

1.1.1. General features

- Native IEC 61850 IED with Edition 2 compatibility
- Scalable hardware to adapt to different applications
- 84 HP or 42HP wide rack size (height: 3U)
- The pre-defined factory configuration can be customized to the user’s specification with the powerful EuroCAP tool
- Flexible protection and control functionality to meet special customer requirements

- Advanced HMI functionality via color touchscreen and embedded WEB server, extended measuring, control and monitoring functions
- User configurable LCD user screens, which can display SLDs (Single Line Diagrams) with switchgear position indication and control as well as measuring values and several types of controllable objects.
- Various protection setting groups available
- Enhanced breaker monitoring and control
- High capacity disturbance recorder (DRE) and event logging (data is stored in non-volatile memory):
    - DRE for up to 32 analogue and 64 digital signal channels.
    - Event recorder can store more than 10,000 events.
- Several mounting methods: Rack; Flush mounting; Semi-flush mounting; Wall mounting; Wall-mounting with terminals; Flush mounting with IP54 rated cover.
- Wide range of communication protocols:
    - Ethernet-based communication: IEC61850; IEC60870-5-104; DNP3.0 TCP; Modbus TCP
    - Serial communication: DNP3.0; IEC60870-5-101/103; MODBUS, SPA
- The EuroProt+ family can handle several communication protocols simultaneously.
- Built-in self-monitoring to detect internal hardware or software errors
- Different time sources available: NTP server; Minute pulse; Legacy protocol master; IRIG-B000 or IRIG-B12X

1.2. Pre-defined configuration variants

All members of the decentralized (OGYD) type have the same functionality, the low-impedance distributed busbar protection. The difference between them is in the number of the protected sub-units (i.e. the number of the COM modules that communicate with the bay units). The currently available configurations of the OGYD type are listed in the table below (the list may grow over time).

VARIANT	MAIN APPLICATION
E1-DBBP	Distributed busbar protection for 3 bays (sub-units)
E2-DBBP	Distributed busbar protection for 6 bays (sub-units)
E3-DBBP	Distributed busbar protection for 9 bays (sub-units)
E4-DBBP	Distributed busbar protection for 12 bays (sub-units)
E5-DBBP	Distributed busbar protection for 15 bays (sub-units)
E6-DBBP	Distributed busbar protection for 18 bays (sub-units)
E7-DBBP	Distributed busbar protection for 21 bays (sub-units)
E8-DBBP	Distributed busbar protection for 24 bays (sub-units)
E10-DBBP	Distributed busbar protection for 30 bays (sub-units)

Table 1-1 The members of the OGYD type

There are two groups of members in the DGYD type, all of them realizing low-impedance centralized busbar protection. The first of them handles all *three phases* of each protected bay (name starting with '**E3**', see below). The second group has the same functionality, but here one device handles only *one phase* of each bay (name starting with '**E1**'). This way more bays can be handled with centralized busbar protection function. This also means that to handle all three phases will require three devices.

The difference between each member is the number of the handled bays (i.e. the number of the contained CT inputs for the bays). The available configurations of the DGYD type for transformers are listed in the table below (the list may grow over time as different configurations will be needed for various bay numbers).

VARIANT	MAIN APPLICATION
E33-CBBP	Centralized three-phase busbar protection for 3 bays
E34-CBBP	Centralized three-phase busbar protection for 4 bays
E35-CBBP	Centralized three-phase busbar protection for 5 bays
E36-CBBP	Centralized three-phase busbar protection for 6 bays
E11-CBBP	Centralized single-phase busbar protection for 12 bays
E14-CBBP	Centralized single-phase busbar protection for 16 bays
E15-CBBP	Centralized single-phase busbar protection for 20 bays
E16-CBBP	Centralized single-phase busbar protection for 24 bays

Table 1-2 The members of the DGYD type

1.3. Hardware configuration

The number of inputs and outputs are listed in the Table below.

Hardware configuration	ANSI	OGYD
Mounting		Op.
Current inputs (4th channel can be sensitive)		-
Voltage inputs		-
Digital inputs		12
Digital outputs		8
Fast trip outputs		-
Temperature monitoring (RTDs) *	38 / 49T	Op.

Table 2 The basic hardware configuration of the OGYD configuration

The basic module arrangement of the OGYD configuration is shown below.

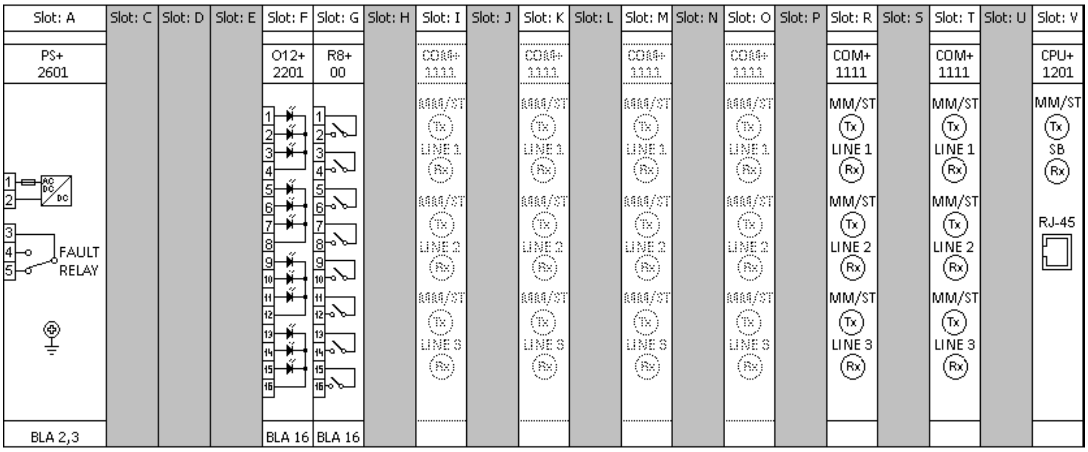


Figure 2 The basic module arrangement of the OGYD configuration (rear view)

1.3.1. The applied hardware modules

The applied modules are listed in Table 3.

Module identifier	Explanation
PS+ 2601	Power supply unit
O12+ 2201	Binary input module
R8+ 00	Signal relay output module
COM+ 1111	Communication module
CPU+ 1201	Processing and communication module

Table 3 The applied modules of the OGYD configuration

1.3.2. Meeting the device

The basic information for working with the ***EuroProt+*** devices are described in the document "***Quick start guide to the devices of the EuroProt+ product line***".

*Figure 3 The 84 inch rack of **EuroProt+** family*

1.3.3. System design

The EuroProt+ protection device family is a scalable hardware platform to adapt to different applications. Data exchange is performed via a 16-bit high-speed digital non-multiplexed parallel bus with the help of a backplane module.
Each module is identified by its location and there is no difference between module slots in terms of functionality. The only restriction is the position of the CPU module because it is limited to the "CPU" position. The built-in self-supervisory function minimizes the risk of device malfunctions.

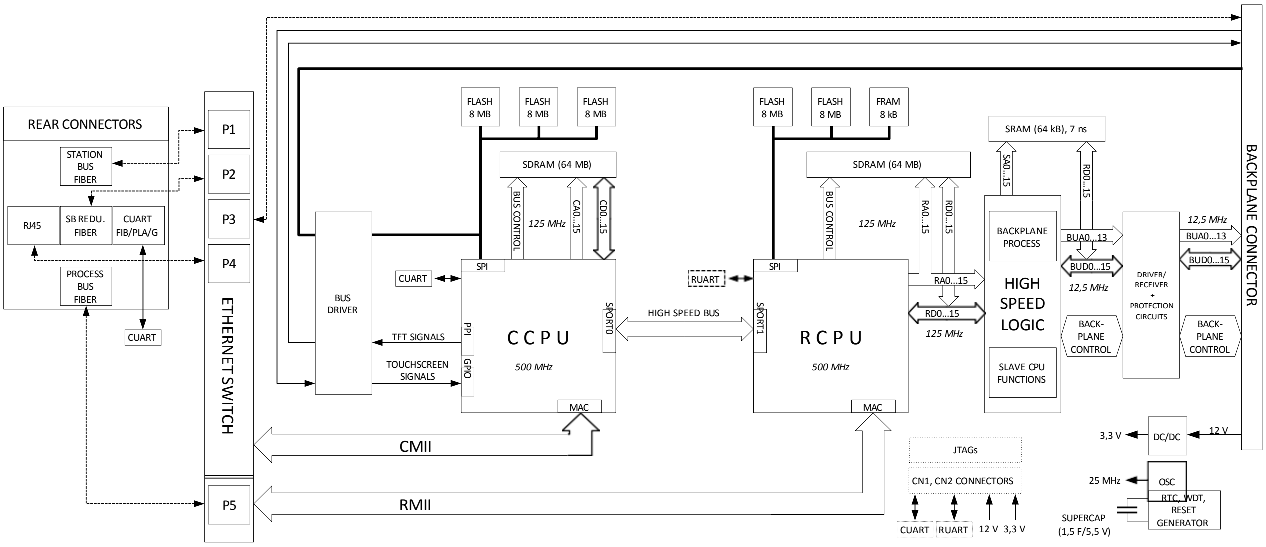


Figure 1-1 CPU block diagram

The backplane board itself is a passive board but it provides a 16-bit bus, power supply distribution, a two-wire interface (TWI) supporting module inventory management and module identification. It is designed to meet the requirements for high-speed digital buses and to comply with electromagnetic emission standards.

1.3.4. CPU and COM module

1.3.4.1. CPU+ module

The CPU module contains all the protection, control and communication functions of the EuroProt+ device. Dual 500 MHz high-performance Analog Devices Blackfin processors separate relay functions (RDSP) from communication and HMI functions (CDSP). Reliable communication between processors is performed via high-speed synchronous serial internal bus (SPORT).

Each processor has its own operative memory such as SDRAM and flash memories for configuration, parameter and firmware storage. Both firmware are stored in a dedicated flash memory independent from the disturbance recorder and event storage.

The CDSP's operating system (uClinux) utilizes a robust JFFS flash file system, which enables fail-safe operation and the storage of disturbance record files, configuration and parameters.

The RDSP core runs at 500 MHz and its external bus speed is 125 MHz. The backplane data speed is limited to approx. 20 MHz, which is more than enough for module data throughput. An additional logic element (CPLD and SRAM) is used as a bridge between the RDSP and the backplane. The CPLD collects analogue samples from CT/VT modules and also controls signaling outputs and inputs.

1.3.4.1.1. Fast start-up

After power-up the RDSP processor starts up with the previously saved configuration and parameters. Generally, the power-up procedure for the RDSP and relay functions takes only a few seconds. That is to say, it is ready to trip within this time. CDSP's start-up procedure is longer because its operating system needs time to build its file system, initializing user applications such as HMI functions and the IEC61850 software stack.

1.3.4.1.2. HMI and communication tasks

- Embedded WEB-server:
    - Firmware upgrade possibility
    - Modification of user parameters
    - Events list and disturbance records
    - Password management
    - Online data measurement
    - Commands
    - Administrative tasks

- Front panel TFT display handling: the interactive menu set is available through the TFT and the touchscreen interface

- User keys: capacitive touch keys on front panel

- The built-in 5-port Ethernet switch allows EuroProt+ to connect to IP/Ethernet-based networks. The following Ethernet ports are available:
    - Station bus (100Base-FX Ethernet) SBW
    - Redundant station bus (100Base-FX Ethernet) SBR
    - Process bus (100Base-FX Ethernet)
    - EOB2 (Ethernet Over Board) or RJ-45 Ethernet user interface on front panel
    - Optional 10/100Base-T port via RJ-45 connector

- PRP/HSR seamless redundancy for Ethernet networking (100Base-FX Ethernet)

- Other communication:
    - RS422/RS485 interfaces (galvanic interface to support legacy or other serial protocols, ASIF)
    - Plastic or glass fiber interfaces to support legacy protocols, ASIF
    - Proprietary process bus communication controller on COM+ module
    - Telecommunication interfaces: G.703, IEEE C37.94

CPU VERSION	PRIMARY STATION BUS SBW	SECONDARY (REDUNDANT) STATION BUS SBR	LEGACY PORT/PROTOCOL	PROCESS BUS (FIBER) PB	SERVICE PORT ON FRONT PANEL EOB/ RJ45
CPU+/0007	-	-	-	-	+
CPU+/0091	-	-	-	+ SM SH	+
CPU+/0201*	-	+ RJ45	-	-	+
CPU+/0211*	-	+ RJ45	-	+ MM	+
CPU+/0281*	-	+ RJ45	-	+ SM LH	+
CPU+/0291*	-	+ RJ45	-	+ SM SH	+
CPU+/0301	-	-	+ POF	-	+
CPU+/0401	-	-	+ GS	-	+
CPU+/0501*	-	-	+ Galv. RS485/422	-	+
CPU+/1001	+ MM	-	-	-	+
CPU+/1004	+ MM	-	-	-	+
CPU+/1011	+ MM	-	-	+ MM	+
CPU+/1091	+ MM	-	-	+ SM SH	+
CPU+/1101*	+ MM	+ MM	-	-	+
CPU+/1111	+ MM	+ MM	-	+ MM	+
CPU+/1181	+ MM	+ MM	-	+ SM LH	+
CPU+/1191	+ MM	+ MM	-	+ SM SH	+
CPU+/1201*	+ MM	+ RJ45	-	-	+
CPU+/1202	+ MM	+ RJ45	-	-	+
CPU+/1211	+ MM	+ RJ45	-	+ MM	+
CPU+/1281	+ MM	+ RJ45	-	+ SM LH	+
CPU+/1291*	+ MM	+ RJ45	-	+ SM SH	+
CPU+/1292	+ MM	+ RJ45	-	+ SM SH	+
CPU+/1301	+ MM	-	+ POF	-	+
CPU+/1311	+ MM	-	+ POF	+ MM	+
CPU+/1331	+ MM	-	+ double POF	-	+
CPU+/1381	+ MM	-	+ POF	+ SM LH	+
CPU+/1391	+ MM	-	+ POF	+ SM SH	+
CPU+/1401	+ MM	-	+ GS	-	+
CPU+/1411	+ MM	-	+ GS	+ MM	+
CPU+/1481	+ MM	-	+ GS	+ SM LH	+
CPU+/1491	+ MM	-	+ GS	+ SM SH	+
CPU+/1501	+ MM	-	+ Galv. RS485/422	-	+
CPU+/1511	+ MM	-	+ Galv. RS485/422	+ MM	+

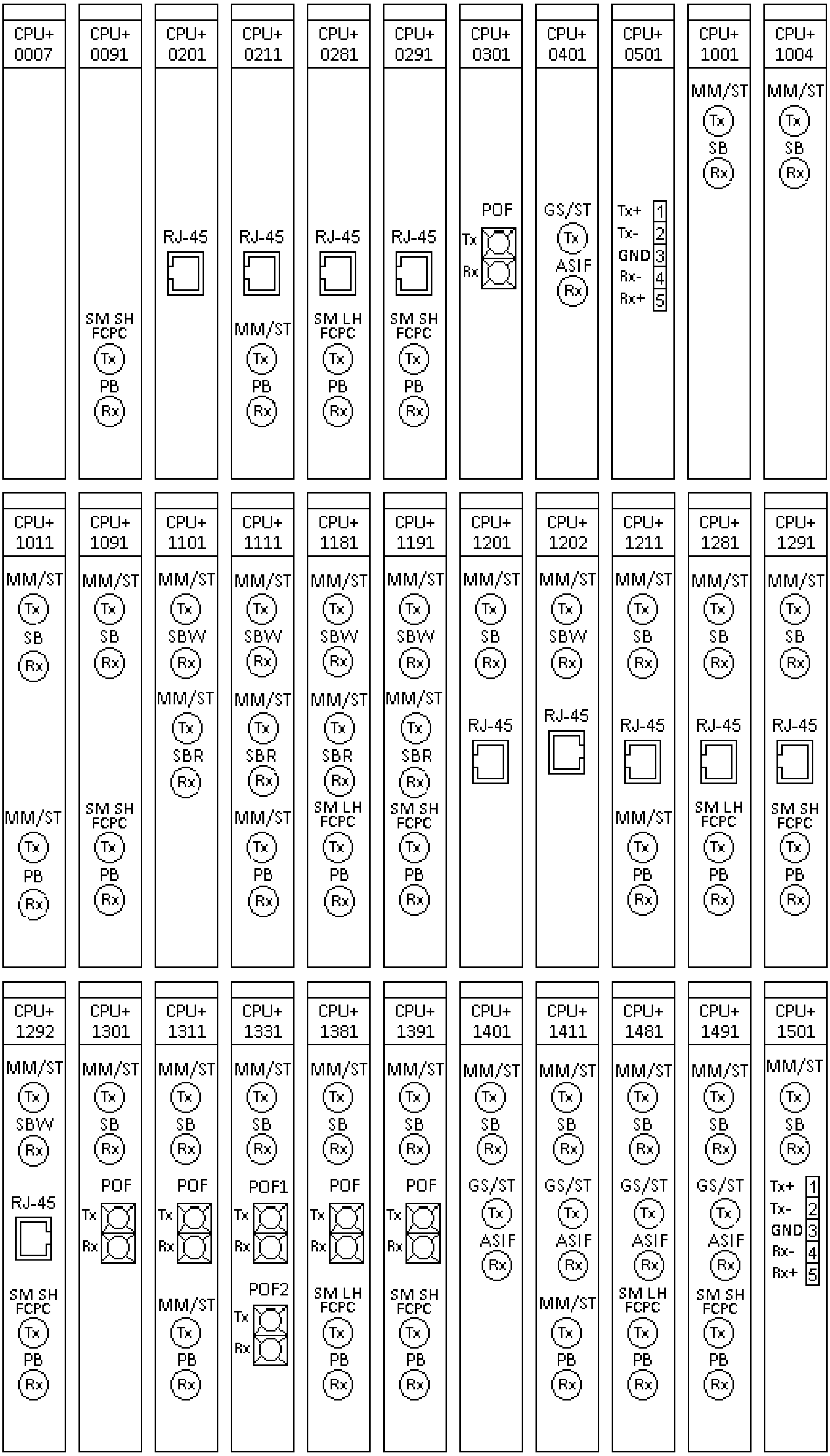
CPU version	Primary station bus (fiber) SBW	Secondary (redundant) Station bus SBR	Legacy port/protocol	Process bus (fiber) PB	Service port on front panel EOB/ RJ45
CPU+/1581	+ MM	-	+ Galv. RS485/422	+ SM LH	+
CPU+/1611	+ MM	-	+ Galvanic sync	+ MM	+
CPU+/1681	+ MM	-	+ Galvanic sync	+ SM LH	+
CPU+/6001	+ MM/LC	-	-	-	+
CPU+/6004	+ MM/LC	-	-	-	+
CPU+/6093	+ MM/LC	-	-	+ SM SH	+
CPU+/6094	+ MM/LC	-	-	+ SM SH	+
CPU+/6601*	+ MM/LC	+ MM/LC	-	-	+
CPU+/9201	+ SM SH	+ RJ45	-	-	+
CPU+/9291	+ SM SH	+ RJ45	-	+ SM SH	+
CPU+/9501	+ SM SH	-	+ Galv. RS485/422	-	+
CPU+/9901	+ SM SH	+ SM SH	-	-	+
CPU+/A001*	+ MM/LC PRP/HSR	-	-	-	+
CPU+/A004	+ MM/LC PRP/HSR	-	-	-	+
CPU+/A011	+ MM/LC PRP/HSR	-	-	+ MM	+
CPU+/A081	+ MM/LC PRP/HSR	-	-	+ SM LH	+
CPU+/A091	+ MM/LC PRP/HSR	-	-	+ SM SH	+
CPU+/A094	+ MM/LC PRP/HSR	-	-	+ SM SH	+

Note: the modules can be equipped with a different handle (narrower and made of aluminum, instead of the standard plastic), if the other modules of the device are equipped with top-screw terminals (see Chapter 20.2). In these cases, a "T" letter appears on the label of the module (e.g. **CPU+/1201T), but all other properties remain the same.*

For legacy CPU cards (e.g. CPU+0001, ...) see *Product availability* chapter.

PRP/HSR option: *A* and *F* types can be ordered with PRP/HSR communication as sw option**Legend for CPU version table:**

MM: Multimode with ST connector	**GS**: Glass with ST connector
MM/LC: Multimode with LC connector	**SFP**: Small Form-factor Pluggable connector
SM: Single mode with FC/PC connector	**SB**: Station Bus
LH: Long Haul with FC/PC connector	**SBW**: Station Bus Working
SH: Short Haul with FC/PC connector	**SBR**: Station Bus Redundant
POF: Plastic Optical Fiber with 1 mm fiber connector	**PB**: Proprietary Process Bus


CPU+ 0007
CPU+ 0091 SM SH FCPC Tx PB Rx
CPU+ 0201 RJ-45
CPU+ 0211 RJ-45 MM/ST Tx PB Rx
CPU+ 0281 RJ-45 SM LH FCPC Tx PB Rx
CPU+ 0291 RJ-45 SM SH FCPC Tx PB Rx
CPU+ 0301 POF Tx Rx
CPU+ 0401 GS/ST Tx ASIF Rx
CPU+ 0501 Tx+ 1 Tx- 2 GND 3 Rx- 4 Rx+ 5
CPU+ 1001 MM/ST Tx SB Rx
CPU+ 1004 MM/ST Tx SB Rx
CPU+ 1011 MM/ST Tx SB Rx MM/ST Tx PB Rx
CPU+ 1091 MM/ST Tx SB Rx SM SH FCPC Tx PB Rx
CPU+ 1101 MM/ST Tx SBW Rx MM/ST Tx SBR Rx
CPU+ 1111 MM/ST Tx SBW Rx MM/ST Tx SBR Rx MM/ST Tx PB Rx
CPU+ 1181 MM/ST Tx SBW Rx MM/ST Tx SBR Rx SM LH FCPC Tx PB Rx
CPU+ 1191 MM/ST Tx SBW Rx MM/ST Tx SBR Rx SM SH FCPC Tx PB Rx
CPU+ 1201 MM/ST Tx SB Rx RJ-45
CPU+ 1202 MM/ST Tx SBW Rx RJ-45
CPU+ 1211 MM/ST Tx SB Rx RJ-45 MM/ST Tx PB Rx
CPU+ 1281 MM/ST Tx SB Rx RJ-45 SM LH FCPC Tx PB Rx
CPU+ 1291 MM/ST Tx SB Rx RJ-45 SM SH FCPC Tx PB Rx
CPU+ 1292 MM/ST Tx SBW Rx RJ-45 SM SH FCPC Tx PB Rx
CPU+ 1301 MM/ST Tx SB Rx POF Tx Rx
CPU+ 1311 MM/ST Tx SB Rx POF Tx Rx MM/ST Tx PB Rx
CPU+ 1331 MM/ST Tx SB Rx POF1 Tx Rx POF2 Tx Rx
CPU+ 1381 MM/ST Tx SB Rx POF Tx Rx SM LH FCPC Tx PB Rx
CPU+ 1391 MM/ST Tx SB Rx POF Tx Rx SM SH FCPC Tx PB Rx
CPU+ 1401 MM/ST Tx SB Rx GS/ST Tx ASIF Rx
CPU+ 1411 MM/ST Tx SB Rx GS/ST Tx ASIF Rx MM/ST Tx PB Rx
CPU+ 1481 MM/ST Tx SB Rx GS/ST Tx ASIF Rx SM LH FCPC Tx PB Rx
CPU+ 1491 MM/ST Tx SB Rx GS/ST Tx ASIF Rx SM SH FCPC Tx PB Rx
CPU+ 1501 MM/ST Tx SB Rx Tx+ 1 Tx- 2 GND 3 Rx- 4 Rx+ 5

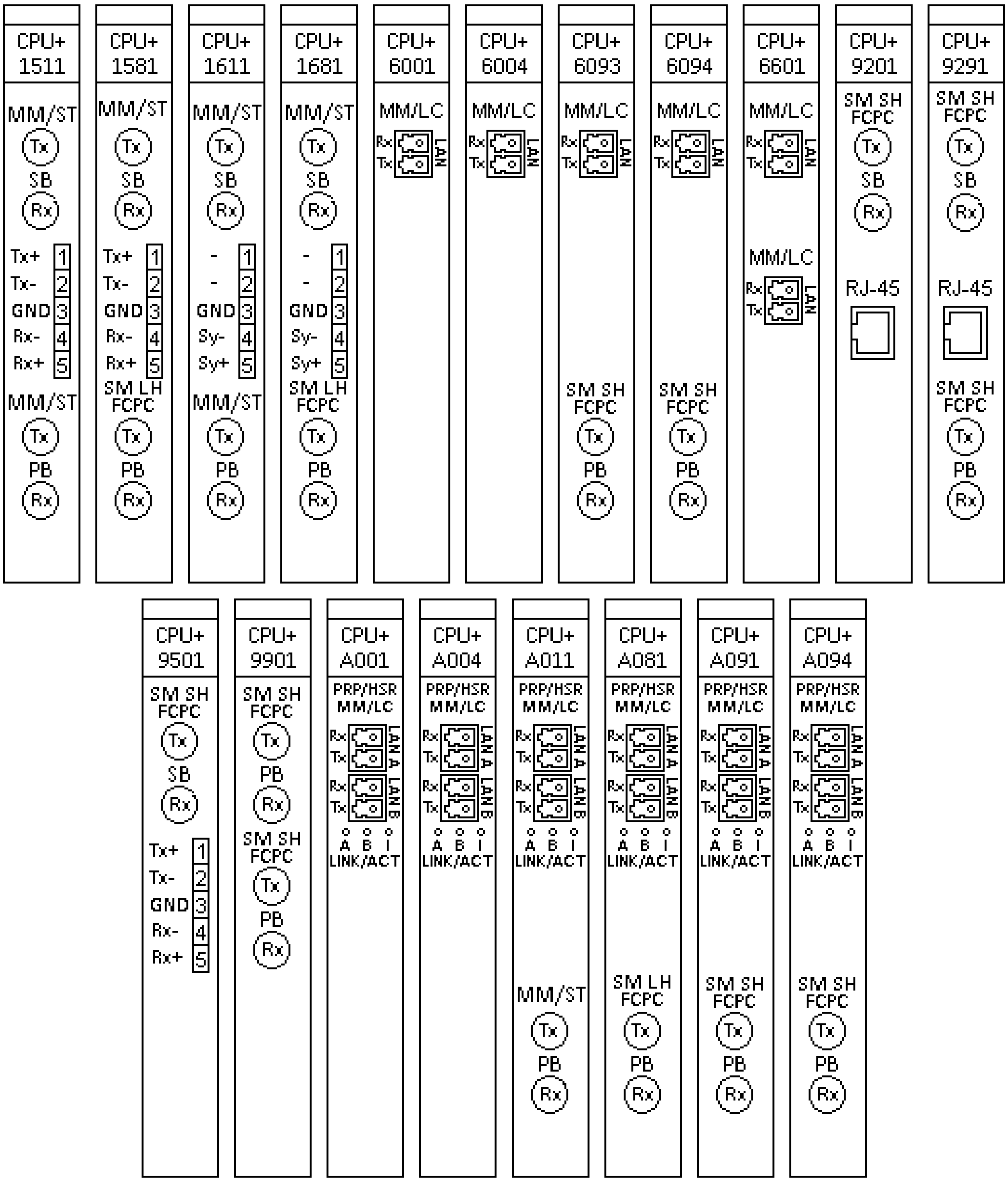


Figure 2-1 CPU versions

Interface types:

- 100Base-FX Ethernet:
  - MM/ST 1300 nm, 50/62.5/125 µm connector, (up to 2 km) fiber
  - SM/FC 1550 nm, 9/125 µm connector, (LH: long haul, up to 120 km)
  - SM/FC 1550 nm, 9/125 µm connector, (SH: short haul, up to 50 km)
  - MM/LC 1300 nm, 50/62.5/125 µm connector, (up to 2 km) fiber
- 10/100 Base-TX Ethernet: RJ-45-8/8
- Service port on HMI:
  - 10/100 Base-T Ethernet: RJ-45-8/8
  - EOB2 interface: attachable to the front panel by a proprietary magnetic connector; the connector box ends in a RJ-45 8/8 plug. It is 10Base-T full duplex interface, and it enables 10/100Base TX communication with service computers.
- ASIF: Asynchronous Serial Interface
  - plastic optical fiber (ASIF-POF)
  - glass with ST connector (ASIF-GS)
  - galvanic RS485/422 (ASIF-G)

1.3.4.2. COM modules

The COM+ modules are responsible for special communication tasks, these are the following:

- binary signal transmission
- line differential protection communication via Ethernet or telecommunication networks
- busbar differential protection communication
- multi-port Ethernet switch using MODBUS/TCP protocol for Remote I/O (RIO) servers

1.3.4.2.1. COM modules for binary signal transmission

MODULE TYPE	INTERFACE TYPE	NUMBER OF INTERFACES	UNIT WIDTH	APPLICATION
COM+/1801*	MM/ST 1300 nm, 50/62.5/125 µm and SM/FC 1550 nm, 9/125 µm connector, 100Base-FX Ethernet	2	4 HP	Line differential protection, binary signal transmission up to 2 km and up to 120 km
COM+/1901*	MM/ST 1300 nm, 50/62.5/125 µm and SM/FC 1550 nm, 9/125 µm connector, 100Base-FX Ethernet	2	4 HP	Line differential protection, binary signal transmission up to 2 km and up to 50 km
COM+/8882	SM/FC 1550 nm, 9/125 µm connector, 100Base-FX Ethernet	3	4 HP	3 direction binary signal transmission up to 120 km
COM+/9902	SM/FC 1550 nm, 9/125 µm connector, 100Base-FX Ethernet	2	4 HP	2 direction binary signal transmission up to 50 km
COM+/9992	SM/FC 1550 nm, 9/125 µm connector, 100Base-FX Ethernet	3	4 HP	3 direction binary signal transmission up to 50 km

Note: the modules can be equipped with a different handle (narrower and made of aluminum, instead of the standard plastic), if the other modules of the device are equipped with top-screw terminals (see Chapter 20.2). In these cases, a "T" letter appears on the label of the module (e.g. **COM+/1801T), but all other properties remain the same*

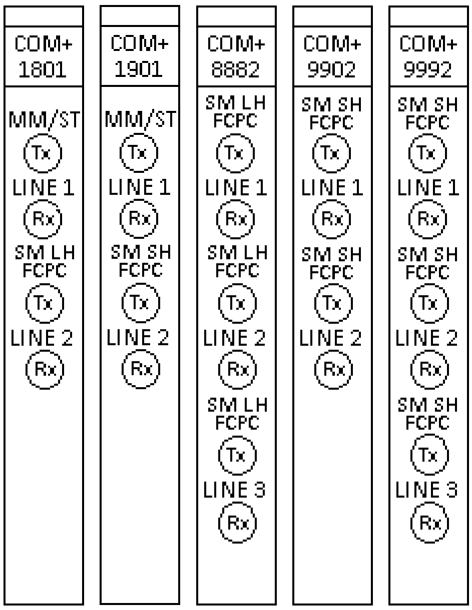


Figure 2-2 COM modules for binary signal transmission

1.3.4.2.2. COM modules for line differential communication

MODULE TYPE	INTERFACE TYPE	NUMBER OF INTERFACES	UNIT WIDTH	APPLICATION
COM+/0091	G703.1 (64 kbit/s)	1	4 HP	Line differential protection via telecom network
COM+/1101	MM/ST 1300 nm, 50/62.5/125 µm connector, 100Base-FX Ethernet	2	4 HP	3 terminals / redundant line differential protection up to 2 km
COM+/1801*	MM/ST 1300 nm, 50/62.5/125 µm and SM/FC 1550 nm, 9/125 µm connector, 100Base-FX Ethernet	2	4 HP	3 terminals / redundant line differential protection up to 2 km and up to 120 km
COM+/1901*	MM/ST 1300 nm, 50/62.5/125 µm and SM/FC 1550 nm, 9/125 µm connector, 100Base-FX Ethernet	2	4 HP	3 terminals / redundant line differential protection up to 2 km and up to 50 km
COM+/8801	SM/FC 1550 nm, 9/125 µm connector, 100Base-FX Ethernet	2	4 HP	3 terminals / redundant line differential protection up to 120 km
COM+/9901	SM/FC 1550 nm, 9/125 µm connector, 100Base-FX Ethernet	2	4 HP	3 terminals / redundant line differential protection up to 50 km

Note: the modules can be equipped with a different handle (narrower and made of aluminum, instead of the standard plastic), if the other modules of the device are equipped with top-screw terminals (see Chapter 20.2). In these cases, a "T" letter appears on the label of the module (e.g. **COM+/1801T), but all other properties remain the same*

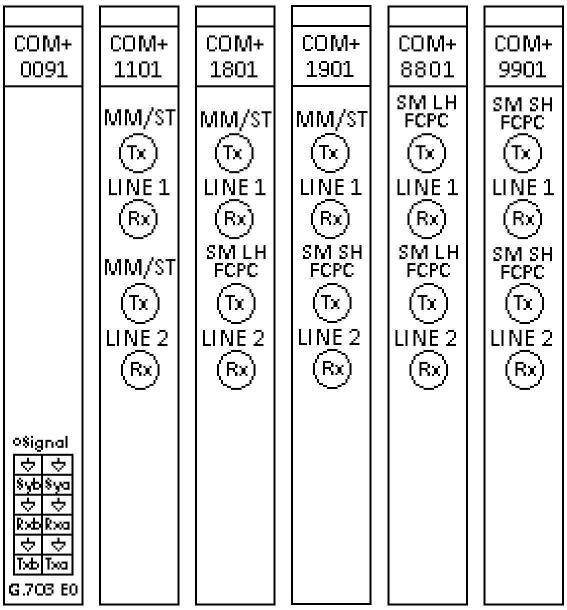


Figure 2-3 COM modules for line differential applications

1.3.4.2.3. COM modules for busbar differential protection communication

Module type	Interface type	Number of interfaces	Unit width	Application
COM+/1111	MM/ST 1300 nm, 50/62.5/125 μm connector, 100Base-FX Ethernet	3	4 HP	Busbar protection for 3 bay units up to 2 km
COM+/1111D	MM/ST 1300 nm, 50/62.5/125 μm connector, 100Base-FX Ethernet	3	4 HP	Busbar protection for 3x2 bay units (dual) up to 2 km

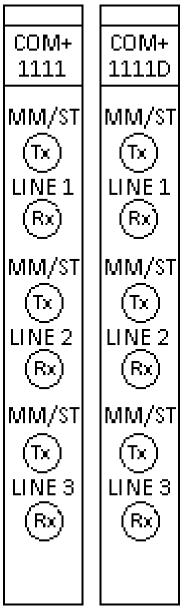


Figure 2-4 COM modules for busbar differential protections

1.3.4.2.4. COM modules for Remote I/O (RIO) servers

Module type	Interface type	Number of interfaces	Unit width	Application
COM+/1202*	MM/LC 1300 nm, 50/62.5/125 µm connector, 100Base-FX Ethernet	2	8 HP	2-port Ethernet switch for MODBUS via RIO
COM+/1324*	MM/LC 1300 nm, 50/62.5/125 µm connector, 100Base-FX Ethernet	4	8 HP	4-port Ethernet switch for MODBUS via RIO
COM+/1335	MM/LC 1300 nm, 50/62.5/125 µm connector, 100Base-FX Ethernet	5	8 HP	5-port Ethernet switch for MODBUS via RIO
COM+/6603	MM/LC 1300 nm, 50/62.5/125 µm connector, 100Base-FX Ethernet	2	4 HP	2-port Ethernet switch for MODBUS via RIO
COM+/6663	MM/LC 1300 nm, 50/62.5/125 µm connector, 100Base-FX Ethernet	3	4 HP	3-port Ethernet switch for MODBUS via RIO

***Obsolete module. These modules are not recommended for new designs!**

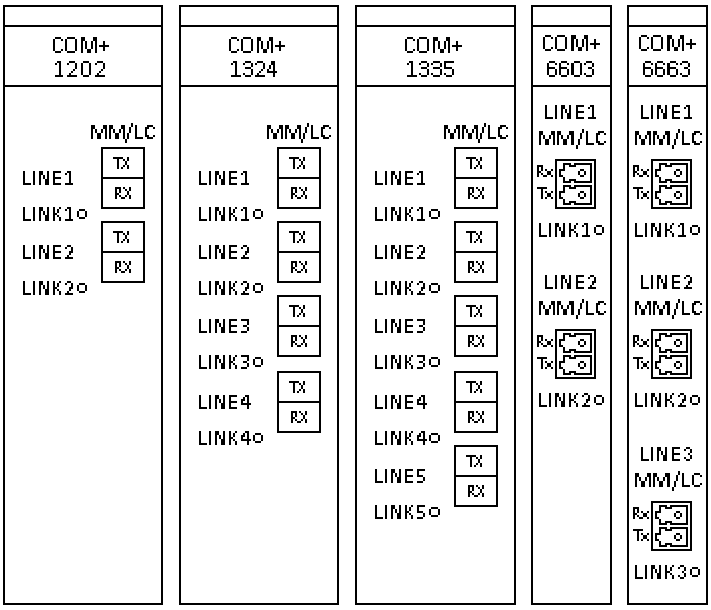


Figure 2-5 COM modules for RIO servers

1.3.4.3. Communication interface characteristics

1.3.4.3.1. Ethernet multi-mode transmitter and receiver

1.3.4.3.1.1. MM/ST connector

Up to approximately 2 km.

Transmitter

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT
OPTICAL OUTPUT POWER 62.5/125 µm, NA = 0.275 FIBER	P_O	BOL*: -19 EOL*: -20	-	-14	dBm avg.
OUTPUT OPTICAL POWER 50/125 µm, NA = 0.20 FIBER	P_O	BOL*: -22.5 EOL*: -23.5	-	-14	dBm avg.
OPTICAL EXTINCTION RATIO	ER	-	-	10 -10	% dB
CENTER WAVELENGTH	λ_C	1270	1308	1380	nm

*** BOL:** Beginning of life, **EOL:** End of life

*Note: according to field experiences, the **62.5/125 µm** cabling is recommended for applications where the center **wavelength is 1300/1310 nm**.*

Receiver sensitivity is measured with $2^{23} – 1$ PRBS pattern within BER = 2.5×10^{-10}

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT
SIGNAL DETECT - ASSERTED	P_A	P_D + 1.5 dB	-	-33	dBm avg.
SIGNAL DETECT - DEASSERTED	P_D	-45	-	-	dBm avg.
SIGNAL DETECT - HYSTERESIS	$P_A – P_D$	1.5	-	-	dB
SIGNAL DETECT ASSERT TIME (OFF TO ON)	AS_Max	0	2	100	µs
SIGNAL DETECT DEASSERT TIME (ON TO OFF)	ANS_Max	0	8	350	µs

1.3.4.3.1.2. MM/LC connector

Up to approximately 2 km.

Transmitter

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT
OPTICAL OUTPUT POWER 62.5/125 µm, NA = 0.275 FIBER**	P_O	BOL*: -19 EOL*: -20	-15.7	-14	dBm avg.
OUTPUT OPTICAL POWER 50/125 µm, NA = 0.20 FIBER	P_O	BOL*: -22.5 EOL*: -23.5	-	-14	dBm avg.
OPTICAL EXTINCTION RATIO	ER	-	0.002 -47	0.2 -27	% dB
CENTER WAVELENGTH	λ_C	1270	1308	1380	nm

*** BOL:** Beginning of life, **EOL:** End of life

*Note: according to field experiences, the **62.5/125 µm** cabling is recommended for applications where the **center wavelength is 1300/1310 nm**.*

Receiver sensitivity is measured with $2^{23} – 1$ PRBS pattern within BER = 2.5×10^{-10}

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT
SIGNAL DETECT - ASSERTED	P_A	P_D + 1.5 dB	-	-33	dBm avg.
SIGNAL DETECT - DEASSERTED	P_D	-45	-	-	dBm avg.
SIGNAL DETECT - HYSTERESIS	$P_A – P_D$	1.5	-	-	dB
SIGNAL DETECT ASSERT TIME (OFF TO ON)	AS_Max	0	2	100	µs
SIGNAL DETECT DEASSERT TIME (ON TO OFF)	ANS_Max	0	5	100	µs

1.3.4.3.2. Ethernet single mode transmitter and receiver

1.3.4.3.2.1. Long haul single mode transceiver

Up to approximately 120 km, with max. 32 dB link attenuation.

Transmitter

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT
OPTICAL OUTPUT POWER	P_O	-6	-	0	dBm avg.
OPTICAL EXTINCTION RATIO	ER	8.3	-	-	dB
CENTER WAVELENGTH	λ_C	1490	1550	1610	nm

Receiver sensitivity is measured with $2^{23} – 1$ PRBS pattern within BER = 2.5×10^{-10}

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT
OPTICAL INPUT SENSITIVITY	P_{IN}	-	-38	-35	dBm avg.
SATURATION	P_{SAT}	-3	0	-	dBm
CENTER WAVELENGTH	λ_C	1100	-	1600	nm
SIGNAL DETECT - ASSERTED	P_A	-	-	-35	dBm avg.
SIGNAL DETECT - DEASSERTED	P_D	-45	-	-	dBm avg.
HYSTERESIS	P_{HYS}	-	3	-	dB

1.3.4.3.2.2. Short haul single mode transceiver

Up to approximately 50 km, with max. 27 dB link attenuation.

Transmitter

Parameter	Symbol	Min.	Typ.	Max.	Unit
Optical Output Power	P_O	-12	-	-6	dBm avg.
Optical Extinction Ratio	ER	8.3	-	-	dB
Center Wavelength	λ_C	1490	1550	1610	nm

Receiver sensitivity is measured with $2^{23} – 1$ PRBS pattern within BER = 2.5×10^{-10}

Parameter	Symbol	Min.	Typ.	Max.	Unit
Optical Input Sensitivity	P_{IN}	-	-38	-35	dBm avg.
Saturation	P_{SAT}	-3	0	-	dBm
Center Wavelength	λ	1100	-	1600	nm
Signal Detect - Asserted	P_A	-	-	-35	dBm avg.
Signal Detect - Deasserted	P_D	-45	-	-	dBm avg.
Hysteresis	P_{HYS}	-	3	-	dB

1.3.4.3.3. ASIF-O transmitter and receiver

1.3.4.3.3.1. ASIF-O POF

Transmitter

Parameter	Symbol	Min.	Typ.	Max.	Unit	Jumper settings
Transmitter Output Optical Power	P_T	-15.3	-	-9	dBm	JP1 2-3
		-23.3	-	-17		JP1 1-2
Peak Emission Wavelength	λ_{PK}	-	660	-	nm	
Effective Diameter	D	-	1	-	mm	
Numerical Aperture	NA	-	0.5	-		

Receiver

Parameter	Symbol	Min.	Typ.	Max.	Unit
Input Optical Power Level Logic 0	$P_{R(L)}$	-39	-	-13.7	dBm
Input Optical Power Level Logic 1	$P_{R(H)}$	-	-	-53	dBm
Effective Diameter	D	-	1	-	mm
Numerical Aperture	NA	-	0.5	-	

These characteristics are valid for both POF interfaces in CPU+1331 module.

1.3.4.3.3.2. ASIF-O GLASS

Transmitter *(Output measured out of 1 meter of cable)*

Parameter	Symbol	Min.	Typ.	Max.	Unit	Jumper settings
50/125 µm Fiber cable NA = 0.2	P_O	-19.4	-16.4	-14.4	dBm peak	JP1 2-3
		-28.9	-25.9	-23.9		JP1 1-2
62.5/125 µm Fiber cable NA = 0.275	P_O	-15.6	-12.6	-10.6	dBm peak	JP1 2-3
		-22.9	-19.9	-17.9		JP1 1-2

Receiver

Parameter	Symbol	Min.	Typ.	Max.	Unit
Peak optical input power Logic level HIGH (λ_P = 820 nm)	P_{RH}	-25.4	-	-9.2	dBm peak
Peak optical input power Logic level LOW	P_{RL}	-	-	-40	dBm peak

1.3.4.3.4. ASIF-G transmitter and receiver

The RS422/RS485 interfaces of our CPU+1501, CPU+1511, CPU+1581, CPU+9501 modules provide galvanic interface to support legacy or other serial protocols. For more details see our RS485/422 application note, available on our homepage.

Transmitter

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT
DIFFERENTIAL OUTPUT VOLTAGE (LOADED, R_L = 100 Ω, RS422)	V_{OD2}	2	-	3.6	V
DIFFERENTIAL OUTPUT VOLTAGE (LOADED, R_L = 54 Ω, RS485)	V_{OD2}	1.5	-	3.6	V

Receiver

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT
DIFFERENTIAL INPUT THRESHOLD VOLTAGE	V_{TH}	-200	-125	-30	mV
INPUT VOLTAGE HYSTERESIS	V_{HYS}	-	15	-	mV
LINE INPUT RESISTANCE	R_{IN}	96	-	-	kΩ

1.3.4.3.5. G.703 64 kbit/s co-directional interface (E0)

The EuroProt+ device also supports line differential communication via telecom networks using • 64 kbit/s co-directional interface type through COM+0091. This type of communication is performed via 2 × 2 wire isolated galvanic type interface. The protection device is connected to a multiplexer or gateway which is responsible for protocol/speed conversion.

- Connector type: Weidmüller: Receptacle: S2L 3.50/12/90 F
  Plug: B2L 3.50/12/180 F
- Impedance: 120 Ω
- Cable length: 50 m
- Interface type: G.703.1 64 kbit/s (E0) co-directional, selectable grounding, with optional external clock input

For further information about the cable assembly of this type of interface please see our G.703 E0 cable assembly guide.

Receiver

PARAMETER	VALUE
LOSS OF SIGNAL ALARM LEVEL	± 1.5 dB difference between alarm-on and alarm-off
DYNAMIC RANGE	10 dB maximum cable loss range

Transmitter

PARAMETER	VALUE
PAIR FOR EACH DIRECTION	± 1.5 dB difference between alarm-on and alarm-off
TEST LOAD IMPEDANCE	10 dB maximum cable loss range
NOMINAL PEAK VOLTAGE OF A "MARK" (PULSE)	One symmetric pair
PEAK VOLTAGE OF A "SPACE" (NO PULSE)	120 Ω resistive
NOMINAL PULSE WIDTH	1.0 V
RATIO OF THE AMPLITUDES OF POSITIVE AND NEGATIVE	0 V ± 0.10 V
PULSES AT THE CENTRE OF THE PULSES INTERVAL	3.9 ms
RATIO OF THE WIDTHS OF POSITIVE AND NEGATIVE PULSES	0.95 to 1.05
AT THE NOMINAL HALF AMPLITUDE	0.95 to 1.05
MAXIMUM PEAK-TO-PEAK JITTER AT THE OUTPUT PORT	Refer to clause 2/G.823

1.3.4.3.5.1. PRP/HSR redundant Ethernet communication interface

The PRP/HSR redundant Ethernet communication interface supports the two new IEC 62439-3 protocols which provide seamless redundancy for Ethernet networking in substations with zero-time recovery in case of a single failure without frame loss:

- PRP – Parallel Redundancy Protocol (IEC 62439-3 Clause 4)
- HSR – High-availability Seamless Redundancy (IEC 62439-3 Clause 5)

This interface uses two MM/LC connectors for double connection to networks as these protocols are based on the duplication of the sent frames.

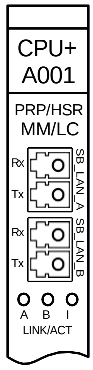


Figure 2-6 PRP/HSR connectors on a CPU+A001 module

1.3.4.3.5.2. Parallel Redundancy Protocol (PRP)

This redundancy protocol implements redundancy in the nodes as they are connected to two independent networks (LAN_A and LAN_B) sending a copy of each frame to both directions. The destination node receives and processes the first copy and discards the other copy of the sent frame.

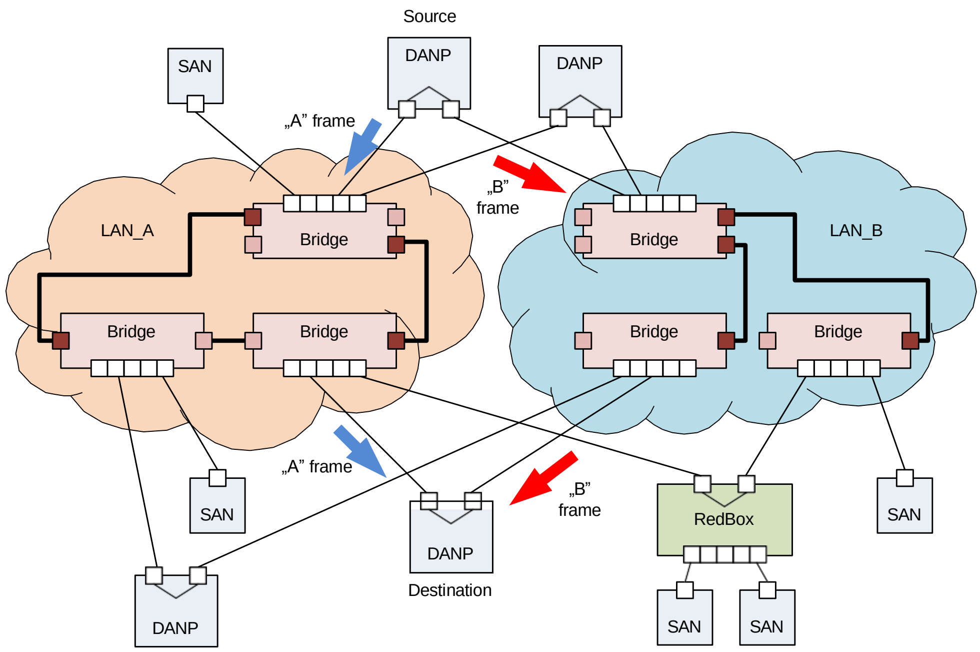


Figure 2-7 Example of a PRP redundant network

Single attached node (SAN): Network device that connects to a network with only one port.
Double attached node implementing PRP (DANP): Network device which connects to a network with two ports implementing PRP redundancy.

1.3.4.3.5.3. High-availability Seamless Redundancy (HSR)

An HSR network provides redundancy with the same safety as PRP does with a lower cost. The principle of this protocol is also based on the duplication of the sent frames but in this solution the nodes are connected to a closed ring. A source node sends two copy of a frame to both direction and the destination node accepts the first received copy and discards the other one. If a frame returns to its source the node does not let it through itself prevent the possibility of an overload of the ring.

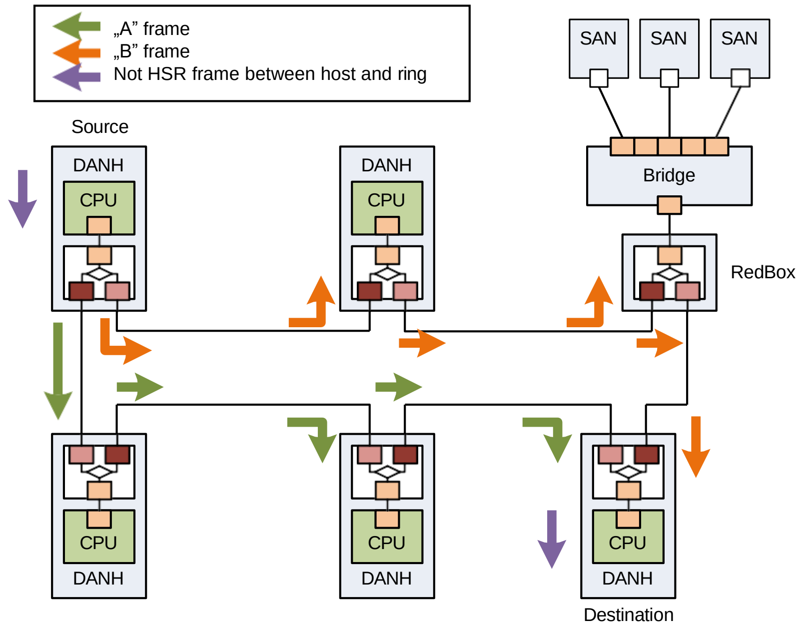


Figure 2-8 Example of an HSR redundant network

Single attached node (SAN): Network device that connects to a network with only one port.
Double attached node implementing HSR (DANH): Network device which connects to a network with two ports implementing HSR redundancy.

1.3.5. Device housings

Three+one versions are available: one is 84 HP wide with 21 module slots, the 42 HP wide, which supports 10 module slots, the double 42 HP wide with 20 module slots, and finally the 24 HP, which supports 6 module slots.

Depending on the installed modules of the configuration, the top and bottom panels of the 84 HP and 42 HP racks can be either solid (default) or perforated by 2 mm holes to prevent overheating. 24 HP housings do not have this feature, as the S24 system is less flexible, their range of the optional modules are narrower.

Rack configuration	Free module slots*	Bottom and top panels	Display options
84 HP, single rack (3 U)	20	Solid, Perforated	3.5" TFT, 5.7" TFT
42 HP, single rack (3 U)	9	Solid, Perforated	3.5" TFT, 5.7" TFT
42 HP, double rack (6 U)	19	Solid, Perforated	3.5" TFT
24 HP, panel instrument case	5	Solid	B/W alphanumeric 3.5" TFT

**CPU module is mandatory, it uses up one fixed position*

Previously, a new rack type has been introduced to the 42HP devices. As of April 2021. this type is introduced to the 84HP devices as well. The depth of the box has been reduced from 242 mm to 223 mm. By default, this reduced-depth housing shall be used for newly manufactured devices. For more information about the previous and new size, see Chapter 22.1.

The following images showcase examples of the different types of available device housings with different kinds of front panel HMI. The available front panels are listed in Chapter 4.

84 HP single rack (3 U) with 3.5" TFT display and solid housing	
84 HP single rack (3 U) with 5.7" TFT display and perforated housing	
42 HP single rack (3 U) with 3.5" TFT display and solid housing	
42 HP double rack (6 U) with 3.5" TFT display and solid housing	
24 HP panel instrument case with B/W display (left) TFT display (right)	

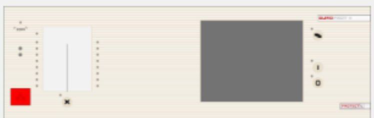
Figure 3-1 Rack configuration illustrations

1.3.6. Human-Machine Interface (HMI) module

The EuroProt+ device HMI consists of the following two main parts:

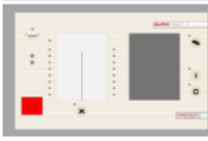
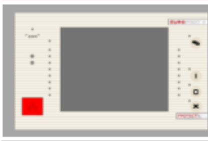
- Hardware: the HMI module, which is the front panel of the device, this is described here
- Software: the embedded web server and the menu system that is accessible through the HMI module. The web server is accessible via station bus, EOB interface or RJ-45 Ethernet connector. This is described in detail in the Operating Manual (external document).

1.3.6.1. Local HMI modules

MODULE TYPE	DISPLAY	SERVICE PORT	RACK SIZE	RACK DEPTH	ILLUSTRATION
HMI+/3505 **HMI+/3405***	3,5" TFT	EOB	42 HP	Reduced	
			84 HP		
HMI+/3506 **HMI+/3406*** **HMI+/3404***	3,5" TFT	RJ-45	42 HP	Reduced	
			Double 42HP		
			84 HP		
HMI+/5005	5,7" TFT	EOB	42 HP	Reduced	
HMI+/5006 **HMI+/5004***	5,7" TFT	RJ-45	42 HP	Reduced	
			Double 42 HP		n/a
HMI+/5706 **HMI+/5704***	5,7" TFT	RJ-45	84 HP	Reduced	

**new display hardware requires CDSP firmware version 1560-H5 or higher!*

The following modules were made for the previous (now obsolete) racks (see Chapter 22.1), so they can be found in numerous devices. These became obsolete as well, **they are not recommended for new designs!**

Module type	Display	Service port	Rack size	Rack depth	Illustration
HMI+/3501	3,5" TFT	EOB	42 HP	Normal	
			84 HP		
HMI+/3502	3,5" TFT	RJ-45	42 HP	Normal	
			84 HP		
HMI+/5001	5,7" TFT	EOB	42 HP	Normal	
HMI+/5002	5,7" TFT	RJ-45	42 HP	Normal	
HMI+/5701	5,7" TFT	EOB	84 HP	Normal	
HMI+/5702	5,7" TFT	RJ-45	84 HP	Normal	

1.3.6.2. Remote HMI

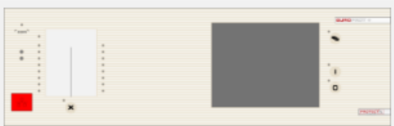
Protecta provides an alternative solution in that case if the IED can be only mounted in a non-practical way for managing the device via usual Human-Machine Interface.

By using a remote HMI *(terminal HMI device),* customers can place the HMI up to 3 meters far from the IED itself *(host device)* and mount the IED in any possible way that is applicable. The connection between the remote HMI and the IED is provided by a custom galvanic interface with DA-15 connector on the remote side.

Figure 4-1 42 HP Remote HMI

Depending on the size of the HMI module you can use any applicable mounting methods that described in the Mounting methods chapter (Flush mounting, Semi-flush mounting, Rack mounting).

Figure 4–2 Remote HMI module with its host device

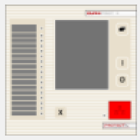
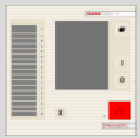
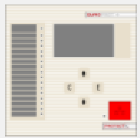
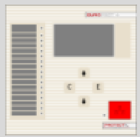
MODULE TYPE	DISPLAY	SERVICE PORT	RACK SIZE	RACK DEPTH	ILLUSTRATION
HMIT+/3505	3,5" TFT	EOB	42 HP	Reduced	
			84 HP		
HMIT+/3506	3,5" TFT	RJ-45	42 HP	Reduced	
			84 HP		
HMIT+/5706	5,7" TFT	RJ-45	84 HP	Reduced	

The following modules were made for the previous (now obsolete) racks (see Chapter 22.1), so they can be found in numerous devices. These became obsolete as well, **they are not recommended for new designs!**

Module type	Display	Service port	Rack size	Rack depth	Illustration
HMIT+/3501	3,5” TFT	EOB	42 HP	Normal	
			84 HP		
HMIT+/3502	3,5” TFT	RJ-45	42 HP	Normal	
			84 HP		
HMIT+/5702	5,7” TFT	RJ-45	84 HP	Normal	

1.3.6.3. S24 HMI

The S24 Smart Line devices have a different HMI family:

MODULE TYPE	DISPLAY	SERVICE PORT	RACK SIZE	MOUNTING	ILLUSTRATION
HMI+/2604* HMI+/2404 HMI+/2304**	3,5" TFT	RJ-45	24 HP	Nornal	
HMI+/2606* HMI+/2406 HMI+/2306**	3,5" TFT	RJ-45	24 HP	DIN-rail	
HMI+/2704* HMI+/2504	B&W LCD	RJ-45	24 HP	Normal	
HMI+/2706* HMI+/2506	B&W LCD	RJ-45	24 HP	DIN-rail	

**for newer, modular-type S24 devices*
***new display hardware requires CDSP firmware version 1560-H5 or higher!*

The following module is **obsolete, it is not recommended for new designs!**

MODULE TYPE	DISPLAY	SERVICE PORT	RACK SIZE	MOUNTING	ILLUSTRATION
HMI+/2401*	3,5" TFT	EOB	24 HP	Normal	

1.3.6.4. Parts of the HMI modules

The EuroProt+ device HMI on the front panel contains the following elements:

Function	Description
16 pieces user LEDs	Three-color, 3 mm circular LEDs
COM LED	Yellow, 3 mm circular LED indicating EOB/RJ-45 (on the front panel) communication link and activity
Capacitive touch key LEDs	4 pcs yellow, 3 mm circular LEDs indicating touch key actions
Device status LED	1 piece three-color, 3 mm circular LED Green: normal device operation Yellow: device is in warning state Red: device is in error state
Device keys (I, O, X, Page)	Capacitive touch keys
	Tactile push buttons
Buzzer	Audible touch key pressure feedback
Changeable LED description label	Describes user LED functionality
Display	320 × 240 pixel TFT color display with resistive touchscreen interface (3.5” or optional 5.7”)
	128 × 64 LCD black & white display
Optical interface for factory usage	For debugging and software development purposes *Only for 42 HP and 84 HP devices.*
EOB connector	**E**thernet **O**ver **B**oard: communication interface accomplishes isolated, non-galvanic Ethernet connection with the help of a magnetically attached EOB device. The EOB device has an RJ-45 type connector supporting Ethernet connection to the user computer. This is a proprietary and patented solution from Protecta Ltd. **EOB1:** Supporting 10Base-T Ethernet connection. Passive device with one RJ45 type connector. Obsolete module. **EOB2:** Supporting 10/100Base-Tx Ethernet connection. An active device that has a USB port in addition to the RJ45 connector for powering up.
Ethernet service port	**IP56** rated Ethernet 10/100-Base-T interface with RJ-45 type connector (IP56 only valid if the cap of the service port is closed.)

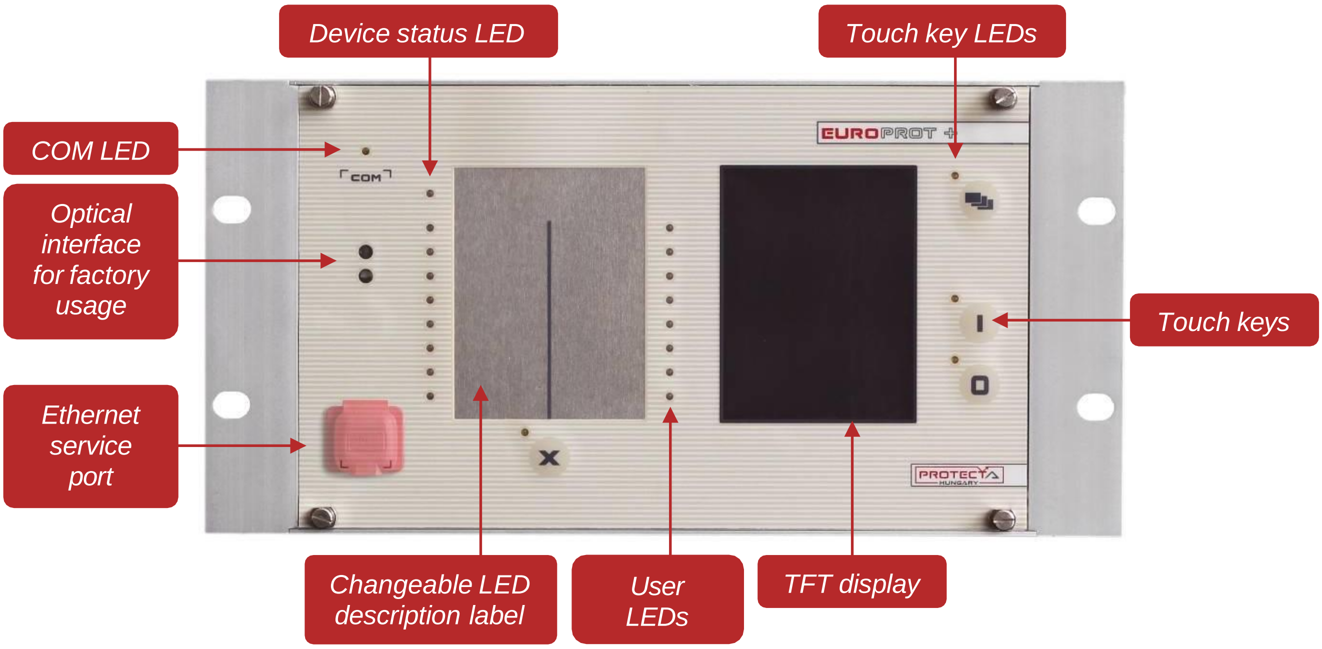


Figure 4–3 HMI signals and controls

LCD dot-defect handling policy

The definitions of dot-defect are as below:

- The defect area of the dot must be bigger than half of a dot.
- For bright dot-defect (sparkle mode), showing black pattern, the dot's brightness must be over 30 % brighter than others at black raster.
- For dark dot-defect (black mode), showing white pattern, the dot's brightness must be under 70 % darker than others at R.G.B. raster.

Dot-defect type		**Maximum number acceptable 3.5"**	**Maximum number acceptable 5.7"**
Sparkle mode	1 dot	4	4
	2 dots	2 (sets)	1
	In total	4	5
Black mode	1 dot	4	5
	2 dots	2 (sets)	2
	In total	4	5
Sparkle mode and black mode	2 dots	2 (sets)	n/a
In total		6	10

For further information please contact our Application Team. (application@protecta.hu)

1.3.7. Current input module

This is an input module with intermediate current transformers to input the phase currents and the zero-sequence current. The rated current for the phase current and for the zero-sequence current can be selectable by parameter.

Main features:

- Rated frequency: 50 Hz, 60 Hz
- *Electronic* iron-core flux compensation

Connector types:

- *The default and optionally available connector types are indicated for each module in the tables below. See Chapter 20.2 for details about each type.*

MODULE TYPE	CT+/0101		CT+/1111*		CT+/1155		CT+/1500	
CHANNEL NUMBER	1 – 4		1 – 4		1 – 4		1 – 3	
SELECTABLE RATED CURRENT, I_N [A]	0.04	0.2	1	5	1	5	1	5
MAX. MEASURED CURRENT (± 10 %)	8 × I_N		50 × I_N		12.5 × I_N		2 × I_N	
POWER CONSUMPTION AT RATED CURRENT [VA]	0.005	0.1	0.01	0.25	0.02	0.45	0.1	1.55
THERMAL WITHSTAND [A]								
continuously	7		20		20		7	
10 s	50		175		120		50	
1 s	150		500		380		150	
10 ms	330		1200		850		330	
CONNECTOR TYPE	Default: STVS Options: -		Default: STVS Options: -		Default: STVS Options: -		Default: STVS Options: R	
RECOMMENDED APPLICATION	DEFL earth fault protection		Special disturbance recorder application in wider frequency range		Special protection applications where the overcurrent in the secondary circuit can not exceed 10 × I_n		General three-phase measurement	

***Obsolete module. These modules are not recommended for new designs!**

Module type	CT+/1515*		CT+/2500*		CT+/5101			
Channel number	1 – 4		1 – 3		1 – 3		4	
Selectable rated current, I_N [A]	1	5	1	5	1	5	0.2	1
Max. measured current (± 10 %)	2 × I_N		2 × I_N		50 × I_N		12.5 × I_N	
Power consumption at rated current [VA]	0.1	1.55	0.1	1.55	0.01	0.25	0.005	0.1
Thermal withstand [A]								
continuously	7		7		20		7	
10 s	50		50		175		50	
1 s	150		150		500		150	
10 ms	330		330		1200		330	
Connector type	Default: STVS Options: -		Default: STVS Options: -		Default: STVS Options: -			
Recommended application	Special disturbance recorder application		Generator protections		Extremely sensitive earth-fault applications			

***Obsolete module. These modules are not recommended for new designs!**

Module type	CT+/5102				CT+/5111*			
Channel number	1 – 3		4		1 – 3		4	
Selectable rated current, I_N [A]	1	5	0.2	1	1	5	0.001	0.005
Max. measured current (± 10 %)	50 × I_N		50 × I_N		50 × I_N		50 × I_N	
Power consumption at rated current [VA]	0.01	0.25	0.001	0.01	0.01	0.25	0.005	0.1
Thermal withstand [A]								
continuously	20		20		20		7	
10 s	175		120		175		50	
1 s	500		380		500		150	
10 ms	1200		850		1200		330	
Connector type	Default: STVS Options: -				Default: STVS Options: R			
Recommended application	Sensitive earth-fault applications				Sensitive earth-fault applications			

***Obsolete module. These modules are not recommended for new designs!**

MODULE TYPE	CT+5115		CT+5116		CT+/5151		CT+/5152	
CHANNEL NUMBER	1 – 4		1 – 3		1 – 4		1 – 4	
SELECTABLE RATED CURRENT, I_N [A]	1	5	1	5	1	5	1	5
MAX. MEASURED CURRENT (± 10 %)	50 × I_N		50 × I_N		50 I_N		50 I_N	
POWER CONSUMPTION AT RATED CURRENT [VA]	0.01	0.25	0.01	0.25	0.01	0.25	0.01	0.25
THERMAL WITHSTAND [A]								
CONTINUOUSLY	20		20		20		20	
10 s	175		175		175		175	
1 s	500		500		500		500	
10 ms	1200		1200		1200		1200	
CONNECTOR TYPE	Default: STVS Options: R		Default: STVS Options: -		Default: STVS Options: R		Default: STVS Options: R	
RECOMMENDED APPLICATION	• General protection applications* • Three-phase measurement*		High-impedance differential protection		General protection applications		Busbar protection bay units	

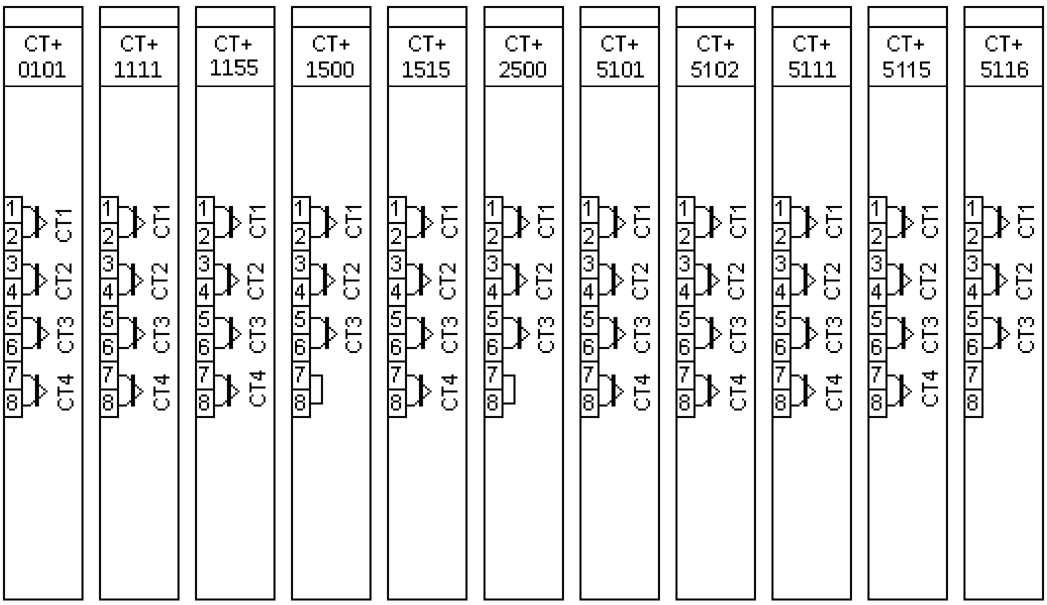
**The CT+/5115 module handles both applications: it can be connected to the protection and measurement core of the primary CT as well*

MODULE TYPE	CT+/5153					CT+/5154*				
CHANNEL NUMBER	1 – 3		4			1 – 3		4		
SELECTABLE RATED CURRENT, I_N [A]	1	5	1	0.2	0.2 sens.	1	5	5	1	0.2
MAX. MEASURED CURRENT (± 10 %)	50 × I_N				10 × I_N	50 × I_N				10 × I_N
POWER CONSUMPTION AT RATED CURRENT [VA]	0.06	1.3	0.6	0.004	0.0004	0.06	1.3	1.3	0.06	0.004
THERMAL WITHSTAND [A]										
CONTINUOUSLY	20		7			20				
10 s	175		50			175				
1 s	500		150			500				
10 ms	1200		330			1200				
CONNECTOR TYPE	Default: STVS Options: R, T**					Default: STVS Options: R				
RECOMMENDED APPLICATION	General protection application, extremely sensitive transient earth-fault protections					General protection application, sensitive transient earth-fault protections				

***Obsolete module. These modules are not recommended for new designs!**
***The connector remains the same STVS, only the handle of the module becomes narrower and will be made of aluminum*

MODULE TYPE	CT+/5155*					CT+/5253**				
CHANNEL NUMBER	1 – 3		4			1 – 3		4		
SELECTABLE RATED CURRENT, I_N [A]	1	5	0.25	0.05	0.05 sens.	5	1	0.25	0.05	0.05 sens.
MAX. MEASURED CURRENT (± 10 %)	50 × I_N				10 × I_N	25 × I_N				
POWER CONSUMPTION AT RATED CURRENT [VA]	0.06	1.3	0.6	0.004	0.0004	0.06	1.3	0.6	0.004	0.0004
THERMAL WITHSTAND [A]										
continuously	20		7			20		7		
10 s	175		50			175		50		
1 s	500		150			500		150		
10 ms	1200		330			1200		330		
CONNECTOR TYPE	Default: STVS Options: -					Default: STVS Options: -				
RECOMMENDED APPLICATION	DMD Special sensitive earth fault protection					Circuit breaker diagnostics				

***Obsolete module. These modules are not recommended for new designs!**
***Special module*



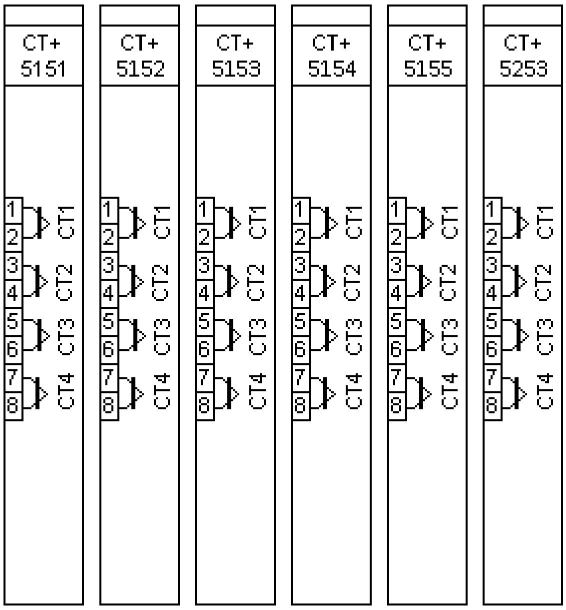


Figure 5-1 CT modules

1.3.8. Voltage input module

If the device performs voltage and/or frequency related functions and measurements (voltage protections, directional protections, frequency protections etc.), then this module is needed.

Connector types:

- *The default and optionally available connector types are indicated for each module in the tables below. See Chapter 20.2 for details about each type.*

MODULE TYPE	VT+/2211	VT+/2212*	VT+/2215**
CHANNEL NUMBER	4	4	4
SELECTABLE VOLTAGE RANGE	**Type 100:** $\frac{100}{\sqrt{3}}$, 100 V **Type 200:** $\frac{200}{\sqrt{3}}$, 200 V	**Type 100:** $\frac{100}{\sqrt{3}}$, 100 V **Type 200:** $\frac{200}{\sqrt{3}}$, 200 V	**Type 100:** $\frac{100}{\sqrt{3}}$, 100 V **Type 200:** $\frac{200}{\sqrt{3}}$, 200 V
CONTINUOUS VOLTAGE WITHSTAND	200 V	200 V	200 V
SHORT TIME OVERLOAD (1 S)	275 V (10s)	275 V	275 V
VOLTAGE MEASURING RANGE (± 10 %)	0.05 U_N – 1.3 U_N	0.05 U_N – 1.3 U_N	0.05 U_N – 1.3 U_N
POWER CONSUMPTION OF VOLTAGE INPUT	0.61 VA at 200 V 0.2 VA at 100 V	0.61 VA at 200 V 0.2 VA at 100 V	**ch. 1-3:** 0.61 VA at 200 V 0.2 VA at 100 V **ch. 4:** 50 mVA at 100 V
CONNECTOR TYPE	Default: BLA Options: F, T, R	Default: BLA Options: -	Default: BLA Options: -
RECOMMENDED APPLICATION	General protection applications.	Special disturbance recorder application in wider frequency range	Special protection applications with voltage transformers that require low power consumption on the 4th channel.

***Obsolete module. These modules are not recommended for new designs!**

***Special module*

Module type	VT+/2245	VT+/2246*
Channel number	4	3
Selectable voltage range	**Type 200:** $\frac{200}{\sqrt{3}}$, 200 V **Type 400:** $\frac{400}{\sqrt{3}}$	
Continuous voltage withstand	400 V	
Short time overload (1 s)	420 V	420 V (10 s)
Voltage measuring range (± 10 %)	0.05 U_N – 1.3 U_N	
Power consumption of voltage input	0.21 VA at 200 V 0.28 VA at 230 V	
Connector type	Default: BLA Options: T	Default: BLA Options: -
Recommended application	Protection applications for 400 V AC secondary voltage	Special protection applications for 400 V AC secondary voltage and increased isolation to 6 kV

*Special module

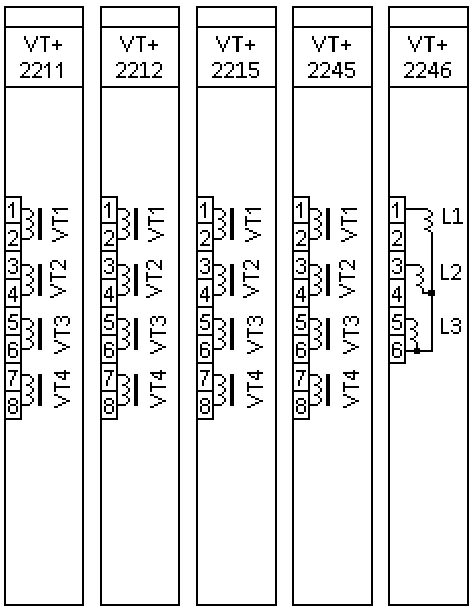


Figure 6-1 VT modules

1.3.9. Binary input module

The inputs are galvanic isolated, and the module converts high-voltage signals to the voltage level and format of the internal circuits. The inputs of this module can be also programmed to serve as a PPM input for time synchronization.

Connector types:

- *The default and optionally available connector types are indicated for each module in the tables below. See Chapter 20.2 for details about each type.*

Notes for the following tables:

- ***Thermal withstand voltage:*** *continuous with 60 % of the input channels are energized.*
- ***Clamp voltage:*** *these are the guaranteed values; the actual ones might differ from those provided here (falling and rising around 0.66 U_N and 0.77 U_N, respectively)*

MODULE TYPE	O8+/2401	O8+/4801	O8+/1101	O8+/2201
CHANNEL NUMBER	8	8	8	8
TIME SYNCHRONIZATION	configured by EuroCAP	configured by EuroCAP	configured by EuroCAP	configured by EuroCAP
RATED VOLTAGE	24 V	48 V	110 V	220 V
THERMAL WITHSTAND VOLTAGE	72 V	100 V	250 V	320 V
CLAMP VOLTAGE	falling 0.64 U_N rising 0.8 U_N	falling 0.64 U_N rising 0.8 U_N	falling 0.64 U_N rising 0.8 U_N	falling 0.64 U_N rising 0.8 U_N
COMMON GROUPS	independent	independent	independent	independent
CONNECTOR TYPE	Default: BLA Options: T	Default: BLA Options: T	Default: BLA Options: T	Default: BLA Options: T

MODULE TYPE	O12+/2401	O12+/4801	O12+/1101	O12+/2201
CHANNEL NUMBER	12	12	12	12
TIME SYNCHRONIZATION	configured by EuroCAP	configured by EuroCAP	configured by EuroCAP	configured by EuroCAP
RATED VOLTAGE	24 V	48 V	110 V	220 V
THERMAL WITHSTAND VOLTAGE	72 V	72 V	250 V	320 V
CLAMP VOLTAGE	falling 0.64 U_N rising 0.8 U_N	falling 0.64 U_N rising 0.8 U_N	falling 0.64 U_N rising 0.8 U_N	falling 0.64 U_N rising 0.8 U_N
COMMON GROUPS	4 × 3 common	4 × 3 common	4 × 3 common	4 × 3 common
CONNECTOR TYPE	Default: BLA Options: T	Default: BLA Options: F, T	Default: BLA Options: F, T	Default: BLA Options: T

Module type	O12+/4201*	O12+/2101*	O15+/4801T	O15+/1101T
Channel number	12	12	15	15
Time synchronization	configured by EuroCAP	configured by EuroCAP	configured by EuroCAP	configured by EuroCAP
Rated voltage	24 V DC / 48 V DC user selectable on channel basis by jumpers	110 V DC / 220 V DC user selectable on channel basis by jumpers	48 V	110 V
Thermal withstand voltage	72 V	320 V	100 V	250 V
Clamp voltage	falling 0.64 U_N rising 0.8 U_N	falling 0.64 U_N rising 0.8 U_N	falling 0.64 U_N rising 0.8 U_N	falling 0.64 U_N rising 0.8 U_N
Common groups	4 × 3 common	4 × 3 common	1 × 15 common	1 × 15 common
Connector type	Default: BLA Options: -	Default: BLA Options: T	BLT	BLT

** O12+2101 and O12+4201 modules can be used only in demonstration applications! For further information see our Product availability chapter.*

Module type	O16+/2401*	O16+/4801*	O16+/1101*	O16+/2201*
Channel number	16	16	16	16
Time synchronization	-	-	-	-
Rated voltage	24 V	48 V	110 V	220 V
Thermal withstand voltage	72 V	100 V	250 V	320 V
Clamp voltage	falling 0.64 U_N rising 0.8 U_N	falling 0.64 U_N rising 0.8 U_N	falling 0.64 U_N rising 0.8 U_N	falling 0.64 U_N rising 0.8 U_N
Common groups	2 × 8 common	2 × 8 common	2 × 8 common	2 × 8 common
Connector type	Default: BL 3.5 Options: -	Default: BL 3.5 Options: -	Default: BL 3.5 Options: -	Default: BL 3.5 Options: -

***Obsolete module. These modules are not recommended for new designs! *O15*+ modules are recommended instead (see above).**

Main features:

- Digitally filtered per channel
- Current drain:
    - max. 1.6 mA per channel at 220 V DC
    - max. 1.8 mA per channel at 110 V DC
    - max. 2 mA per channel at 48 V DC
    - max. 3 mA per channel at 24 V DC
- In such applications where the input voltage is 60 V the modules with 48 V rated voltage can be used.
- Input voltage type can be either DC or AC voltage. If AC voltage is used make sure that the type and the parameters of the binary inputs are configured properly in EuroCAP tool.

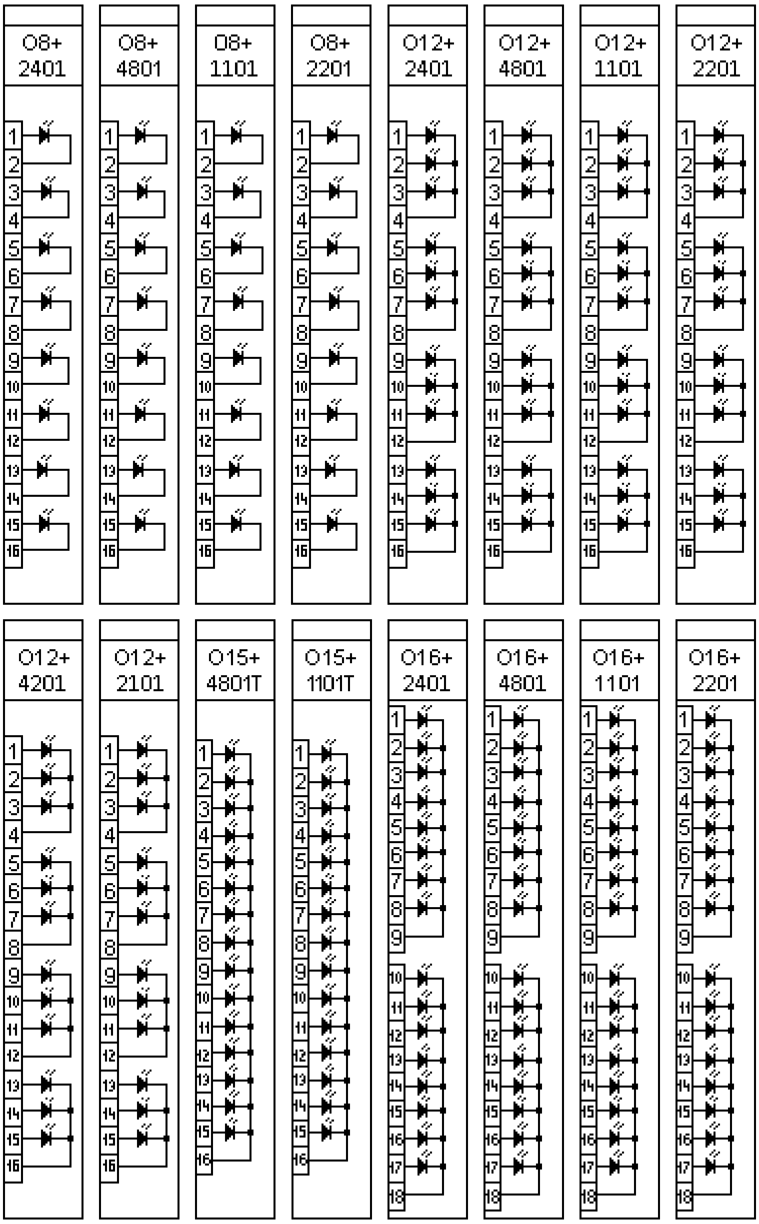


Figure 7-1 Binary input modules

1.3.10. Signaling module

The signaling module has 4, 8, 12 or 16 relay outputs with dry contacts.

Connector types:

- *The default and optionally available connector types are indicated for each module in the tables below. See Chapter 20.2 for details about each type.*

Module type	R4+/01	R8+/00	R8+/80	R8+/C0
Rated voltage	250 V AC/DC	250 V AC/DC	250 V AC/DC	250 V AC/DC
Continuous carry	8 A	8 A	8 A	8 A
Contact versions	4 CO	8 NO	CH8 NC others NO	CH7 and CH8 NC others NO
Group isolation	4 independent	8 independent	8 independent	8 independent
Connector type	Default: BLA Options: F	Default: BLA Options: F, T	Default: BLA Options: T	Default: BLA Options: T

Module type	R8+/FF	R12+/0000	R12+/4000
Rated voltage	250 V AC/DC	250 V AC/DC	250 V AC/DC
Continuous carry	8 A	8 A	8 A
Contact versions	8 NC	12 NO	CH12 NC others NO
Group isolation	8 independent	4 × 3 common	4 × 3 common
Connector type	Default: BLA Options: -	Default: BLA Options: F, T	Default: BLA Options: F, T

Module type	R16+/0000	R16+/8000	R16+/8080
Rated voltage	250 V AC/DC	250 V AC/DC	250 V AC/DC
Continuous carry	8 A	8 A	8 A
Contact versions	16 NO	CH16 NC others NO	CH16 and CH8 NC others NO
Group isolation	2 × 8 common	2 × 8 common	2 × 8 common
Connector type	Default: BLA Options: -	Default: BLA Options: -	Default: BLA Options: -

Module type	R4S+/01*	R4S+/16*	R1T+/0001***
Rated voltage	250 V AC/DC	250 V AC/DC	320 V AC/DC
Continuous carry	8 A 120 mA**	120 mA	32 A
Contact versions	4 CO (1 SSR, 3 normal)	4 CO (4 SSR)	1 NO
Group isolation	4 independent	4 independent	1 independent
Connector type	Default: BLA Options: -	Default: BLA Options: -	Default: BLA Options: -

*Modules with **solid-state relays (SSR)**
**If the signaling is performed via the solid-state relay the continuous carry value is 120 mA.
***Thyristor module.** Can be used only unipolarly. *For further information see our Product availability chapter.*

Main features (according to IEC 60255-1):

- Maximum switching voltage: 400 V AC
- Breaking capacity: (L/R=40 ms) at 220 V DC: 0.2 A, at 110 V DC: 0.3 A
- Breaking capacity max.: 2000 VA
- Short time carrying capacity: 1 s, 35 A
- Limiting making current, max. 4 s: 15 A (df = 10 %)
- Dielectric strength between open contacts, 1 min: 1000 V_{RMS}
- Mechanical endurance: 10 × 10^6 cycles
- Circuit closing capability: typically 10 ms, maximally 22 ms, with SSR 0.5 ms.
- Bounce time: typically 6,5 ms, maximally 10 ms, with SSR 0.5 ms.
- Minimal switching requirement: 5 V
- *The signaling is also performed via a solid-state relay (SSR) channel on R4S+01 and R4S+16 module*

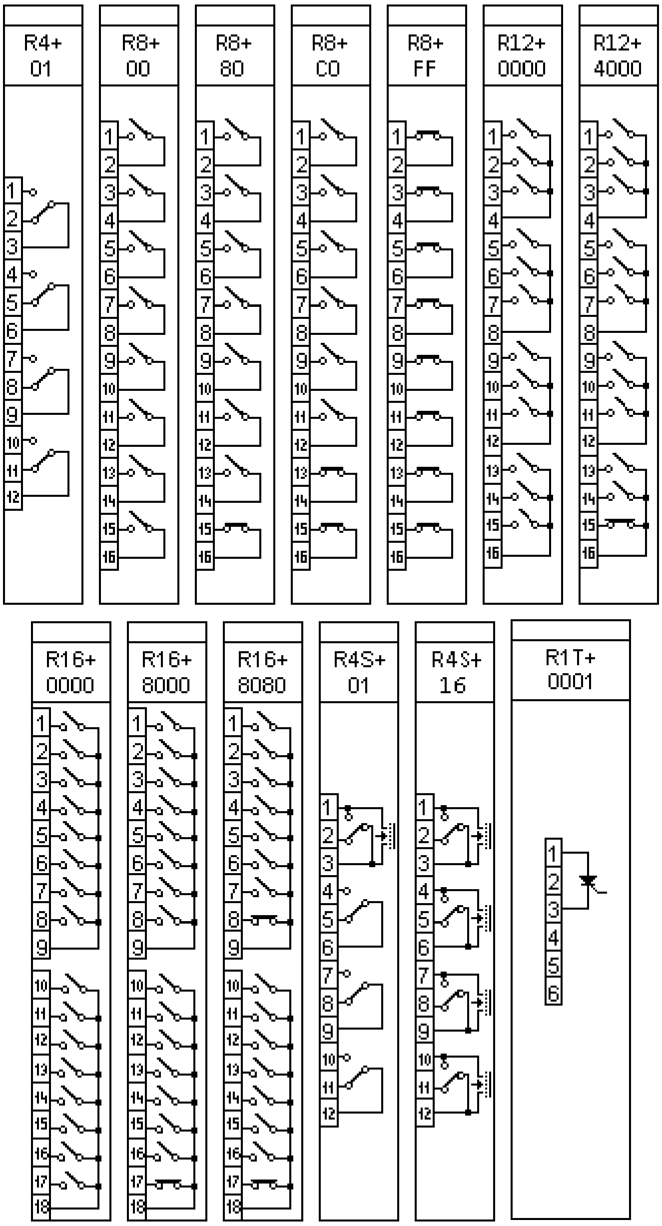


Figure 8-1 Signaling modules

1.3.11. Tripping module

The tripping module is a proprietary and patented solution that facilitates direct control of a circuit breaker.

<u>Connector types:</u>

- *The default and optionally available connector types are indicated for each module in the table below. See Chapter <u>20.2</u> for details about each type.*

MODULE TYPE	TRIP+/4201	TRIP+1101*	TRIP+/2101	TRIP+/21F1**	TRIP+/2201
CHANNEL NUMBER	4	4	4	4	4
RATED VOLTAGE	24 V DC and 48 V DC	110 V DC	110 V DC	110 V DC	220 V DC
THERMAL WITHSTAND VOLTAGE	72 V DC	242 V DC	150 V DC	150 V DC	242 V DC
CONTINUOUS CARRY	8 A	8 A	8 A	8 A	8 A
MAKING CAPACITY	0.5 s, 30 A	0.5 s, 30 A	0.5 s, 30 A	0.5 s, 30 A	0.5 s, 30 A
BREAKING CAPACITY	L/R = 40 ms: 4 A DC	L/R = 40 ms: 4 A DC	L/R = 40 ms: 4 A DC	L/R = 40 ms: 4 A DC	L/R = 40 ms: 4 A DC
CONNECTOR TYPE	<u>Default:</u> BLA <u>Options:</u> F, T	<u>Default:</u> BLA <u>Options:</u> -	<u>Default:</u> BLA <u>Options:</u> F, T	<u>Default:</u> BLA <u>Options:</u> T	<u>Default:</u> BLA <u>Options:</u> T

***Obsolete module. These modules are not recommended for new designs!**
***Without trip circuit supervision.*

Main features:

- High-speed operation: with pre-trip 0.5 ms, without pre-trip typically 10 ms, maximally 22 ms.
- Trip circuit supervision for each trip contact, except TRIP+21F1
- With 2-wire wiring, the tripping output can be *dry* contact type, too

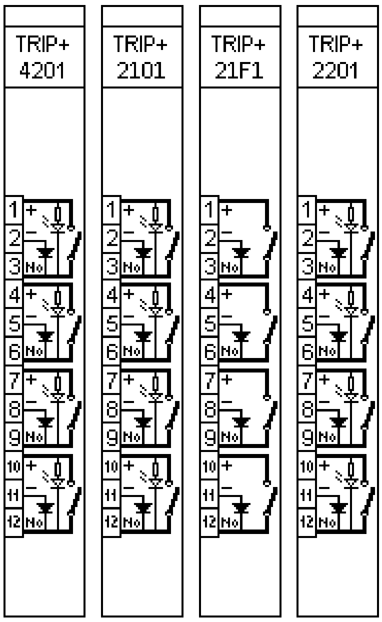


Figure 9-1 Tripping modules

1.3.11.1. TRIP+ module wiring

The tripping module provides tripping circuit supervision function (TCS). The wiring of these modules can be 2-wire or 3-wire. (TCS function is active for all wiring methods.)

The voltage of the "No" contact is maximized at 15 V by a Zener-diode. Make sure that the voltage caused by the resistance of the circuit breaker and the injected current from the TRIP+ module does not reach 10 V.

Our TRIP+ modules are improved to switch DC circuits. **Using reversed polarity or AC voltage can cause the damage of the internal circuits. Improper wiring might cause improper operation!**

1.3.11.1.1. 3-wire TRIP+ wiring methods

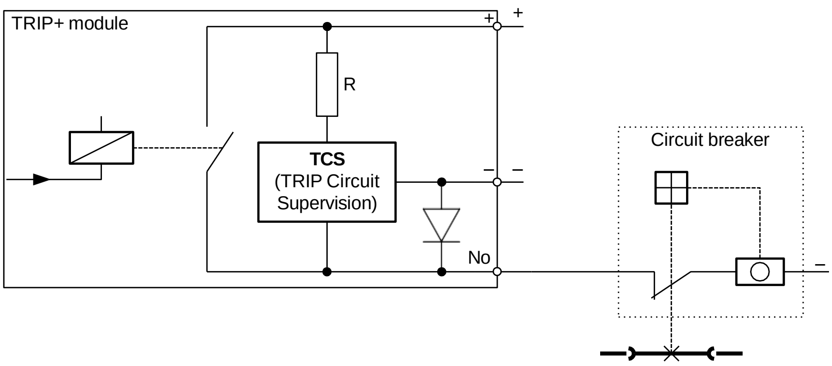


Figure 9-2 3-wire TRIP+ wiring

It is possible to use parallel connected TRIP+ modules. In this case the negative terminals must be common.

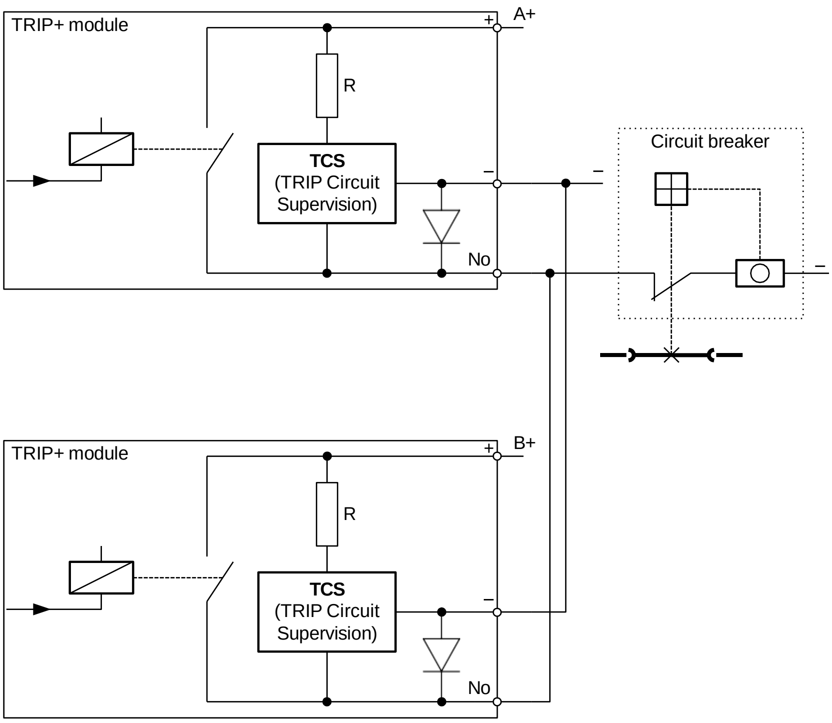


Figure 9-3 3-wire TRIP+ wiring using parallel connected TRIP+ modules

1.3.11.1.2. 2-wire TRIP+ wiring methods

If necessary, the TRIP+ modules can be wired using only the "+" and the "No" contacts.

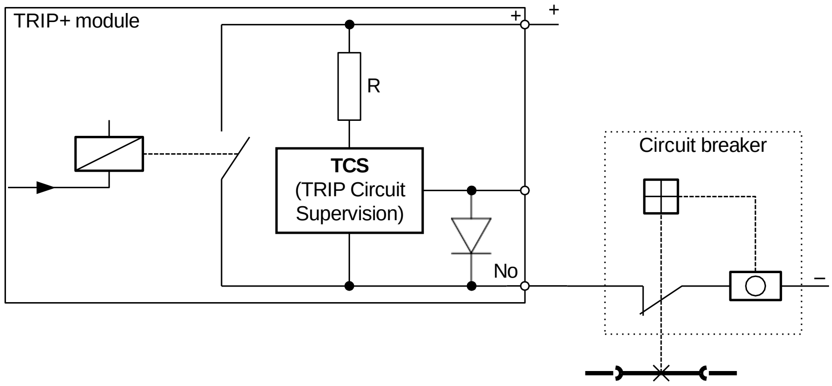


Figure 9-4 2-wire TRIP+ wiring

It is possible to use parallel connected TRIP+ modules.

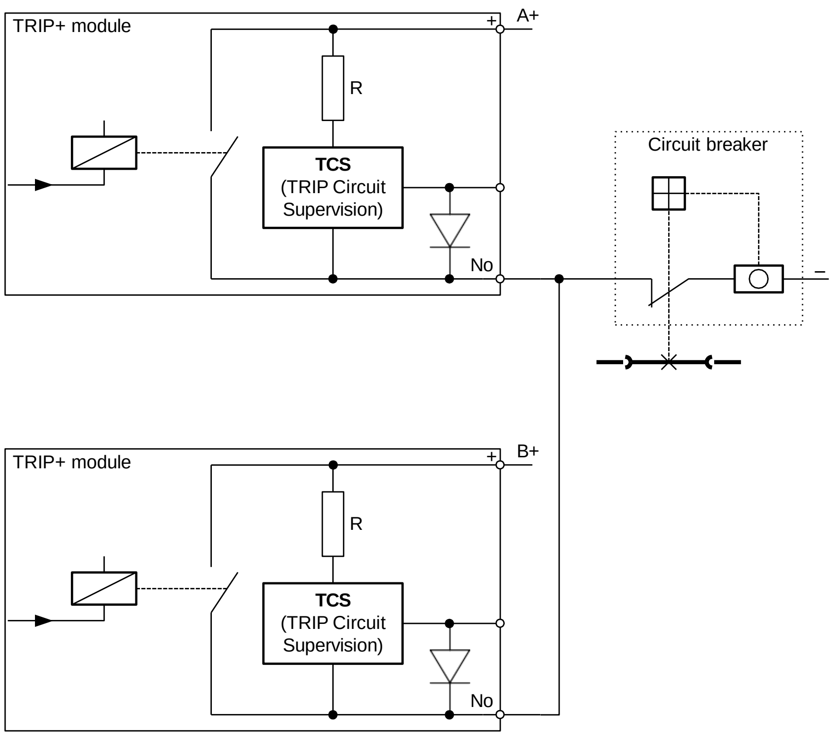


Figure 9-5 2-wire TRIP+ wiring using parallel connected TRIP+ modules

If the circuit breaker needs two-pole switching TRIP+ modules can be connected series as you can see in Figure 9–6.

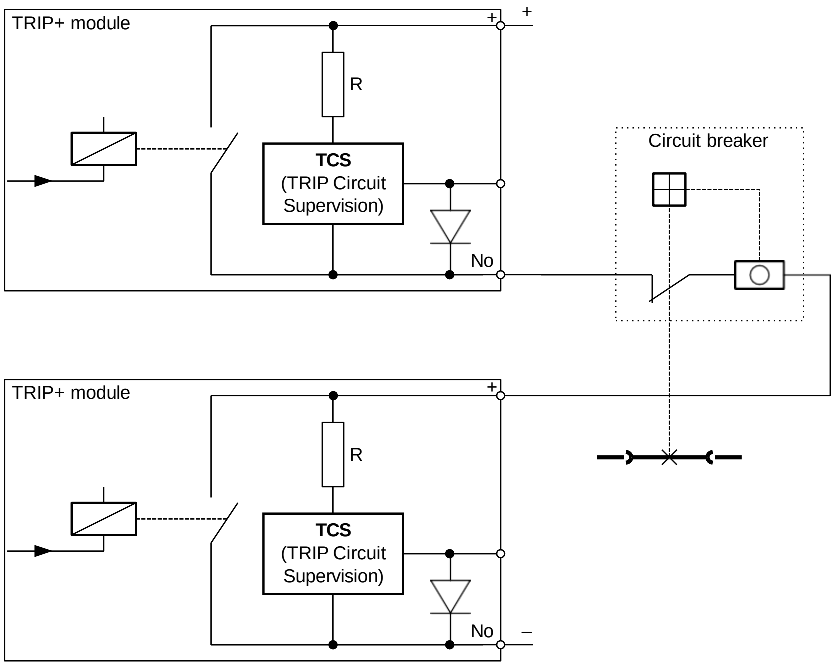


Figure 9-6 2-wire TRIP+ wiring using series connected TRIP+ modules

1.3.11.2. Trip Circuit Supervision (TCS)

Apart from the TRIP+/21F1, all TRIP modules have TCS. The feature is described in detail (tech. data, instructions, etc.) in a separate document:
https://www.protecta.hu/downloads/tcs_en

The technical data of the TCS is shown here as well:

	Module type	TRIP+/4201	TRIP+/2101	TRIP+/2201
	Value of R resistor (± 10 %)	10 kΩ	73 kΩ	130 kΩ
	Injected current at "NO" contact	2.4 mA @ 24 V DC 4.8 mA @ 48 V DC	1.5 mA @ 110 V DC	1.7 mA @ 220 V DC
Maximum resistance of the trip coil	**3-wire wiring (max. 10 V)**	**11.8 kΩ** @ 24 V DC **3.7 kΩ** @ 48 V DC	**9.7 kΩ** @ 110 V DC **8.4 kΩ** @ 125 V DC	**8.1 kΩ** @ 220 V DC
	3-wire wiring with in parallel (max. 10 V)	**5.9 kΩ** @ 24 V DC **1.8 kΩ** @ 48 V DC	**4.8 kΩ** @ 110 V DC **4.2 kΩ** @ 125 V DC	**4 kΩ** @ 220 V DC
	2-wire method (1 mA min. current)	**14 kΩ** @ 24 V DC **38 kΩ** @ 48 V DC	**37 kΩ** @ 110 V DC **52 kΩ** @ 125 V DC	**90 kΩ** @ 220 V DC

1.3.11.3. Relay output modules of the EuroProt+ system

1.3.11.3.1. Types of the relay output modules of the EuroProt+ system

Basically there are two different types of relay output modules in the EuroProt+ devices: TRIP relay output module for high-speed operation of the circuit breakers Signal relay output module

1.3.11.3.2. Operating modes of the relay contacts

For operation of the relay output modules there are four different modes:
Application of TRIP relays for commands of fast protection functions
User application of the TRIP relays Fast operation of any relay contacts (TRIP relays or signal relays) Control of signal relay outputs.
The procedures of command processing are shown in. This document describes the details using the TRIP relay contacts as an example.
The left side of the Figure shows the available sources of the trip commands:
The functionblocks, configured in the device,
The communication channels to the SCADA system,
Commands generated using the front panel LCD of the device,
Any other binary signals, e.g. signals from the binary inputs of the device.

The right side of the Figure shows one of the TRIP relays symbolically.
The Figure provides a survey of the configured trip command processing methods. In the middle of the Figure, the locations indicated by “User” shows the possibilities for the user to modify the procedures. All other parts are factory programmed.

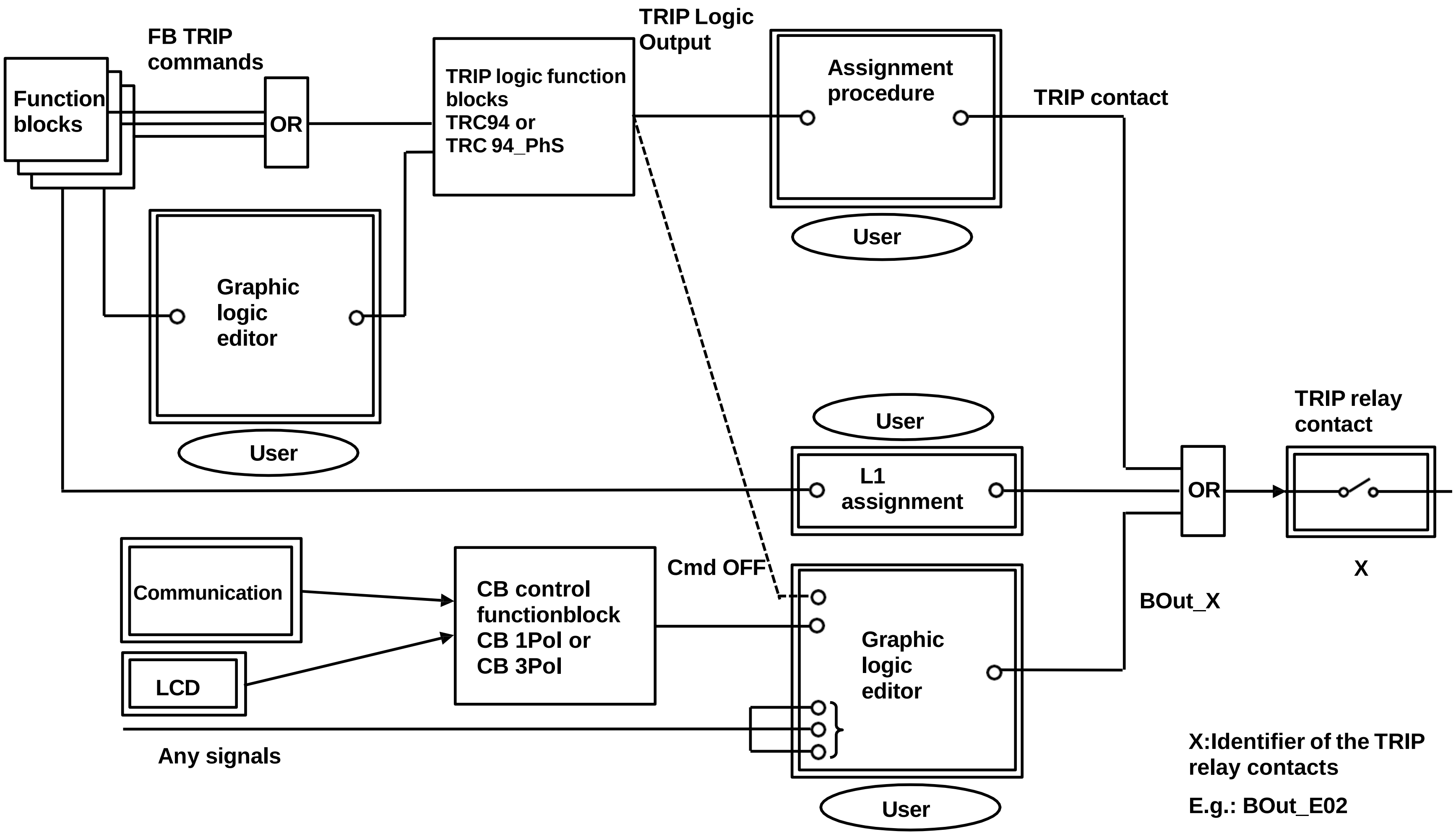


Figure 1-1 Principle of TRIP command processing

1.3.11.3.3. Application of TRIP relays for commands of fast protection functions

1.3.11.3.3.1. Aim of application of TRIP relays

The main aim of application of TRIP relays is to bypass the time delay of the mechanical contacts. For this aim there is a „slow" mechanical contact and a „fast" electronic switch in serial connection.

1.3.11.3.3.2. Control of the TRIP relays

The operation of the TRIP relays is performed in two steps:
Preparation of the circuit for the trip command Trip command generation

1.3.11.3.3.2.1. Preparation of the circuit for the trip command

At the time when a protection function detects violation of the setting value of the characteristic quantity, the preparation process closes the „slow" mechanical contact, preparing the circuit for command generation.

1.3.11.3.3.2.2. The trip command generation

At the moment when the fast protection function – after some repeated checks, i.e. the timeout of the internal time counter – decides to generate the trip command then the „fast" electronic switch performs the operation, generating the trip command to the circuit breaker. This command is generated via the „TRC94_ PhS" or via the simplified „TRC94" trip logic functionblocks.

NOTE: If the TRIP command is not received within the expected time delay, then the command preparation resets after 50 ms. When the device is tested in the laboratory
e.g. for measuring the limits of the distance protection characteristic, this can result a cyclic closing and opening of the mechanical contact and rattling can be heard. This does not mean faulty operation of the device!

1.3.11.3.3.3. The factory programming for relay control

For the trip command of protection functions, where the requirement is the fast operation (distance protection first zone, line differential protection, transformer differential protection, fast overcurrent stage, synchronous switching, etc.) the process of preparation and command generation is programmed in the form of „Fast logic".

The alignment of the TRIP command is the task of the "TRIP logic functionblock". All devices operating with TRIP binary output module, has a configured TRC 94 simplified, or a TRC 94_PhS TRIP logic functionblock. This converts e.g. the trip command due to phase-to-phase fault to a three-phase trip command, or extends the duration of the command according to the parameter setting. All these are described in the dedicated document.

The fast TRIP commands are assigned to the TRIP relay output contacts according to the factory configuration, but the user has a possibility to modify or extend this assignment using the EuroCAP configuration software. The factory assignment is described in the user manual of the given device configuration.

To ensure fast operation, this „Fast logic" is performed in each sampling cycle (1ms).

1.3.11.3.3.4. Changing the TRIP command assignment

The user has a possibility to modify or extend the TRIP command assignment using the EuroCAP configuration software. The menu item to be started is shown in *Figure 2-1.*

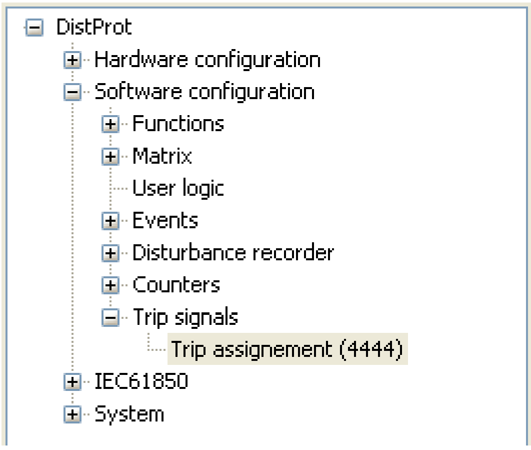


Figure 2-1 Menu item for TRIP command assignment

As *Figure 2-2* shows, the signal of type „TripLogic Output" (this is the command generated by the „TRIP logic functionblock") can be assigned to a „Trip Contact" type relay output. The dialog window of the EuroCAP software selects these types of signals only; the available signals however can be assigned freely.

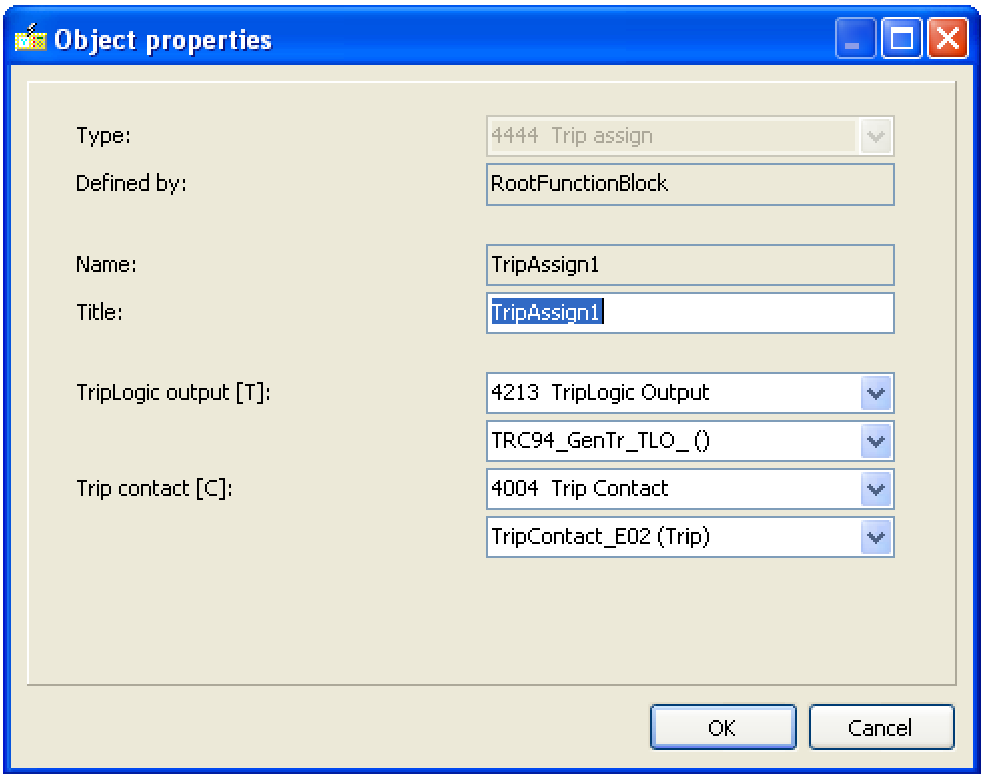


Figure 2-2 Changing the TRIP command assignment

The assigned signal is the input of an OR gate. As it is described below, several other signals can be directed to this OR gate. Using this method, also other TRIP modules extended by the user can be applied to operate the TRIP coil of the circuit breaker.

1.3.11.3.3.5. Fast operation of the relays

If the aim is to operate the contacts by a signal in each sampling cycle (1 ms), then the “Fast L1 contact option is to be applied. This option is provided by the EuroCAP configuration software in the menu „Hardware configuration/ IO signals/ Binary outputs/ Relay contacts/ Fast_L1 contacts”.

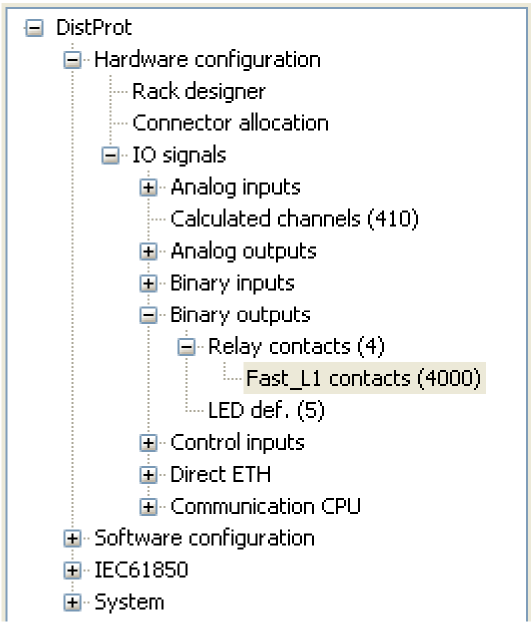


Figure 2-3 Configuring Fast L1 contacts

This menu offers the assignment of the appropriate binary signals to the relay contacts. As *Figure 2-4* shows, the signal can be of several types.

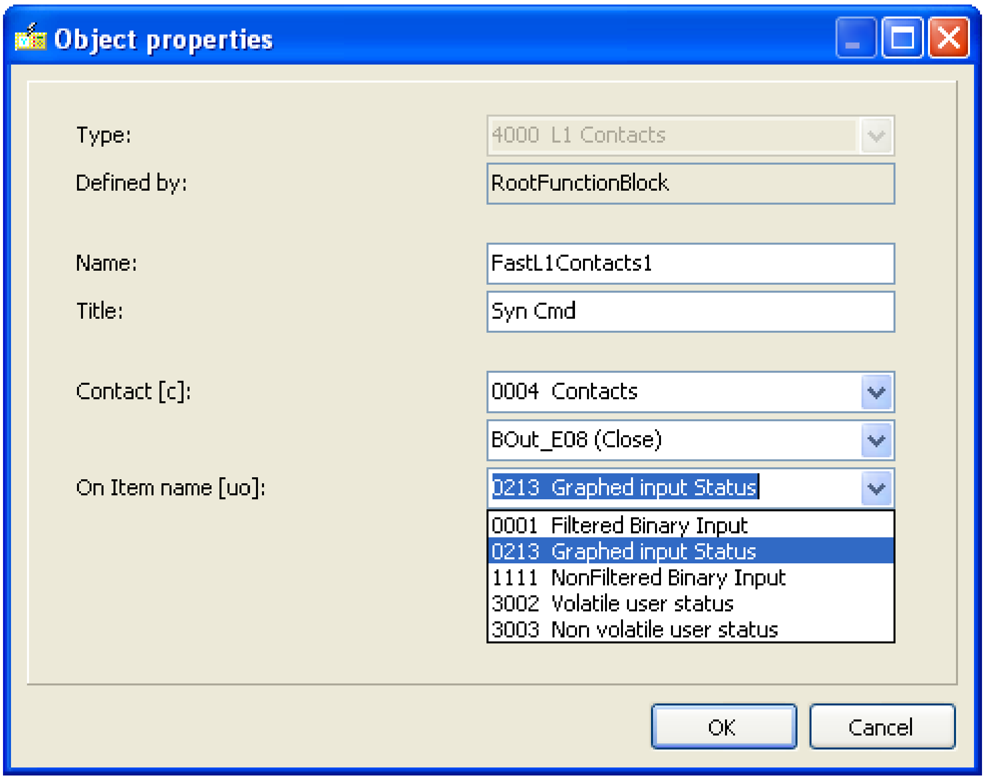


Figure 2-4 Fast L1 contact assignment

The processing of these fast signals is performed in a single step, the possibility for command preparation in the first step and additionally the TRIP command generation in the second step is not offered for the user. To perform this assignment, the application of the EuroCap configuration program in “Master” level is needed.

The selected signal is the input of an OR gate. To this gate additional other signals are connected, as it is described in the previous chapter, or in the description below.

IMPORTANT NOTE: The contacts of a TRIP hardware module are configured in the factory as “Fast L1 contacts”, the user does not need to define them additionally!

1.3.11.3.4. User application of the TRIP relays

The contacts controlling the circuit breaker operation can be programmed also by the user. Additionally to the command of the factory configured protection functions the user can assign signals to the channels of the TRIP hardware module. The two steps for the command generation however, as it is described in the paragraph above, cannot be applied by the user.

In this case, the source of the signals can be:

- Pre-configured TRIP commands
  - Received from the SCADA system via communication channels,
  - Generated by the user, applying the front panel LCD of the device,
- Any additional binary signals, e.g. an external command received by the binary input module of the device.

The pre-configured TRIP commands are aligned by the “CB control functionblock”, the output of which is the “CmdOff” TRIP command. This one and several other signals can be programmed by the user to the output TRIP contact of the device, using the graphic logic editor of the EuroCAP configuration software.

Additionally the output signals of the „TRC94_ PhS” trip logic or those of the „TRC94” simplified trip logic block can be programmed here. (These function-blocks are described in separate documents.) The output signal of the graphic logic editor is the
„BOut_X” logic variable, where X is the identifier of the relay module and the contact,
e.g. BOut_E02.

1.3.11.3.4.1. Graphic editor for the signal logic

For the protection functions, the operation of which are not required being extreme fast (in the range of one network period), the trip command must be assigned to the trip contacts usually by the user. These logic assignments can be programmed also in the factory, but the user can modify or extend them according to the requirements. To do this, the graphic editor of the EuroCap configuration tool must be applied with
„Master” access rights.

1.3.11.3.4.2. The process of command generation

If a “simple” protection function generates a trip command then this logic signal is present on the dedicated output of the functionblock (see the description of the functionblocks).

The operation of the logic connections edited in the graphic editor is performed outside the sampling cycle, consequently, depending on the actual load of the processor a random time delay of additional 2-4 ms can be measured.

The contacts of the TRIP hardware modules are operated by several sources parallel:

The high-speed factory configured fast protection functions,
The defined Fast L1 signals,
The graphically edited logic connections (programmed in the factory and editable also by the user).

1.3.11.3.5. Control of signal relay outputs

If there is no special requirement to generate the signal with high speed, i.e. a time delay of 2-4 ms can be tolerated between the intent to generate the signal and the closing of the output contact then it is sufficient to apply normal signal relay contacts. To perform this programming the graphic editor of the EuroCap configuration tool is to be applied. To perform the programming the „Master” access level is needed.

1.3.11.4. Examples

1.3.11.4.1. Application of the TRIP logic

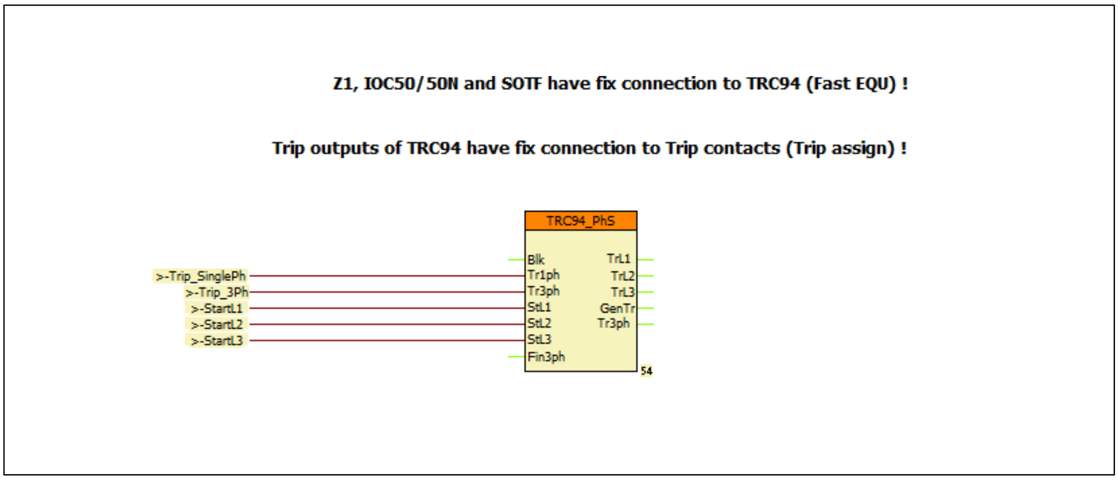


Figure 5-1 Example: A simple configuration to trip the circuit breaker

Figure 5-1 shows a simple configuration to trip the circuit breaker. In this Figure it is supposed that the fast protection functions operate according to the factory configuration and they control the TRIP contacts applying two steps of the preparation and command generation phases. This part of the program is not visible. (The description of the fast operating protection functions are listed in the configuration description of the devices.)

The outputs of the TRC94_PhS trip logic block are assigned to the channels of the TRIP hardware module. This assignment, which can be modified also by the user, is made not here but in the “TRIP assignment” menu of the EuroCAP configuration software. Consequently the Figure is complete; related to the outputs, the user needs additional graphic programming only if e.g. the operation is to be visualized also by signal relays.

If the configuration includes protection functions blocks the trip command of which does not need fast contact operation then these commands must be additionally directed to the TRIP relay outputs. To do this, the user collects these commands (with OR connection) and connects them to the dedicated inputs of the TRC94_PhS functionblock.

This Figure shows the collected signals (E.g. “Trip_SinglePh”, “Trip_3Ph”, etc.) only. As an example the „Trip_3Ph” signal collects the commands of all (not fast operating) protection functions which can generate three-phase trip command. The detailed description of the inputs and operation of the “TRC94_PhS” trip logic functionblock can be found in another document.

1.3.11.4.2. Application of circuit breaker control block

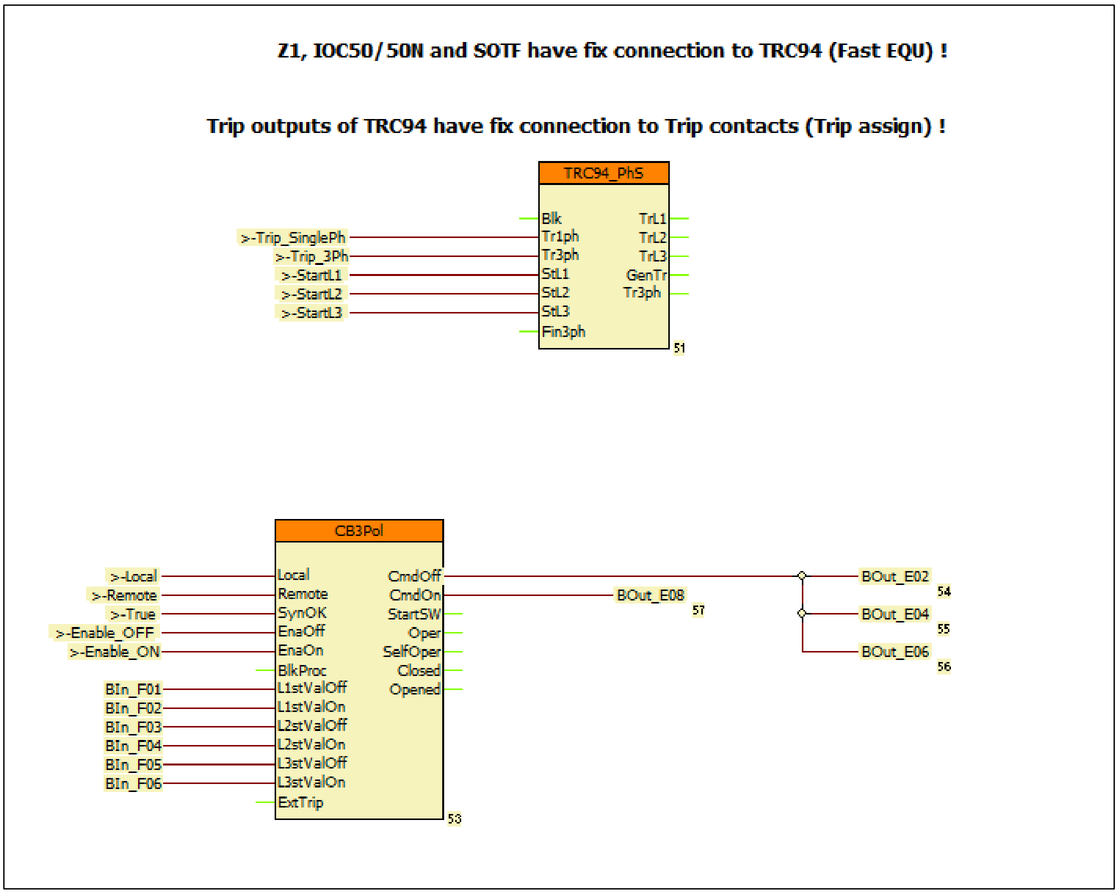


Figure 5-2 Example: Application of circuit breaker control block

Figure 5-2 shows an example for the application of the circuit breaker control block “CB3Pol”. In this Figure it is supposed that the fast protection functions operate according to the factory configuration and they control the TRIP contacts applying two steps of the preparation and command generation phases. This part of the program is not visible. (The description of the fast operating protection functions are listed in the configuration description of the devices.)

The outputs of the TRC94_PhS trip logic block are assigned to the channels of the TRIP hardware module. This assignment, which can be modified also by the user, is made not here but in the “TRIP assignment” menu of the EuroCAP configuration software. Consequently the Figure is complete; related to the outputs, the user needs additional graphic programming only if e.g. the operation is to be visualized also by signal relays.

If the configuration includes protection functions blocks the trip command of which does not need fast contact operation then these commands must be additionally connected to the TRIP relay outputs. To do this, the user collects these commands (with OR connection) and assigns them to the dedicated inputs of the TRC94_PhS functionblock.

This Figure shows the collected signals (E.g. “Trip_SinglePh”, “Trip_3Ph”, etc.) only. As an example the „Trip_3ph” signal collects the commands of all (not fast operating) protection functions which can generate three-phase trip command. The detailed description of the inputs and operation of the “TRC94_PhS” trip logic functionblock can be found in another document.

An extension to the example in *Figure 5-2* is that in this configuration also the „CB3pol" (circuit breaker control block) is applied. This block is needed if e.g. the front panel LCD of the device can display an active control scheme. For this purpose the signals „BIn_F…" in the Figure are the status signals of the circuit breaker poles, connected to the dedicated binary inputs of the device. The signals „Local"/"Remote" enable the local or remote control of the primary equipment. In the standard factory configurations these signals are programmed in the factory, but they can be modified also by the user.

If there is no synchro-check function activated in the device, connect the input „SynOK" of the "CB3Pol" to logic TRUE state. *Figure 5-2,* the local command issued via LCD of the device or the remote command received from the remote SCADA system is processed by the „CB3pol" functionblock (Output „CmdOff"). This control is programmed in the factory to "BOut_xx" variables. The user can perform any modification in the graphic programming.

The close command is connected directly to a dedicated "BOut_xx" variable. (This directs usually the fourth contact of the TRIP hardware module.)

The programming of the interlocking function must be performed by the user.

1.3.11.4.3. Automatic reclosing and circuit breaker control

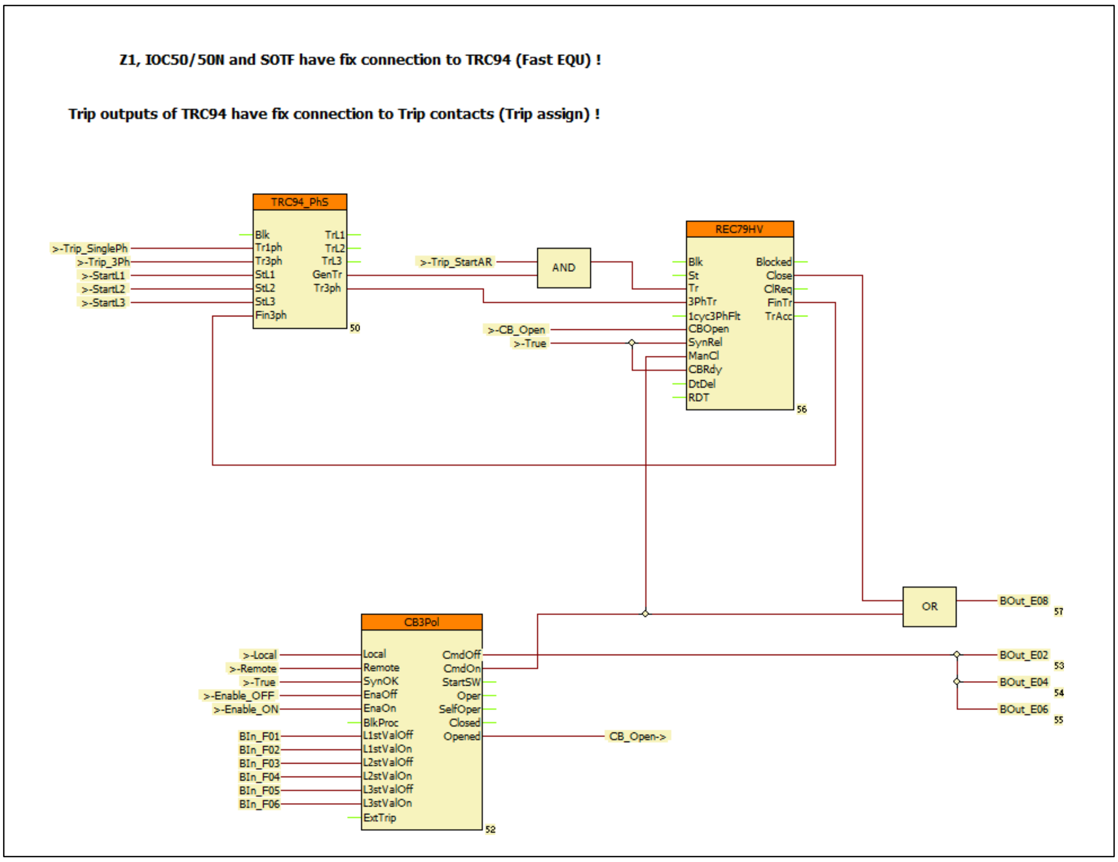


Figure 5-3 Example: Automatic reclosing and circuit breaker control

Figure 5-3 shows an example for the application of the automatic reclosing control block. In this Figure it is supposed that the fast protection functions operate according to the factory configuration and they control the TRIP contacts applying two steps of the preparation and command generation phases. This part of the program is not visible in “Master” level. (The description of the fast operating protection functions are listed in the configuration description of the devices.)

The outputs of the TRC94_PhS trip logic block are assigned to the output channels of the TRIP hardware module. This assignment, which can be modified also by the user, is made not here but in the “TRIP assignment” menu of the EuroCAP configuration software. Consequently the Figure is complete; related to the outputs, the user needs additional graphic programming only if e.g. the operation is to be visualized also by signal relays.

If the configuration includes protection functions blocks the trip command of which does not need fast contact operation then these commands must be additionally assigned to the TRIP relay outputs. To do this, the user collects these commands (with OR connection) and assigns them to the dedicated inputs of the TRC94_PhS functionblock.

This Figure shows the collected signals (E.g. “Trip_SinglePh”, “Trip_3Ph”, etc.) only. As an example the „Trip_3ph” signal collects the commands of all (not fast operating) protection functions which can generate three-phase trip command. The detailed description of the inputs and operation of the “TRC94_PhS” trip logic functionblock can be found in another document.

In this configuration also the „CB3pol" (circuit breaker control block) is applied. This block is needed if e.g. the front panel LCD of the device can display an active control scheme. For this purpose the signals „BIn_F…" in the Figure are the status signals of the circuit breaker poles, connected to the dedicated binary inputs of the device. The signals „Local"/"Remote" enable the local or remote control of the primary equipment. In the standard factory configurations these signals are programmed in the factory, but they can be modified also by the user.

If there is no synchro-check function activated in the device, connects the input „SynOK" of the "CB3Pol" to logic TRUE state.

According to *Figure 5-3*, the local command issued via LCD of the device or the remote command received from the remote SCADA system is processed by the „CB3pol" functionblock (Output „CmdOff"). This control is programmed in the factory to "BOut_xx" variables. The user can perform any modification in the graphic programming.

The close command is connected directly to a dedicated "BOut_xx" variable. (This directs usually the fourth contact of the TRIP hardware module.)

In *Figure 5-3* the close command is connected directly to a dedicated output. (This is usually the fourth contact of the TRIP hardware module.)

The programming of the interlocking function must be performed by the user.

An extension to the example in *Figure 5-2* is the application of the „REC79_HV" automatic reclosing function. The start signal „Trip_StartAR" can be programmed by the user. The automatic reclosing function is started only if the preceding trip command was performed by the circuit breaker, i.e. for example that the function is not disabled. The AND gate on this Figure performs this checking.

The „REC79_HV" automatic reclosing function needs the status signal indicating three-phase open state of the circuit breaker, connected to the „3PhTr" input of the „REC79_HV" functionblock. This signal is generated by the „TRC94_PhS" functionblock on the output „Tr3Ph".

If the automatic reclosing is to be disabled after a fault caused by a manual close command, then the „CmdOn" output of the „CB3Pol" module must be connected to the „ManCl" input of the „REC79_HV" automatic reclosing function.

If there is no synchro-check function configured in the device, connect the „SynRel" input of the „REC79_HV" automatic reclosing function to logic TRUE state.

The evaluation of the status signals indicating the open state of the circuit breker poles in OR gate is needed for the operation of the automatic reclosing function. According to the scheme of *Figure 5-3* the open state is indicated by at least one pole open state of the circuit breaker. (For simplicity, this Figure shows a realization without checking the FALSE signal of the closed states.)

Figure 5-3 supposes that the CB ready signal is not connected to the device; accordingly the steady TRUE state signal is connected to the „CBRdy" input of the „REC79_HV" automatic reclosing function. If the real signal is available, the signal must be connected similarly.

The close command of the „REC79_HV" automatic reclosing function is connected via OR gate to the dedicated close contact.

1.3.11.4.4. Closing the circuit breaker with synchro-check

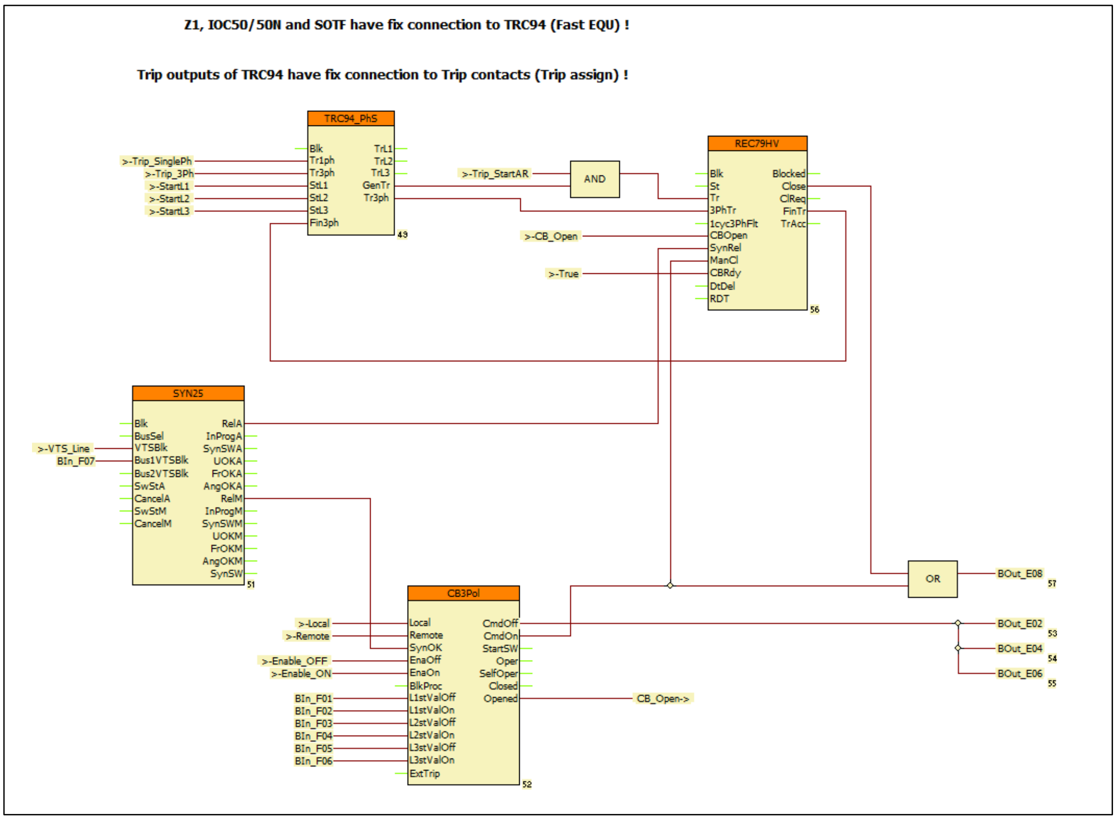


Figure 5-4 Example: closing the circuit breaker with synchro-check

Figure 5-4 shows an example for the application of “SYN25” cynchro-check functionblock. In this Figure it is supposed that the fast protection functions operate according to the factory configuration and they control the TRIP contacts applying two steps of the preparation and command generation phases. This part of the program is not visible in “Master” level. (The description of the fast operating protection functions are listed in the configuration description of the devices.)

The outputs of the TRC94_PhS trip logic block are assigned to the output channels of the TRIP hardware module. This assignment, which can be modified also by the user, is made not here but in the “TRIP assignment” menu of the EuroCAP configuration software. Consequently the Figure is complete; related to the outputs, the user needs additional graphic programming only if e.g. the operation is to be visualized also by signal relays.

If the configuration includes protection functions blocks the trip command of which does not need fast contact operation then these commands must be additionally assigned to the TRIP relay outputs. To do this, the user collects these commands (with OR connection) and assigns them to the dedicated inputs of the TRC94_PhS functionblock.

This Figure shows the collected signals (E.g. “Trip_SinglePh”, “Trip_3Ph”, etc.) only. As an example the „Trip_3ph” signal collects the commands of all (not fast operating) protection functions which can generate three-phase trip command. The detailed description of the inputs and operation of the “TRC94_PhS” trip logic functionblock can be found in another document.

In this configuration also the „CB3pol” (circuit breaker control block) is applied. This block is needed if e.g. the front panel LCD of the device can display an active control scheme. For this purpose the signals „BIn_F…” in the Figure are the status signals of the circuit breaker poles, connected to the dedicated binary inputs of the device. The signals „Local”/”Remote” enable the local or remote control of the primary equipment. In the standard factory configurations these signals are programmed in the factory, but they can be modified also by the user.

According to *Figure 5-4*, the local command issued via LCD of the device or the remote command received from the remote SCADA system is processed by the „CB3pol” functionblock (Output „CmdOff”). This control is programmed in the factory to “BOut_xx” variables. The user can perform any modification in the graphic programming.

The close command is connected directly to a dedicated “BOut_xx” variable. (This directs usually the fourth contact of the TRIP hardware module.)

In *Figure 5-4* the close command is connected directly to a dedicated output. (This is usually the fourth contact of the TRIP hardware module.)

The programming of the interlocking function must be performed by the user.

Figure 5-4 includes the application of the „REC79_HV” automatic reclosing function. The start signal „Trip_StartAR” can be programmed by the user. The automatic reclosing function is started only if the preceding trip command was performed by the circuit breaker, i.e. for example that the function is not disabled. The AND gate on this Figure performs this checking.

The „REC79_HV” automatic reclosing function needs the status signal indicating three-phase open state of the circuit breaker, connected to the „3PhTr” input of the „REC79_HV” functionblock. This signal is generated by the „TRC94_PhS” functionblock on the output „Tr3Ph”.

If the automatic reclosing is to be disabled after a fault caused by a manual close command, then the „CmdOn” output of the „CB3Pol” module must be connected to the „ManCl” input of the „REC79_HV” automatic reclosing function.

The evaluation of the status signals indicating the open state of the circuit breaker poles in OR gate is needed for the operation of the automatic reclosing function. According to the scheme of *Figure 5-4* the open state is indicated by at least one pole open state of the circuit breaker. (For simplicity, this Figure shows a realization without checking the FALSE signal of the closed states.)

Figure 5-4 supposes that the CB ready signal is not connected to the device; accordingly the steady TRUE state signal is connected to the „CBRdy” input of the „REC79_HV” automatic reclosing function. If the real signal is available, the signal must be connected similarly.

The close command of the „REC79_HV” automatic reclosing function is connected via OR gate to the dedicated close contact.

An extension to the example in *Figure 5-3* is the close command to the circuit breaker is generated by synchro-check. The enabling signal for the close command is generated by the „SYN25” software module. This module is described in details in a separate document. The needed input signals indicating the state of the voltage transformers („VTSBlk” and „Bus1VTSBlk”), must be programmed graphically.

The output signal „RelA” of the „SYN25” software module enables the closing operation of the „REC79_HV” automatic reclosing function via its „SynRel” input.

For manual close commands the output signal „RelM” of the „SYN25” software module enables the closing operation of the „CB3pol” via its „SynOK” input.

1.3.11.4.5. Closing the circuit breaker with synchro-check and synchro-switch

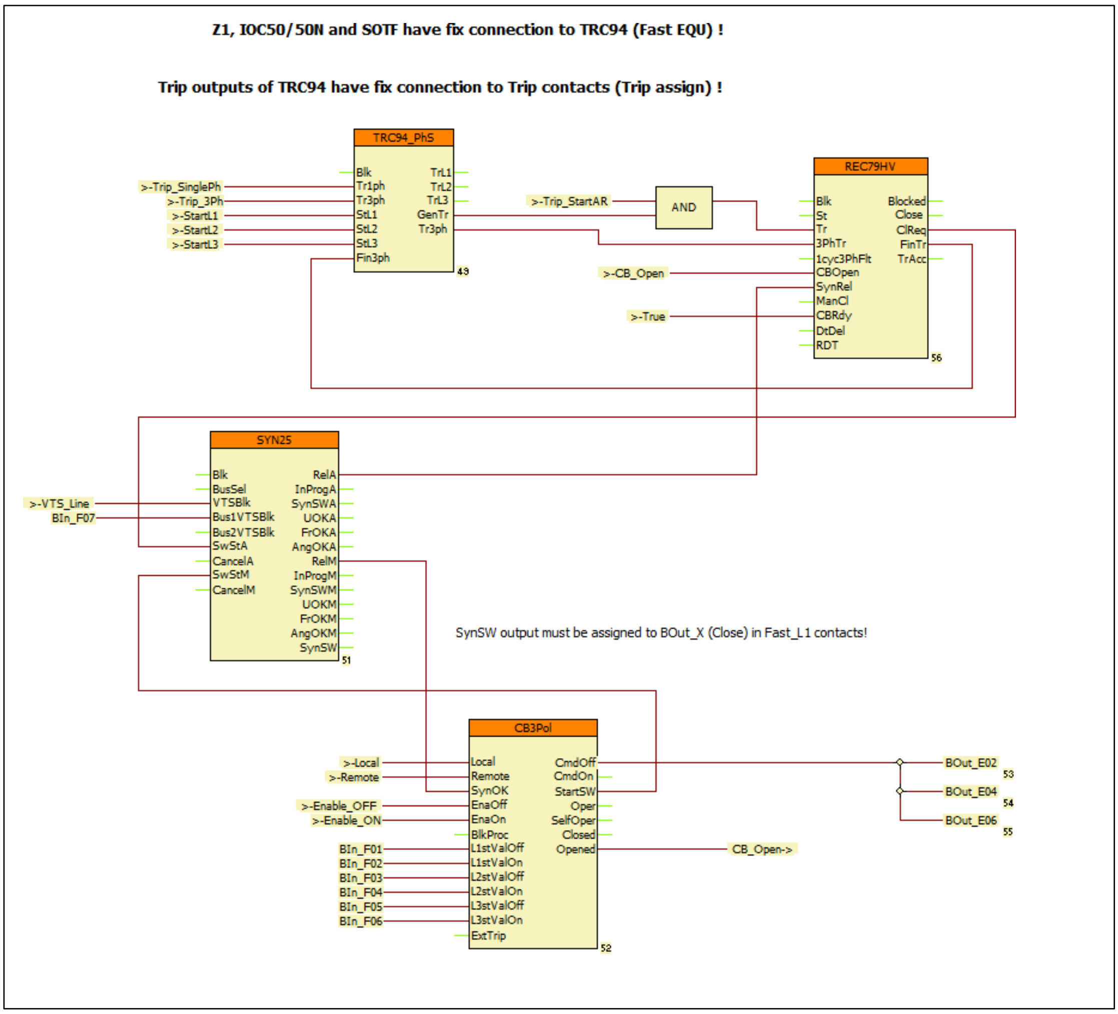


Figure 5-5 Example: closing the circuit breaker with synchro-check and synchro- switch

Figure 5-5 shows an example for the application of “SYN25” cynchro-check functionblock with synchro switch extension. In this Figure it is supposed that the fast protection functions operate according to the factory configuration and they control the TRIP contacts applying two steps of the preparation and command generation phases. This part of the program is not visible in “Master” level. (The description of the fast operating protection functions are listed in the configuration description of the devices.)

The outputs of the TRC94_PhS trip logic block are assigned to the output channels of the TRIP hardware module. This assignment, which can be modified also by the user, is made not here but in the “TRIP assignment” menu of the EuroCAP configuration software. Consequently the Figure is complete; related to the outputs, the user needs additional graphic programming only if e.g. the operation is to be visualized also by signal relays.

If the configuration includes protection functions blocks the trip command of which does not need fast contact operation then these commands must be additionally assigned to the TRIP relay outputs. To do this, the user collects these commands (with OR connection) and assigns them to the dedicated inputs of the TRC94_PhS functionblock.

This Figure shows the collected signals (E.g. “Trip_SinglePh”, “Trip_3Ph”, etc.) only. As an example the „Trip_3ph” signal collects the commands of all (not fast operating) protection functions which can generate three-phase trip command. The detailed description of the inputs and operation of the “TRC94_PhS” trip logic functionblock can be found in another document.

In this configuration also the „CB3pol” (circuit breaker control block) is applied. This block is needed if e.g. the front panel LCD of the device can display an active control scheme. For this purpose the signals „BIn_F…” in the Figure are the status signals of the circuit breaker poles, connected to the dedicated binary inputs of the device. The signals „Local”/”Remote” enable the local or remote control of the primary equipment. In the standard factory configurations these signals are programmed in the factory, but they can be modified also by the user.

According to *Figure 5-5,* the local command issued via LCD of the device or the remote command received from the remote SCADA system is processed by the „CB3pol” functionblock (Output „CmdOff”). This control is programmed in the factory to “BOut_xx” variables. The user can perform any modification in the graphic programming.

The close command is connected directly to a dedicated “BOut_xx” variable. (This directs usually the fourth contact of the TRIP hardware module.)

In *Figure 5-5* the close command is connected directly to a dedicated output. (This is usually the fourth contact of the TRIP hardware module.)

The programming of the interlocking function must be performed by the user.

Figure 5-5 includes the application of the „REC79_HV” automatic reclosing function. The start signal „Trip_StartAR” can be programmed by the user. The automatic reclosing function is started only if the preceding trip command was performed by the circuit breaker, i.e. for example that the function is not disabled. The AND gate on this Figure performs this checking.

The „REC79_HV” automatic reclosing function needs the status signal indicating three-phase open state of the circuit breaker, connected to the „3PhTr” input of the „REC79_HV” functionblock. This signal is generated by the „TRC94_PhS” functionblock on the output „Tr3Ph”.

If the automatic reclosing is to be disabled after a fault caused by a manual close command, then the „CmdOn” output of the „CB3Pol” module must be connected to the „ManCl” input of the „REC79_HV” automatic reclosing function.

If there is no synchro-check function configured in the device, then connect the „SynRel” input of the „REC79_HV” automatic reclosing function to logic TRUE state.

The evaluation of the status signals indicating the open state of the circuit breaker poles in OR gate is needed for the operation of the automatic reclosing function. According to the scheme of *Figure 5-5* the open state is indicated by at least one pole open state of the circuit breaker. (For simplicity, this Figure shows a realization without checking the FALSE signal of the closed states.)

Figure 5-5 supposes that the CB ready signal is not connected to the device; accordingly the steady TRUE state signal is connected to the „CBRdy” input of the „REC79_HV” automatic reclosing function. If the real signal is available, the signal must be connected similarly.

The close command of the „REC79_HV” automatic reclosing function is connected via OR gate to the dedicated close contact.

In this application the close command to the circuit breaker is generated by synchro- check. The enabling signal for the close command is generated by the „SYN25” software module. This module is described in details in a separate document. The needed input signals indicating the state of the voltage transformers („VTSBlk” and „Bus1VTSBlk”), must be programmed graphically.

The output signal „RelA” of the „SYN25” software module enables the closing operation of the „REC79_HV” automatic reclosing function via its „SynRel” input.

For manual close commands the output signal „RelM” of the „SYN25” software module enables the closing operation of the „CB3pol” via its „SynOK” input.

An extension to the example in *Figure 5-4* is the following: If there is no continuous synchron state because the frequency at one side of the circuit breaker is different to that of the other side, then the voltage vector of one side rotates continuously as compared to the other one. In this case a synchronous switching is attempted to restore the normal operation of the network.

The manual synchron switching mode is started by the signal on the „StSwM” input of the SYN25 functionblock. To do this the the „StartSW” output of the „CB3Pol” functionblock must be connected here.

For automatic synchron switching mode the „ClReq” output of the „Rec79HV” module must be connected to the „SwStA” input of the „SYN25” software module.

IMPORTANT NOTE: the close command is generated for both manual and automatic

switching at the output „SynSW” of the „SYN25” software module. It is advised not to connect this output using the „slow” graphic programming, but the contact assigned to the close command („BOutClose”) must be handled as fast operating „L1 contact”. The „SynSW” signal must be programmed to this contact. This assignment is performed using the EuroCap configuration tool in the menu „Hardware configuration/Binary outputs/Relay contacts/Fast_L1 contacts”.

1.3.12. RTD input module

The RTD+1100 module is used to measure the temperature through the variation of resistance of temperature detectors. RTD+0200 and RTD+1200 are special modules for Petersen coil controllers (DRL) measuring the resistance of the potentiometer.

Connector types:

- *The default and optionally available connector types are indicated for each module in the table below. See Chapter 20.2 for details about each type.*

MODULE TYPE	**RTD+/0200***	**RTD+/1100**	**RTD+/1200***
CHANNEL NUMBER	1	4	1
MEASUREMENT METHOD	3 wire configuration	2, 3 or 4 wire configuration	3 wire configuration
ACCURACY	± 0.5 % ± 1 digit	± 0.5 % ± 1 digit	± 0.5 % ± 1 digit
SENSOR TYPE	Service-Ohm	Pt100/Ni100 Ni120/Ni120US Pt250/Ni250 Pt1000/Ni1000 Cu10 Service-Ohm (60 Ω … 1.6 kΩ)	Service-Ohm
MEASUREMENT RANGES	2 Ω … 200 Ω	- 50 °C – +150 °C	10 Ω … 1000 Ω
CONNECTOR TYPE	Default: BLA Options: -	Default: BLA Options: T	Default: BLA Options: -
RECOMMENDED APPLICATION	Arc suppression coil controller	General resistance-based temperature measurement	Arc suppression coil controller

**Special module*

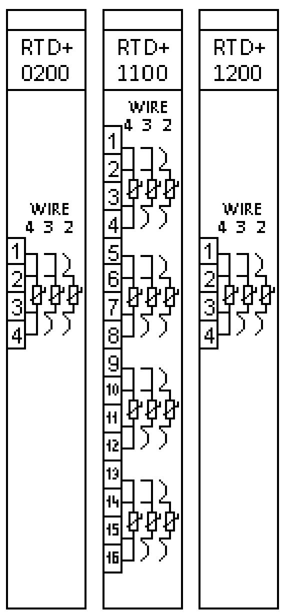


Figure 10-1 RTD input modules

1.3.12.1. RTD module wiring

If 2-wire wiring is used you have to make sure that the value of RA and RD resistors are set correctly in the “parameters” menu of the web server.

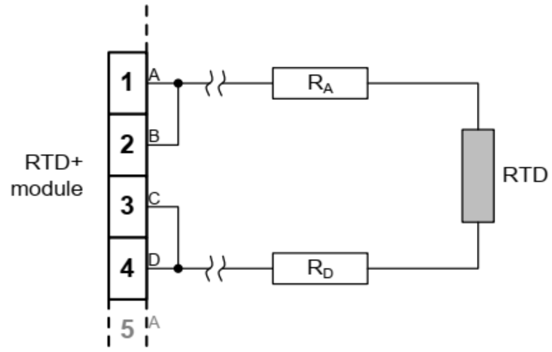


Figure 10-2 2-wire RTD wiring

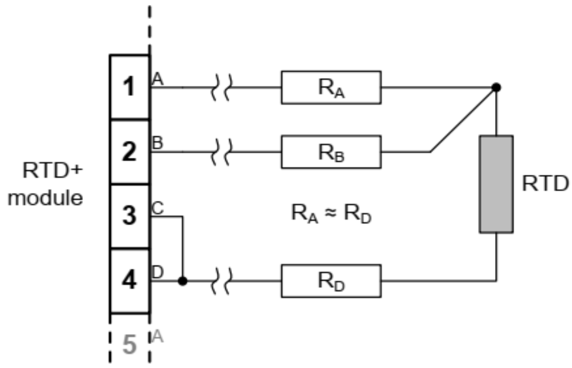


Figure 10-3 3-wire RTD wiring

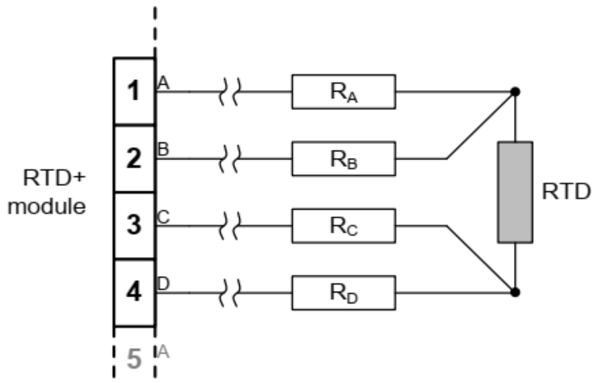


Figure 10-4 4-wire RTD wiring

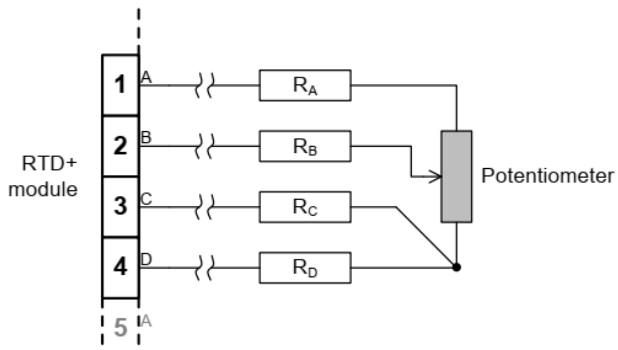


Figure 10-5 4-wire RTD wiring of potentiometer

1.3.13. Analog input module (AI)

The analog input module accepts transducers' current outputs. The AIC module can measure unipolar and bipolar current values in wide ranges.

<u>*Connector types:*</u>

- *The default and optionally available connector types are indicated for each module in the table below. See Chapter 20.2 for details about each type.*

MODULE TYPE	AIC+/0200*	AIC+/0201*	AIC+/0202
CHANNEL NUMBER	4	4	4
MEASUREMENT METHOD	2 wire inputs	2 wire inputs with optional 12 V excitation	2 wire inputs
RELATIVE ACCURACY	± 0.5 % ± 1 digit	± 0.5 % ± 1 digit	± 0.5 % ± 1 digit
MEASUREMENT RANGES	**± 20 mA** (typical 0-20, 4-20 mA) R_{LOAD} = 56 Ω	**± 20 mA** (typical 0-20, 4-20 mA) R_{LOAD} = 56 Ω	**± 20 mA** (typical 0-20, 4-20 mA) R_{LOAD} = 56 Ω
CONNECTOR TYPE	<u>Default:</u> BLA <u>Options:</u> -	<u>Default:</u> BLA <u>Options:</u> -	<u>Default:</u> BLA <u>Options:</u> F, T

***Obsolete module. These modules are not recommended for new designs!**

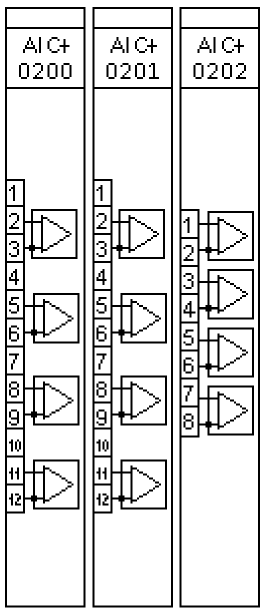


Figure 11-1 Analog input modules

1.3.13.1. AI module wiring

The following wiring method can be applied.

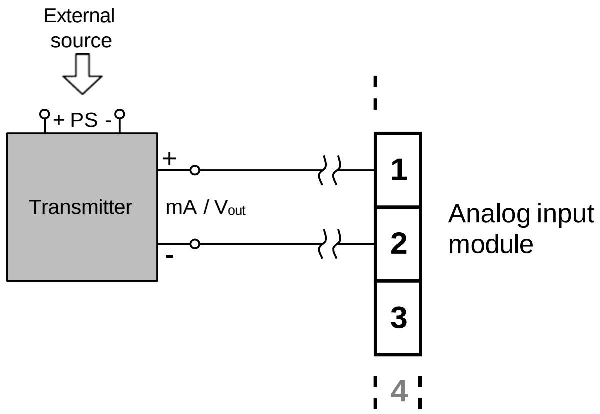


Figure 11-2 AI wiring

1.3.14. Analog output module (ATO)

The analog output module transmits current or voltage signals. The ATO module can be used in wide ranges in unipolar and bipolar mode.

<u>*Connector types:*</u>

- *The default and optionally available connector types are indicated for each module in the table below. See Chapter 20.2 for details about each type.*

MODULE TYPE	ATO+/0002	ATO+/0004
CHANNEL NUMBER	2	4
OUTPUT MODE	2 wire output	2 wire output
MAXIMUM LOAD (R_{CABLE} + $R_{RECEIVER}$)	500 Ω	500 Ω
OUTPUT RANGES	± 20 mA 0 - 20 mA 4 - 20 mA	± 20 mA 0 - 20 mA 4 - 20 mA
CONNECTOR TYPE	Default: BLA Options: T	Default: BLA Options: -

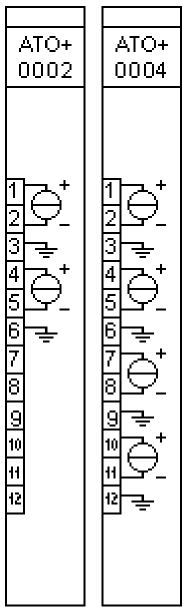


Figure 12-1 Analog output modules

1.3.14.1. ATO module wiring

The analog output module should be connected according to the following wiring diagram.

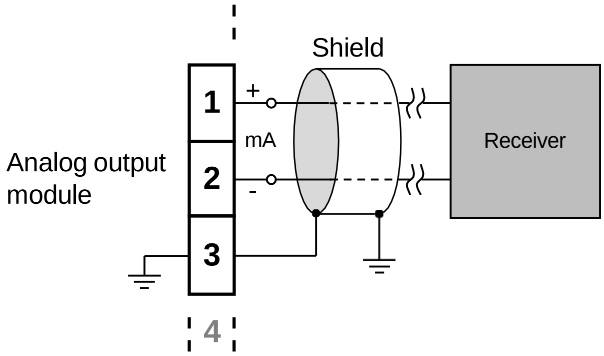


Figure 12-2 Analog output module wiring diagram

1.3.15. Sensor input module

The sensor modules receive low-level signals of current and voltage sensors (low-power instrument transformers).

Connector types:

- *The default and optionally available connector types are indicated for each module in the table below. See Chapter 20.2 for details about each type.*

MODULE TYPE	CVS+/0001		CVSR+/0001		VS+/0031***
CHANNEL NUMBER	4 U	4 I	4 U	4 I	4 U
NOMINAL VALUES	3.25 V	0.225 V*	1.27 V	0.150 V**	3.25 V
CONTINUOUS VOLTAGE WITHSTAND	35 V DC		35 V DC		35 V DC
SHORT TIME OVERLOAD (1 S)	40 V AC / 56 V DC		40 V AC / 56 V DC		40 V AC / 56 V DC
MAX. MEASURED VALUE (± 10 %)	1.8 U_N	50 I_N	2.1 U_N	50 I_N	1.6 U_N
ACCURACY	≤ 0.5 % (0.1 U_N – 1.2 U_N)		≤ 0.5 % (0.1 U_N – 1.2 U_N)		≤ 0.5 % (0.1 U_N – 1.2 U_N)
FREQUENCY RANGE	DC – 1 kHz		DC – 1 kHz		DC – 1 kHz
INPUT RESISTANCE	200 kΩ ± 1%	21 kΩ ± 1%	10 MΩ ± 1%	1.1 MΩ ± 1%	200 kΩ ± 1%
INPUT CAPACITANCE	300 pF (1 kHz)	300 pF (1 kHz)	300 pF (1 kHz)	300 pF (1 kHz)	300 pF (1 kHz)
CONNECTOR TYPE	RJ45 – 8 pole, shielded connector, isolated shielding		RJ45 – 8 pole, shielded connector, grounded shielding		M8 3-pin connector Receptacle: Hirschmann ELST 3308 RV FM 8 05 Plug: Binder 768 99-3360-00-03

**Voltage proportional to current*
***Voltage proportional to current change (Rogowski coil)*
******Obsolete module. These modules are not recommended for new designs!***

For more information about more available nominal values please contact our Application Team. (application@protecta.hu)

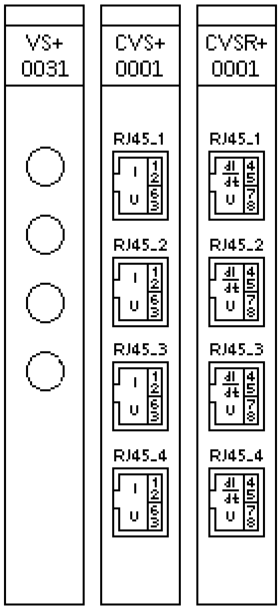


Figure 13-1 Voltage sensor modules

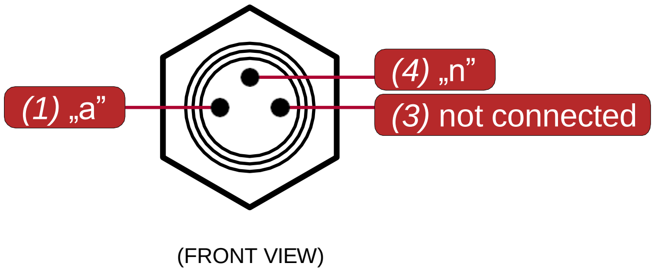
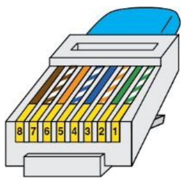
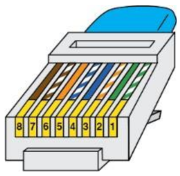


Figure 13-2 M8 connector pinout



1.: S1
2.: S2
3.: “a”
6.: “n”

Figure 13-3 CVS module connector pinout



4.: S1
5.: S2
8.: “n”
7.: “a”

Figure 13-4 CVSR module connector pinout

1.3.16. INJ module

Complex module for controlling the Petersen coil, which contains an injector function for the measurements, an enabling and a blocking input, and a fault relay indicating if there is any fault in the injection circuit.

Connector types:

- *The default and optionally available connector types are indicated for each module in the table below. See Chapter 20.2 for details about each type.*

MODULE TYPE	INJ+/0005	INJ+/0015*
INJECTED CURRENT	2 A	4 A
ENABLING INPUT CLAMP VOLTAGE	85 V AC	Not available function
BLOCKING INPUT CLAMP VOLTAGE	200 V AC	200 V AC
ADDITIONAL RESISTANCE FOR VOLTAGE INPUT	Not available function	265 kΩ ± 1%
CONNECTOR TYPE	Default: STVS6, BLA10 Options: -	
RECOMMENDED APPLICATION	Arc suppression coil controller	Network compensation level measurement on resonant grounded networks

Special module

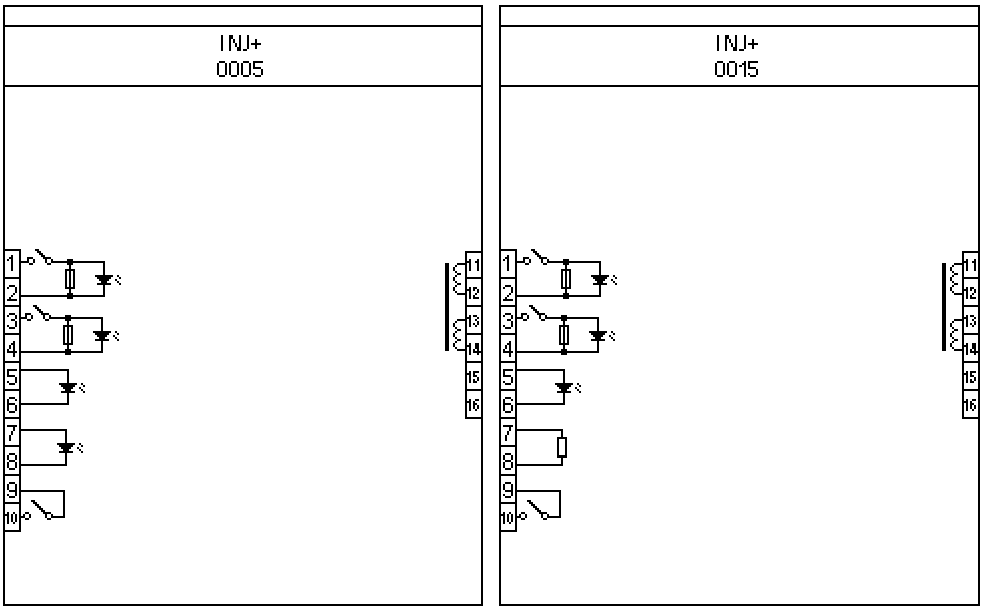


Figure 14-1 INJ modules

1.3.17. Generator protection modules

Special generator protection modules whose system measures and produces the necessary analog signals.

<u>Connector types:</u>

- *The default and optionally available connector types are indicated for each module in the tables below. See Chapter <u>20.2</u> for details about each type.*

MODULE TYPE	RAI+/01	RAI+/11	RINJ+/21
NOMINAL VOLTAGE	-	-	110 V / 220 V
INPUT VOLTAGE RANGE	-	-	88 - 264 V DC 80 - 250 V AC
OUTPUT VOLTAGE	-	-	100V DC ± 2 %
MEASUREMENT RANGE	± 20 mA	± 20 mA	-
THERMAL WITHSTAND CONTINUOUS: 30 SEC:	15 mA 20 mA	10 mA 20 mA	20 mA
CONNECTOR TYPE	<u>Default:</u> STVS8 <u>Options:</u> -	<u>Default:</u> STVS8 <u>Options:</u> T*	<u>Default:</u> STVS8 <u>Options:</u> T*
RECOMMENDED APPLICATION	Rotor earth-fault protection of middle-grounded rotors	Rotor earth-fault protection of ungrounded (isolated) rotors	Rotor earth-fault protection of ungrounded (isolated) rotors

**By choosing this option, the connector remains the same, only the handle is changed*

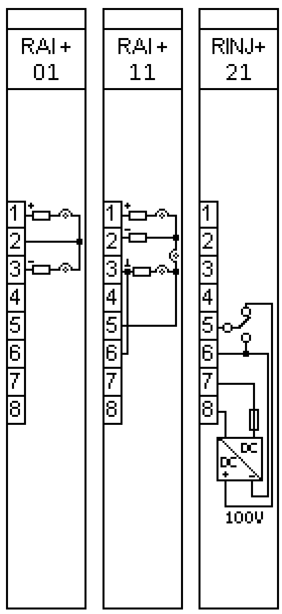


Figure 15-1 Generator protection modules

1.3.17.1. Auxiliary boxes for rotor earth fault protection

These DIN-rail mounted external boxes serve as couplings between the rotor (exciter circuit) of the generator and the corresponding RAI module of the protection device.

Note: the data about the resistances and capacitors provided here does not tell the actual time constants of the measured values, as those can be determined on-site only, when the rotor earth fault protection is being tested on the actual generator itself.

MODULE TYPE	RAI+01 BOX	RAI+11 BOX BASE	RAI+11 BOX EXTENSION*
MAXIMUM INPUT VOLTAGE	200 V, 300 V, 400 V, 500 V**	600 V	1200 V
SERIES RESISTANCE ON SIDES	10 kΩ, 15 kΩ, 20 kΩ, 25 kΩ**	35 kΩ	30 kΩ
FILTER CAPACITORS	4x10 µF	2x1 µF	-
CONNECTOR TYPE	Default: STVS6 Options: -	Default: STVS6 Options: -	Default: STVS6 Options: -
RECOMMENDED APPLICATION	Middle-grounded rotors	Ungrounded (isolated) rotors	Ungrounded (isolated) rotors

**This extension module can only be used together with RAI+11 BOX BASE module*
***According to the chosen wiring*

1.3.17.1.1. Use of auxiliary boxes

- **Ungrounded (isolated) rotors:**

If the excitation voltage is lower than 600 V, then it is enough to use the RAI+11 BOX BASE auxiliary box. If the excitation voltage is higher than 600 V, the RAI+11 BOX EXTENSION auxiliary box shall be used *additionally*, so the protection can connect to up to 1200 V excitation voltage.

- **Middle-grounded rotors**

Front drawings near the connectors on the box itself indicate the available maximum voltages. The choice from these shall be made according to the excitation voltage. Wiring shall be done according to the chosen voltage.

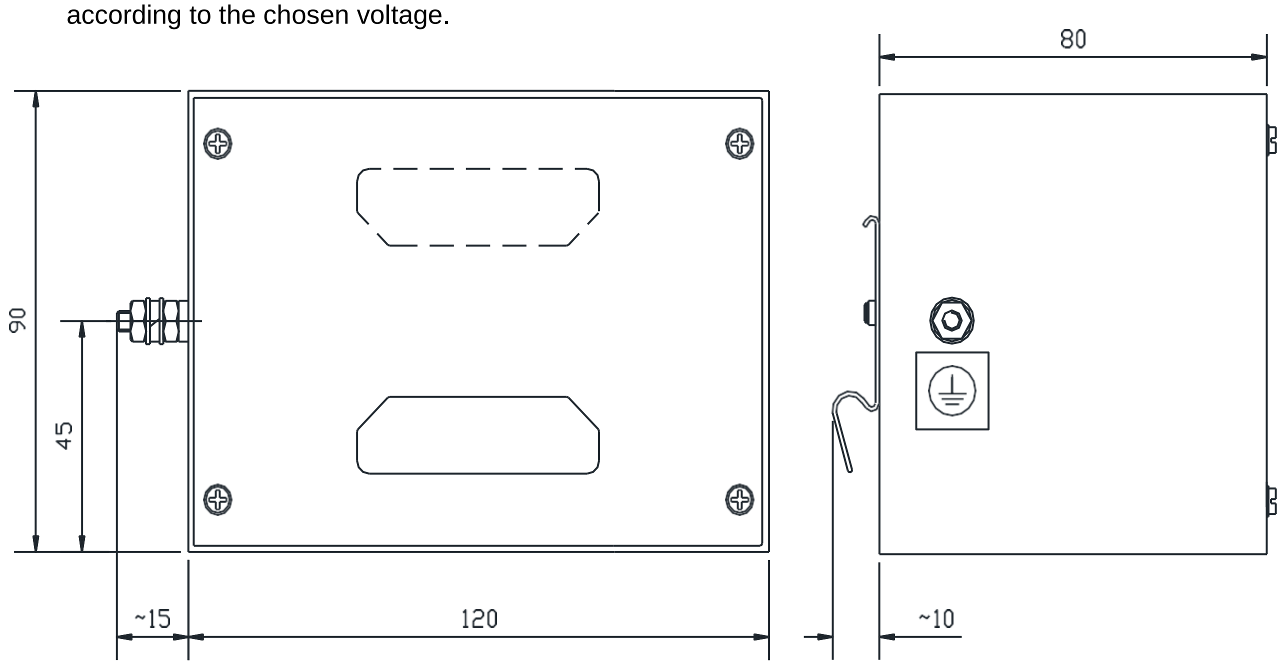


Figure 15-2 Size of the auxiliary boxes

1.3.17.2. Wiring of the rotor earth fault protection modules

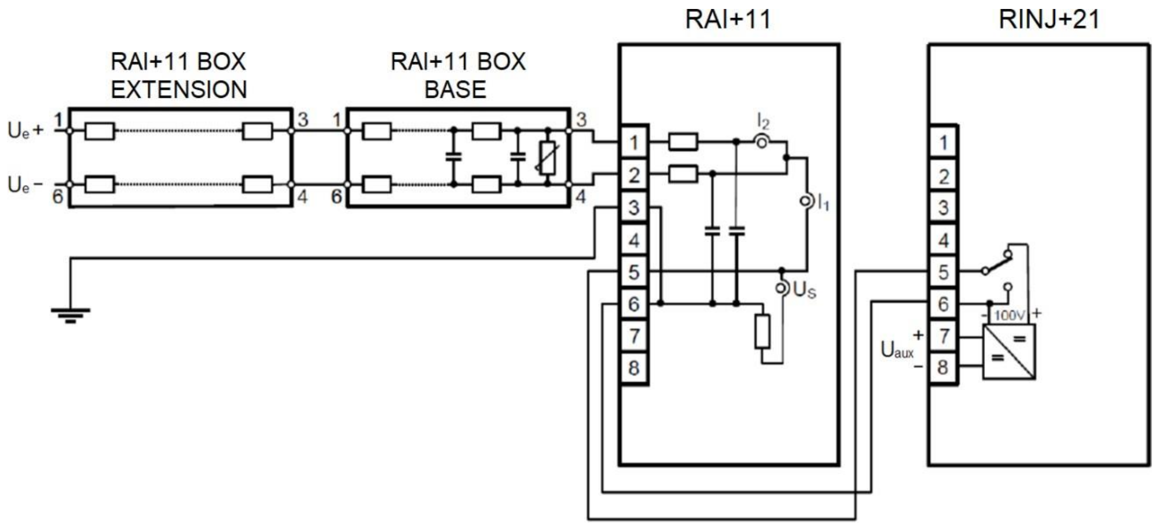


Figure 15-3 Wiring for ungrounded (isolated) rotors

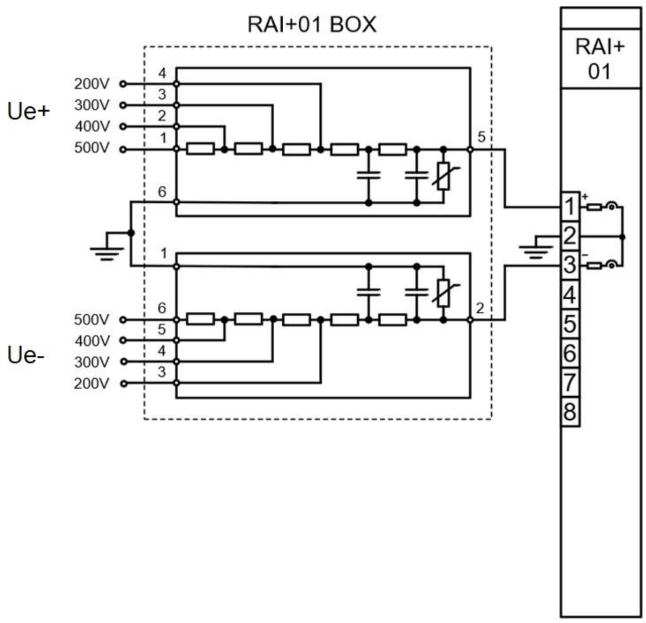


Figure 15-4 Wiring for middle-grounded rotors

1.3.18. Power supply module

The power supply module converts primary AC and/or DC voltage to required system voltages. In most applications, one power supply module is sufficient to provide the required power to the system. Redundant power supply modules extend system availability in case of the outage of any power source.

IMPORTANT

Depending on the hardware configuration, the power consumption of the devices can be different. We reserve the right to make the decision about which PS+ module must be used.

For most applications where the power consumption does not reach 20 W, a 4 HP wide PS+ module shall be installed.

Connector types:

- *The default and optionally available connector types are indicated for each module in the tables below. See Chapter 20.2 for details about each type.*

MODULE TYPE	PS+/4201 (4 HP wide)	PS+/2101 (4 HP wide)
RATED VOLTAGE	24 V DC / 48 V DC / 60 V DC	110 V DC / 220 V DC
INPUT VOLTAGE OPERATIVE RANGE	19.2 - 72 V DC	88 - 264 V DC 80 - 250 V AC
NOMINAL POWER	20 W	20 W
VOLTAGE DIP WITHSTAND AT 80% UN → 0% INPUT VOLTAGE CHANGE (IEC 60255-26)	**50 ms**	**100 ms**
INTERNAL FUSE	3.15A/250V	3.15A/250V
CONNECTOR TYPE	Default: BLA Options: T	Default: BLA Options: F, T

IMPORTANT
Devices with 20W or higher power consumption shall be equipped with an 8 HP wide PS module.

MODULE TYPE	PS+/1301	PS+/1303**	PS+/2301	PS+/2303**	PS+/1030*
RATED VOLTAGE	110 V DC	110 V DC	220 V DC	220 V DC	110 V DC / 220 V DC
INPUT VOLTAGE OPERATIVE RANGE	88 - 132 V DC 85 - 130 V AC	88 - 150 V DC 85 - 130 V AC	176 - 264 V DC 160 - 250 V AC	176 - 264 V DC 160 - 250 V AC	88 - 264 V DC 85 - 250 V AC
MAX. CONTINUOUS POWER OUTPUT	30 W	30 W	30 W	30 W	25 W
VOLTAGE DIP WITHSTAND AT 80% UN → 0% INPUT VOLTAGE CHANGE *(IEC 60255-26)*	**50 ms** **100 ms** at 100%Un → 0%	**50 ms** **100 ms** at 100%Un → 0%	**50 ms** **100 ms** at 100%Un → 0%	**50 ms** **100 ms** at 100%Un → 0%	**20 ms** **100 ms** at 100%Un → 0%
INTERNAL FUSE	2.5A/250V	2.5A/250V	2.5A/250V	2.5A/250V	2.5A/250V
CONNECTOR TYPE	Default: BLA Options: -	Default: BLA Options: -	Default: BLA Options: -	Default: BLA Options: -	Default: BLA Options: F, T

***Special module**, *available only in custom configurations.*
****Can be connected in parallel.**

MODULE TYPE	PS+/1060*	PS+/1601	PS+/1602*	PS+/2601	PS+/4301***
RATED VOLTAGE	110 V DC / 220 V DC	110 V DC	110 V DC	220 V DC	48 V DC
INPUT VOLTAGE OPERATIVE RANGE	88 - 264 V DC	88 - 132 V DC 95 - 130 V AC	88 - 132 V DC 95 - 130 V AC	176 - 264 V DC 160 - 250 V AC	38.4 - 57.6 V DC
MAX. CONTINUOUS POWER OUTPUT	60 W	60 W	60 W	60 W	25 W
VOLTAGE DIP WITHSTAND AT 80% UN → 0% INPUT VOLTAGE CHANGE *(IEC 60255-26)*	**20 ms** **100 ms** at 100%Un → 0%	**50 ms** **100 ms** at 100%Un → 0%	**50 ms** **100 ms** at 100%Un → 0%	**50 ms** **100 ms** at 100%Un → 0%	**20 ms** **30 ms** at 100%Un → 0%
INTERNAL FUSE	3.15A/250V	2.5A/250V	2.5A/250V	2.5A/250V	3.15A/250V
CONNECTOR TYPE	Default: BLA Options: F, T	Default: BLA Options: -	Default: BLA Options: F	Default: BLA Options: T	Default: BLA Options: -

Special module**, *available only in custom configurations. PS+1602 supports* ***auxiliary voltage measurement*. The module is calibrated to DC voltage measurement.*
*****Obsolete module. These modules are not recommended for new designs!**

MODULE TYPE	PS+/2161*	PS+/2164**	PS+/4261*	PS+/4264**
RATED VOLTAGE	110 V DC / 220 V DC	110 V DC / 220 V DC	24 V DC / 48 V DC / 60 V DC	24 V DC / 48 V DC / 60 V DC
INPUT VOLTAGE OPERATIVE RANGE	88 - 264 V DC	88 - 264 V DC	19.2 - 72 V DC	19.2 - 72 V DC
MAX. CONTINUOUS POWER OUTPUT	60 W	60 W	60 W	60 W
VOLTAGE DIP WITHSTAND AT 80% UN → 0% INPUT VOLTAGE CHANGE *(IEC 60255-26)*	**40 ms**	**40 ms**	**40 ms**	**40 ms**
INTERNAL FUSE	3.15A/250V	3.15A/250V	8A/250V	8A/250V
CONNECTOR TYPE	Default: BLT Options: -	Default: BLT Options: -	Default: BLT Options: -	Default: BLT Options: -

Can be connected in parallel.**Can be connected in parallel** *and supports* ***auxiliary voltage measurement.

MODULE TYPE	PS+/4401**	PS3F+/1001*
RATED VOLTAGE	48 V DC / 60 V DC	3x100 V AC (line voltage)
INPUT VOLTAGE OPERATIVE RANGE	38.4 - 72 V DC	80 - 120 V AC
MAX. CONTINUOUS POWER OUTPUT	30 W	20 W
VOLTAGE DIP WITHSTAND AT 80% UN → 0% INPUT VOLTAGE CHANGE *(IEC 60255-26)*	**20 ms** **30 ms** at 100%Un → 0%	**50 ms** **100 ms** at 100%Un → 0%
INTERNAL FUSE	3.15A/250V	2.5A/250V
CONNECTOR TYPE	Default: BLA Options: F, T	Default: BLA Options: -

***Special module.** *At least 2 healthy phase voltages are needed for the operation of the PS3F+1001 module. LEDs on the front of the module indicate the presence of healthy phase voltages. For the correct internal signals connect the common point of the suppling 3 phase voltage to the 4th connector ("N").*
****Can be connected in parallel.**

Main features:

- Fault relay contacts (NC and NO): device fault contact and also assignable to user functions. All the three relay contact points are accessible to users.
- Redundant applications (nominal power and reliability can be increased by using parallel power supplies)
- On-board self-supervisory circuits: temperature and voltage monitors
- Short-circuit-protected outputs
- Efficiency: > 70 %, power consumption = nominal power / efficiency
- Passive heatsink

- Early power failure indication signals to the CPU for the possibility of power outage, thus the CPU has enough time to save the necessary data to non-volatile memory
- Inrush current (until 0.1 s): < 10 A for all types excluding PS+4401 which has < 21 A inrush current.
- Common features for internal fuses:
  - 5 mm x 20 mm (0.20" x 0.79")
  - TT characteristics (very inverse time-lag)
  - 35 A @ 250 V AC rated breaking capacity
- Recommended external protection: miniature circuit breaker, 6 A (C char.)

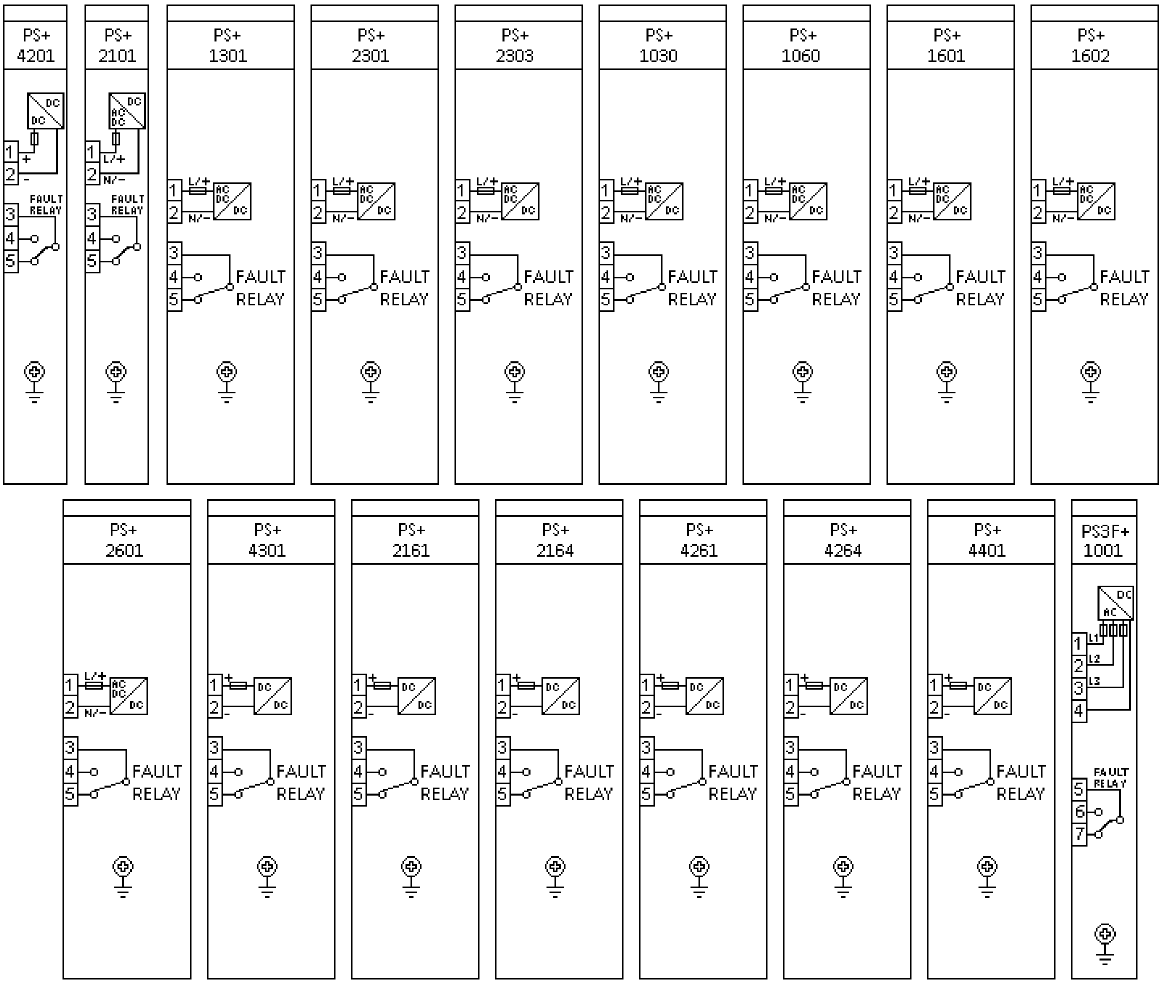


Figure 16-1 Power supply modules

1.3.19. Sampling synchronization module

The IED sampling system is synchronized via this module to an external source (IRIG-B) in PMU (Phasor Measurement Unit) applications. The PLL of the module handles the setting of the phase and frequency if valid IRIG-B signal is received. Note that the sampling signal is generated even if the IRIG-B signal is not present, however in that case, it runs independently.

MODULE TYPE	TSYNC+/0071
IRIG-B TYPE	B000 (unmodulated)
INPUT TYPE	BNC (coaxial)
SIGNAL THRESHOLD	5 VDC CMOS max. 5.5 VDC
MAX. CABLE LENGTH	50 m
CLAMP VOLTAGES	falling 1.7 VDC rising 3.1 VDC
SAMPLING ACCURACY*	< 100 ns
IRIG SYNCH. TIME	max. 1 minute
HOLDOVER TIME**	30 s
SAMPLING FREQUENCY	2 kHz @ 50 Hz 2.4 kHz @ 60 Hz
SAMPLING ACCURACY IN INDEPENDENT MODE***	< 1 ppm

**max. time difference between synchronized systems connecting to different GNSS (e.g. GPS)*
***the sampling accuracy stays below the given value during this time if the IRIG-B signal is lost*
****the accuracy of the 2/2.4 kHz sampling signal if an IRIG-B signal is not present*

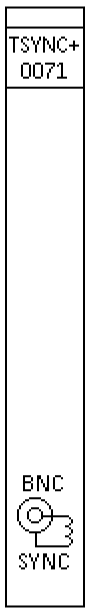


Figure 17-1 Sampling synchronization module

1.3.20. Mixed function modules

1.3.20.1. PSTP+ module

IMPORTANT
PSTP+ modules can be used only if the power consumption of the device does not reach 20 W and maximum 2 TRIP contacts are needed. If the application does not meet any of these two requirements, it is not allowed to use these cards. In this case separate PS+ (Chapter 16) and TRIP+ (Chapter 9) modules must be used.

Connector types:

- *The default and optionally available connector types are indicated for each module in the tables below. See Chapter 20.2 for details about each type.*

Note for the following tables:

- ***Thermal withstand voltage:** continuous with 60 % of the input channels are energized.*

MODULE TYPE	PSTP+/2101	PSTP+/2102*	PSTP+/2131**
	POWER SUPPLY CHARACTERISTICS		
RATED VOLTAGE	110 V / 220 V	110 V / 220 V	110 V / 220 V
INPUT VOLTAGE OPERATIVE RANGE	88 - 264 V DC 80 - 250 V AC	88 - 264 V DC 80 - 250 V AC	88 - 264 V DC 80 - 250 V AC
MAXIMUM CONTINUOUS POWER OUTPUT	20 W	20 W	20 W
VOLTAGE DIP DURATION AT 0% RESIDUAL VOLTAGE *(IEC 60255-26)*	**min. 100 ms** in the specified input voltage range	**min. 100 ms** in the specified input voltage range	**min. 100 ms** in the specified input voltage range
INTERNAL FUSE	3.15A/250V	3.15A/250V	3.15A/250V
CONNECTOR TYPE	Default: BLA Options: F, T	Default: BLA Options: F, T	Default: BLA Options: T
	TRIPPING CHARACTERISTICS		
CHANNEL NUMBER	2	2	2
RATED VOLTAGE	110 V DC and 220 V DC or dry contacts	110 V DC and 220 V DC or dry contacts	110 V DC and 220 V DC or dry contacts
THERMAL WITHSTAND VOLTAGE	242 V DC	242 V DC	242 V DC
CONTINUOUS CARRY	8 A	8 A	8 A
MAKING CAPACITY	0.5 s, 30 A	0.5 s, 30 A	0.5 s, 30 A
BREAKING CAPACITY	L/R = 40 ms: 4 A DC	L/R = 40 ms: 4 A DC	L/R = 40 ms: 4 A DC
CONNECTOR TYPE	Default: BLA Options: F, T	Default: BLA Options: F, T	Default: BLA Options: T

***Special module** *that supports **auxiliary voltage measurement**. The module is calibrated to DC voltage measurement.*
*****Without trip circuit supervision***

MODULE TYPE	PSTP+/4201	PSTP+/4202*
	POWER SUPPLY CHARACTERISTICS	
RATED VOLTAGE	24 V / 48 V / 60 V	24 V / 48 V / 60 V
INPUT VOLTAGE OPERATIVE RANGE	19.2 - 72 V DC	19.2 - 72 V DC
MAXIMUM CONTINUOUS POWER OUTPUT	20 W	20 W
VOLTAGE DIP DURATION AT 0% RESIDUAL VOLTAGE *(IEC 60255-26)*	**50 ms** at nominal input voltages min. **40 ms** in the specified input voltage range	**50 ms** at nominal input voltages min. **40 ms** in the specified input voltage range
INTERNAL FUSE	3.15A/250V	3.15A/250V
CONNECTOR TYPE	Default: BLA Options: T	Default: BLA Options: T
	TRIPPING CHARACTERISTICS	
CHANNEL NUMBER	2	2
RATED VOLTAGE	24 V DC and 48 V DC or dry contacts	24 V DC and 48 V DC or dry contacts
THERMAL WITHSTAND VOLTAGE	72 V DC	72 V DC
CONTINUOUS CARRY	8 A	8 A
MAKING CAPACITY	0.5 s, 30 A	0.5 s, 30 A
BREAKING CAPACITY	L/R = 40 ms: 4 A DC	L/R = 40 ms: 4 A DC
CONNECTOR TYPE	Default: BLA Options: T	Default: BLA Options: T

***Special module** *that supports **auxiliary voltage measurement**. The module is calibrated to DC voltage measurement.*

Main features:

- High-speed operation: with pre-trip 0.5 ms, without pre-trip typically 10 ms, maximally 22 ms.
- Trip circuit supervision for each trip contact
- 1 unit wide (4 HP) modules
- Inrush current (until 0.1 s): < 10 A
- Common features for internal fuses:
    - 5 mm x 20 mm (0.20" x 0.79")
    - TT characteristics (very inverse time-lag)
    - 35 A @ 250 V AC rated breaking capacity
- Recommended external protection: miniature circuit breaker, 6 A (C char.)

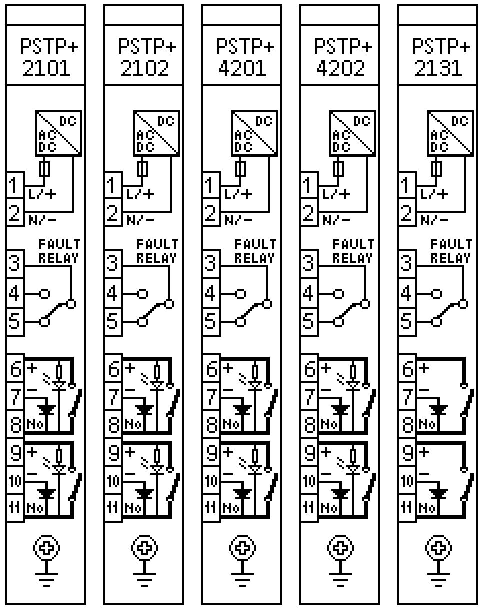


Figure 18-1 Power supply with 2 Ch. TRIP modules

1.3.20.1.1. Trip Circuit Supervision (TCS) in PSTP modules

Apart from the PSTP+/2131, all PSTP modules have TCS.

The technical data of the TCS in PSTP modules:

	MODULE TYPE	PSTP+/4201 PSTP+/4202	PSTP+/2101 PSTP+/2102
	INJECTED CURRENT AT “NO” CONTACT	1.5 mA	1.5 mA
MAXIMUM RESISTANCE OF THE TRIP COIL	3-WIRE WIRING (1 mA CURRENT)	**8 kΩ** (max. 8 V)	**13 kΩ** (max. 13 V)
	3-WIRE WIRING IN PARALLEL	**4 kΩ** (max. 8 V)	**6.5 kΩ** (max. 13 V)
	2-WIRE METHOD (1 mA MIN. CURRENT)	**24 kΩ** @ 24 V DC **48 kΩ** @ 48 V DC **60 kΩ** @ 60 V DC	**110 kΩ** @ 110 V DC **220 kΩ** @ 220 V DC

IMPORTANT
PSR2+ modules can be used only if the power consumption of the device does not reach 20 W and maximum 2 contacts are needed. If the application does not meet any of these two requirements it is not allowed to use these cards. In this case separate PS+ (Chapter 16) and Signaling (Chapter 8) modules must be used.

1.3.20.2. PSR2+ module

Connector types:

- *The default and optionally available connector types are indicated for each module in the table below. See Chapter 20.2 for details about each type.*

MODULE TYPE	PSR2+/2101
POWER SUPPLY CHARACTERISTICS	
RATED VOLTAGE	110 V / 220 V
INPUT VOLTAGE OPERATIVE RANGE	88 - 264 V DC 80 - 250 V AC
MAXIMUM CONTINUOUS POWER OUTPUT	20 W
VOLTAGE DIP DURATION AT 0% RESIDUAL VOLTAGE *(IEC 60255-26)*	**min. 100 ms** in the specified input voltage range
INTERNAL FUSE	3.15A/250V
CONNECTOR TYPE	Default: BLA Options: T
SIGNALING RELAY CHARACTERISTICS	
CHANNEL NUMBER	2
RATED VOLTAGE	250 V AC/DC
CONTINUOUS CARRY	8 A
MAKING CAPACITY	0.5 s, 30 A
CONNECTOR TYPE	Default: BLA Options: T

Main features (according to IEC 60255-26):

- Maximum switching voltage: 400 V AC
- Breaking capacity: (L/R=40 ms) at 220 V DC: 0.2 A, at 110 V DC: 0.3 A
- Breaking capacity max.: 2000 VA
- Short time carrying capacity: 1 s, 35 A
- Limiting making current, max. 4 s: 15 A (df = 10 %)
- Dielectric strength between open contacts, 1 min: 1000 V_{RMS}
- Mechanical endurance: 10 × 10^6 cycles
- Circuit closing capability: typically 10 ms, maximally 22 ms.
- Bounce time: typically 6,5 ms, maximally 10 ms.
- Minimal switching requirement: 5 V

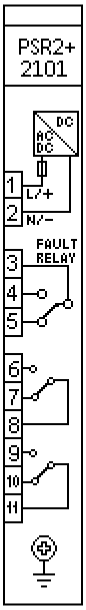


Figure 18-2 Power supply with 2 Ch. signaling modules

1.3.20.3. O6R5+ module

The O6R5+ module contains 6 binary input channels in one grounding group, and 5 relay outputs with 2 × 2 NO contacts and one CO contact.

Connector types:

- *The default and optionally available connector types are indicated for each module in the tables below. See Chapter 20.2 for details about each type.*

Notes for the following table:

- ***Thermal withstand voltage:** continuous with 60 % of the input channels are energized.*
- ***Clamp voltage:** these are the guaranteed values; the actual ones might differ from those provided here (falling and rising around 0.66 U_N and 0.77 U_N, respectively)*

MODULE TYPE	O6R5+/2101	O6R5+/4201
BINARY INPUT CHARACTERISTICS		
CHANNEL NUMBER	6	6
RATED VOLTAGE	110 V / 220 V user selectable on channel basis by jumpers	24 V / 48 V user selectable on channel basis by jumpers
TIME SYNCHRONIZATION	configured by EuroCAP	configured by EuroCAP
THERMAL WITHSTAND VOLTAGE	320 V	72 V
CLAMP VOLTAGE	falling 0.64 U_N rising 0.8 U_N	falling 0.64 U_N rising 0.8 U_N
COMMON GROUPS	1 × 6 common	1 × 6 common
RELAY OUTPUT CHARACTERISTICS		
RATED VOLTAGE	250 V AC/DC	250 V AC/DC
CONTINUOUS CARRY	8 A	8 A
CONTACT VERSIONS	4 NO, 1 CO	4 NO, 1 CO
GROUP ISOLATION	2 × 2 common, 1 independent	2 × 2 common, 1 independent
CONNECTOR TYPE FOR BOTH BINARY INPUT AND RELAY OUTPUT	Default: BLA Options: T	Default: BLA Options: T

Main features for binary inputs:

- Digitally filtered per channel
- Current drain:
  - max. 1.6 mA per channel at 220 V DC
  - max. 1.8 mA per channel at 110 V DC
  - max. 2 mA per channel at 48 V DC
  - max. 3 mA per channel at 24 V DC
- In such applications where the input voltage is 60 V the modules with 48 V rated voltage can be used.
- Input voltage type can be either DC or AC voltage. If AC voltage is used make sure that the type and the parameters of the binary inputs are configured properly in EuroCap tool.

Main features for signaling outputs:

- Maximum switching voltage: 400 V AC
- Breaking capacity, (L/R=40 ms) at 220 V DC: 0.1 A, at 110 V DC: 0.2 A
- Breaking capacity max.: 2000 VA
- Short time carrying capacity: 1 s, 35 A
- Limiting making current, max. 4 s: 15 A (df = 10 %)
- Initial dielectric strength between open contacts, 1 min: 1000 V_{RMS}
- Circuit closing capability: typically 10 ms, maximally 22 ms.
- Bounce time: typically 6,5 ms, maximally 10 ms.
- Mechanical endurance: 10×10^6 cycles
- Circuit closing capability

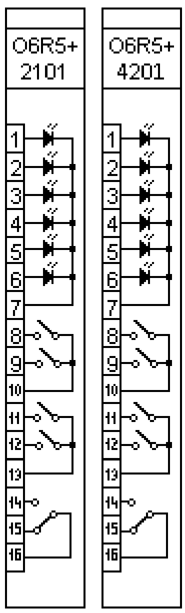


Figure 18-3 Binary input/output modules

1.3.20.4. Binary input module with time synchronization

The inputs are galvanically isolated and the module converts high-voltage signals to the voltage level and format of the internal circuits. This module is also used as an external IRIG-B synchronization **(IRIG-B000, unmodulated)**, PPM or PPS input. Dedicated synchronization input is used for this purpose.

<u>Connector types:</u>

- *The default and optionally available connector types are indicated for each module in the tables below. See Chapter <u>20.2</u> for details about each type.*

Notes for the following table:

- ***Thermal withstand voltage:** continuous with 60 % of the input channels are energized.*
- ***Clamp voltage:** these are the guaranteed values; the actual ones might differ from those provided here (falling and rising around 0.66 U_N and 0.77 U_N, respectively)*

MODULE TYPE	O9S+/2111	O9S+/2121	O9S+/4221
CHANNEL NUMBER	9	9	9
SYNCHRON CHANNEL TYPE AND NUMBER	1 isolated BNC connector	1 850 nm multimode fiber with ST connector	1 850 nm multimode fiber with ST connector
RATED VOLTAGE	110 V DC / 220 V DC user selectable by jumpers	110 V DC / 220 V DC user selectable by jumpers	24 V DC / 48 V DC user selectable by jumpers
THERMAL WITHSTAND VOLTAGE	320 V	320 V	72 V
WITHSTAND VOLTAGE FOR SYNC. INPUT	35 V_{PEAK}	-	-
CLAMP VOLTAGE	falling 0.64 U_N rising 0.8 U_N	falling 0.64 U_N rising 0.8 U_N	falling 0.64 U_N rising 0.8 U_N
COMMON GROUPS	9 (3 × 3 common)	9 (3 × 3 common)	9 (3 × 3 common)
CONNECTOR TYPE	<u>Default:</u> BLA <u>Options:</u> T	<u>Default:</u> BLA <u>Options:</u> F, T	<u>Default:</u> - <u>Options:</u> F, T

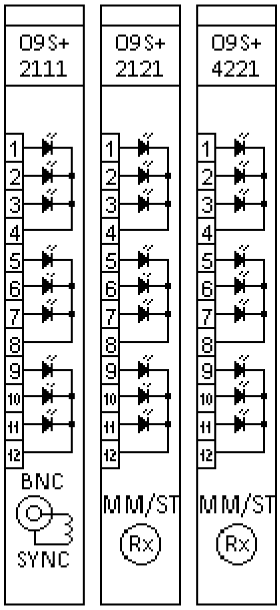


Figure 18-4 Binary input modules with time synchronization

1.3.20.5. Externally driven trip module

The R4MC+01 is a special TRIP module, which can be operated from the connector side. It also has two diode inputs with cathodes which are connected and led to the connector side.

<u>Connector types:</u>

- *The default and optionally available connector types are indicated for each module in the tables below. See Chapter 20.2 for details about each type.*

Module type	R4MC+/01*
CHANNEL NUMBER	2
RATED VOLTAGE	110 V DC
THERMAL WITHSTAND VOLTAGE	132 V DC
CONTINUOUS CARRY	8 A
MAKING CAPACITY	0.5 s, 30 A
BREAKING CAPACITY	L/R = 40 ms: 4 A DC
DIODE PROPERTIES	1 A, 1000 V DC
CONNECTOR TYPE	Default: BLA Options: F

**Special module*

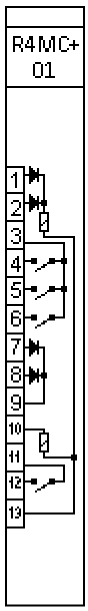


Figure 18-5 Externally driven TRIP module

1.3.21. General data

- Storage temperature: - 40 ºC … + 70 ºC
- Operation temperature: - 20 ºC … + 55 ºC
- Humidity: 10 % ... 93 %
- Altitude: up to 2000 m
- Atmospheric pressure: 86 ... 106 kPa

1.3.21.1. Standard conformance

- Electrostatic discharge immunity (ESD), IEC-EN 60255-26:2013, Level 4
    - Test voltages: 15 kV air discharge, 8 kV contact discharge
- Radiated, radio-frequency, electromagnetic field immunity, IEC-EN 60255-26:2013 Level 3
    - Test field strength: 10 V/m
- Electrical fast transient/burst immunity (EFT/B), IEC-EN 60255-26:2013, Level 4
    - Test voltage: 4 kV
- Surge immunity test, IEC-EN 60255-26:2013
    - Test voltages: 4 kV line-to-earth, 2 kV line-to-line
- Immunity to conducted disturbances, induced by radio-frequency fields, IEC-EN 60255-26:2013, Level 3
    - Test voltage: 10 V
- Damped oscillatory wave immunity test, IEC-EN 60255-26:2013
    - Test frequency: 1 MHz
    - Test voltage: 2.5 kV in common mode, 1 kV in differential mode
- Voltage dips, short interruptions and voltage variations immunity, IEC-EN 60255-26:2013
    - Voltage dips: 40 % (200 ms), 70 % (500 ms), 80 % (5000 ms)
- Ripple on d.c. input power port immunity, IEC-EN 60255-26:2013
    - Level 4, 15 % of rated d.c. value
- Power frequency magnetic field immunity test, IEC-EN 60255-26:2013, Level 5
    - Test field field strength: 100 A/m continuous, 1000 A/m for 3 s
- Power frequency immunity test on the binary inputs, IEC-EN 60255-26:2013, Class A
    - Test voltages: 300 V in common mode, 150 V in differential mode
- Insulation tests, IEC-EN 60255-27:2013
    - Impulse voltage test
        - Test levels: 5 kV (1 kV for transducer and temperature measuring inputs)
    - Dielectric test
        - Test levels: 2 kV AC 50 Hz (0.705 kV DC for transducer inputs)
    - Insulation resistance
        - Insulation resistance > 15 GΩ
- Radiated emission, IEC-EN 60255-26:2013
  Limits:
    - 30 MHz to 230 MHz: 50 dB(μV/m) quasi peak, 3 m
    - 230 MHz to 1 000 MHz: 57 dB(μV/m) quasi peak, 3 m
    - 1 GHz to 3 GHz: 76 dB(μV/m) peak,3 m
    - 3 GHz to 6 GHz: 80 dB(μV/m) peak,3 m
- Conducted emission, IEC-EN 60255-26:2013
  Limits:
    - 0,15 MHz to 0,50 MHz: 79 dB(μV) quasi peak, 66 dB(μV) average
    - 0,5 MHz - 30 MHz: 73 dB(μV) quasi peak, 60 dB(μV) average
- Vibration, shock, bump and seismic tests on measuring relays and protection equipment
    - Vibration tests (sinusoidal), Class I, IEC 60255-21-1:1988
    - Shock and bump tests, Class I, IEC 60255-21-2:1988
    - Seismic tests, Class I, IEC 60255-21-3:1993

1.3.22. Mechanical data

1.3.22.1. General mechanical data

- Construction: chromate aluminum surface with built-in EMC accessories

■ If the power consumption of a 84 HP or 42 HP device does not exceed 30 W (84 HP) or 14 W (42 HP), the construction will be built with solid top and bottom cover panels. ☐ If the power consumption exceeds 30 W (84 HP) or 14 W (42 HP), the construction will be built with (honeycomb) perforated top and bottom cover panels.

- EMC rack protects against electromagnetic environmental influences and protects the environment from radiation from the interior
- IP protection:
  - 24 HP panel instrument case: IP4x; optionally IP54 (front)
  - 84 HP and 42 HP (including double) rack: IP4x from front side, IP2x from rear side; optionally IP54 (front)
- Size:
  - 19” (84 HP), 3 U, single rack
  - ½ 19” (42 HP), 3 U, single rack
  - ½ 19” (42 HP), 6 U, double rack
  - 24 HP, panel instrument case
- Weight:
  - 84 HP: max. 8 kg
  - 42 HP, 3 U: max. 4.5 kg
  - 42 HP, 6 U: max. 8 kg
  - 24 HP: max. 3 kg

1.3.22.2. Connectors

Optionally, certain modules can be equipped with different terminals for different connectors. The available choices are listed among each module's technical data with their *short ID* (see the first column of the table below).

The type of the used terminal is indicated on the module's label with its *short ID* (see the following example). The actual type of the connector is chosen according to the number of the available pins of the module.

Example: the *VT+/2211* module may have four types of connectors. In its description (Chapter 6), these are indicated with their ID:

- The default terminal is indicated with nothing attached (*VT+/2211*), only its name (BLA) is mentioned. Since it has 8 pins, the type is BLA 8/180
- The flanged terminal's *short ID* is **F**, so the module's label will be *"VT+/2211F"*, if it is equipped with this terminal (BLA 8B/180)
- Top-screw terminal: **T**, the label becomes *"VT+/2211T"* (BLT 5.08HC/08/180F)
- Ring-lug terminal: **R**, so the module's label shall be *"VT+/2211R"*

Connector name (short ID)	Connector types	Strip length [mm]	Conductor area [mm²]	Conductor diameter [mm]	Tightening torque [Nm]	Minimum bend radius*
BLA (-)	Weidmüller BLA 2/180, BLA 3/180, BLA 4/180, BLA 6/180, BLA 8/180, BLA 10/180, BLA 12/180, BLA 13/180, BLA 16/180	7	0.2 – 1.5 solid: 0.2 – 2.5	0.5 – 1.4 solid: 0.5 – 1.8	0.4 – 0.5	3 × OD**
BL 3.5 (-)	Weidmüller BL 3.5/05/180 BL 3.5/09/180	6	0.2 – 1.5	0.5 – 1.4	0.2 – 0.25	3 × OD**
Flanged (F)	Weidmüller BLA 2B/180, BLA 3B/180, BLA 4B/180, BLA 6B/180, BLA 8B/180, BLA 10B/180, BLA 12B/180, BLA 16B/180	7	0.2 – 1.5 solid: 0.2 – 2.5	0.5 – 1.4 solid: 0.5 – 1.8	0.4 – 0.5	3 × OD**
Top-screw (T)	Weidmüller BLT 5.08HC/06/180F, BLT 5.08HC/08/180F, BLT 5.08HC/12/180F, BLT 5.08HC/16/180F	13	0.2 – 1.5 solid: 0.2 – 2.5	0.5 – 1.4 solid: 0.5 – 1.8	0.4 – 0.5	3 × OD**
Ring-lug (R)	TE Connectivity BC6-Q308-08	-	0.33 – 3.31	0.65 – 2.05	0.79	3 × OD**

** Bend radius is measured along the inside curve of the wire or wire bundles.*
*** OD is the outer diameter of the wire or cable, including insulation.*

CONNECTOR NAME (SHORT ID)	CONNECTOR TYPES	STRIP LENGTH [MM]	CONDUCTOR AREA [MM^2]	CONDUCTOR DIAMETER [MM]	TIGHTENING TORQUE [NM]	MINIMUM BEND RADIUS*
STVS (-)	Weidmüller STVS 6 SB, STVS 8 SB	9	0.5 – 4	0.8 – 2.3	0.5 – 0.6	3 × OD**
B2L 3.5	Weidmüller B2L 3.5	7	0.2 – 1	0.5 – 1.1	tension clamp connection	3 × OD**
ST/FC/LC	Bayonet/Screw/Snap Fiber Optic	-	-	-	-	30 mm
PE FASTON TERMINAL	TE Connectivity 6.3x0.8	7	min. 4	min. 2.3	-	3 × OD**

** Bend radius is measured along the inside curve of the wire or wire bundles.*
*** OD is the outer diameter of the wire or cable, including insulation.*

The tightening torque of the screw for protective earth connection and the wall mounting must be approx. 5 Nm.
The tightening torque of the screw for fastening the STVS connector must be approx. 1 Nm.

The minimum distance between an EP+ device and its wire channel must be at least 3 cm.
The minimum distance between two EP+ devices must be at least 10 cm.

During the installation make sure that the shortest possible length for PE (Protective Earth) cable routing is applied.

1.3.23. Mounting methods

- Flush mounting
  - 84 HP single rack
  - 42 HP single rack
  - 42 HP double rack
  - 24 HP panel instrument case
  - Remote HMI
- Rack mounting
  - 84 HP single rack
  - 42 HP single rack
  - Remote HMI
- Semi-flush mounting
  - 84 HP single rack
  - 42 HP single rack
  - 24 HP panel instrument case
  - Remote HMI
- Wall mounting (with terminals)
  - 84 HP single rack
  - 42 HP single rack
- Din rail mounting
  - 24 HP panel instrument case
- IP54 rated mounting
  - 84 HP single rack
  - 42 HP single rack
  - 24 HP panel instrument case (original frame with additional gasket)
- Fold-down mounting (with optional terminals)
  - 84 HP single rack
  - 42 HP single rack
- No mounting
  - 84 HP single rack
  - 42 HP single rack

Mounting method	84 HP single rack	42 HP single rack	42 HP double rack	24 HP panel instrument case	Remote HMI
Flush mounting	x	x	x	x	x
Rack mounting	x	x			x
Semi-flush mounting	x	x		x	x
Wall mounting (with terminals)	x	x			
Din rail mounting				x	
IP54 rated mounting	x	x		x*	
Fold-down mounting	x	x			

**additional gasket inserted into the original front panel frame*

It is recommended to leave at least 80 mm free space for the wiring at the back of the IED in case of Flush mounting, Rack mounting, and Semi-flush mounting.

1.3.23.1. Flush mounting

Flush mounting can be used for all size of racks (84 HP, 42 HP, double 42 HP) including the 24 HP panel instrument case and the remote HMI devices. When this type of mounting alternative is used the 84 HP, 42 HP, double 42 HP and remote HMI devices have got a cover profile fit on and the 24 HP devices have got a mounting frame fit on.

The dimensions of the cut-outs for the 84 HP and 42 HP devices are also applicable for the same sized remote HMI devices.

1.3.23.1.1. Flush mounting of 84 HP and 42 HP single rack

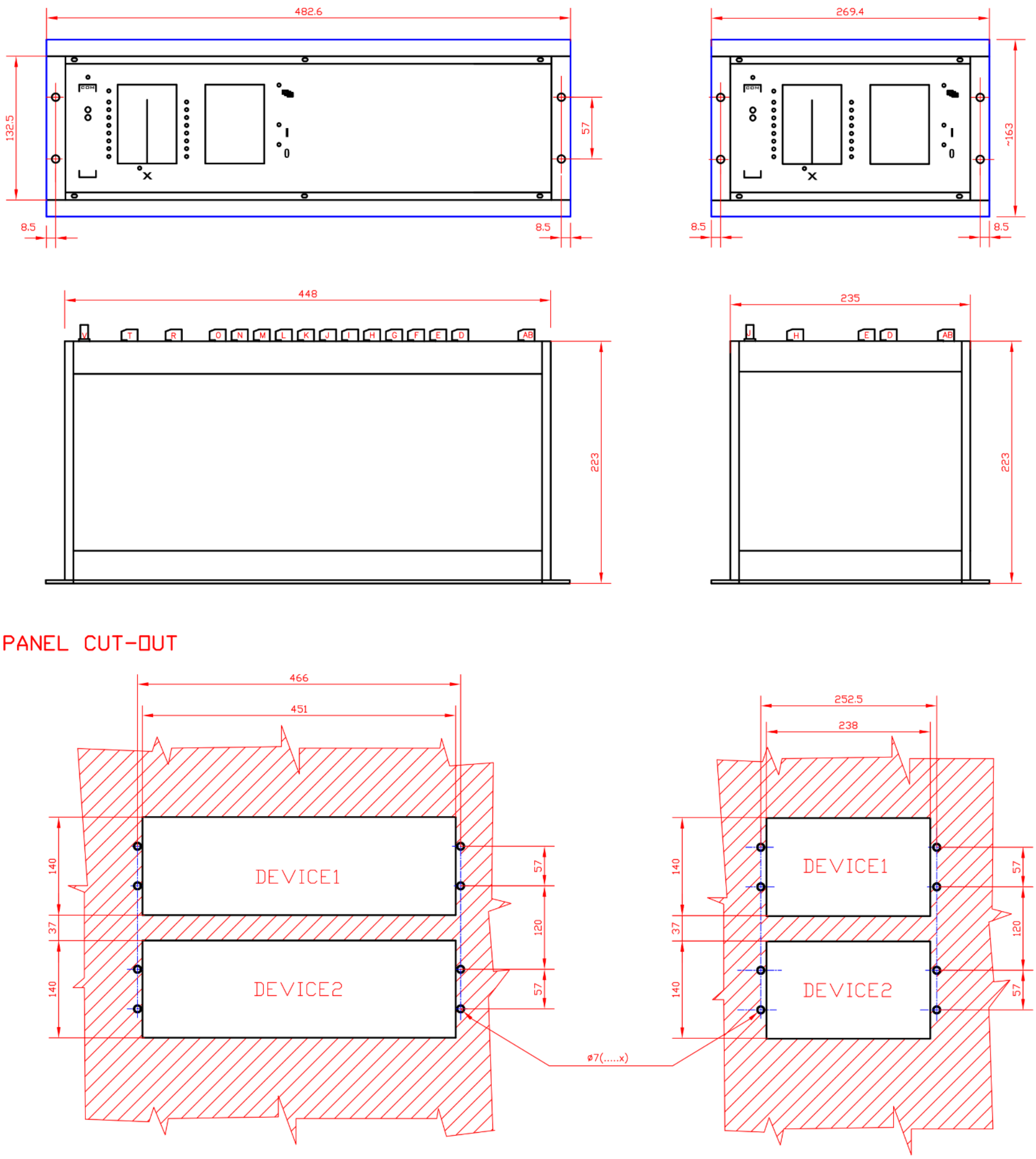


Figure 21-1 Dimensions for flush mounting of 84 HP and 42 HP single rack

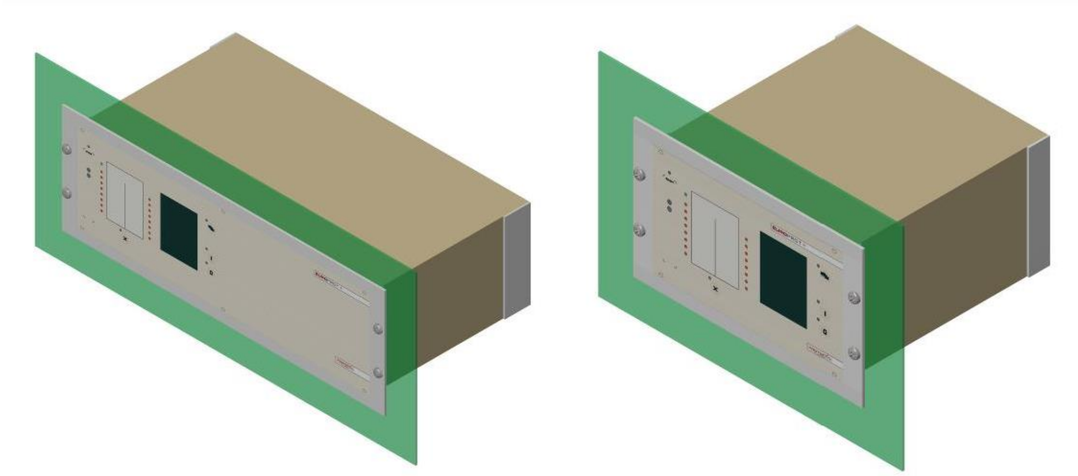


Figure 21-2 3D illustration for flush mounting of 84 HP and 42 HP devices

1.3.23.1.2. Flush mounting of 42 HP double rack

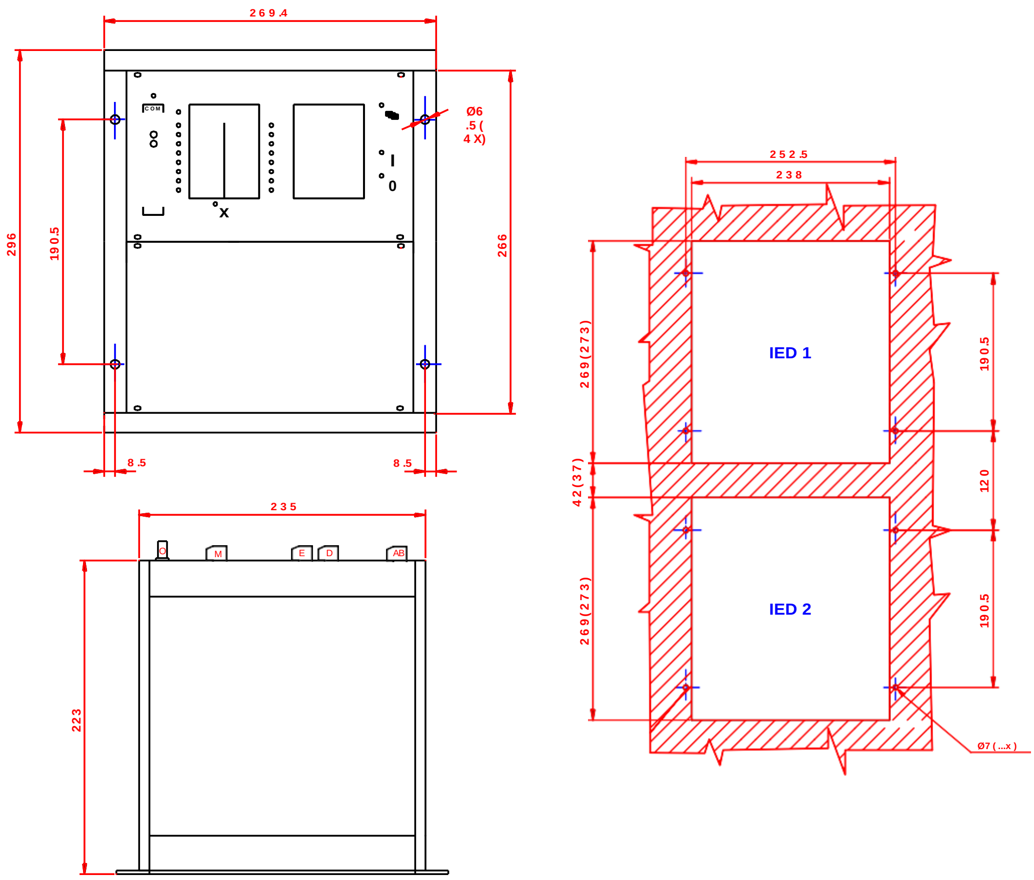


Figure 21-3 Dimensions for flush mounting of 42 HP double rack

Figure 21-4 42 HP wide cover profile

1.3.23.1.3. Flush mounting of 24 HP panel instrument case

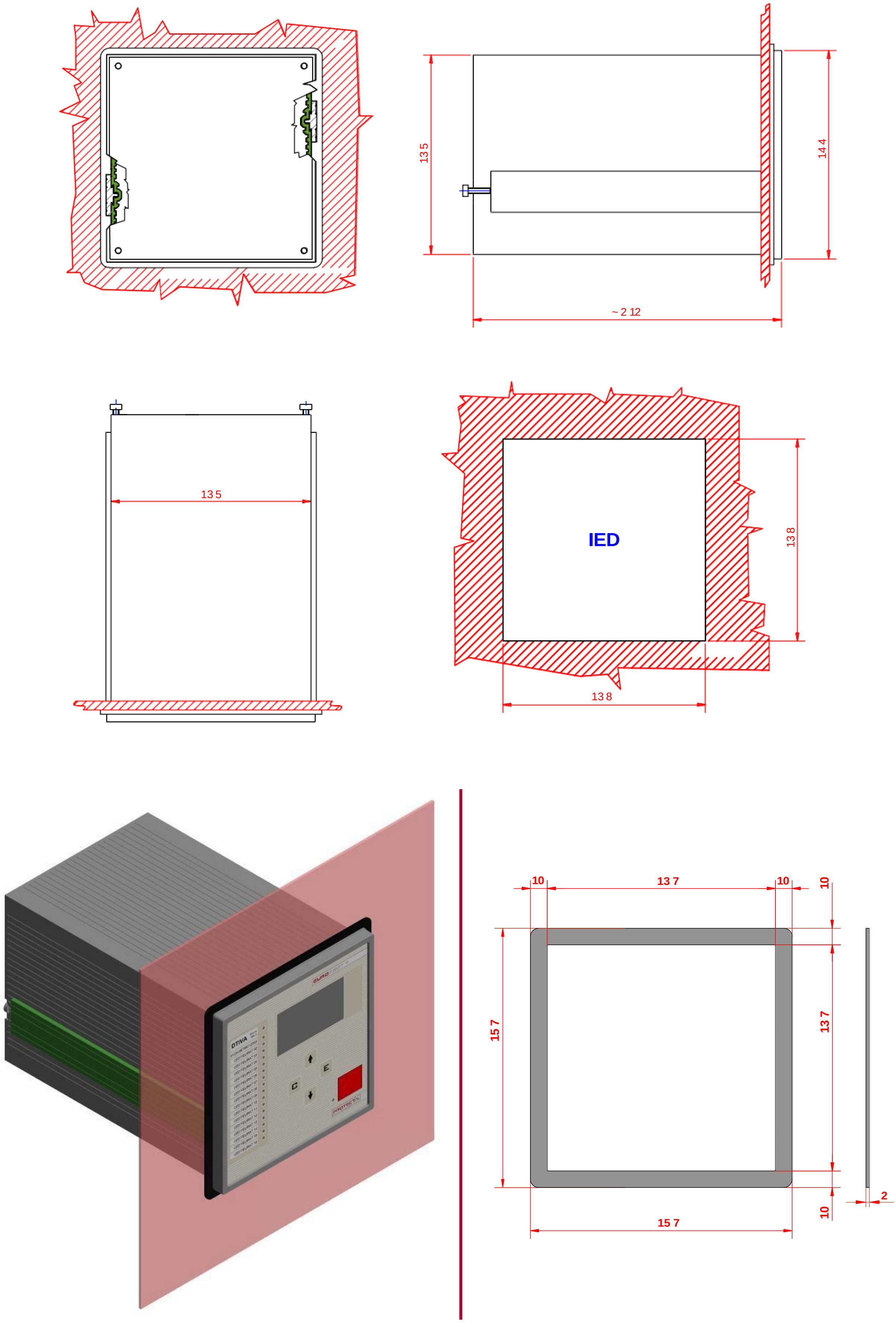


Figure 21-5 Dimensions for flush mounting of 24 HP panel instrument case with 3D illustration

1.3.23.2. Rack mounting

When rack mounting is used, the devices do not have a cover profile fit on, so it is possible to mount them in a 19" rack.

1.3.23.2.1. Rack mounting of 84 HP and 42 HP single rack

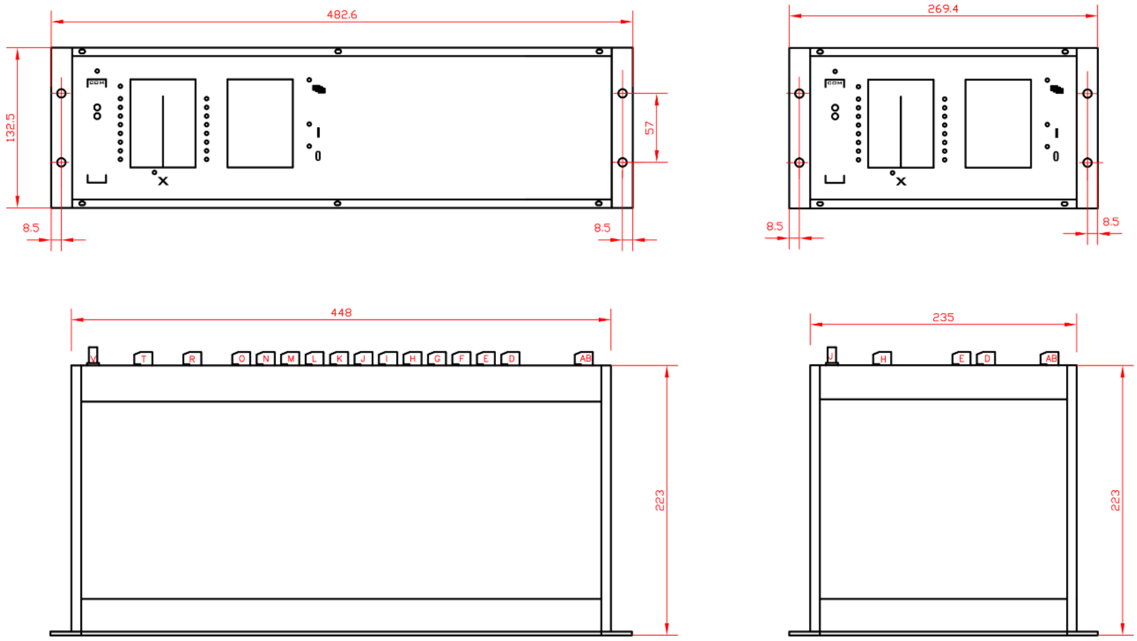


Figure 21-6 Dimensions for rack mounting of 84 HP and 42 HP single rack

Note that rack mounting type devices can also be mounted in a cut-out (e.g. on a switchgear door). It is possible to mount them from the front or from the back of the cut-out. The dimensions for rack mounting cut-outs are in the figure below. Dimensions in brackets are applicable in case of mounting from the back.

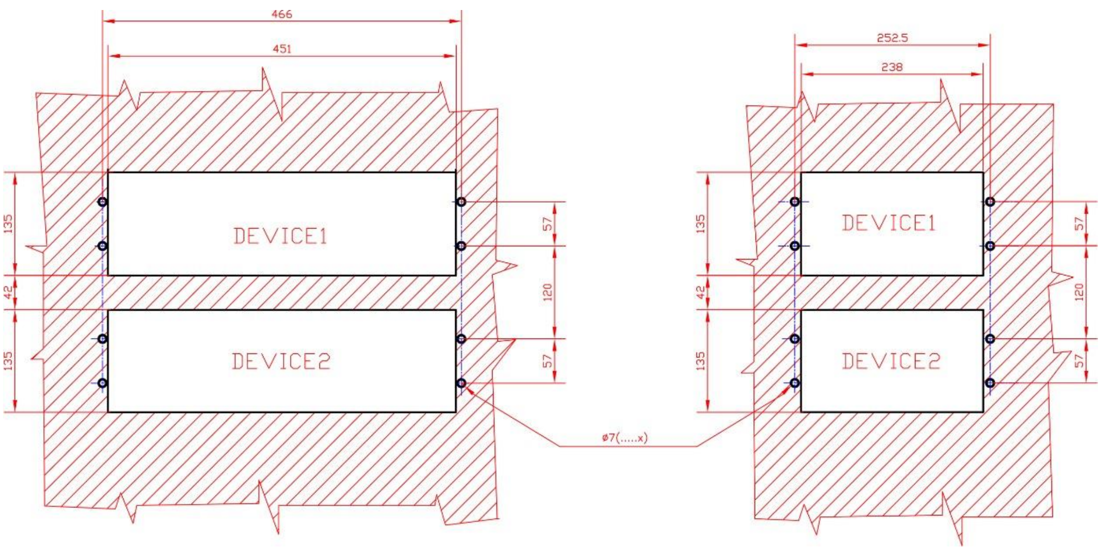


Figure 21-7 Dimensions of rack mounting cut-outs

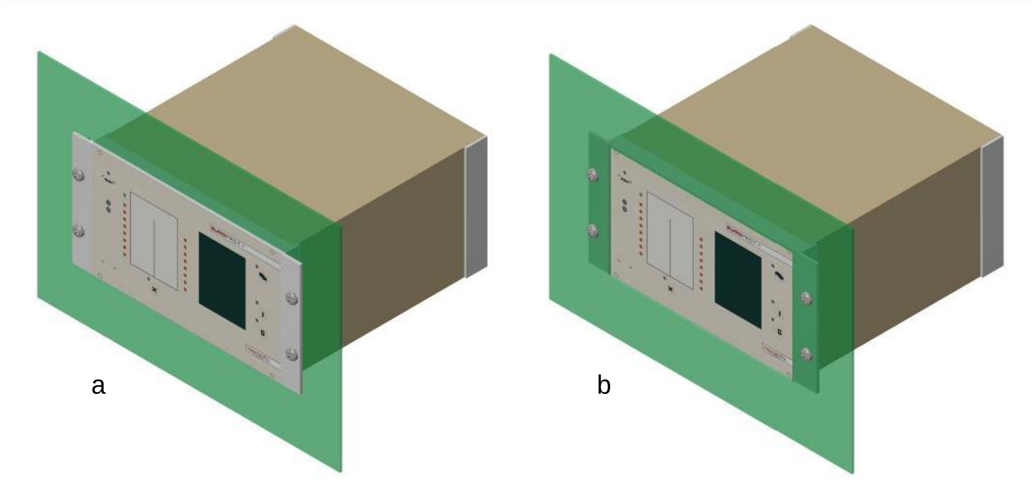


Figure 21-8 3D illustration for rack mounting of 42 HP device
(a - from the front; b - from the back)

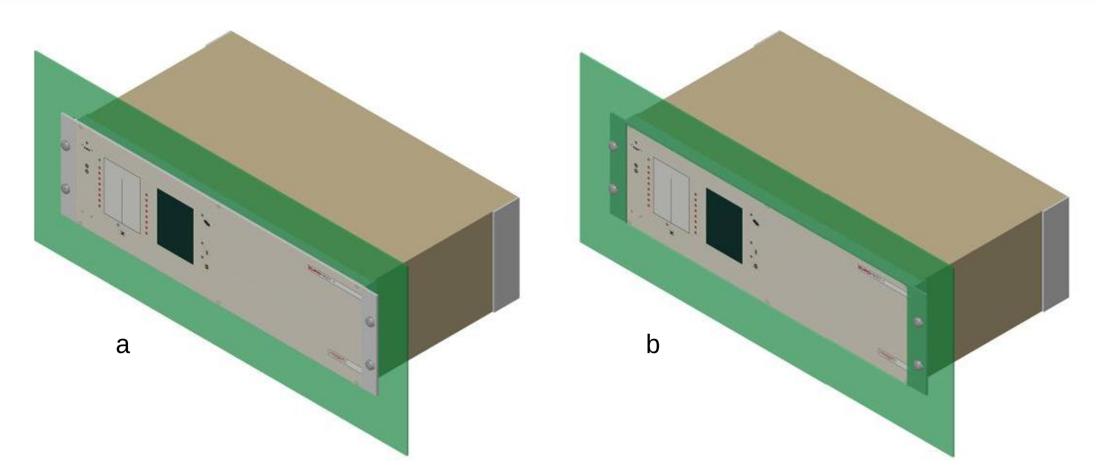


Figure 21-9 3D illustration for rack mounting of 84 HP device
(a - from the front; b - from the back)

1.3.23.2.2. Rack mounting of 42 HP double rack

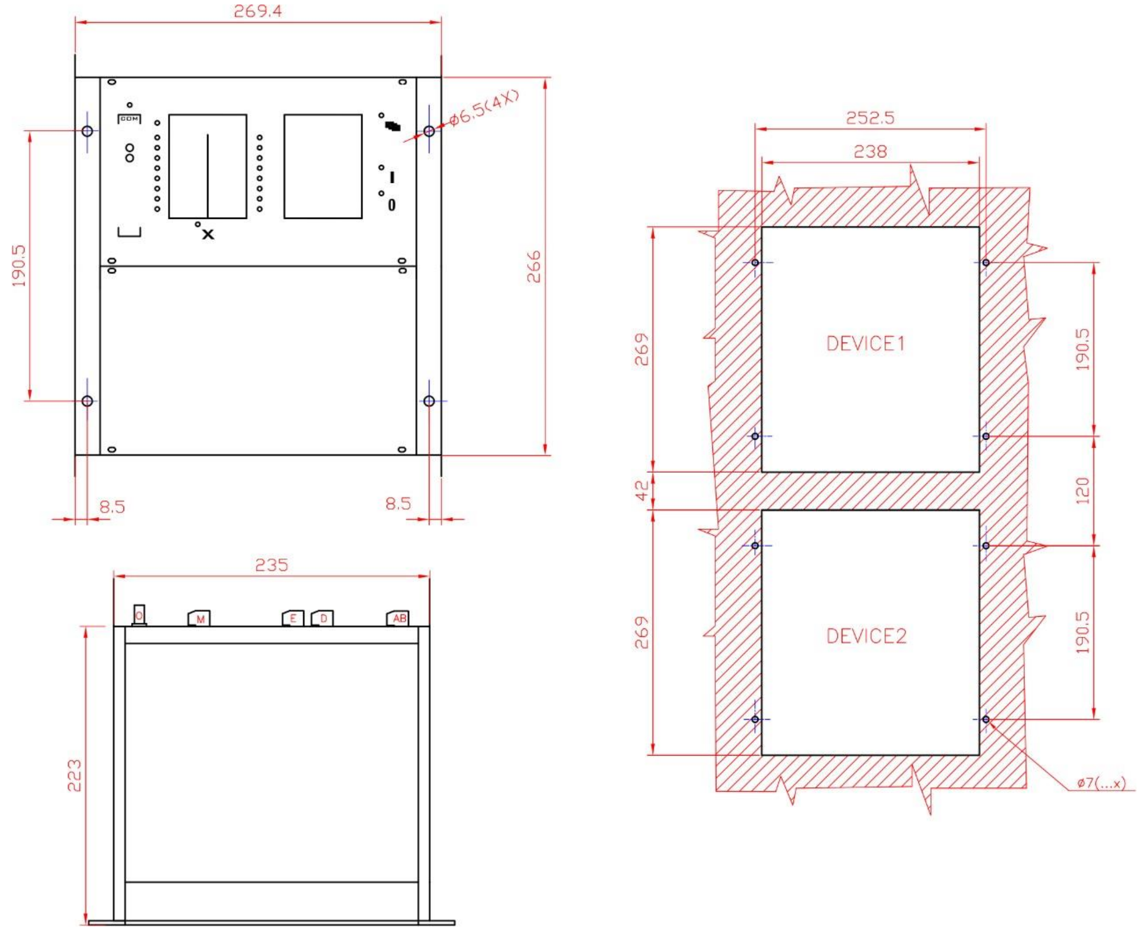


Figure 21-10 Dimensions for rack mounting of 42 HP double rack

1.3.23.3. Semi-flush mounting

Semi-flush mounting can be used for 84 HP and 42 HP single racks, for 24 HP panel instrument cases and for remote HMI devices. The purpose of this type of mounting alternative is to reduce the depth of the devices in the switchgear/rack if there is not enough space in that direction. To achieve this, a special mounting collar must be fit on the rack type devices. The default color of the mounting collar is grey (RAL 7035).

The dimensions of the special mounting collars and the cut-outs for the 84 HP and 42 HP devices are also applicable for the same sized remote HMI devices.

1.3.23.3.1. Semi-flush mounting of 84 HP single rack

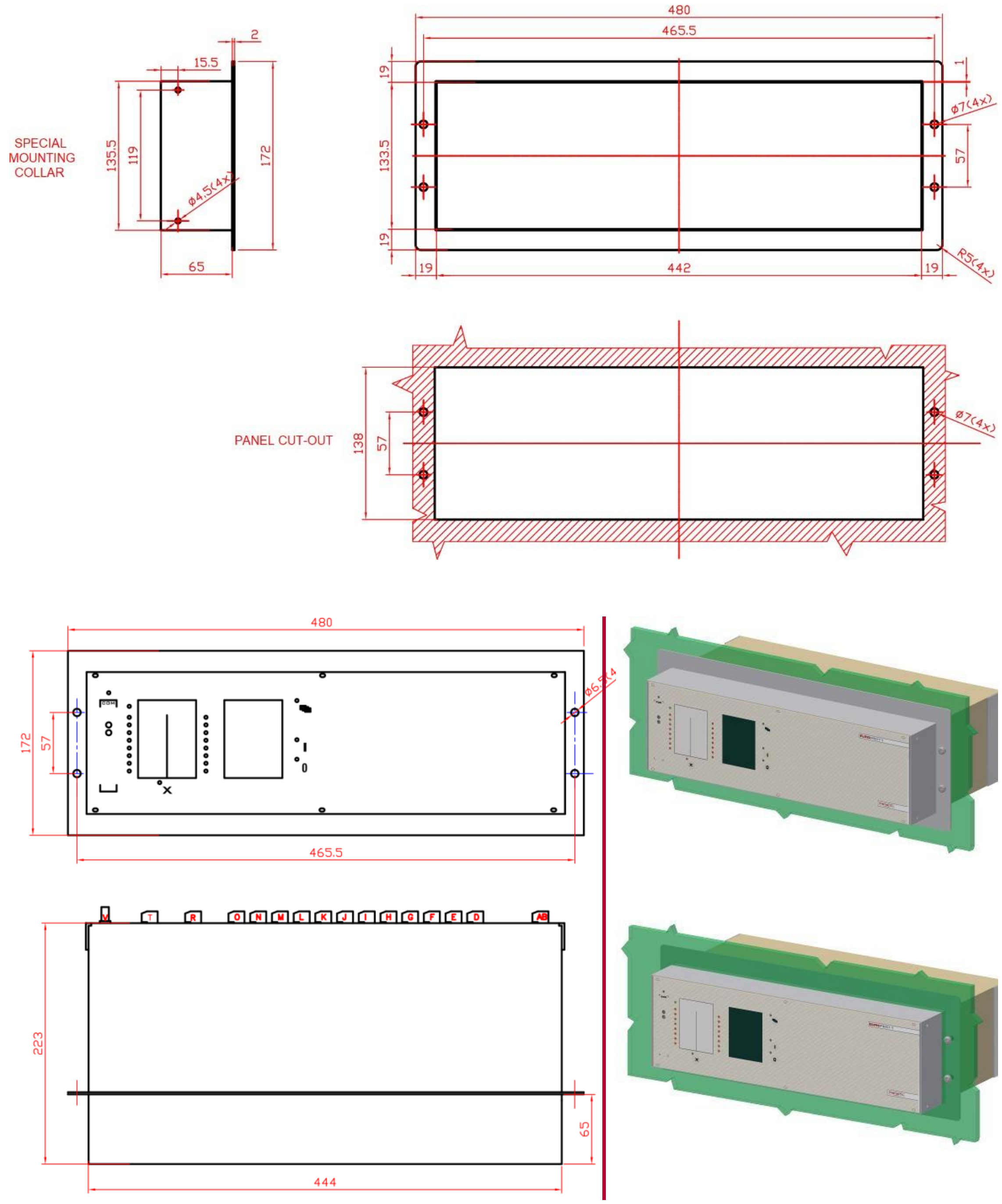


Figure 21-11 Dimensions for semi-flush mounting of 84 HP single rack with 3D illustration

1.3.23.3.2. Semi-flush mounting of 42 HP single rack

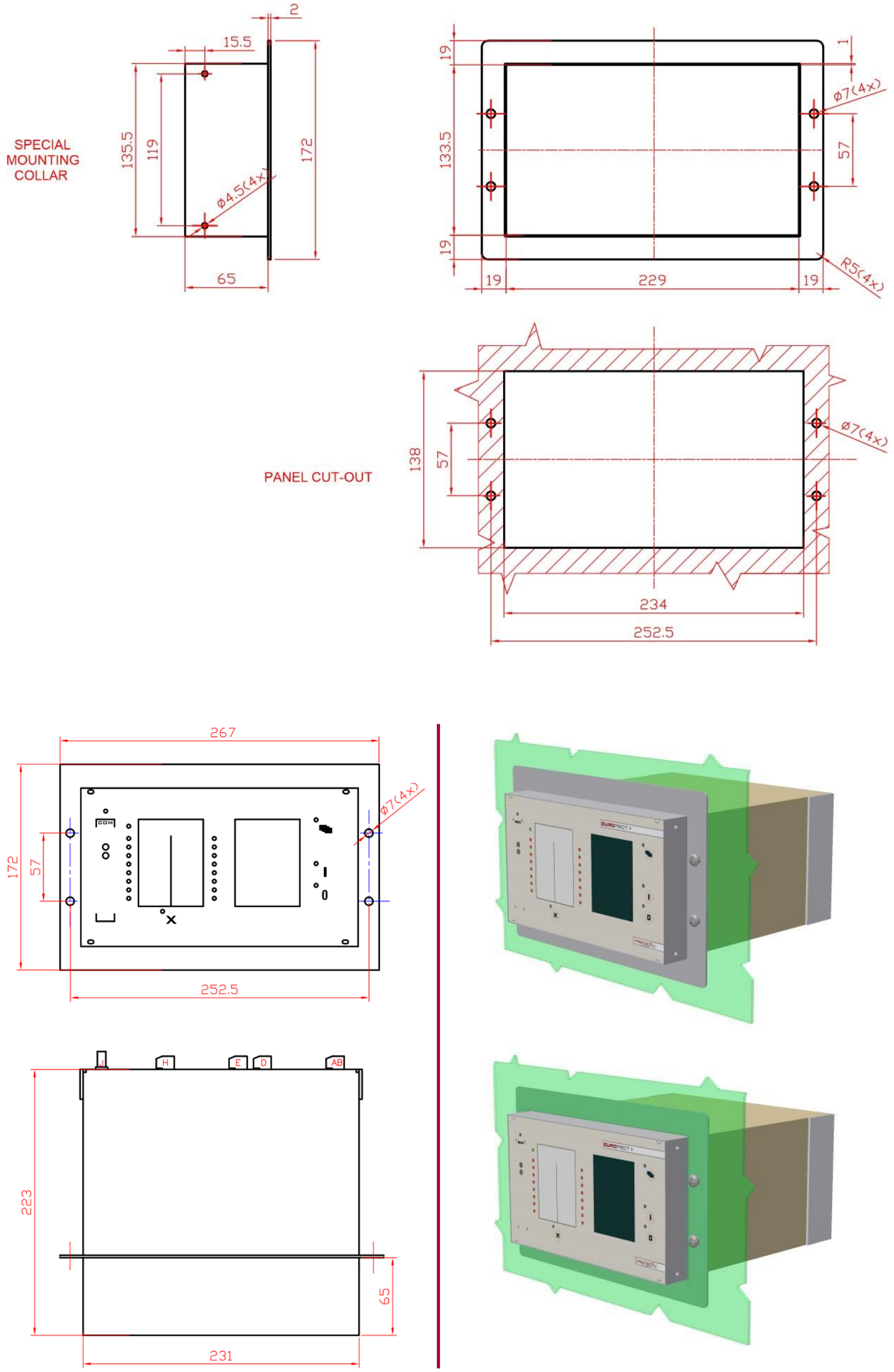
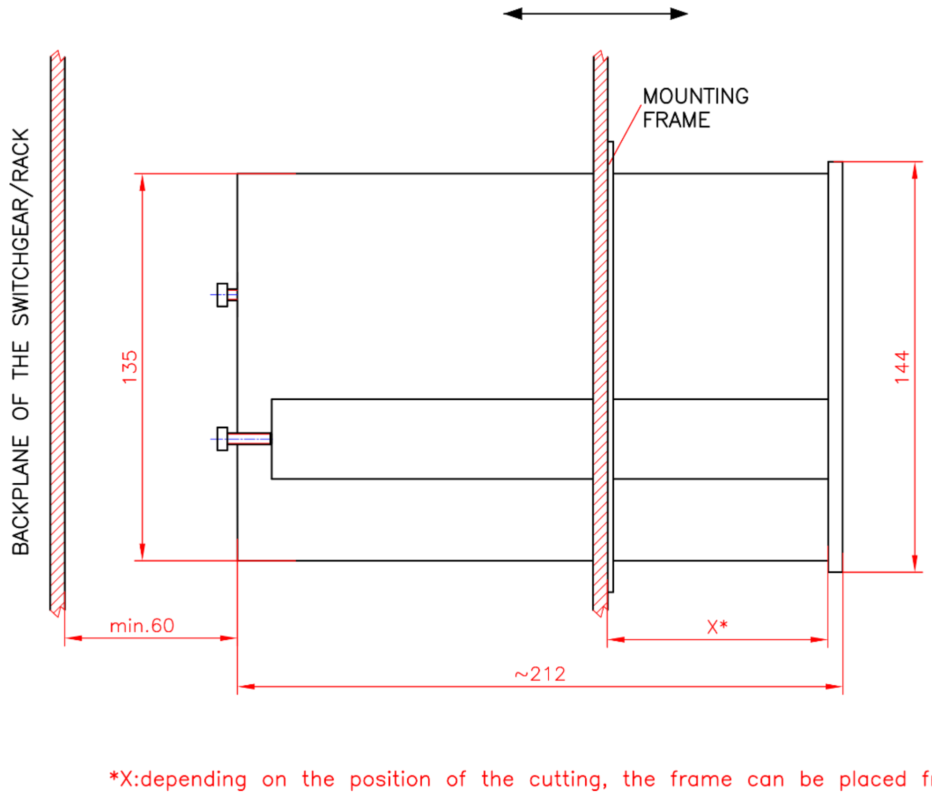


Figure 21-12 Dimensions for semi-flush mounting of 42 HP single rack with 3D illustration

1.3.23.3.3. Semi-flush mounting of 24 HP panel instrument case

The dimensions of the panel cut-out for this type of mounting method are the same as in case of flush mounting (138 mm × 138 mm). For semi flush mounting, it is enough to cut in two the fixing elements (with green colour in the 3D illustration below) and to make the assembly as shown in the pictures below.

Note that the IP54 front panel option cannot be utilized with this type of mounting.



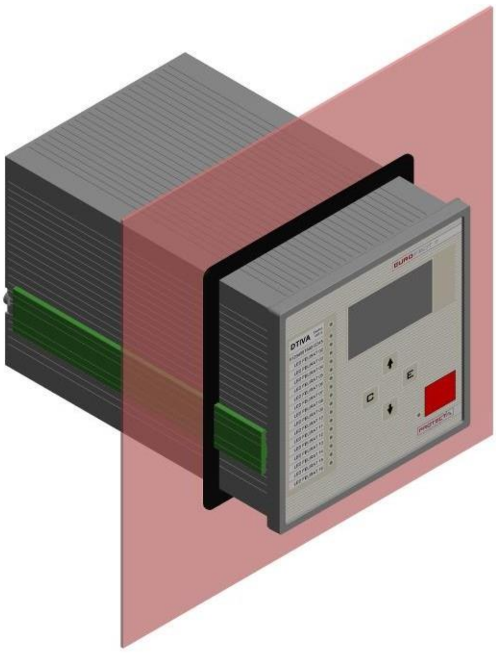


Figure 21-13 Dimensions for semi-flush mounting of 24 HP panel instrument case with 3D illustration

1.3.23.4. Wall mounting of 42 HP and 84 HP devices

Depending on the amount of the terminal contacts, it is possible to use both upper and lower terminals.

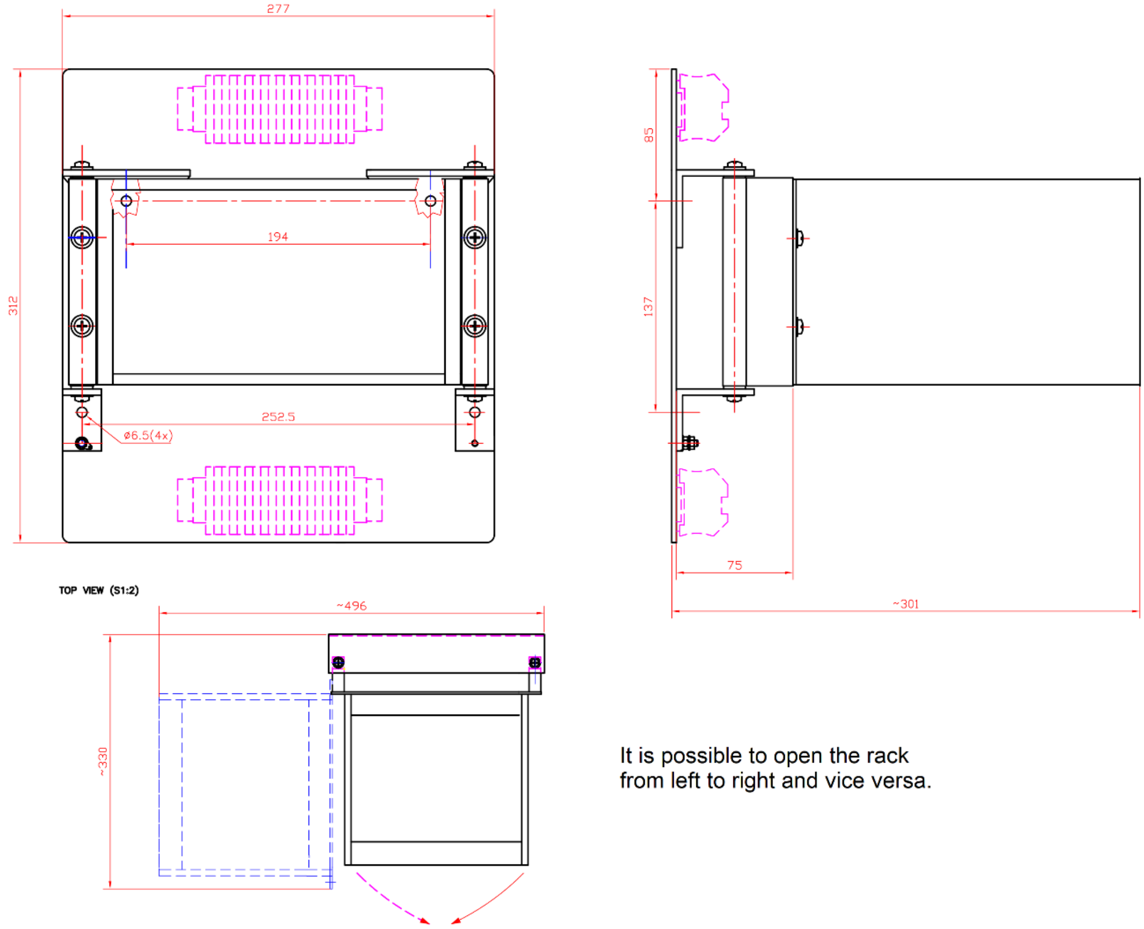


Figure 21-14 Dimensions for wall mounting of 42 HP devices (upper and lower terminals)

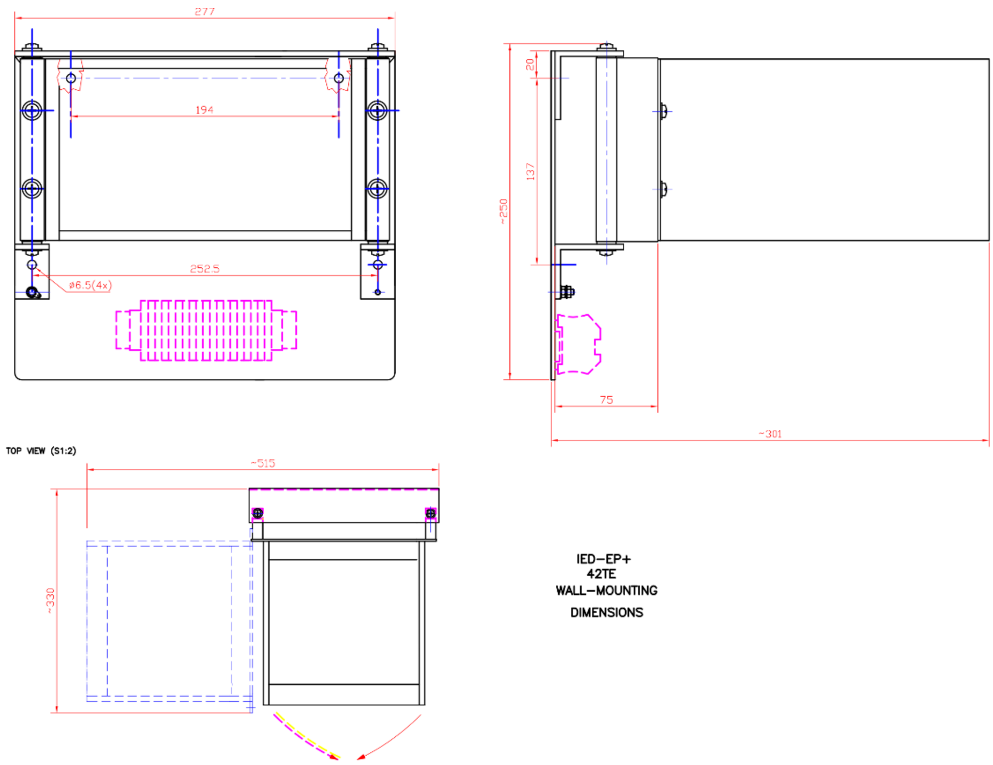


Figure 21-15 Dimensions for wall mounting of 42 HP devices (lower terminal only)

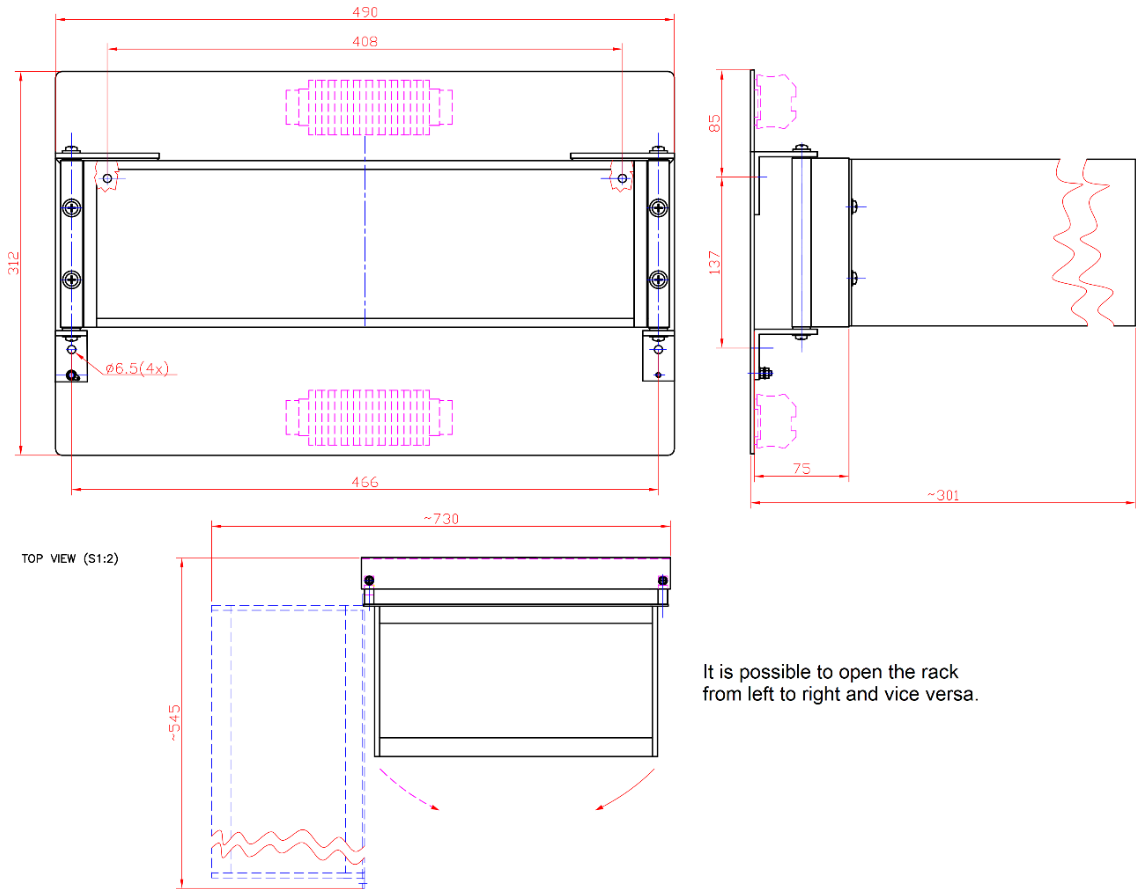


Figure 21-16 Dimensions for wall mounting of 84 HP devices (upper and lower terminals)

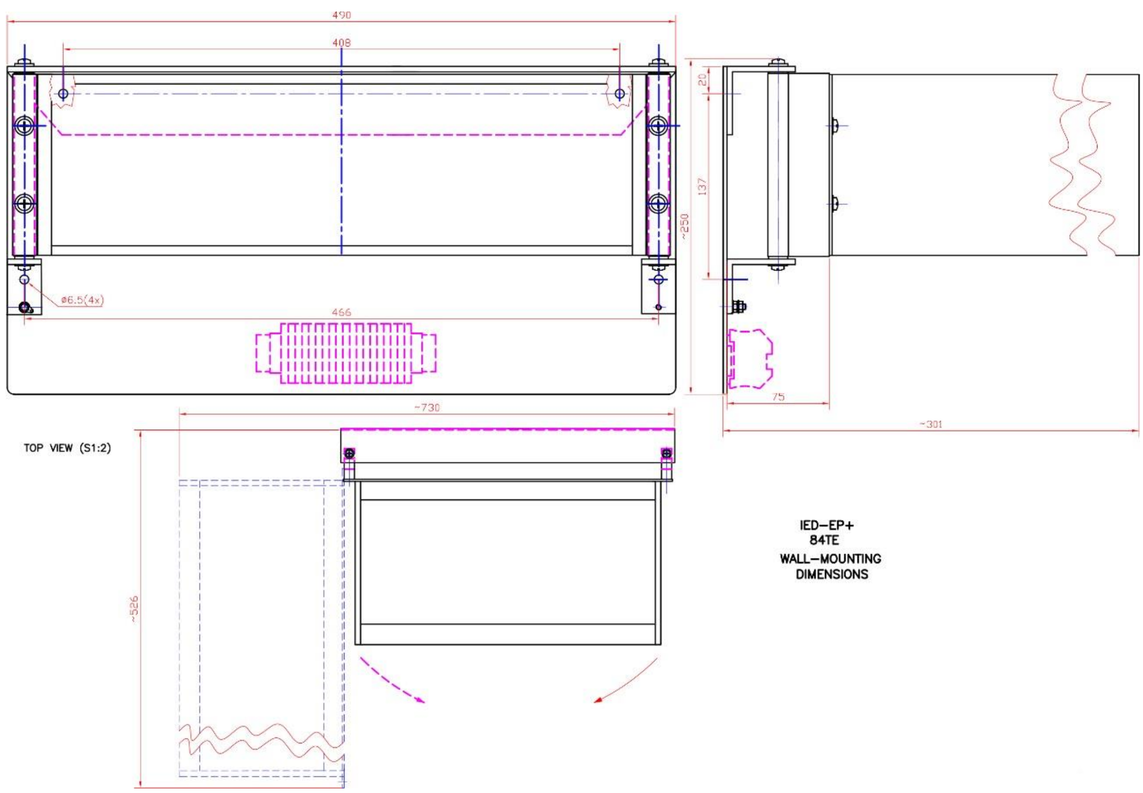


Figure 21-17 Dimensions for wall mounting of 84 HP devices (lower terminals only)

1.3.23.5. Din rail mounting of 24 HP panel instrument case

Note that the IP54 front panel option cannot be utilized with this type of mounting.

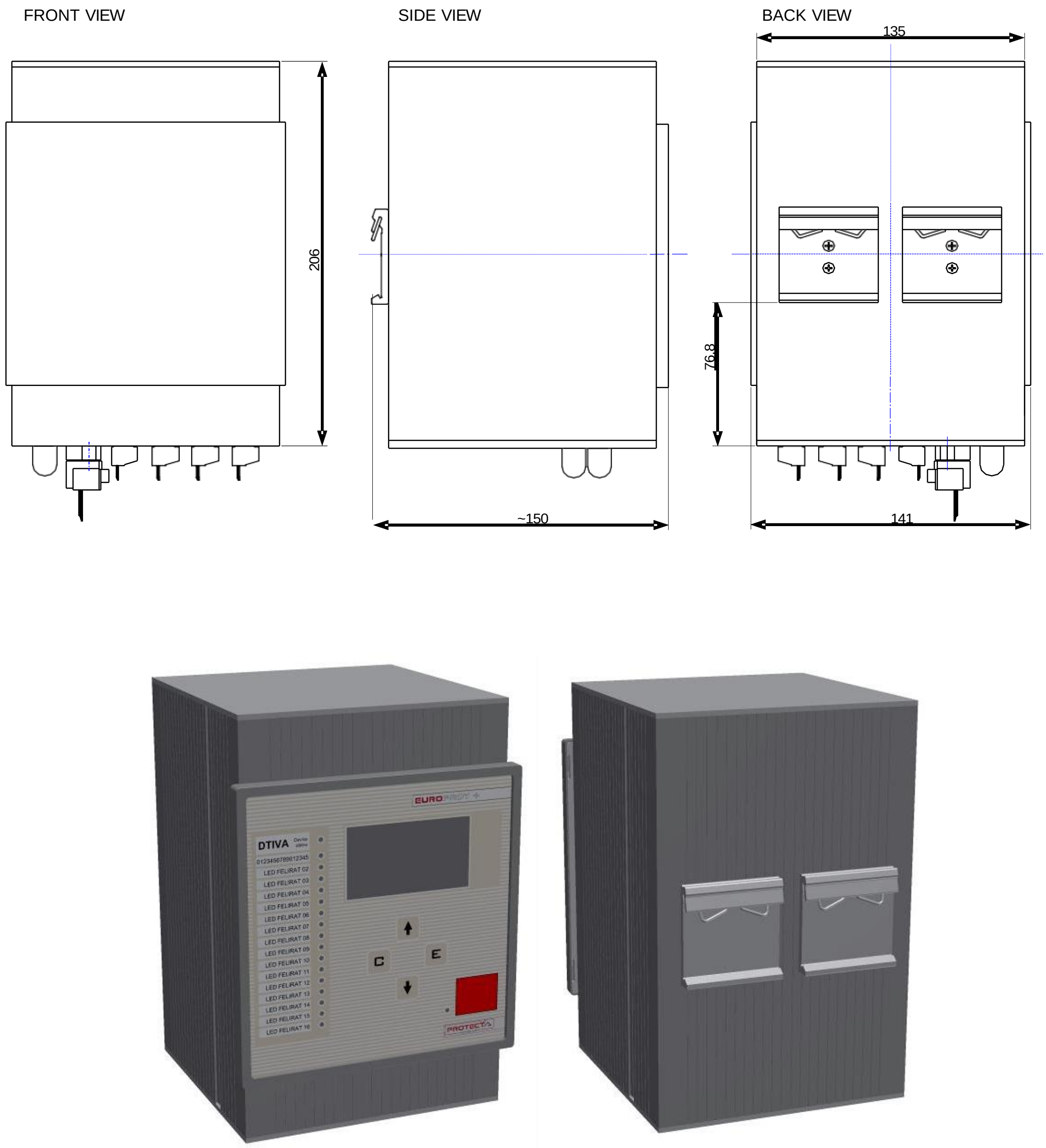


Figure 21-18 Dimensions for din rail mounting of 24 HP panel instrument case

1.3.23.6. IP54 rated mounting kit

The IP frame seen below provides IP54 protection from front side for 84HP and 42HP devices.

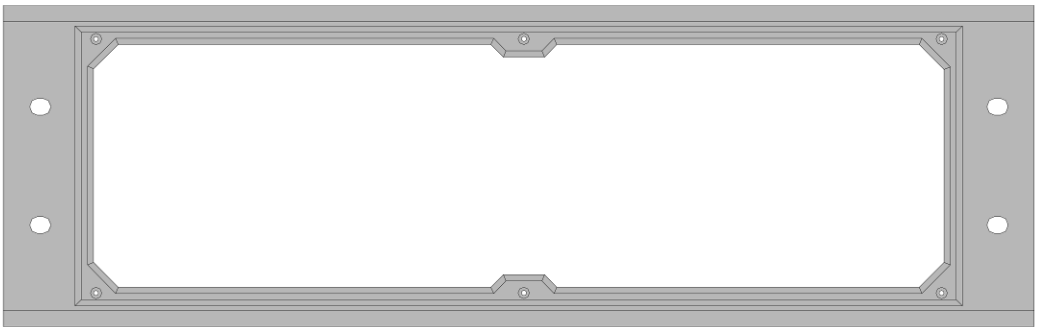


Figure 21-19 84 HP IP frame front view

Figure 21-20 42 HP IP frame front view

S24 devices

The S24 devices' front panel *does not differ from the normal front panel on the outside*, as there is IP54 gasket applied within the frame itself. Devices ordered with this option must be mounted by *flush mounting*; with other types of mountings (e.g. semi-flush), the IP54 protection is not guaranteed!

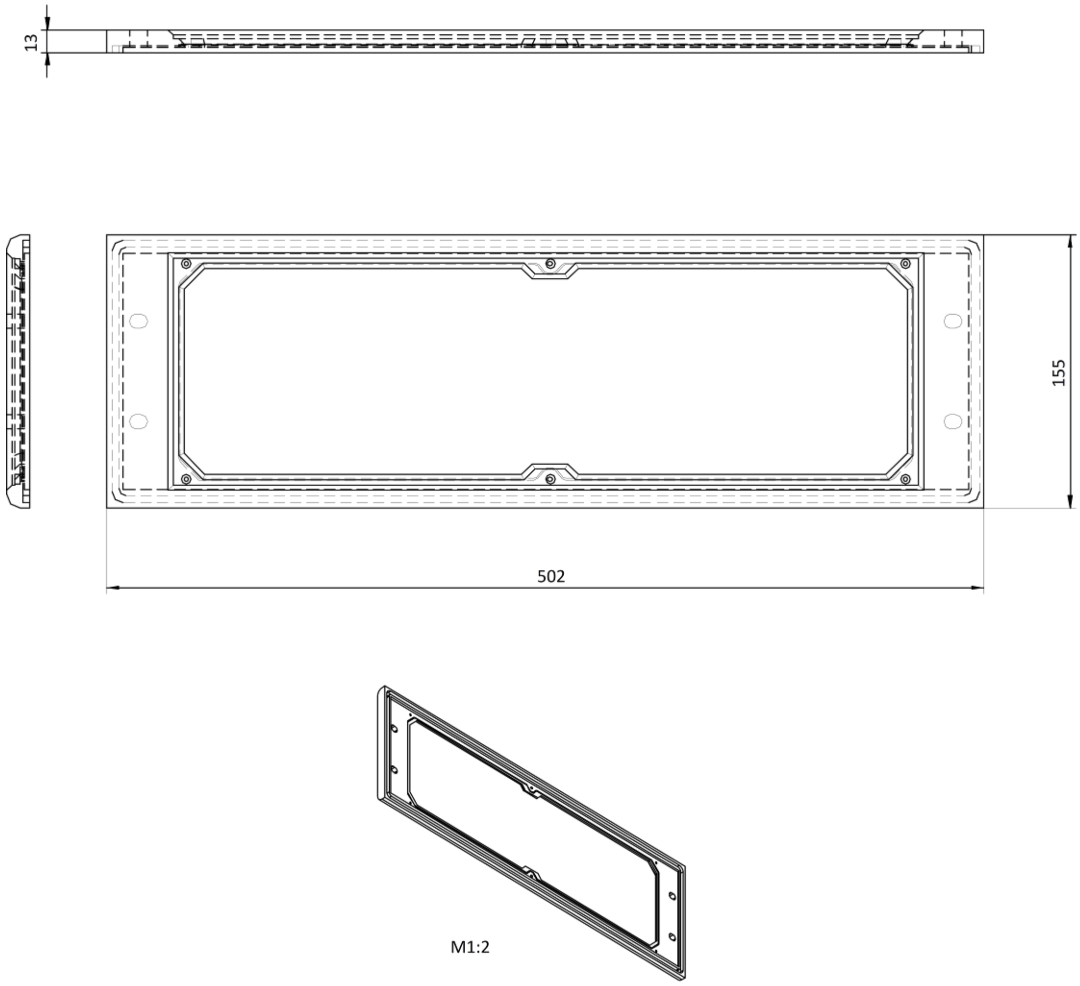


Figure 21-21: 84 HP IP frame dimensions

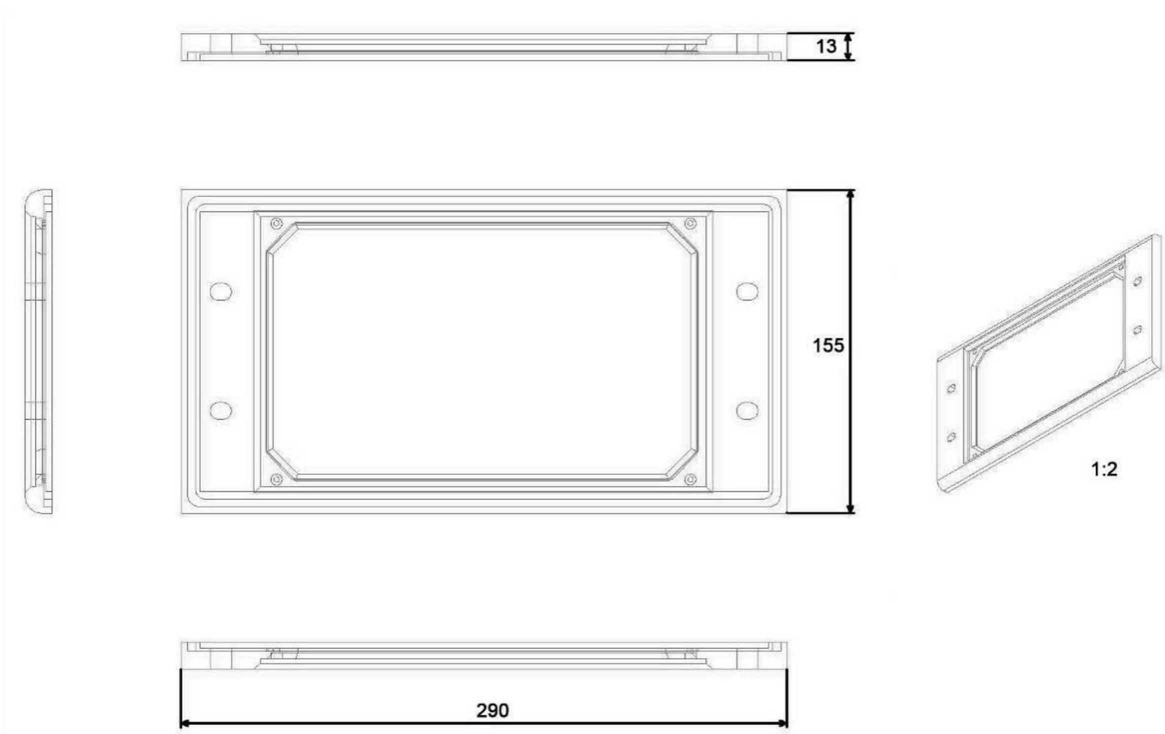


Figure 21-22 42 HP IP frame dimensions

1.3.23.7. Fold-down mounting

1.3.23.7.1. Fold-down mounting without terminals

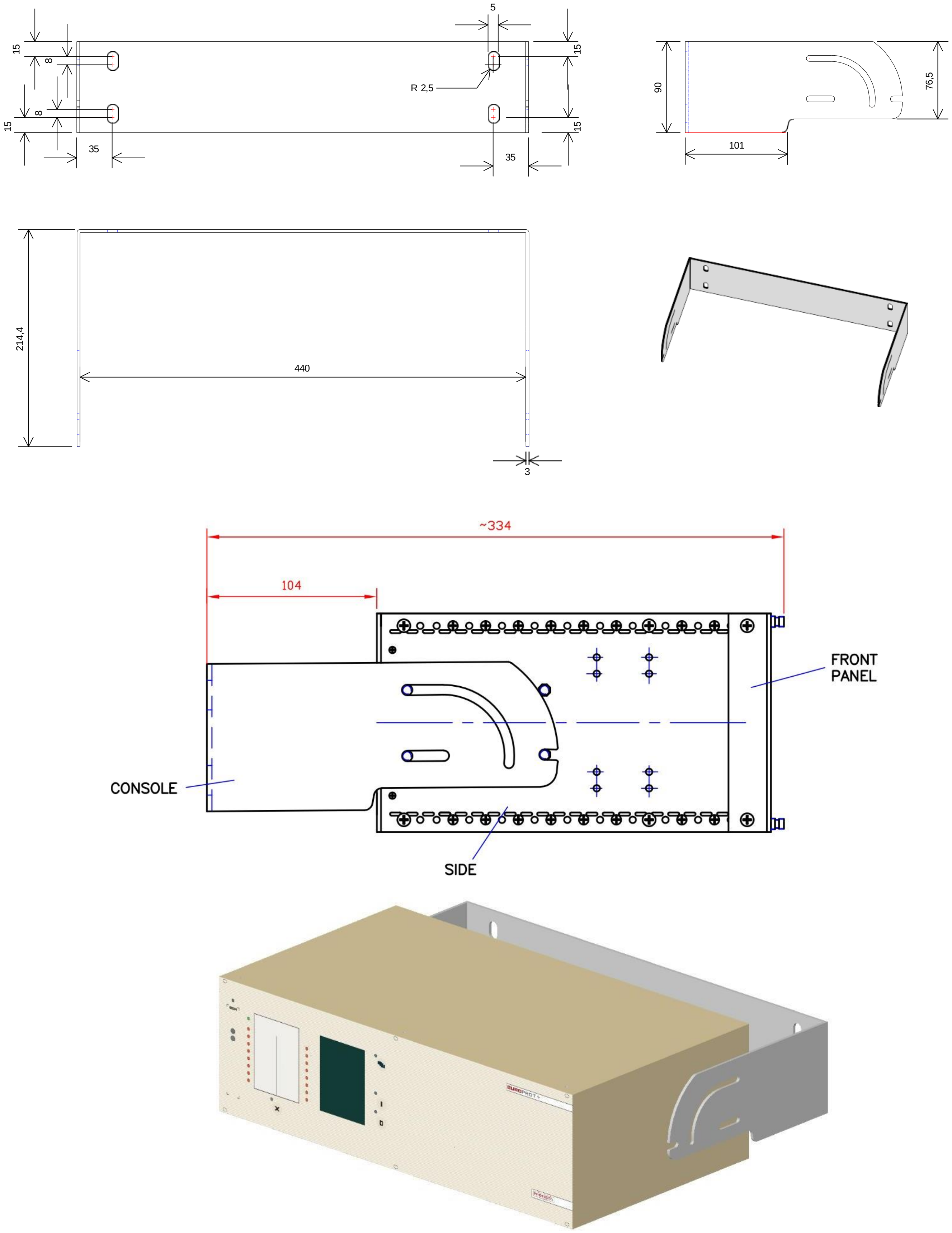


Figure 21-23 84 HP fold-down mounting

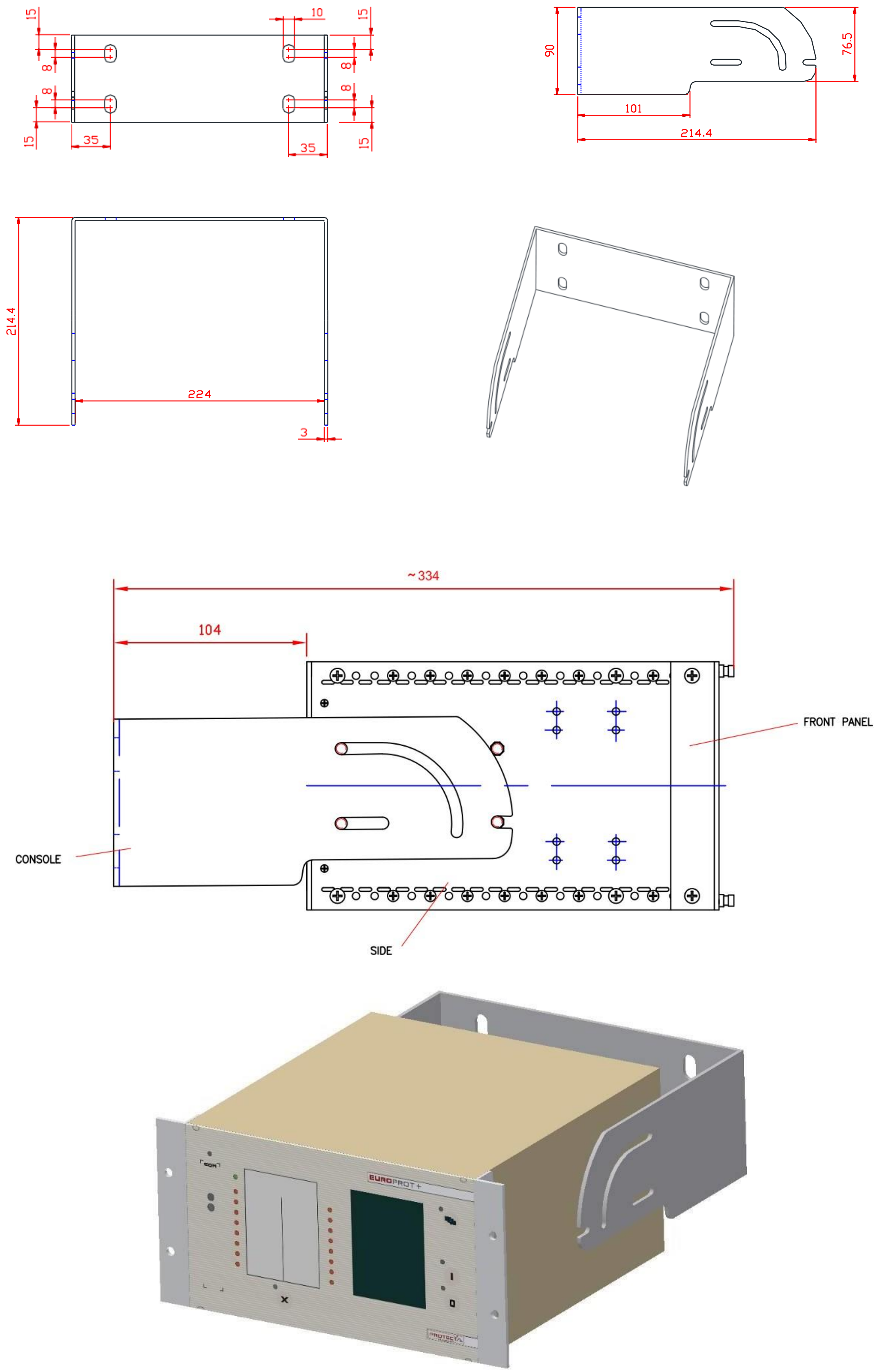


Figure 21-24 42 HP fold-down mounting

1.3.23.7.2. Fold-down mounting with terminals

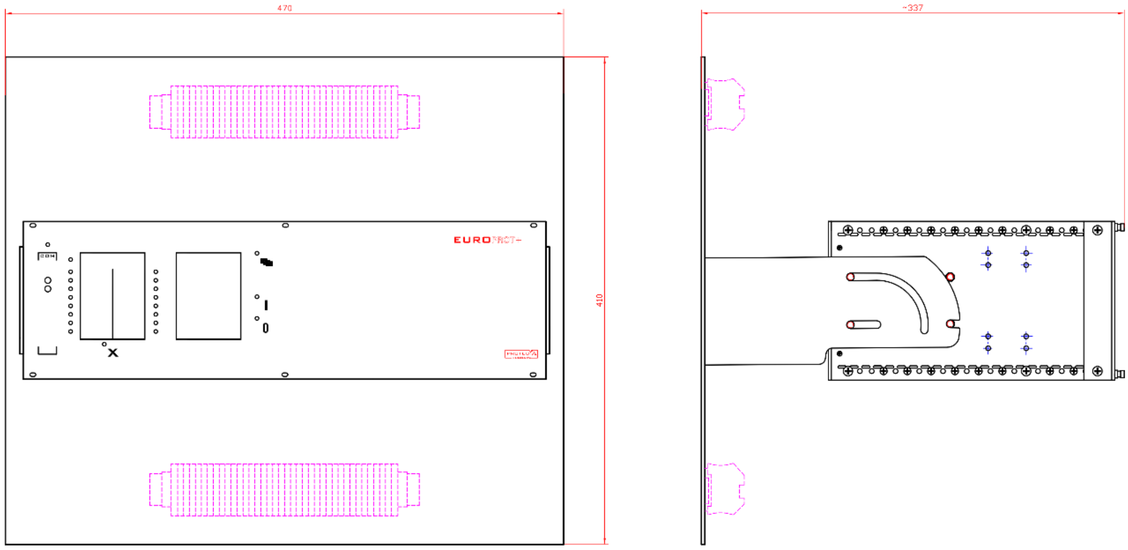


Figure 21-25 Fold-down mounting with terminals for 84HP devices

*fastening points are customized

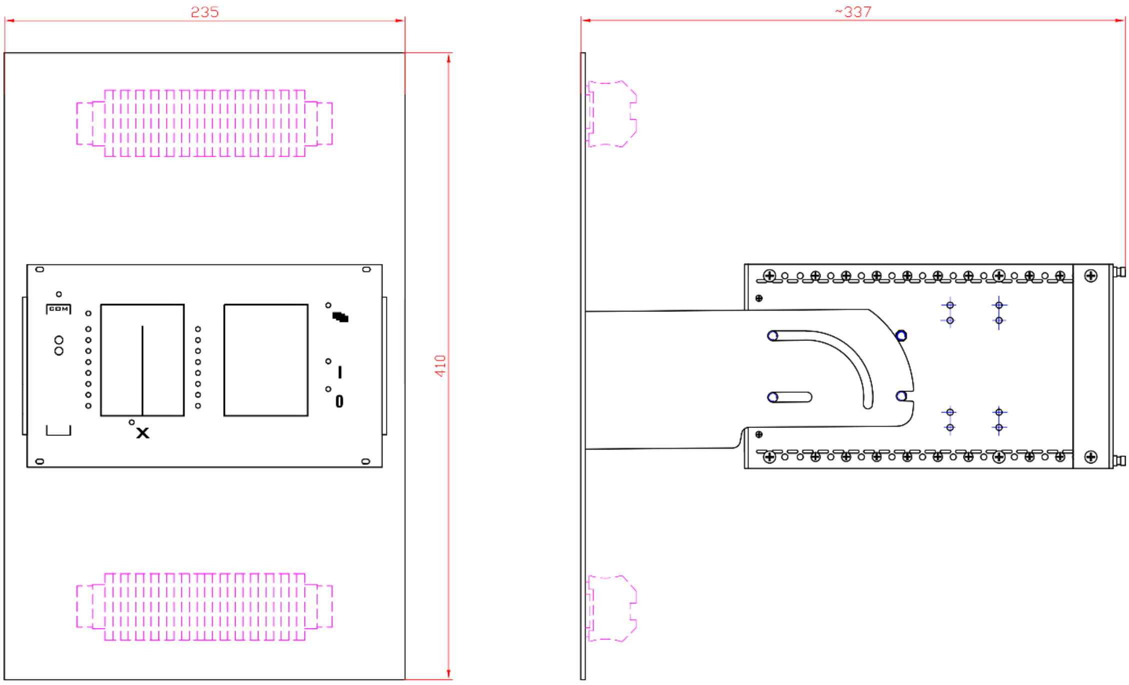


Figure 21-26 Fold-down mounting with terminals for 42HP devices

1.3.23.8. No mounting

"No mounting" means that the 84 HP and 42 HP devices do not have any mounting accessories on them.

This mounting method is only applicable if the device is for demonstration application.

For more information about this topic please contact our Application Team. (*application@protecta.hu*)

IMPORTANT
The dimensions of the cut-outs applicable for the remote HMI are depending on which previously mentioned mounting method is used (flush mounting, semi-flush mounting or rack mounting).

1.3.23.9. Remote HMI devices

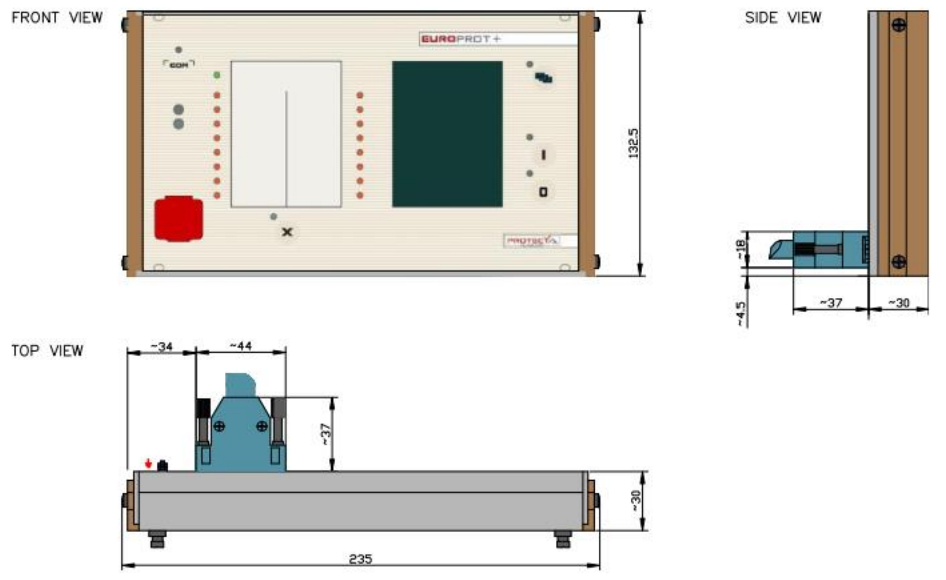


Figure 21-27 Dimensions for 42 HP wide remote HMI

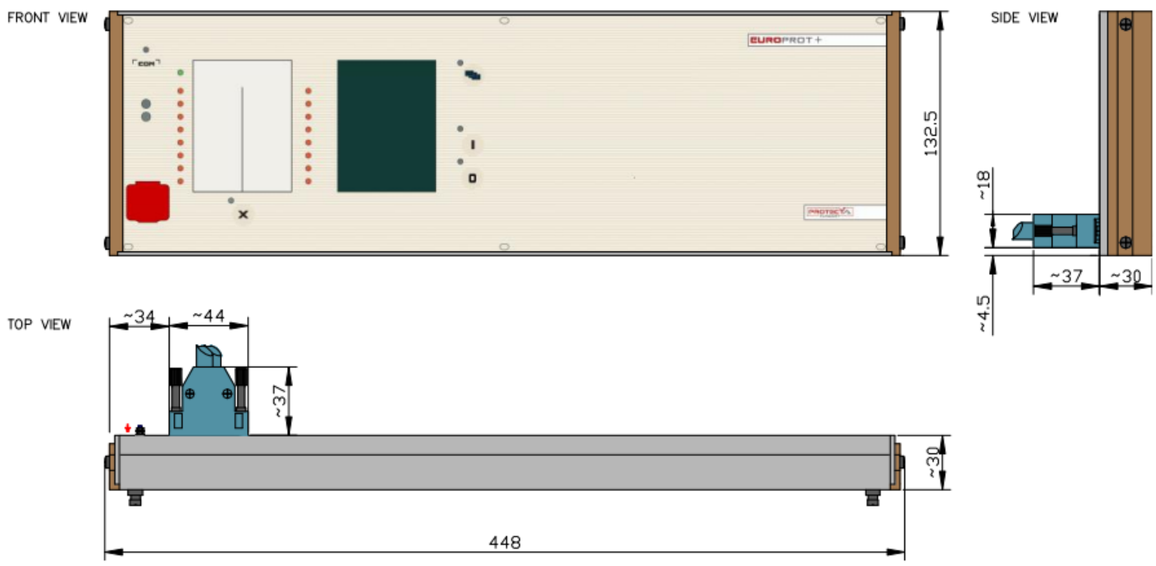


Figure 21-28 Dimensions for 84 HP wide remote HMI

1.3.24. Product availability (special and obsolete modules)

In this chapter you can read a list of the modules that have not regular availability for any reason (being obsolete or being used only in special configurations).

Special modules:

These modules can be ordered in case of special applications which are indicated for each module at its description in the previous chapters.

For more information about these devices please contact our Application Team. (application@protecta.hu)

Optional connectors:

The optional connectors are indicated at each module's description in the previous chapters. If a module is to be shipped with an optional connector, the issue must be discussed during ordering.

MODULE TYPE	COMMENT	DATE
CPU+/0001	Legacy CPU card, not recommended for new configurations. Replacement: CPU+1211	2013-06-12
CPU+/0002	Legacy CPU card, not recommended for new configurations. Replacement: CPU+1111	2013-06-12
CPU+/0003	Legacy CPU card, not recommended for new configurations. Replacement: CPU+1101	2013-06-12
CPU+/0004	Legacy CPU card, not recommended for new configurations. Replacement: CPU+1201	2013-06-12
CPU+/0005	Legacy CPU card, not recommended for new configurations. Replacement: CPU+1281	2013-06-12
CPU+/0006	Legacy CPU card, not recommended for new configurations. Replacement: CPU+1381	2013-06-12
CT+/1155	Available only for special configurations.	2013-06-12
CT+/5152	Available only for OGYD bay unit configurations.	2013-06-12
VT+/2215	Available only for special configurations.	2013-06-12
O12+/2101	Available only for demonstration applications.	2013-06-12
O12+/4201	Available only for demonstration applications.	2013-06-12
R4S+/01	Available only for special configurations.	2013-06-12
R4S+/16	Available only for special configurations.	2013-06-12
TRIP+/1101	Obsolete module. Not recommended for new designs.	2013-06-12
PS+/1602	Available only for special configurations.	2013-06-12
HMI+/2401	Obsolete module. Not recommended for new designs.	2014-10-06

HMI+/2404	Smart Line S24 special selection modules.	2014-10-06
HMI+/2504	Smart Line S24 special selection modules.	2014-10-06
COM+/8882	Available only for special configurations.	2014-10-06
CT+/1111	Available only for special configurations.	2014-10-06
CT+/2500	Available only for special configurations.	2014-10-06
CT+/5153	Available only for special configurations.	2014-10-06
VT+/2212	Available only for special configurations.	2014-10-06
R8+/01	Available only for special configurations.	2014-10-06
R8+/A1	Available only for special configurations.	2014-10-06
R8+/C0	Available only for special configurations.	2014-10-06
R8+/FF	Available only for special configurations.	2014-10-06
R12+/4400	Available only for special configurations.	2014-10-06
R16+/0101	Available only for special configurations.	2014-10-06
R16+/0001	Available only for special configurations.	2014-10-06
R16+/A001	Available only for special configurations.	2014-10-06
PS+/4401	Available only for special configurations.	2014-10-06
CT+/2500	Obsolete module. Not recommended for new designs. Replacement: CT+1500.	2015-02-13
PSTP+/2102	Available only for special configurations.	2015-06-23
PSTP+/4202	Available only for special configurations.	2015-06-23
CT+/5111	Available only for special configurations.	2015-12-08
CT+/0101	Available only for special configurations. DEFL earth fault protection only.	2018-03-19
INJ+/0015	Available only for special configurations.	2018-03-19
CT+/5155	Available only for special configurations.	2018-03-26
VT+/2246	Available only for special configurations.	2018-03-26
AIC+/0201	Obsolete module. Not recommended for new designs.	2018-03-26
CT+/5111	Obsolete module. Not recommended for new designs.	2018-03-27
VS+/0031	Obsolete module. Not recommended for new designs.	2018-05-25

R1T+/0001	Available only for special configurations. DMD.	2018-10-05
CT+/5253	Available only for special configurations.	2018-10-05
42 HP housing	The length of the 42 HP box has been reduced from 242 mm to 223 mm. For more information about the previous size of the 42 HP box please see the Figure 22-1.	2018-12-18
AIC+/0200	Obsolete module. Not recommended for new designs.	2019-04-08
PS+/1030	Available only for special configurations.	2020-05-07
PS+/1060	Available only for special configurations.	2020-05-07
HMI+/5001	Obsolete module. Not recommended for new designs.	2020-06-04
HMI+/5002	Obsolete module. Not recommended for new designs.	2020-06-04
HMI+/3502 (for 42HP)	Obsolete module. Not recommended for new designs.	2020-06-04
CT+/1515	Available only for special configurations.	2020-06-04
CT+/5115	Available only for special configurations.	2020-06-04
CT+/5116	Available only for special configurations.	2020-06-04
CT+/5154	Available only for special configurations.	2020-06-04
PSF+/1001	Available only for special configurations.	2020-06-04
RTD+/0200	Available only for special configurations.	2020-06-04
RTD+/1200	Available only for special configurations.	2020-06-04
R4MC+/01	Available only for special configurations.	2020-06-04
PS+/4301	Obsolete module. Not recommended for new designs.	2020-06-04
84 HP housing	The depth of the 84 HP box has been reduced from 242 mm to 223 mm. For more information about the previous size of the 84 HP box, see the Figure 22-1.	2021-04-01
HMI+/3501	Obsolete module. Not recommended for new designs.	2021-04-20
HMI+/3502	Obsolete module. Not recommended for new designs.	2021-04-20
HMI+/5701	Obsolete module. Not recommended for new designs.	2021-04-20
HMI+/5702	Obsolete module. Not recommended for new designs.	2021-04-20
COM+/1202	Obsolete module. Not recommended for new designs.	2021-04-20
COM+/1324	Obsolete module. Not recommended for new designs.	2021-04-29
VT+/2212	Obsolete module. Not recommended for new designs.	2021-05-06
CT+/5154	Obsolete module. Not recommended for new designs.	2021-05-06
O16+/2401	Obsolete module. Not recommended for new designs.	2022-03-22
O16+/4801	Obsolete module. Not recommended for new designs.	2022-03-22

O16+/1101	Obsolete module. Not recommended for new designs.	2022-03-22
O16+/2201	Obsolete module. Not recommended for new designs.	2022-03-22

1.3.24.1. Previous 42HP and 84HP device housings

As of 2021. Q2, not only the 42HP, but the 84HP devices are shipped with shorter racks as well. Note that this is the only difference between the new and old housings. The new racks are shorter by 19 mm from the front, thus their depth is 223 mm instead of 242 mm.

The mounting methods described in Chapter 21 are valid for the previous racks as well, keeping in mind that the depth of the device is 19 mm bigger than that of the drawings. As an example, see the previous drawing of the flush mounting for 42HP and 84HP devices in Figure 22-1. As a comparison, the new, shorter rack is also drawn in **light blue**.

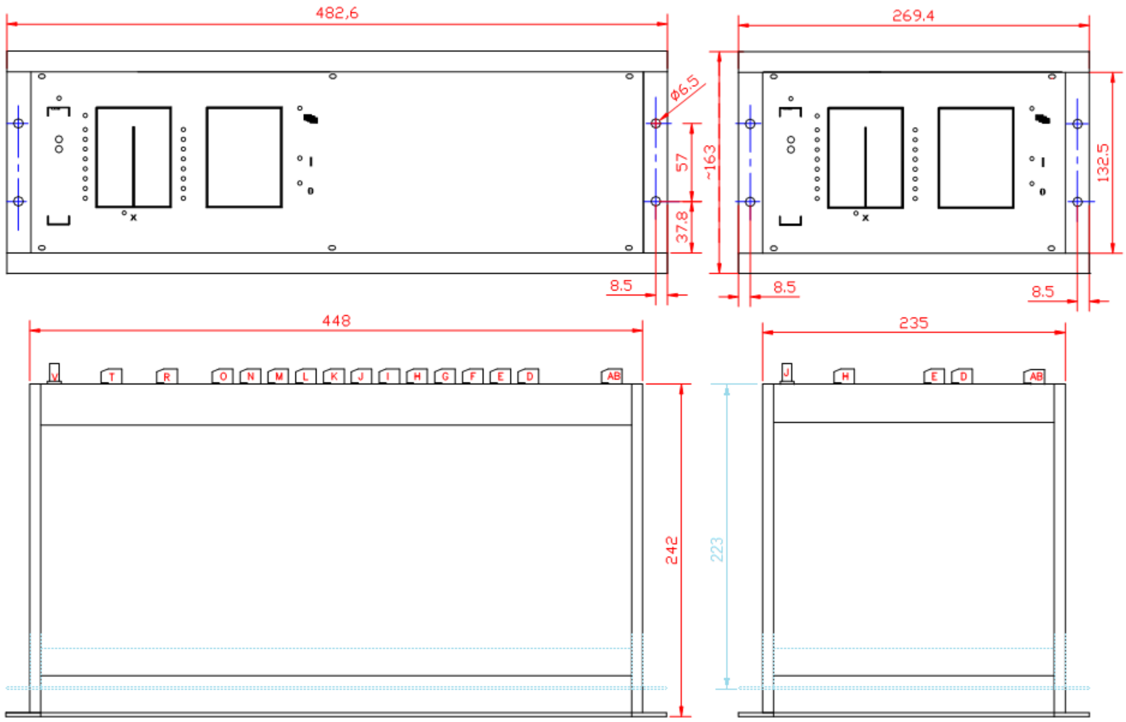


Figure 22-1 Dimensions for flush mounting of the previous 84HP and 42HP single rack, including the new (shorter) rack dimensions as well.

1.3.25. Remote I/O (RIO) server description

1.3.25.1. Introduction

Remote I/O (RIO) server is an IED, which provides remote binary inputs and outputs far from an EuroProt+ protection device.

Figure 1-1 Remote I/O device

Figure 1-2 Front view and rear view with fastening for mounting rail

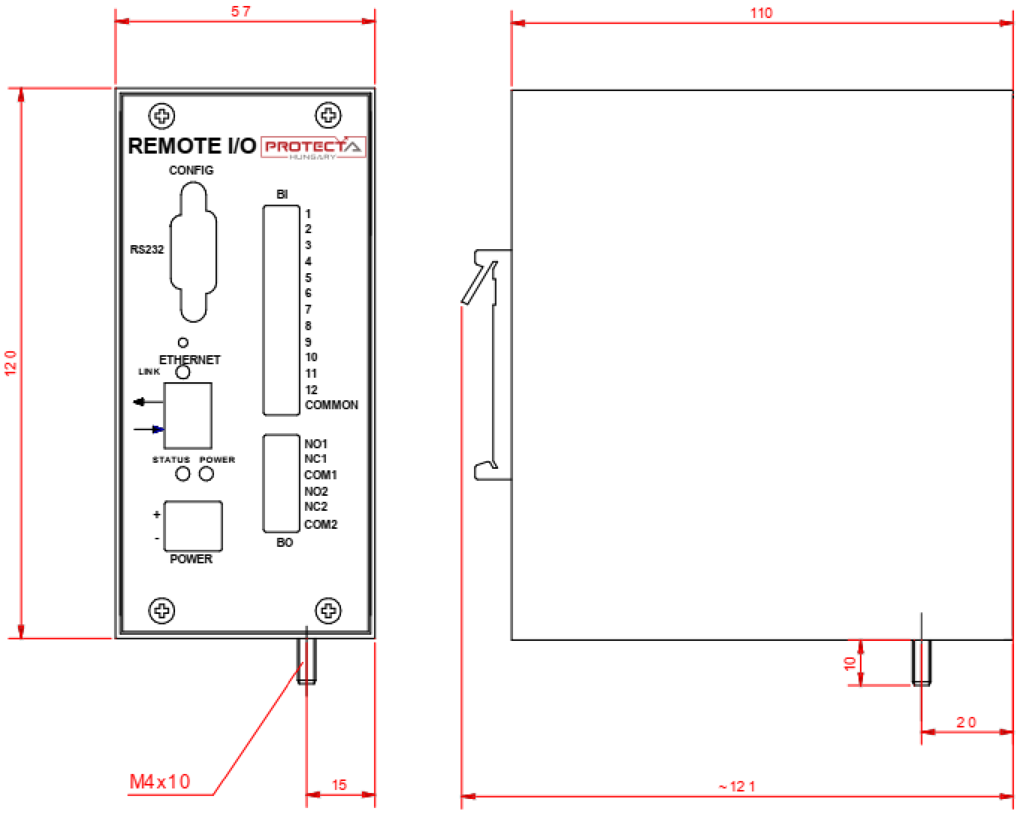


Figure 1-3 Remote I/O dimensions

1.3.25.2. Application

1.3.25.2.1. Connectors, LEDs

The connectors of the device are illustrated in the following figure.

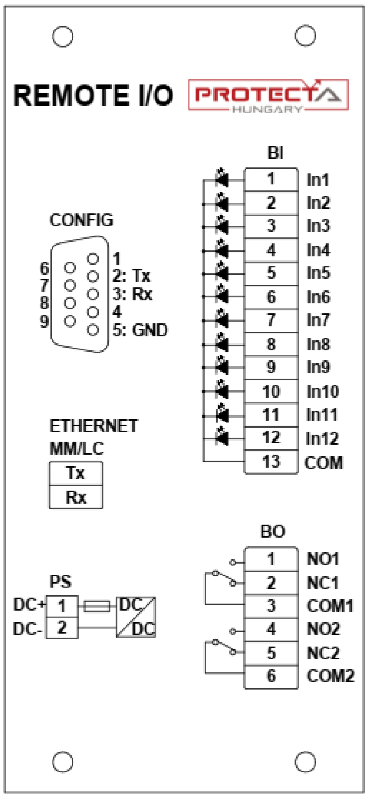


Figure 2-1 Connectors of the device

The RIO server has three LED indicators:

- **LINK**: located at the Ethernet connector; it shows active communication (green color)
- **POWER**: located above the power connector; it lights up if the device is operating (green color)
- **STATUS**: located also above the power connector. The behavior and color of this LED shows different situations:
  - Blinking red: there are no clients connected
  - Blinking alternatively red-green: the server has one client connected
  - Blinking green: two or more clients are connected

1.3.25.2.2. Wiring, usage

The device communicates with the EP+ device using the MODBUS/TCP protocol, via either of the COM+/1202, COM+1324, COM+/1335, COM+/6603 or COM+/6663 modules.

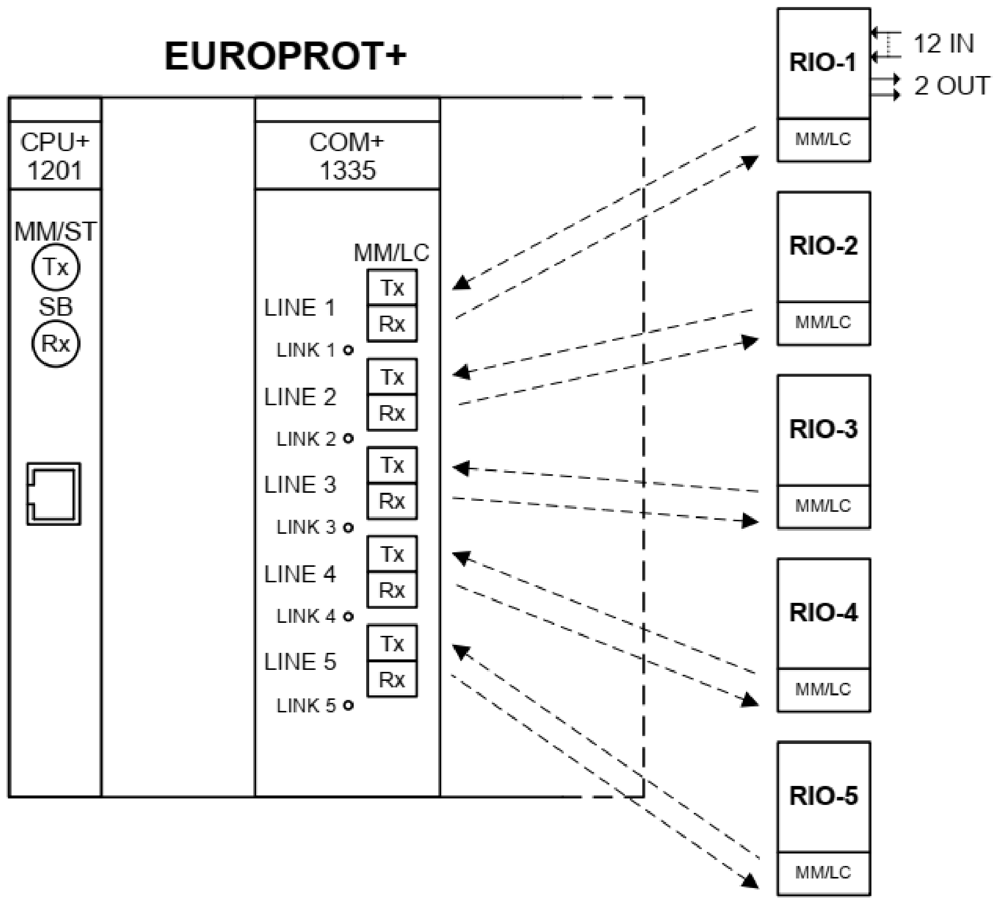


Figure 2-2 Wiring of the Remote I/O-s

The RIO inputs and outputs appear among the other binary inputs and outputs of the EuroProt+ device, and they can be utilized the same way.

1.3.25.3. Sub-modules

The RIO server consists of two mixed function modules:

- SCPU/PS: combination of a CPU and power supply module
- SO12/R2: binary I/O module with 12 inputs and 2 relay outputs

1.3.25.3.1. SCPU/PS sub-module

The SCPU/PS module contains all the control, communication and the power supply functions of the device.

1.3.25.3.1.1. CPU

Table 3-1 Technical data of the RIO CPU

CPU TYPE	ETHERNET INTERFACE	SERVICE PORT
SCPU+0011	MM/LC 1300 nm, 50/62,5/125 µm connector, 100Base-FX	RS232*

**The service port labeled "CONFIG" is only for factory usage*

1.3.25.3.1.2. Power supply, external MCB

Table 3-2 Technical data of the RIO power supply

PS TYPE	INPUT VOLTAGE	NOMINAL POWER	INPUT VOLTAGE INTERRUPTION TIME	INRUSH CURRENT (< 0.1 s)	CONNECTOR TYPE
PS+1101	65-180 V DC	9 W	min. 140 ms @ 110 V DC input voltage	< 10 A	Weidmüller BLA 2/180
PS+2301	176 – 264 V DC 160 – 250 V AC	9 W	min. 50 ms @ 230 V AC input voltage	< 10 A	Weidmüller BLA 2/180

The power supply must be protected by an **external midget circuit breaker**. Note that it is not part of the RIO device:

- Characteristics: **6A C**

1.3.25.3.2. SO12/R2 sub-module

The SO12/R2 module contains 12 binary inputs in one grounding group, and 2 relay outputs with dry contacts.

1.3.25.3.2.1. Binary inputs

Main features:

- Digitally filtered per channel
- Current drain approx.: 2 mA per channel

Table 3-3 Technical data of the binary inputs

BI TYPE	CHANNEL NUMBER	TIME SYNC.	RATED VOLTAGE	THERMAL WITHSTAND VOLTAGE	CLAMP VOLTAGE	CONNECTOR TYPE
SO12+4801	12	-	48 V	72 V	falling 0.71 U_N rising 0.76 U_N	Weidmüller BL 3.5/13/180
SO12+1101	12	-	110 V	250 V	falling 0.7 U_N rising 0.73 U_N	Weidmüller BL 3.5/13/180

Thermal withstand voltage: continuous with 60 % of the input channels energized.

1.3.25.3.2.2. Binary outputs

Main features:

- Breaking capacity, (L/R = 40 ms) at 220 V DC: 0.2 A
- Breaking capacity, (L/R = 40 ms) at 110 V DC: 0.3 A

Table 3-4 Technical data of the relay outputs

BO TYPE	RATED VOLTAGE	CONTINUOUS CARRY	CONTACT VERSIONS	GROUP ISOLATION	CONNECTOR TYPE
R2+0001	250 V AC/DC	6 A	CO	2 independent	Weidmüller BL 3.5/6/180

1.3.25.4. General data

- Storage temperature: - 40 ºC … + 70 ºC
- Operation temperature: - 20 ºC … + 55 ºC
- Humidity: 10 % ... 93 %
- Altitude: up to 2000 m
- Atmospheric pressure: 86 ... 106 kPa

1.3.25.4.1. Standard conformance

- Electrostatic discharge immunity (ESD), IEC-EN 60255-26:2013, Level 4
  - Test voltages: 15 kV air discharge, 8 kV contact discharge
- Radiated, radio-frequency, electromagnetic field immunity, IEC-EN 60255-26:2013 Level 3
  - Test field strength: 10 V/m
- Electrical fast transient/burst immunity (EFT/B), IEC-EN 60255-26:2013, Level 4
  - Test voltage: 4 kV
- Surge immunity test, IEC-EN 60255-26:2013
  - Test voltages: 2 kV line-to-earth, 1 kV line-to-line
- Immunity to conducted disturbances, induced by radio-frequency fields, IEC-EN 60255-26:2013, Level 3
  - Test voltage: 10 V
- Damped oscillatory wave immunity test, IEC-EN 60255-26:2013
  - Test frequency: 1 MHz
  - Test voltage: 2.5 kV in common mode, 1 kV in differential mode
- Voltage dips, short interruptions and voltage variations immunity, IEC-EN 60255-26:2013
  - Voltage dips: 40 % (200 ms), 70 % (500 ms), 80 % (5000 ms)
- Ripple on d.c. input power port immunity, IEC-EN 60255-26:2013
  - Level 4, 15 % of rated d.c. value
- Power frequency magnetic field immunity test, IEC-EN 60255-26:2013, Level 5
  - Test field field strength: 100 A/m continuous, 1000 A/m for 3 s
- Power frequency immunity test on the binary inputs, IEC-EN 60255-26:2013, Class A
  - Test voltages: 300 V in common mode, 150 V in differential mode
- Insulation tests, IEC-EN 60255-27:2013
  - Impulse voltage test
    - Test levels: 5 kV (1 kV for transducer and temperature measuring inputs)
  - Dielectric test
    - Test levels: 2 kV AC 50 Hz (0.705 kV DC for transducer inputs)
  - Insulation resistance
    - Insulation resistance > 15 GΩ
- Radiated emission, IEC-EN 60255-26:2013
  Limits:
  - 30 MHz to 230 MHz: 50 dB(μV/m) quasi peak, 3 m
  - 230 MHz to 1 000 MHz: 57 dB(μV/m) quasi peak, 3 m
  - 1 GHz to 3 GHz: 76 dB(μV/m) peak,3 m
  - 3 GHz to 6 GHz: 80 dB(μV/m) peak,3 m
- Conducted emission, IEC-EN 60255-26:2013
  Limits:
  - 0,15 MHz to 0,50 MHz: 79 dB(μV) quasi peak, 66 dB(μV) average
  - 0,5 MHz - 30 MHz: 73 dB(μV) quasi peak, 60 dB(μV) average
- Vibration, shock, bump and seismic tests on measuring relays and protection equipment
  - Vibration tests (sinusoidal), Class I, IEC 60255-21-1:1988
  - Shock and bump tests, Class I, IEC 60255-21-2:1988
  - Seismic tests, Class I, IEC 60255-21-3:1993

1.3.25.5. Mechanical data

1.3.25.5.1. General mechanical data

- Construction
  - Painted steel surface
- IP protection:
  - IP2x
- Size:
  - See Figure 1-3 for the device dimensions
- Weight:
  - 0.7 kg

1.3.25.5.2. Connectors

Table 5-1 Connectors on the RIO

CONNECTOR NAME	CONNECTOR TYPE	STRIP LENGTH [MM]	CONDUCTOR AREA [MM^2]	CONDUCTOR DIAMETER [MM]	TIGHTENING TORQUE [NM]	MINIMUM BEND RADIUS*
BLA	Weidmüller BLA 2/180	7	0.2 – 1.5 solid: 0.2 – 2.5	0.5 – 1.4 solid: 0.5 – 1.8	0.4 – 0.5	3 × OD**
BL 3.5	Weidmüller BL 3.5/6/180 BL 3.5/13/180	6	0.2 – 1.5	0.5 – 1.4	0.2 – 0.25	3 × OD**
PE FASTON TERMINAL	TE Connectivity 6.3x0.8	7	min. 4	min. 2.3	-	3 × OD**

** Bend radius is measured along the inside curve of the wire or wire bundles.*
*** OD is the outer diameter of the wire or cable, including insulation.*

The tightening torque of the screw for protective earth connection must be approx. 5 Nm.

During the installation, make sure that the shortest possible length for PE (Protective Earth) cable.

The minimum distance between the device and its wire channel must be at least 3 cm.

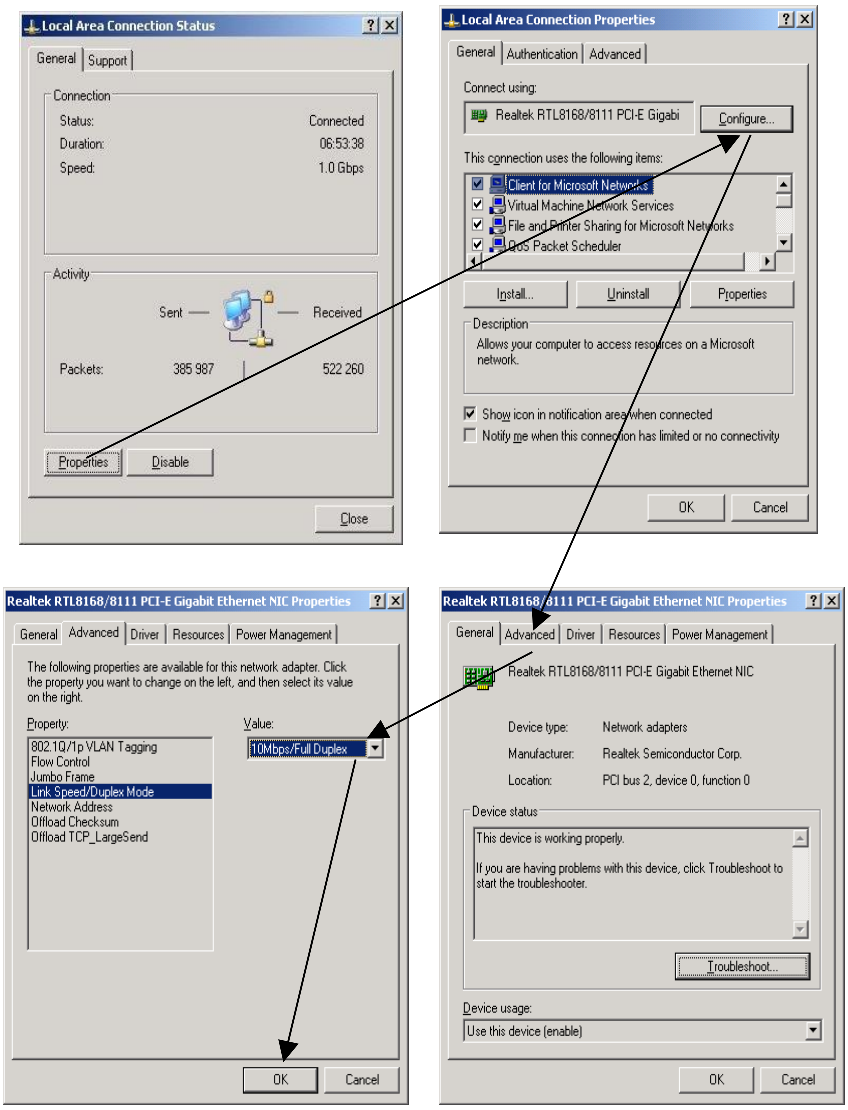
1.3.26. Technical notes on EOB interoperability

1.3.26.1. Description

We experienced some interoperability issues regarding front panel communication with EP+ devices. The link establishement procedure of the ethernet communication become unstable with certain type of NICs (Network Interface Card) of network devices. Network devices with 10/100Base-T speed support has no limitation but devices with 1000Base-T (called gigabit) may cause this link establishement failure. In this case the operating system periodically signals that interface is connected, then disconnected, then connected etc.

1.3.26.2. EOB Troubleshooting

- force NIC speed and mode to 10Base-T Full-duplex (setting method may depend on Your PC hardware configuration) on Your PC. Local Area Network settings can be found at:
  - WindowsXP: Control Panel/Network Connections/Local Area Connection
  - Windows 7: Control Panel\All Control Panel Items\Network and Sharing Center



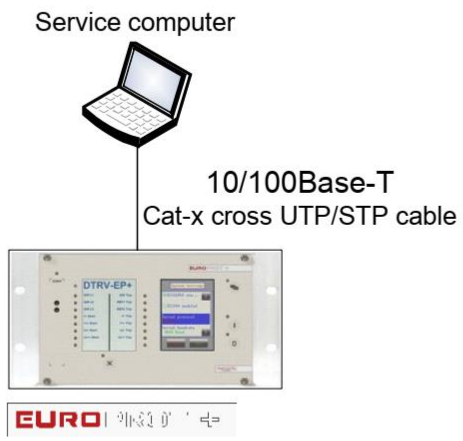
1.3.26.3. Workaround

- using station bus interface connector at the front panel of the CPU card

    - if the device equipped with 100Base-Fx station bus interface then You can connect Your computer via a third-party media converter unit

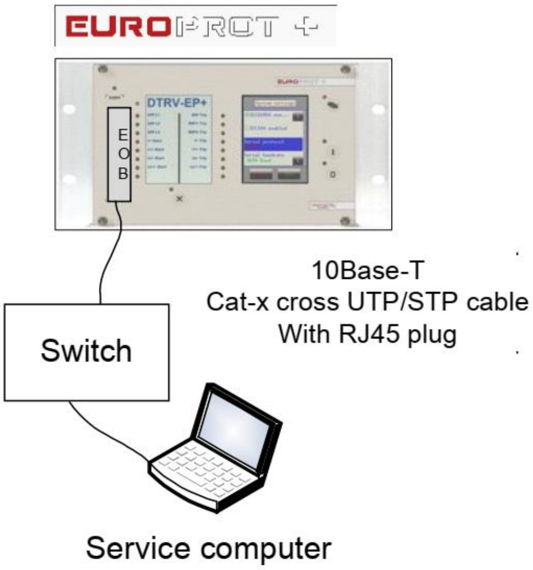
    - if the device equipped with 10/100Base-Tx station bus interface (RJ45) then connect Your computer directly to the EP+ via a crossed CATx cable

Service computer



- using EOB at the HMI:

    - in case of unstable link with Your PC apply a third-party external 10/100Base-T switch with one port connected via EOB to the EP+ and other port connected to Your PC via a CATx cable.



1.3.26.4. Further details

For getting started guide and IP configuration download: http://www.protecta.hu/epp-prelim/QuickStart/Quick_Start_Guide_V1.0.pdf

1.3.27. EP+ Installation manual

USED SYMBOLS

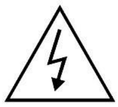
Symbols on devices:

Test voltage: 2 kV

Protective conductor terminal

Do not dispose of this device

Symbols in this document:



Caution, risk of electric shock

Caution, hot surface

Caution, refer to the documentation

Do not dispose of this device

1.3.27.1. Introduction

This manual is intended to provide instruction for proper device installation, which includes mechanical mounting and electrical wiring. Furthermore, the information provided here will strongly support commissioning, maintenance, and deinstallation work as well. This document's targeted user groups are skilled electrical professionals executing installation works and commissioning with EuroProt+ devices.

Given that the EuroProt+ product family has a modular design, the instructions provided here can cover all configurations. Therefore, this manual shall be used in conjunction with the "EuroProt+ Hardware description" document, which includes essential information about all hardware components of the product.

1.3.27.2. Equipment handling

1.3.27.2.1. Unpacking

Inspect the package for transport damages. Carefully remove the packing material without applying excessive force.

1.3.27.2.2. Visual inspection

Identify the product by reading the order code. This can be found on the device nameplate located mostly on the right side of the device in the top right corner and shall be identical to your order.

Picture 2-2 Device nameplate

The protection device may have loose items packed in a different box based on the configuration. Check, that these items are also included in the shipment.

Visually inspect all unpacked items for damages, water ingress, or any sign of external impact. If you discover any transport damage, please notify Protecta Ltd. first and do not start any further work on the equipment.

1.3.27.2.3. Storage

If temporary storage is required before installation, please store the device in its original packing in a dry and clean place. The required environmental conditions can be found in the “General data” section of the “EuroProt+ Hardware description” document.

1.3.27.3. Mounting

1.3.27.3.1. Tools for mounting

The tools and screws necessary for mounting depend on the method of the mounting, see the “Mounting methods” section of the “EuroProt+ Hardware description” document.

Assuming the panel or cubicle is ready for installation of the device, screwdrivers matching the screws used, plyers, wrenches, etc. are necessary. For safety aspects, mechanical protective gloves shall be used to avoid injuries.

1.3.27.3.2. Environmental conditions

Make sure, that the mounting location fulfils environment requirements stated in the “General data” section of the “EuroProt+ Hardware description” document. The IP protection class of the device shall fit the surrounding environment at the place of installation. It is also important to have space around the device to support conventional cooling (See 3.3).

1.3.27.3.3. Mounting location

Before mounting the device make sure, that suitable space is available in the location of installation. Cutouts shall fit the device rack dimensions and it is recommended to leave 80mm free space behind the IED for the wiring.

The minimum distance between an EP+ device and its wire channel must be at least 3 cm.
The minimum distance betweena two EP+ devices must be at least 10 cm.

1.3.27.3.4. Mounting the device

The EuroProt+ product line utilizes different rack sizes and depending on that different mounting methods. An overview of the rack sizes with dimensions and mounting methods can be found in the “Mounting methods” section of the “EuroProt+ Hardware description” document.

During the installation make sure that the shortest possible length for PE (Protective Earth) cable routing is applied.

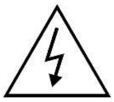
1.3.27.3.5. Safety aspects

1.3.27.3.5.1. Earth connections

1.3.27.3.5.1.1. Protective earth

The device shall be connected to the station earth system with a minimum of 2,5 mm^2 cross-section solid or stranded wire. A 6,3 mm (1/4 inch) female flat connector (according to IEC 61210) shall be used crimped to the earthing wire. During the installation make sure that the shortest possible length for PE (Protective Earth) cable routing is applied.

The earth connection of the device is situated at all kinds of Power supply modules. In the case of more Power supply modules, all of them shall be earthed.

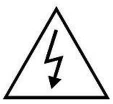


The protective earth connections should not be removed when the equipment is energized.

Picture 3-5-1-1 Earth connection point of the device at the Power supply module

1.3.27.3.5.1.2. Stranded wires

Soft soldering of stranded wires is not allowed due to the cold flow of the solder material.

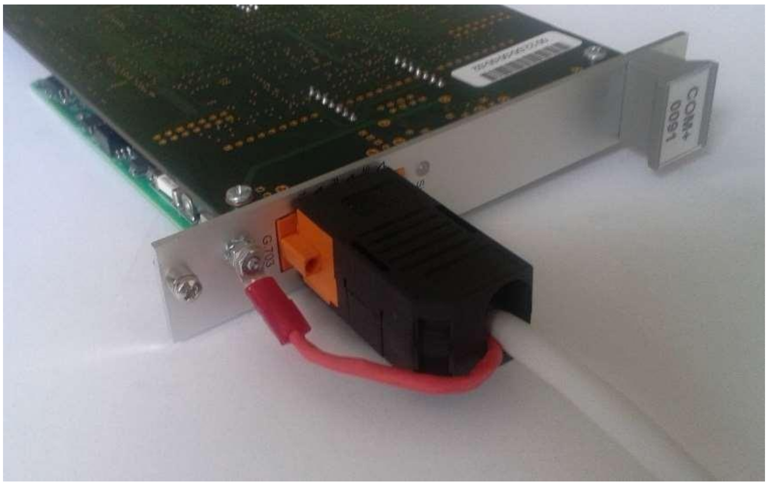


Loose strands of stranded wires can cause fire risk or electric shock. Insulated crimp terminals shall be used.

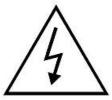
1.3.27.3.5.1.3. Cable screen connection

The screen of the telecommunication cables connected directly to the device shall be terminated to the earthing connection point of the corresponding module.

Picture 3-5-1-3 An example of the cable screen connection



1.3.27.3.5.1.4. CT and VT circuits

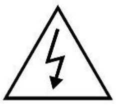


The CT and VT circuits to be connected to the device shall be connected to the station earth system.

1.3.27.3.5.2. Connections of the device

Before connecting the wires, make sure that all voltage levels correspond to the device ratings. It is particularly important by the power supply, trip and binary input, CT and VT module

Use only the connectors provided to the device or identical ones.



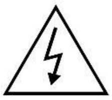
The CT connectors shall be fixed with screws provided. During the operation of the device, the CT connectors can be disconnected only after the CT circuits having short-circuited.

1.3.27.3.5.3. Optical ports

Take adequate measures to protect your eyes and do not view directly into optical ports.

The fiber optics cables are vulnerable. Sharp bending can damage them. The minimum bending radius can be between 15 cm and 25 cm approximately, depending on the type and the material of the cable. For details see the datasheets of the fiber optics cables to be installed. The fiber shall not be twisted or bent. When connecting or disconnecting the cable always hold the connector, not the cable.

1.3.27.3.5.4. Removing and changing modules



Before removing and changing modules first the power supply voltage of the device shall be disconnected. Then all the energizing quantities connected to each module of the device shall be disconnected. Before removing the connectors of the CT modules, the CT circuits shall be short-circuited and disconnected.

The protective earth connection can be disconnected last if it is necessary (e.g. when removing a Power supply module).

The devices contain components that are sensitive to electrostatic discharges. ESD wrist strap shall be worn during any operations with modules.

Some of the modules can operate at high internal temperatures. Remove these modules carefully to avoid any burn injury. Take care of the possible high temperature at each module.

The modules have got sharp edges. Remove them carefully to avoid injury.

After changing a module, it shall be fixed with the screws provided with a torque of 0,5 Nm. Use Philips 2 screwdriver.

1.3.27.4. Wiring

1.3.27.4.1. Tools for connecting

Screwdrivers for the connectors: blade 0,6/3,5 mm, 0,4/2,5 mm.

Cutter, stripper, crimper tools to prepare the connecting end of the wires.

1.3.27.4.2. Connectors

The “Connectors” section of the “EuroProt+ Hardware description”

provides information about the required conductor dimensions and connecting methods. The “Connectors” table shall be used together with the other sections describing the different modules.

1.3.27.5. Deinstallation and Repair

1.3.27.5.1. Deinstallation

Before removing the device make sure, that all incoming power supply and control voltages are switched off. The earth connection of the device shall be disconnected last.

1.3.27.5.2. Repair

Thanks to its modular design, many hardware problems can be fixed by replacing single modules. By executing this procedure note, that the printed board’s surface may get hot during normal operation.

In addition, attention shall be paid to the sharp edges of the modules to avoid minor injuries on the hand.

1.3.27.5.3. Disposal

Removed IEDs shall be handed over to a local electronic waste handler for proper disposal and recycling.

Table 5-3 Disposal of the components and parts

IED	PARTS	MATERIAL	METHOD OF DISPOSAL
Enclosure	Metal sheets, fastening elements	Aluminum, steel	Separation and recycling
Modules	Metallic parts, fastening elements	Aluminum, steel	Separation and recycling
	Mounted PC boards	Plastic, various electronic elements	Separation and recycling
	Connectors	Plastic, various metals	Separation and recycling
	Transformers, coils	Iron, copper, plastic, paper	Separation and recycling
	Relays	Iron, copper, plastic, other metals	Separation and recycling
Package	Box	Cardboard	Recycling
Attachments	Manuals, certificates	Paper	Recycling

2. Function and I/O listing

The hardware information in Table 2-1 below corresponds to the maximum available number of digital I/O, and the default number of analog inputs.

For description about the busbar protection functions please refer to Chapter 3. Detailed information is available in their respective stand-alone descriptions on the Protecta website after logging in.

*The ‘INST.’ column contains the numbers of the pre-configured function blocks in the factory configuration. These numbers may be different in order to meet the user’s requirements.

Decentralized busbar protection application														
		FAMILY			EuroProt+									
		TYPE			OGYD									
		CONFIGURATION			E1	E2	E3	E4	E5	E6	E7	E8	E10
HARDWARE		Handled bay number (max)			3	6	9	12	15	18	21	24	30
		VT inputs			4(op.)	4(op.)	4(op.)	4(op.)	4(op.)	4(op.)	4(op.)	4(op.)	4(op.)
		Digital inputs (max)			120	108	96	84	72	60	48	36	24
		Signaling relay outputs (max)			120	108	96	84	72	60	48	36	24
		Fast Trip outputs (max)											
FUNCTIONALITY		Function name	IEC	ANSI	E1	E2	E3	E4	E5	E6	E7	E8	E10
	Protection	Low impedance busbar differential	3IdB >	87B	✔	✔	✔	✔	✔	✔	✔	✔	✔
		Voltage breakdown condition			Op.	Op.	Op.	Op.	Op.	Op.	Op.	Op.	Op.
		Breaker failure protection	CBFP	50BF	✔	✔	✔	✔	✔	✔	✔	✔	✔
	Control & supervision	Trip Logic		94	✔	✔	✔	✔	✔	✔	✔	✔	✔
		Lockout trip logic		86	Op.	Op.	Op.	Op.	Op.	Op.	Op.	Op.	Op.
		Ethernet Links			Op.	Op.	Op.	Op.	Op.	Op.	Op.	Op.	Op.
		Trip Circuit Supervision		74TC	✔	✔	✔	✔	✔	✔	✔	✔	✔
		Fuse failure (VTS)		60	Op.	Op.	Op.	Op.	Op.	Op.	Op.	Op.	Op.
		Current transformer failure detection		60	✔	✔	✔	✔	✔	✔	✔	✔	✔
	Meas.	Current input			✔	✔	✔	✔	✔	✔	✔	✔	✔
		Voltage input			Op.	Op.	Op.	Op.	Op.	Op.	Op.	Op.	Op.

Table 2-1 Basic functionality and I/O of the decentralized (OGYD) type

Centralized busbar protection application													
		FAMILY			EuroProt+								
		TYPE			DGYD								
		CONFIGURATION			E33	E34	E35	E36	E11	E14	E15	E16
HARDWARE		Handled bay number (max)			3	4	5	6	15	18	21	24
		VT inputs			Op.	Op.	Op.	Op.	Op.	Op.	Op.	Op.
		Digital inputs (max)			96	96	96	96	144	144	102	90
		Signaling relay outputs (max)			53	53	53	53	113	105	88	80
		Fast Trip outputs (max)			24	24	24	24	24	24	24	24
FUNCTIONALITY		Function name	IEC	ANSI	E33	E34	E35	E36	E11	E14	E15	E16
	Protection	Low impedance busbar differential	3IdB >	87B	✔	✔	✔	✔	✔	✔	✔	✔
		Voltage breakdown condition			Op.	Op.	Op.	Op.	Op.	Op.	Op.	Op.
		Breaker failure protection	CBFP	50BF	✔	✔	✔	✔	✔	✔	✔	✔
	Control & supervision	Trip Logic		94	✔	✔	✔	✔	✔	✔	✔	✔
		Lockout trip logic		86	Op.	Op.	Op.	Op.	Op.	Op.	Op.	Op.
		Ethernet Links			Op.	Op.	Op.	Op.	Op.	Op.	Op.	Op.
		Trip Circuit Supervision		74TC	✔	✔	✔	✔	✔	✔	✔	✔
		Fuse failure (VTS)		60	Op.	Op.	Op.	Op.	Op.	Op.	Op.	Op.
		Current transformer failure detection		60	✔	✔	✔	✔	✔	✔	✔	✔
	Meas.	Current input			✔	✔	✔	✔	✔	✔	✔	✔
		Voltage input			Op.	Op.	Op.	Op.	Op.	Op.	Op.	Op.

Table 2-2 Basic functionality and I/O of the centralized (DGYD) type

3. Software configuration

3.1. Protection functions

The numerical protection integrates two independent protection functions:

- numerical differential protection,
- breaker failure protection.

The joint discussion of these functions is based on the fact that the breaker failure protection utilizes the processed status information of the busbar protection to disconnect only the section of the busbar to which the faulty circuit breaker is connected. So the other zones can remain in continuous service.

Protection functions	IEC	ANSI	OGYD
Busbar differential	$3I_dT>$	87B	X
Breaker failure protection	CBFP	50BF	X

Table 1 The protection functions of the OGYD configuration

The configured functions are drawn symbolically in the Figure below.
NOTE: The voltage measuring is optional for the higher stability (voltage breakdown condition).

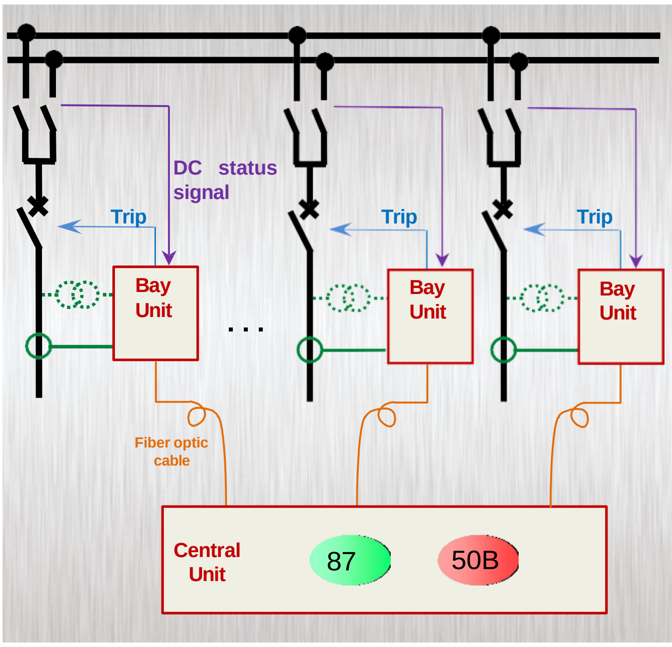


Figure 1 Implemented protection functions

3.1.1. Distributed busbar differential protection function and breaker failure protection

Protecta provides two different types for busbar protection. Both of them perform basically the well-known principle: the sum of the currents flowing into and out of the busbar results zero, if there are no internal faults. If the sum is not zero then there is an internal fault, and a fast trip command is generated. The scheme in both versions is the low impedance, biased differential scheme, the application of Kirchhoff`s node law.

The difference between the two types is the structure of the differential protection system:

- Centralized version:
  - If the number of bays connected to the busbar is limited (there are not more bays than 6) the tasks related to the three-phase busbar differential protection function are performed within one device.
  - With increasing number of the bays the tasks are divided among three independent devices. Each of them is responsible for the differential protection of one phase (L1, L2 or L3) of the busbar. This version can be considered also as a centralized version.

- Distributed (Decentralized) version:
  - In this version other individual protective devices of the bays (e.g. distance protection, overcurrent protection, etc., but also dedicated bay units can perform the related tasks) are involved in the busbar protection scheme. They are located in the substation according to the bay structure of the primary system. These devices perform the sampling of the currents and have access to all information needed for the busbar protection system. This information is sent by fiber optic link to the central unit. The calculation and decision is performed by the central unit, and the dedicated trip commands are sent back to the devices also via fiber optic links.

This description contains the details of the distributed version; the centralized version is described in a separate document.

The numerical protection integrates two independent protection functions:

- numerical differential protection,
- breaker failure protection.

The joint discussion of these functions is based on the fact that the breaker failure protection utilizes the processed status information of the busbar protection to disconnect only the section of the busbar to which the faulty circuit breaker is connected. So the other zones can remain in continuous service.

3.1.1.1. Distributed numerical busbar differential protection

In this version other individual protective devices of the bays (e.g. distance protection, overcurrent protection, etc.) are involved in the busbar protection scheme. They are located in the substation according to the bay structure of the primary system. These devices perform the sampling of the currents and have access to all information needed for the busbar protection system. This information is sent by fiber optic link to the central unit. The calculation and decision is performed by the central unit, and the dedicated trip commands are sent back to the devices also via fiber optic links.

3.1.1.1.1. Main features of the distributed numerical busbar differential protection

The main features of the busbar differential protection function can be summarized as follows:

- The function is performed within one central device, but the analog currents and status signals from all bays of the busbar are accessed by protection devices dedicated to the bay;
- The bay units can perform any other protection functions, but they communicate binary information and sampled values with the device via fiber optic links;
- Dynamic busbar replica, based on disconnector status signals;
- High stability in case of external faults in spite of current transformer saturation;
- Short tripping time;
- Selectivity for internal fault, only the bays connected to the faulty busbar section are disconnected, all other bays remain in continuous operation;
- Easily to extend according to the busbar configuration;
- Easy adaptation of the function for different primary bus systems:
    - Single busbar,
    - Up to quadruple busbar,
    - Ring bus,
    - 1 ½ circuit breaker arrangement,
    - Bus couplers,
    - Bus sectionalizers with one or two current transformers,
    - Transfer bus;
- Individual numerical calculation and decision for all three phases;
- Stabilized differential current characteristics;
- The security and stability are increased with special software methods;
- Voltage breakdown condition,
- Check zone application (details see below),
- Saturated waveform compensation,
- Directionality check,
- Current transformer failure detection,
- Checking the disconnector status signals,
- Included breaker failure protection.

3.1.1.1.2. The configuration of the function

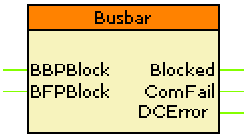
In the distributed version, the functionality of the busbar differential protection function is performed in co-operation of one central unit and of several bay units.

3.1.1.1.2.1. The applied function blocks in the central device

In the factory configuration process, the required software function blocks are configured. The applied functions blocks in the central device are as follows:

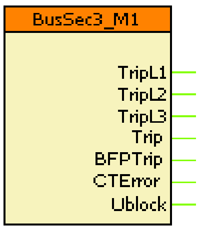
- **“Busbar” function block**: this performs the organization of the busbar protection system, and also the numerical calculations and decisions are performed in this module. Based on the disconnector status information, received from the bus sections, “Measuring elements” are composed. A “Measuring element” processes all currents, which flow into or out of the interconnected bus sections. Accordingly, the number of the processed “Measuring elements” can be the number of the individual bus sections, as a maximum; or there can be less “Measuring elements”, if some bus sections are interconnected with each other.

  The busbar protection function always contains one “Busbar” function block. Its task is also to process the parameters of the busbar protection function. The symbol of the “Busbar” function block, as it appears in the graphic logic editor, is as follows.

  Programming the inputs of the “Busbar” block, the busbar protection and/or the breaker failure protection functions can be enabled or disabled.

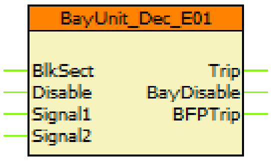
- **“Bus section” function blocks**: the number of these blocks coincides with the maximum number of the bus sections. Up to 12 sections can be included. The task of this function block is to process the status signals, and to send them to the “Busbar” block to form the “Measuring elements”. (The ”Measuring element” performs the algorithm for the interconnected busbar sections, as it is described in Chapter 2.3.2.) The symbol of the “Bus section” function block, as it appears in the graphic logic editor, is as follows.

- **“Bay unit” function blocks**: the number of these blocks coincides with the number of the bays in the substation. The task of this block is to receive all information from the distributed bay unit protection devices of the bay via fiber optic channels:
  - Sampled values of three currents,
  - Status signals of the disconnectors: these signals are received with dual signals (disconnector open and diconnector closed). Up to 4 disconnectors can be configured to a physical bay,
  - Status signal for the voltage break-down condition,
  - Breaker failure signal from the bay protection.

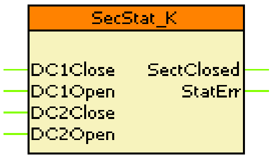
  This block passes the trip command to the circuit breaker via the protection device related to the bay. It can send also two user defined binary signals to the bay devices. „Signal1” and „Signal2” binary input signals of the function serve this purpose.

The symbol of the “Bay unit” function block, as it appears in the graphic logic editor, is as follows.



The “BlkSect” blocking input signal disables the operation of the “Measuring element”, to which this bay is dynamically assigned. The bay unit itself can be disabled with the “Disable” binary input signal (it has the same effect as the Bay disable Boolean parameter).

- **“Sectionalizer unit” function blocks**: These blocks serve mapping the sectionalizer bays, the bays which interconnect bus sections with disconnectors. These blocks receive up to two disconnector status signals.



Appendix I describes the configuration process which can be performed by the user with “Master” access level. This appendix shows also application examples for some frequent practical cases.

For the configuration the central device parameter values are needed; these parameter values are to be set in the central device for the bays individually.

Enumerated parameters for the distributed busbar differential protection function, bay unit are listed in *Table 2-1*. They are to be set for the bays individually. In the parameter names “xxx” is different for each connected bays:

Parameter name	Title	Selection range	Default
Rated secondary current of the current transformer in the bay			
BayUnit_Nom_EPar_	Rated Secondary	1A,5A	1A
Parameter for positive direction of the current, indicated as the location of the grounded point of the three current transformers in the bay			
BayUnit_Dir_EPar_	Starpoint I1-3	Line,Bus	Line

Table 2-1 The enumerated parameter of the distributed busbar differential protection function, bay unit

Boolean parameter for the distributed busbar differential protection function, bay unit is shown in *Table 2-2*:

Parameter name	Title	Default	Explanation
Disabling the bay			
BayUnit_BayDisable_BPar_	Bay Disable	0	• means enabling; • means that the current values and the status signals received from the bay are not considered (to be applied for maintenance purposes).

Table 2-2 The Boolean parameters of the distributed busbar differential protection function, bay unit

Integer parameter for the distributed busbar differential protection function, bay unit is shown in *Table 2-3*:

Parameter name	Title	Unit	Min	Max	Step	Default
Rated primary current of the current transformer in the bay						
BayUnit_CTNom_IPar_	CT nominal	A	100	10000	1	1000

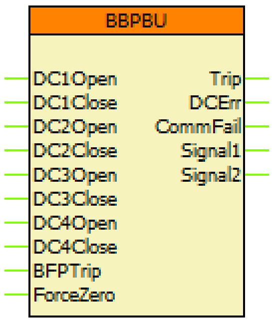
Table 2-3 The integer parameter for the "Max.I_load" calculation

3.1.1.1.2.2. The applied function blocks in the bay device

In the factory configuration process, the required software function blocks are configured. The applied functions blocks in the bay device are as follows:

"Busbar bay unit" function block: This block is the "interface" between the power technology (measuring transformers, disconnector status signals, circuit breaker trip commands) and the busbar protection function in the central device. In the bay device it receives the disconnector status information, the breaker failure signal from the protection function (according to the graphic assignment), and a special signal (ForceZero input) to exclude the measurements from the evaluation. This last input is used for buscoupler bays for correct handling of dead zone faults.

If the bay protection is to be involved in the busbar protection scheme, this function block is mandatory. The busbar protection function in the central device always contains one "Busbar" function block. Its task is also to process the parameters of the busbar protection configuration received from the "Busbar bay unit" function blocks. The symbol of the "Busbar bay unit" function block, as it appears in the graphic logic editor, is as follows.



In the "background" this block samples the assigned phase currents and voltages, and sends them, together with the status information to the central device via fiber optic network.

3.1.1.1.3. Method of operation for the busbar protection function

3.1.1.1.3.1. The busbar replica evaluation

The algorithm is processed in the central device.

The algorithm continuously evaluates the status signals of the disconnectors and if there are changes in the status signals then based on the received signals the algorithm performs "configuration", which means determination of the busbar replica of the substation and an assignment of "Measuring elements" to each interconnected bus sections.

NOTE: if bus sections are interconnected with each other then only one of the assigned measuring elements performs the calculation and the results are passed to all other inactive measuring elements of interconnected bus sections. It means that the on-line displayed values will be the same for these bus sections.

3.1.1.1.3.2. The protection algorithm

The bay units perform synchronous sampling of all analog signals and send them to the central device. These values are used by the assigned "Measuring elements" of the central unit. The "Measuring elements" perform the following tasks:

3.1.1.1.3.2.1. The differential current calculation

The method of the differential current calculation is as follows:

- Summation of the sampled I_p momentary current values for the bays connected to the "Measuring element". The result is the calculated momentary value of the differential current:

$$I_{d.p} = \sum I_p$$

- Filtering the current DC component by subtracting the value sampled 10 ms before from the actual value, and the difference is divided by two. The result is the calculated momentary value of the differential current without the DC component.

$$I_{d.p1} = \frac{I_{d.p} - I_{d.p-10ms}}{2}$$

- The magnitudes of the ten last calculated values are averaged, receiving the *Id* trip current. The result is the "rectified average" of the differential current. (The method is the numerical realization of the measuring principle of the Depres measuring instruments.)

$$Id = \frac{\sum_{n=1}^{10} \left| I_{d.pn} \right|}{10}$$

3.1.1.1.3.2.2. The biasing current calculation

The method of the biasing current calculation is as follows:

- From the absolute value of the sampled I_p momentary current values a predetermined "*Max.I_load*" current peak value, determined with parameter setting is subtracted:

$$\left|I_p\right| - Max.I\_load$$

  Here *Max.I_load* is a parameter setting, the proposed value of it is the expected maximum load current value of all bay currents. The result is that in normal operation, when all bay currents are below the maximum load current, the calculated values get negative.

- Out of these differences only the values above 0 (if $(\left|I_p\right| - Max.I\_load) > 0$) are summed

$$I_{s.p} = \sum(\left|I_p\right| - Max.I\_load)$$

  The differences can be positive only if there are currents above the maximum load values, i.e. there is a fault (either external or internal of the busbar).

- Then the average of this value and that received 10 ms before is calculated:

$$I_{s.p1} = \frac{I_{s.p} + I_{s.p-10ms}}{2}$$

  - The last ten calculated values stored in the memory are averaged, receiving the *Is* biasing current:

$$Is = \frac{\sum_{n=1}^{10} I_{s.pn}}{10}$$

3.1.1.1.3.2.3. The differential characteristics

The trip characteristic for a measuring element is shown in *Figure 2-1*.

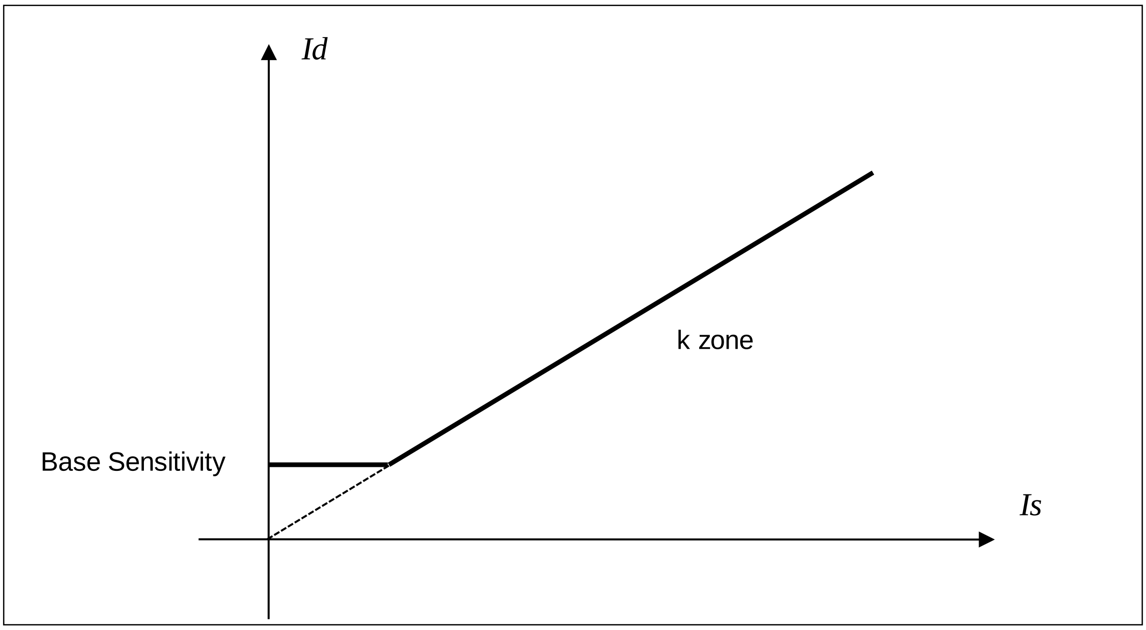


Figure 2-1The trip characteristic of the busbar differential protection

Integer parameters of the differential characteristics are listed in *Table 2-4*.

Parameter name	Title	Unit	Min	Max	Step	Default
Differential protection trip characteristic, base sensitivity						
Busbar_ZoneSens_IPar_	Base Sensitivity	(primary) A	100	10000	1	1000
Differential protection trip characteristic, slope*						
Busbar_ZoneK_IPar_	k zone*	%	40	90	1	60

** NOTE: In case of detected through fault, the slope of the characteristic is dynamically changed to 90%. This fact has to be considered when the characteristic is tested with through faults.*

Table 2-4 The integer parameters of the differential characteristics

Enumerated parameter to enable the differential protection is shown in *Table 2-5*.

Parameter name	Title	Selection range	Default
Parameter to enable the centralized busbar differential protection function:			
Busbar_BBPOper_EPar__	Operation	Off, On	Off

Table 2-5 Enabling the operation of the differential protection function

3.1.1.1.3.3. Role of the maximum current setting ("*Max.I_load*") for normal operation

There are two main requirements for the busbar differential protection:

- In case of busbar fault the operation shall be fast;
- In case of external faults the protection must be stable; no trip command may be generated.

Subtracting the "*Max.I_load*" value from all current samples serves both these aims. In normal operation all current samples are expected to be below this setting value, which is to be the maximum possible current peak value. Consequently in normal operation the bias current is zero.

If in this state an internal fault occurs then the current samples get very fast above "*Max.I_load*" value. Consequently the locus of the Id-Is points on the plane of the differential characteristics (*Figure 2-1*) is at once above the broken line described by the slope "k" (parameter setting "*k_zone*") and the base sensitivity (parameter setting "*Base Sensitivity*"). In this case the trip command needs a few checking points only, the trip command can be fast.

In case of external fault however, the locus of the Id-Is points on the plane of the differential characteristics (*Figure 2-1*) start moving in the direction of the Is axis. If the algorithm recognizes this movement, i.e. the locus is below the line described by the slope "k" then the number of the required check points gets a high value. This extended checking period does not permit trip command generation during the time period, when the iron core of the overloaded current transformer gets saturated, and it cannot deliver proportional secondary current for the measurement. (Additionally to this method, the "saturated waveform compensation" is another means to avoid unwanted trip generation; See Chapter 2.3.6.)

The required parameter setting is described in the table below:

Integer parameter for the offset setting is shown in Table 2-6.

Parameter name	Title	Unit	Min	Max	Step	Default
Maximum load current						
Busbar_Offset_IPar_	Max.I_load*	(primary) A	100	10000	1	1000

** NOTE: This parameter value should not be higher than the “Base sensitivity” of the differential characteristics. In case of wrong setting the top left LED on the front panel of the device gets yellow, indicating a warning.*

Table 2-6 The integer parameters of the “Max.I_load” calculation

3.1.1.1.3.4. Voltage breakdown condition

In case of current transformer circuit error, the missing current from any of the bays, the measuring element detects current difference. This could result a trip command to the bus section. To prevent this kind of operation error, the trip command is released only if in the affected bus section the voltage collapses.

To perform this supervision, the presence of the voltage is monitored with a quick voltage measuring function. The result of the supervision is considered in every millisecond. If before increasing the current, the voltage is in the range of the normal operating voltage (above approximately 0.6Un), and then during a fault any of the phase voltages is below 0.6Un, the function enables the operation of the differential protection function. If the currents fulfill the differential criteria, the algorithm generates a trip command.

If the differential protection function started and any of the bay units received trip command then this voltage condition does not play any role. The trip command resets only if the currents are outside the tripping zone of the characteristics.

A voltage monitoring function can allow trip command only for 0.5 s, then the function is disabled until the measured voltage returns to healthy state again, or a new initializing is performed (caused by disconnector status change, switching on or off, parameter changes).

If all voltage monitoring functions assigned to a measuring element detect low voltage then the bus-bar section is considered to be disconnected, and the operation of the bus-bar differential protection is enabled again (to cover the switch-on-to-fault condition).

If the trip command is disabled by the voltage condition then the “On-line” screen of the connected PC displays the status signal as “U>disable: +“. If one or more voltage supervisions detect low voltage then the display changes form “+“ to “-”. At that moment a 0.5s timer is started, and when it expires then the operated voltage supervision function is disabled. As a consequence the signal shows “+“ again.

The parameters for the voltage breakdown condition are fix values, the function does not need any parameter setting.

3.1.1.1.3.5. The check zone

If any of the status signals received from the bays is wrong then the false operation based on this wrong signal could disconnect the bus section. To avoid this kind of errors the “check zone” is applied. This additional “check zone measuring element” supposes the whole busbar system as a single node. It gets all current samples from the bays (except those sampled from the current transformers connecting bus sections; this is to be selected in the process of the topology configuration by the user with “Master” access rights) and adds them all to get the check zone differential current. The individual measuring elements can generate a trip command only if also the “check zone measuring element” detects an internal busbar fault. The check zone operation must be enabled by the binary parameter *“CheckZone”*.

The parameters of the “check zone measuring element” are similar to those of the individual measuring element, but the values can be set independently.

The parameters of the check zone differential characteristics are listed in the tables below.

Integer parameters of the check zone differential characteristics are listed in *Table 2-7*.

Parameter name	Title	Unit	Min	Max	Step	Default
Checkzone characteristic, base sensitivity						
Busbar_CheckSens_IPar_	CheckZone Sens.	(primary) A	100	10000	1	1000
Checkzone characteristic, slope						
Busbar_CheckK_IPar_	k checkzone	%	40	90	1	60

Table 2-7 The integer parameters of the check zone differential characteristics

Enumerated parameter to enable the check zone supervision is shown in *Table 2-8*.

Parameter name	Title	Selection range	Default
Parameter to enable the supervision by the “check zone”			
Busbar_CheckOper_EPar_	CheckZone Operation	Off, On	Off

Table 2-8 Parameter to enable the check zone supervision

3.1.1.1.3.6. Saturated waveform compensation

In case of external fault, with the exception of the faulty bay, all bays deliver currents towards the busbar. The sum of these currents flows through the current transformer of the faulty bay. Consequently this current can be extremely high, which can saturate the iron core of this current transformer. The shape of this secondary current gets distorted, and the “missing” section of the wave-shape is a differential current.

To prevent unwanted operation of the busbar differential protection function for these external faults, there are several remedies. One of them is the “saturated waveform compensation”. When saturation is detected, the algorithm “keeps” the detected current peak till the end of the half period, decreasing the chanche for the false trip decision.

This method does not need any special parameter setting.

3.1.1.1.3.7. Directionality check

In case of internal fault all bays deliver currents towards the busbar. In case of external fault however, with the exception of the faulty bay, all bays deliver currents towards the busbar, and the current of the faulty bay flows out of the busbar. When considering this basic difference, the stability of the busbar differential protection can be improved by “directionality check”.

The busbar differential protection algorithm compares the sign of all current samples in a “measuring element”. If during the majority of the samples one of the currents shows opposite sign, indicating opposite direction, then this fact prevents generation of the trip command.

3.1.1.1.3.8. Current transformer failure detection

If the current transformers do not deliver correct currents for the evaluation then the correct decision of the busbar differential protection is not possible.

The currents are continuously supervised also during normal operation of the system, when the currents are below the operation level of the differential protection. If in this state any of the currents is missing then a relatively high differential current is measured (which is still not sufficient to operate the differential protection). The algorithm performs the current supervision based on a similar characteristic as the trip characteristic, which has a sensitive base *(„CT failure Sens")* and a slope *(„k CT failure")* setting. (See also *Figure 2-1*) These have to be set below the trip characteristic, of course.

If the measured currents result an Id–Is point above this characteristic, then after a time delay set by the *„CT failure Delay"* paremeter, the "measuring element" gets blocked.

Integer parameters for current transformer failure detection are shown in *Table 2-9*.

Parameter name	Title	Unit	Min	Max	Step	Default
CT error detection, base sensitivity						
Busbar_CTErrSens_IPar_	CT failure Sens.	A	50	5000	1	500
CT error detection, slope						
Busbar_CTErrK_IPar_	k CT failure	%	40	90	1	60

Table 2-9 The integer parameters of the current transformer failure detection

Timer parameter for current transformer failure detection is shown in *Table 2-10*.

Parameter name	Title	Unit	Min	Max	Step	Default
Time delay for signaling CT error						
Busbar_CTErrDelay_TPar_	CT failure Delay	msec	100	60000	1	1000

Table 2-10 The timer parameters of the current transformer failure detection

3.1.1.1.3.9. Checking the disconnector status signals

The actual configuration of the busbar (interconnected or separated bus sections and the connection of the bays to the bus sections) is evaluated using status signals of the disconnectors. The status of each disconnectors is characterized by dual signals: "Disconnector open" and "Disconnector closed". Only one of them can be true and one of them can be false at the same time. This function checks these status signals, and performs the decision based on parameter setting.

In normal operation when receiving faulty status signals from the disconnectors the device keeps the previous state for a time period defined by parameter setting "BadState Delay". After this time delay the reaction of the algorithm depends on the setting of the dedicated enumerated parameter. If the setting of the "BadState Tolerate" is true, then the operation neglects the faulty status signal, and the last valid status is kept. In case of setting "BadState Tolerate" parameter to "false", the "measuring element" gets blocked.

If the status error is detected after energizing or following parameter changes, the protection remains disabled until the faulty status is corrected, and generates "Blocked" status signal and event.

Enumerated parameter for checking the disconnector status signals is shown in *Table 2-11*.

Parameter name	Title	Selection range	Default
Toleration of the disconnector status signal errors			
Busbar_BadTol_EPar_	BadState Tolerate	Off, On	Off

Table 2-11 The enumerated parameter for checking the disconnector status signals

Timer parameter for checking the disconnector status signals in the central device is shown in *Table 2-12.*

Parameter name	Title	Unit	Min	Max	Step	Default
Time delay for signaling bad state						
Busbar_BadDelay_TPar_	BadState Delay*	msec	100	60000	1	1000

** This parameter is applicable only if the central unit receives the status signals of the busbar sectionalizers. If the busbar configuration includes more than one sectionalizer then this parameter is common for all of them.*

Table 2-12 The timer parameters for checking the disconnector status signals in the central device

In each bay device there is also a timer parameter needed for checking the disconnectors, monitored by the bay device:

Timer parameter for checking the disconnector status signals in the bay device is shown in *Table 2-13.*

Parameter name	Title	Unit	Min	Max	Step	Default
Time delay for signaling bad state						
BBPBU_BadDelay_TPar_	BadState Delay	msec	100	60000	1	1000

Table 2-13 The timer parameters for checking the disconnector status signals in the bay device

3.1.1.1.4. Measured values

For each bays the device displays one phase current. * The reference vector selection depends on the factory configuration.

Table 2-14 shows as an example the current of a bay.

Measured value	Dim.	Explanation
Current Ch - I1	(secondary) A	Phase current L1, Fourier base component
Angle Ch - I1	deg*	Phase angle of the current in L1
		The measurement is repeated for each bay

** The reference vector selection depends on the factory configuration.*

Table 2-14 The measured analogue currents of the centralized busbar differential protection function (example)

For each bus sections the device measures and displays the differential currents and the bias currents per each phases. *Table 2-15* shows as an example the currents of a bus section. (If the bus sections are interconnected with each other then the displayed values are the same of the interconnected sections.)

Measured value	Dim.	Explanation
I Diff L1	(primary) A	Differential current L1, Fourier base component
I Diff L2	(primary) A	Differential current L2, Fourier base component
I Diff L3	(primary) A	Differential current L3, Fourier base component
I Bias L1	(primary) A	Bias current L1, Fourier base component
I Bias L2	(primary) A	Bias current L2, Fourier base component
I Bias L3	(primary) A	Bias current L3, Fourier base component
		The measurement is repeated for each bus section

Table 2-15 The measured analogue currents of the centralized busbar differential protection function (example)

Note: The evaluated basic harmonic values of the measured input phase currents help the commissioning of the distributed busbar differential protection function.

3.1.1.2. The breaker failure protection function

After a protection function generates a trip command, it is expected that the circuit breaker opens and the fault current drops below the pre-defined normal level.

If not, then an additional trip command must be generated for all backup circuit breakers to clear the fault. At the same time, if required, a repeated trip command can be generated to the circuit breaker(s) which are expected to open.

The breaker failure protection function can be applied to perform this task.

3.1.1.2.1. Breaker failure protection function in the central device

The breaker failure protection in the central device does not need any extra configuration.

In the central device there is only one parameter related to the breaker failure protection function:

Enumerated parameter for the breaker failure protection function for enabling or disabling the operation in the central device is shown in *Table 3-1*.

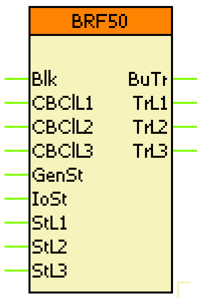
Parameter name	**Title**	**Selection range**	**Default**
Parameter to enable the trip command processing in the breaker failure protection function in the bay			
Busbar_BFPOper_EPar_	Intertrip Operation	Off, On	Off

Table 3-1 Enabling the operation of the breaker failure protection function in the central device

All other parameters are set in the bay devices.

3.1.1.2.2. Breaker failure protection function in the bay devices

“Breaker failure unit” function block: This block is identical to the BFP function block used in the EP+ protection devices. The backup trip output (BuTr) shall be connected to the BFPTrip input of the BBPBU function block of the bay unit, which sends this signal to the central unit. The breaker failure trip signal arriving from the central unit is factory connected to the TRIP module of the bay unit.



The breaker failure protection function needs parameters related to the bays individually.

These parameters are as follows:

Enumerated parameters for the breaker failure protection function, bay modules are listed in *Table 3-2:*

Parameter name	Title	Selection range	Default
Enabling the bay to participate in the breaker failure protection function			
BRF50_Oper_EPar___	Operation	Off,Current,Contact,Current/Contact	Off
Enabling the repeated trip command in the bay itself			
BRF50_ReTr_EPar___	Retrip	Off,On	Off

Table 3-2 The enumerated parameter of the breaker failure protection function, bay devices

Integer parameters for the breaker failure protection function, bay modules are listed in *Table 3-3.*

Parameter name	Title	Unit	Min	Max	Step	Default
Phase current condition for the breaker failure protection function						
BRF50_StCurrPh_IPar_	Start Ph Current	%	20	200	1	30
Residual current condition for the breaker failure protection function						
BRF50_StCurrN_IPar_	Start Res Current	%	10	200	1	20

Table 3-3 The integer parameters of the breaker failure protection function, bay devices

Timer parameters for the breaker failure protection function, bay modules are listed in *Table 3-4.*

Parameter name	Title	Unit	Min	Max	Step	Default
Time delay for the retrip command generation						
BRF50_TrDel_TPar___	Retrip Time Delay	msec	0	1000	1	100
Time delay for the backup trip command generation						
BRF50_BUDel_TPar___	Backup Time Delay	msec	60	1000	1	200
Trip impulse duration						
BRF50_Pulse_TPar___	Pulse Duration	msec	0	60000	1	100

Table 3-4 The timer parameters of the breaker failure protection function, bay devices

3.1.1.2.3. Method of operation for the breaker failure protection function

The starting signal of the breaker failure protection function is usually the trip command of any other protection functions. **The user has the task to define these starting signals using the graphic editor** as the "GenSt", or if the operation of the individual phases is needed, then the start signals for the phases individually. The phase start signals are: "StL1", "StL2" and "StL3".

For operation the phase current or the residual current of the bay must be above the level, as set by two integer parameter values (Start Ph Current, Start Res Current).

Dedicated timers start at the rising edge of the start signals, one for the backup trip command and one for the repeated trip command, separately for operation in the individual phases. During the running time of the timers the function optionally monitors the currents, the closed state of the circuit breakers or both, according to the user's choice. The selection is made using the enumerated parameter BRF50_Oper_EPar_ (Operation), where the choice is (Off, Current, Conract, Current/Contact):

- If this parameter setting is "Current", the current limit values BRF50_StCurrPh_IPar_ (Start Ph Current) and BRF50_StCurrN_IPar_ (Start Res Current) must be set correctly. The binary inputs indicating the status of the circuit breaker poles have no meaning.
- If this parameter setting is "Contact", the current limit values BRF50_StCurrPh_IPar_ (Start Ph Current) and BRF50_StCurrN_IPar_ (Start Res Current) have no meaning. The binary inputs indicating the status of the circuit breaker poles must be programmed correctly using the graphic logic editor. The input variables to be programmed are: BRF50_**CBClL1**_GrO_ (CB closed L1), BRF50_**CBClL2**_GrO_ (CB closed L2) and BRF50_**CBClL3**_GrO_ (CB closed L3).
- If this parameter setting is "Current/Contact", the current parameters and the status signals must be set correctly. The breaker failure protection function resets only if all conditions for faultless state are fulfilled.
- The breaker failure protection function can be disabled by setting this parameter to "Off".

If at the end of the running time of the backup timer the currents do not drop below the pre-defined level, and/or the monitored circuit breaker is still in closed position, then a backup trip command is generated. The time delay is defined using the parameter BRF50_BUDel_TPar_ (Backup Time Delay).

If repeated trip command is to be generated for the circuit breakers that are expected to open, then the enumerated parameter BRF50_ReTr_EPar_ (Retrip) must be set to "On". In this case, at the end of the retrip timer(s) the delay of which is set by the timer parameter BRF50_TrDel_TPar_ (Retrip Time Delay), a repeated trip command is also generated in the phase(s) where the backup timer(s) run off.

The pulse duration of the trip command is not shorter than the time defined by setting the parameter BRF50_Pulse_TPar_ (Pulse Duration).

The breaker failure protection function can be enabled or disabled by setting the parameter BRF50_Oper_EPar_ (Operation) to "Off".

Dynamic blocking is possible using the binary input BRF50_**Blk**_GrO_ (Block). **The conditions are to be programmed by the user, using the graphic logic editor**.

In the central device, based on the status signals of the disconnectors, received from the bay units via fiber optic communication network, the algorithm selects all bays, which are interconnected with the bay announcing breaker failure. Accordingly only the minimum number of the bays gets the trip command, the other bus-sections remain in continuous operation.

Each "Bay unit" function block in the central device has an BFPTrip binary status output. This output is activated if the breaker failure starting signal comes from the related bay.

3.1.1.3. Setting of the communication

The currents, status signals from the bay devices and the commands are sent via Ethernet network on proprietary protocol. The VLAN-addresses for this communication have to be set only in the bay devices, because the addresses in the central device are determined by the position of the communication port. The rx- and tx-addresses have to be identical for the same bay.

Every central device of the busbar protections has a service page among the LCD screens which provides information about the VLAN-addresses which have to be set in the bay-devices. These addresses and connection-positions are obligatory, do not mix the cables or the addresses! An example for such a service page for a central device with 6 bays can be seen on Figure 4-1.

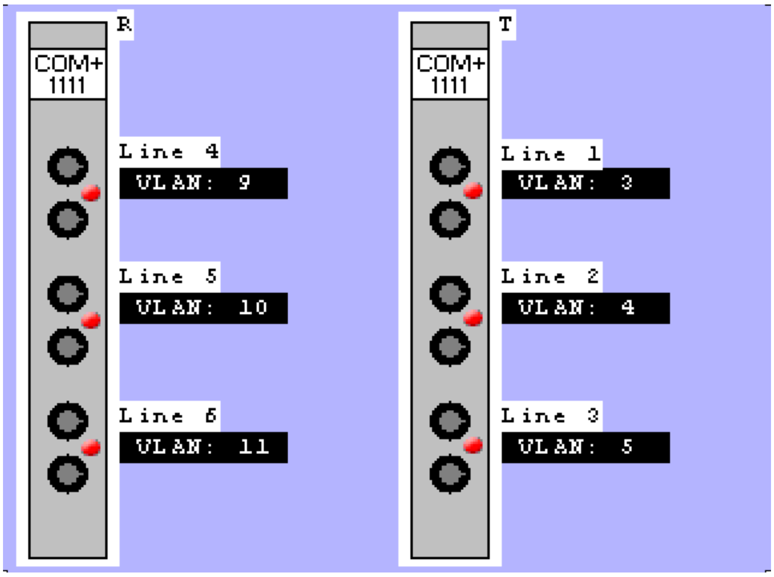


Figure 4-1 Service page on the LCD-screen of a central device with 6 bays

The VLAN-address can be calculated for each bay with the following formal:

$$VLAN = 3 \cdot P_m + P_p,$$

where:

- *VLAN* is the common VLAN address of the bay,
- P_m is identifier for the position of the module to which the bay device connects. It is a number between 0…21. The last position (pos. V) gets the number 0, and the other positions get a number according to the distance to the last position in ascending order.
- P_p is the identifier of the port to which the bay device connects on the module. It is number between 0…2. The upper position gets the number 0, the middle position 1, and the lower position 2.

These addresses are parameters of the "BB communication" function block in the bay devices. The values of the "Priority" and "MCast Addr" parameters are to be left on default. The value 4 for the Priority is the default value according to the standard, and the value 1 for MCast Addr is what the central device expects.

Parameters of the communication:

Integer parameters:

Parameter name	Title	Unit	Min	Max	Step	Default
VLAN addresses (these have to be set identical to each other for the same bay device)						
CPUBB_TxVLAN_IPar_	TxVLAN	-	1	4096	1	1
CPUBB_RxVLAN_IPar_	RxVLAN	-	1	4096	1	1
Priority, recommended to be left as default						
CPUBB_Priority_IPar_	Priority	-	0	7	1	2
MCast Addr, recommended to be left as default						
CPUBB_MCast_IPar_	MCast Addr	-	1	65535	1	1

Table 4-1 Parameters of the "BB communication" function block (bay devices)

3.1.1.4. Technical summary

3.1.1.4.1. Technical data

Function	Value	Accuracy
Current measurement		±2%
Current reset ratio	0.7*	
Operate time (Idiff>2 x In) (Idiff>5 x In)	 Typical 30 ms <20 ms	
Reset time	60 ms	

** The reset ratio is the result of the applied special algorithm*

Table 5-1 Technical data of the distributed busbar differential protection

3.1.1.4.2. The parameters of the distributed busbar differential protection function

The parameters of the distributed busbar differential protection function are explained in the following tables.

3.1.1.4.2.1. Parameters of the central device

3.1.1.4.2.1.1. Parameters for the “Busbar” function block in the central device

Enumerated parameters for the distributed busbar differential protection function, central device are summarized in *Table 5-2*:

Parameter name	Title	Selection range	Default
Parameter to enable the centralized busbar differential protection function:			
Busbar_BBPOper_EPar__	BBP Operation	Off, On	Off
Parameter to enable the supervision by the “check zone”			
Busbar_CheckOper_EPar_	CheckZone Operation	Off, On	Off
Toleration of the disconnector status signal errors			
Busbar_BadTol_EPar_	BadState Tolerate	Off, On	Off

Table 5-2 The enumerated parameter of the distributed busbar differential protection function, central device

Integer parameters for the distributed busbar differential protection function, central device are summarized in *Table 5-3*.

Parameter name	Title	Unit	Min	Max	Step	Default
Differential protection trip characteristic, base sensitivity						
Busbar_ZoneSens_IPar_	Base Sensitivity	(primary) A	100	10000	1	1000
Differential protection trip characteristic, slope						
Busbar_ZoneK_IPar_	k zone	%	40	90	1	60
Checkzone characteristic, base sensitivity						
Busbar_CheckSens_IPar_	CheckZone Sens.	(primary) A	100	10000	1	1000
Checkzone characteristic, slope						
Busbar_CheckK_IPar_	k checkzone	%	40	90	1	60
CT error detection, base sensitivity						
Busbar_CTErrSens_IPar_	CT failure Sens.	(primary) A	50	5000	1	500
CT error detection, slope						
Busbar_CTErrK_IPar_	k CT failure	%	40	90	1	60
Maximum load current						
Busbar_Offset_IPar_	Max.I_load	(primary) A	100	10000	1	1000

Table 5-3 The integer parameters of the distributed busbar differential protection function, central device

Timer parameters for the distributed busbar differential protection function, central device are summarized in *Table 5-4*.

Parameter name	Title	Unit	Min	Max	Step	Default
Time delay for signaling bad state						
Busbar_BadDelay_TPar_	BadState Delay	msec	100	60000	1	1000
Time delay for signaling CT error						
Busbar_CTErrDelay_TPar_	CT failure Delay	msec	100	60000	1	1000

Table 5-4 The timer parameters of the distributed busbar differential protection function, central device

3.1.1.4.2.1.2. Parameters for the "Bay unit" function block in the central device

Boolean parameter for the distributed busbar differential protection function, bay unit function blocks in the central device are summarized in *Table 5-5*.

Parameter name	Title	Default	Explanation
Disabling the bay			
BayUnit1f_BayDisable_BPar__T1	Bay Disable	0	• means enabling; • means that the current values and the status signals received from the bay are not considered (to be applied for maintenance purposes).

Table 5-5 The Boolean parameters of the distributed busbar differential protection function, bay unit function blocks

Enumerated parameters for the distributed busbar differential protection function, bay unit function blocks in the central device are summarized in *Table 5-6*:

Parameter name	Title	Selection range	Default
CT secondary rated current			
BayUnit1f_Nom_EPar T1	Rated Secondary	1A, 5A	1A
Location of the CT star point for the CT-s in three lines			
BayUnit1f_Dir_EPar__T1	Star point I1-3	Line, Bus	Line

Table 5-6 The enumerated parameter of the distributed busbar differential protection function, bay unit function block in the central device

NOTE: If the bay does not include a current transformer then these parameters are missing.

Integer parameter for the distributed busbar differential protection function, bay unit function blocks in the central device are summarized in *Table 5-7*:

Parameter name	Title	Unit	Min	Max	Step	Default
CT primary rated current						
BayUnit1f_CTNom_IPar__T1	CT nominal	A	100	10000	1	1000

Table 5-7 The integer parameter of the distributed busbar differential protection function, bay unit function block in the central device

NOTE: If the bay does not include a current transformer then this parameter is missing.

3.1.1.4.2.2. Parameters of the bay devices

There is only one parameter in the BBP Bay Unit function of the bay devices related to the busbar protection function. This parameter sets the time delay for the reaction of bad status signals received from the disconnectors of the bay:

Timer parameter for the distributed busbar differential protection function, bay device are summarized in *Table 5-8*:

Parameter name	Title	Unit	Min	Max	Step	Default
Time delay for signaling bad state						
BBPBU_BadDelay_TPar_	BadState Delay	msec	100	60000	1	1000

Table 5-8 The timer parameter of the distributed busbar differential protection function, bay device

With the parameters of the BB communication function block the communication between the central and the bay devices can be set, see chapter 4:

Integer parameters:

Parameter name	Title	Unit	Min	Max	Step	Default
VLAN addresses (these have to be set identical to each other for the same bay device)						
CPUBB_TxVLAN_IPar_	TxVLAN	-	1	4096	1	1
CPUBB_RxVLAN_IPar_	RxVLAN	-	1	4096	1	1
Priority, recommended to be left as default						
CPUBB_Priority_IPar_	Priority	-	0	7	1	2
Priority, recommended to be left as default						
CPUBB_MCast_IPar_	MCast	-	1	65535	1	1

Table 5-9 Parameters of the "BB communication" function block (bay devices)

3.1.1.4.2.3. Parameters of the breaker failure module

3.1.1.4.2.3.1. Parameter for the breaker failure module in the "Busbar" function block of central device

Enumerated parameter for the breaker failure protection function for enabling or disabling the trip command distribution in the central device are summarized in *Table 5-10*:

Parameter name	Title	Selection range	Default
Parameter to enable the trip command distribution of the breaker failure protection function (in Busbar function)			
Busbar_BFPOper_EPar_	Intertrip Operation	Off, On	Off

Table 5-10 The enumerated parameter of the breaker failure protection function in the central device

3.1.1.4.2.3.2. Parameter for the "Breaker failure" function block in the bay devices

The breaker failure protection function needs parameters related to the bays individually.

These parameters are as follows:

Enumerated parameters for the breaker failure protection function, bay devices are summarized in *Table 5-11*:

Parameter name	Title	Selection range	Default
Enabling the bay to participate in the breaker failure scheme			
BRF50_Oper_EPar_	Operation	Off,Current,Contact,Current/Contact	Off
Enabling the retrip command			
BRF50_ReTr_EPar_	Retrip	Off,On	Off

Table 5-11 The enumerated parameter of the breaker failure protection function, bay devices

Integer parameters for the breaker failure protection function, bay devices are summarized in

Table 5-12:

Parameter name	Title	Unit	Min	Max	Step	Default
Phase current condition for the breaker failure protection function						
BRF50_StCurrPh_IPar_	Start Ph Current	%	20	200	1	30
Residual current condition for the breaker failure protection function						
BRF50_StCurrN_IPar_	Start Res Current	%	10	200	1	20

Table 5-12 The integer parameters of the breaker failure protection function, bay devices

Timer parameters for the breaker failure protection function, bay devices are summarized in *Table 5-13*:

Parameter name	Title	Unit	Min	Max	Step	Default
Time delay for the retrip command generation						
BRF50_TrDel_TPar	Retrip Time Delay	msec	15	1000	1	100
Time delay for the backup trip command generation						
BRF50_BUDel_TPar__	Backup Time Delay	msec	60	1000	1	200
Trip impulse duration						
BRF50_Pulse_TPar__	Pulse Duration	msec	0	60000	1	100

Table 5-13 The timer parameters of the breaker failure protection function, bay devices

3.1.1.4.3. Binary output status signals

The binary output status signals of the function blocks for the distributed busbar differential protection function are summarized in the Tables below.

3.1.1.4.3.1. Binary output status signals of the central device

3.1.1.4.3.1.1. Binary output status signals of the “Busbar” function block in central device

Binary output signals	Signal title	Explanation
Busbar_Blocked_GrI_	Blocked	The busbar protection is in blocked state
Busbar_CommFail_GrI_	CommFail	Communication error
Busbar_DCError_GrI_	DCError	Disconnector status error
Busbar_TestMode_GrI_	TestMode	The central device is in “test/blocked” mode.

Table 5-14 The binary output status signals of the distributed busbar differential protection function, busbar function block

3.1.1.4.3.1.2. Binary output status signals of the “BusSec” (bus section) function block in the central device

Binary output signals	Signal title	Explanation
BusSec_TripL1_GrI_	TripL1	L1 trip signal for the bus section
BusSec_TripL2_GrI_	TripL2	L1 trip signal for the bus section
BusSec_TripL3_GrI_	TripL3	L1 trip signal for the bus section
BusSec_Trip_GrI_	Trip	General trip command for the bus section
BusSec_BFPTrip_GrI_	BFPTrip	Trip command generated by the breaker failure protection function
BusSec_CTError_GrI_	CTError	Error in current measurement
BusSec_Ublock_GrI_	Ublock	The differential protection is blocked by voltage condition

Table 5-15 The binary output status signals of the distributed busbar differential protection function, bus section function block

3.1.1.4.3.1.3. Binary output status signals of the “Bay unit” function block in the central device

Binary output signals	Signal title	Explanation
BayUnit_Trip_GrI_	Trip	Trip command to the circuit breaker of the bay
BayUnit_BayDisable_GrI_	BayDisable	Bay disabled
BayUnit_BFPTrip_GrI_	BFPTrip	The Breaker failure protection of the related bay has tripped.

Table 5-16 The binary output status signals of the distributed busbar differential protection function, bay unit function block

3.1.1.4.3.1.4. Binary output status signals of the “SecStat” (sectionalizer) function block in the central device

Binary output signals	Signal title	Explanation
SecStat_SectClosed_GrI_	SectClosed	Closed state of the sectionalizer
SecStat_StatErr_GrI_	StatErr	Status signal error

Table 5-17 The binary output status signals of the distributed busbar differential protection function, sectionalizer function block

3.1.1.4.3.2. Binary output status signals of the bay devices

3.1.1.4.3.2.1. Binary output status signals of the “BBP Bay unit” protection function block in the bay devices

Binary output signals	Signal title	Explanation
BBPBU_Trip_GrI_	Trip	Trip command to the circuit breaker of the bay
BBPBU_DCErr_GrI_	DCErr	Disconnector status error
BBPBU_CommFail_GrI_	CommFail	Communication failure
BBPBU_Signal1_GrI_	Signal1	Binary signal receiving from the central device
BBPBU_Signal2_GrI_	Signal2	Binary signal receiving from the central device

Table 5-18 The binary output status signals of the distributed busbar differential protection function, bay unit function block

3.1.1.4.3.2.2. Binary output status signals of the “Breaker failure” function block in the bay devices

Binary output signal	Signal title	Explanation
BRF50_BuTr_GrI_	BuTr	Trip command for the bay, generated by the breaker failure function
BRF50_BuTrL1_GrI_	BuTrL1	Trip command for the bay in phase L1, generated by the breaker failure function
BRF50_BuTrL2_GrI_	BuTrL2	Trip command for the bay in phase L2, generated by the breaker failure function
BRF50_BuTrL3_GrI_	BuTrL3	Trip command for the bay in phase L3, generated by the breaker failure function

Table 5-19 The binary output status signals of the distributed busbar differential protection function, bay devices

3.1.1.4.4. Binary input status signals

The conditions are defined by the user applying the graphic logic editor.

The binary input status signals of the function blocks for the distributed busbar differential protection function are summarized in the Tables below.

3.1.1.4.4.1. Binary input status signal of the central device

3.1.1.4.4.1.1. Binary input status signal of the “Busbar” function block in central device

Binary input signals	Signal title	Explanation
Busbar_BBPBlock_GrO_	BBPBlock	Blocking the busbar differential protection function
Busbar_BFPBlock_GrO_	BFPBlock	Blocking the breaker failure protection function

Table 5-20 The binary input status signal of the distributed busbar differential protection function, busbar function block central device

3.1.1.4.4.1.2. Binary input status signals of the “BusSec” (bus section) function block in the central device

The Bus section function block does not have binary input status signals.

3.1.1.4.4.1.3. Binary input status signals of the "Bay unit" function block in the central device

Binary input signals	Signal title	Explanation
BayUnit_BlkSect_GrO_	BlkSect	In TRUE state of this input signal the measuring element related to this bay gets in blocked state
BayUnit_Disable_GrO_	Disable	The bay can be disabled with this input
BayUnit_Signal1_GrO_	Signal1	Binary signal transmitting to the bay device device
BayUnit_Signal2_GrO_	Signal2	Binary signal transmitting to the bay device device

Table 5-21 The binary input status signals of the distributed busbar differential protection function, bay unit function block

3.1.1.4.4.1.4. Binary output status signals of the "SecStat" (sectionalizer) function block in the central device

Binary input signals	Signal title	Explanation
SecStat_DC1Close_GrO_	DC1Close	Disconnector 1 in closed state
SecStat_DC1Open_GrO_	DC1Open	Disconnector 1 in open state
SecStat_DC2Close_GrO_	DC2Close	Disconnector 2 in closed state
SecStat_DC2Open_GrO_	DC2Open	Disconnector 2 in open state

Table 5-22 The binary input status signals of the distributed busbar differential protection function, sectionalizer function block

3.1.1.4.4.2. Binary input status signals of the bay devices

3.1.1.4.4.2.1. Binary input status signals of the "BBP Bay unit" function block in the bay devices

Binary input signals	Signal title	Explanation
BBPBU_DC1Close_GrO_	DC1Close	Disconnector 1 in closed state
BBPBU_DC1Open_GrO_	DC1Open	Disconnector 1 in open state
BBPBU_DC2Close_GrO_	DC2Close	Disconnector 2 in closed state
BBPBU_DC2Open_GrO_	DC2Open	Disconnector 2 in open state
BBPBU_DC3Close_GrO_	DC3Close	Disconnector 3 in closed state
BBPBU_DC3Open_GrO_	DC3Open	Disconnector 3 in open state
BBPBU_DC4Close_GrO_	DC4Close	Disconnector 4 in closed state
BBPBU_DC4Open_GrO_	DC4Open	Disconnector 4 in open state
BBPBU_BFPTrip_GrO_	BFPTrip	Breaker failure signal from the protection of the bay. The breaker failure protection passes this signal to all bays of the interconnected bus sections, related to this particular bay
BBPBU_ForceZero_GrO_	ForceZero	In TRUE state of this input signal the bay unit sends zero value as the sampled current

Table 5-23 The binary input status signals of the breaker failure modules

3.1.1.4.4.2.2. Binary input status signals of the “Breaker failure” function block in the bay devices

Binary input signals	Signal title	Explanation
BRF50_Blk_GrO_	Blk	Blocking of the breaker failure protection function
BRF50_CBClL1_GrO_	CBClL1	Signal indicating the closed state of the circuit breaker in phase L1
BRF50_CBClL2_GrO_	CBClL2	Signal indicating the closed state of the circuit breaker in phase L2
BRF50_CBClL3_GrO_	CBClL3	Signal indicating the closed state of the circuit breaker in phase L3
BRF50_GenSt_GrO_	GenSt	General starting signal
BRF50_StL1_GrO_	StL1	Starting signal in phase L1
BRF50_StL2_GrO_	StL2	Starting signal in phase L2
BRF50_StL3_GrO_	StL3	Starting signal in phase L3
BRF50_IoSt_GrO_	IoSt	Starting signal for the residual current

Table 5-24 The binary input status signals of the breaker failure modules

3.1.1.4.5. The function blocks

The function blocks of the distributed busbar differential protection function, central device are shown in *Figure 5-1.* These blocks show all binary input and output status signals that are applicable in the graphic logic editor. The block of the distributed busbar differential protection function, bay devices is shown in *Figure 5-2.*

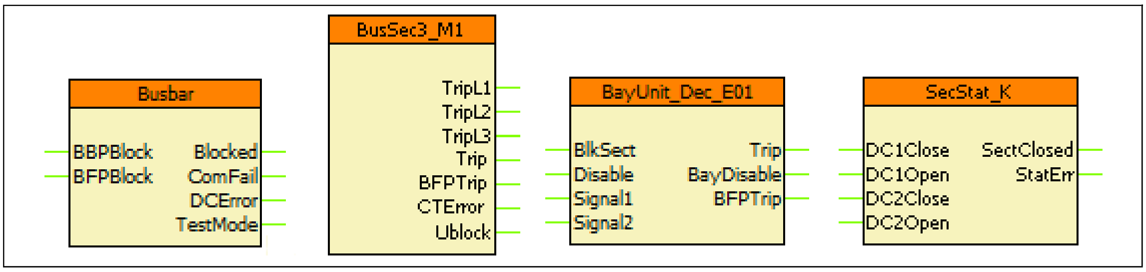


Figure 5-1 The function blocks of the distributed busbar differential protection function, central device

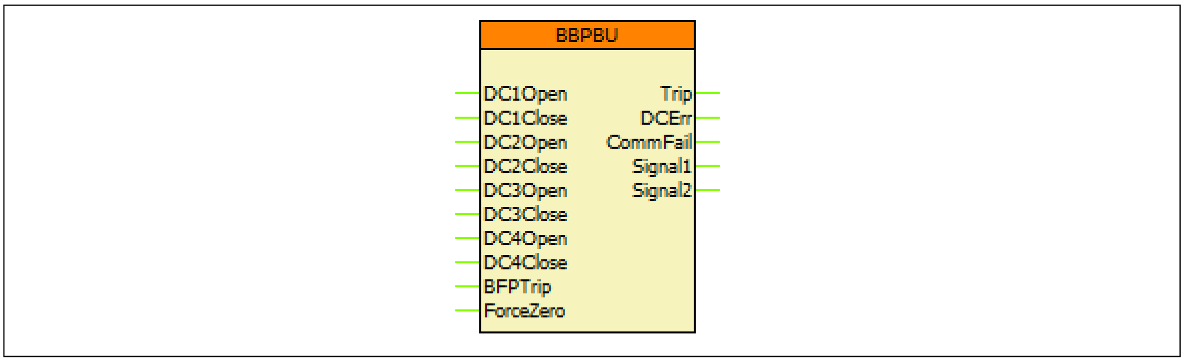


Figure 5-2 The function block of the distributed busbar differential protection function, bay device

The function block of a breaker failure protection scheme in the bay device is shown in *Figure 5-3.*

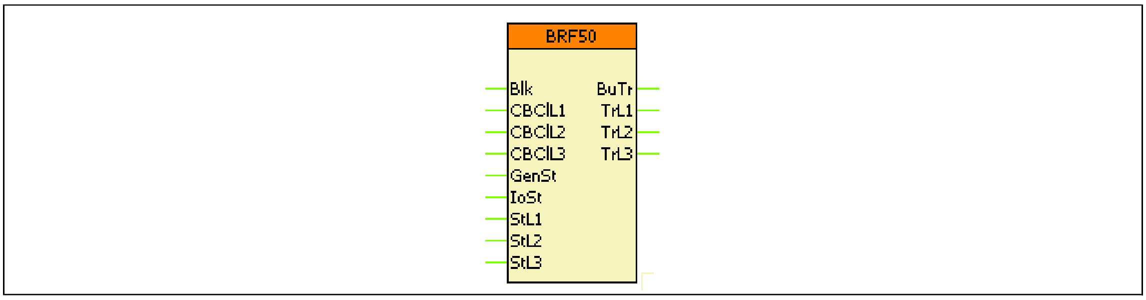


Figure 5-3 The function block of the breaker failure protection function, bay device

3.1.1.5. Appendix I

3.1.1.5.1. The procedure of the busbar protection configuration

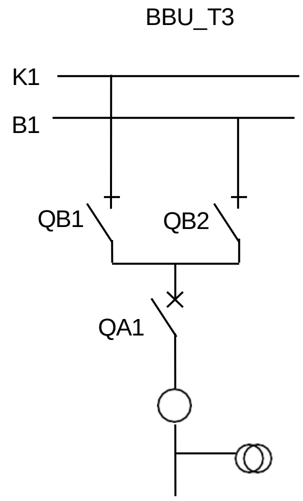
3.1.1.5.1.1. Configuration in the factory

The factory configuration assembles the needed number of hardware elements and the related software elements. If the description of the bay system is not specified at ordering, or if the substation is extended by new elements, then the user has the task to describe the busbar topology.

In the factory configuration each bay unit gets the assigned hardware elements, e.g. analog current inputs, analog voltage inputs if any, available disconnector status signal inputs, and the assigned trip contacts.

3.1.1.5.1.2. Defining the bay topology

The definition of a topology in the central device of the busbar protection system is illustrated with the example of a bay connected to a double busbar below:



The user describes the topology, stating to which busbar sections the given bay is connected. This is performed using the “EuroCap” configuration software with the application of dialog window in the menu “Software configuration / Functions / Busbar protection / Bay topology” as in the Figure below. In the topology element related to this window the bay “BBU-T3” is connected via “Disconnector 1” (QB1) to the busbar section “K1” and via “Disconnector 2” (QB2) to the busbar section “B1”

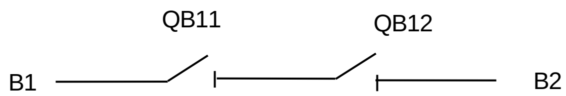
In this application disconnectors 3 and 4 are not applied. The information “Include to check zone” states that the information of this bay is applied also for check zone calculation. (As an example the current of a bus couple bay generally may not be involved in the check zone calculation.)

The subsequent parameter in the Figure below (CT dir inverted) states that the positive direction of the current is not inverted. (As an opposite example the current transformer direction in a bus coupler bay must be inverted for one of the bus sections.)

The “Connection ref. No.” setting is usually 0, indicating that the bay is not interconnected with any of other bays. The code number deviating from zero means that the may is interconnected with bays having the same value for this parameter.

Assigned bay [l]:	0198 Bay units
	BayUnit1f_BU_BBU__T3 (Bay Unit)
1. disconnector section [h]:	0197 Sections
	BusSection_K1 (BusSection)
2. disconnector section [h]:	0197 Sections
	BusSection_B1 (BusSection)
3. disconnector section [h]:	
	(nothing)
4. disconnector section [h]:	
	(nothing)
Include to check zone [0,1]:	0
CT Dir.Inverted [0,1]:	0
Connection ref.No. [0,255]:	101

3.1.1.5.1.3. Defining the sectionalizers



The user describes the topology, stating how the sectionalizers connect the busbar sections. This is performed using the “EuroCap” configuration software with the application of dialog window in the menu “Software configuration / Functions / Busbar protection / Sectionalizers” as in the Figure below.

1. disconnector on [u]:	0213 Graphed input Status
	SecStat_SectClosed_GrI__B ()
Sect.disconnector status error [u]:	0213 Graphed input Status
	SecStat_StatErr_GrI__B (Status Error)
1. disconnector section [h]:	0197 Sections
	BusSection_B1 (BusSection)
2. disconnector section [h]:	0197 Sections
	BusSection_B2 (BusSection)

In this example the sectionalizer interconnects the bus sections B1 and B2. The closed status is the result of closed states QB11 AND QB12. This is the task of the user to compose a graphic binary logic for the binary variable “SecStat_SectClosed_GrI_B()”.

Similarly the disconnector status error is composed in a binary logic for the graphic binary variable “SecStat_StatErr_GrI_B(Status Error”).

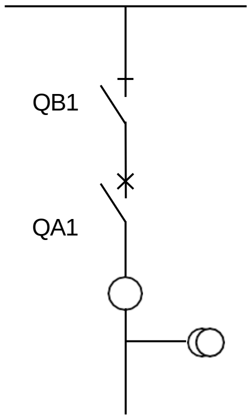
The chapter below shows further application examples for some frequent practical cases.

3.1.1.6. Appendix II

3.1.1.6.1. Application examples

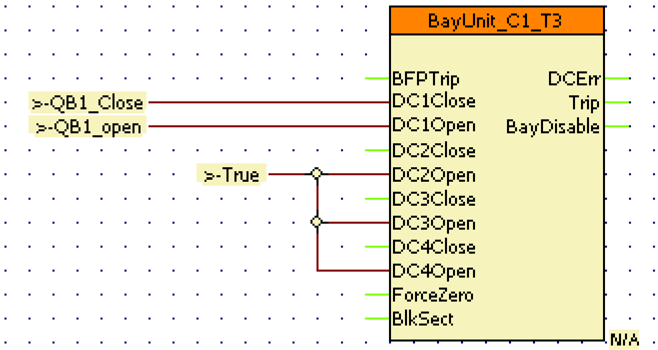
These application examples show typical solutions for defining the busbar topology. Based on these examples, also the details of here not discussed busbar configurations can be defined. The individual examples show the graphic connections of the bay units and the parameter setting of the topology objects.

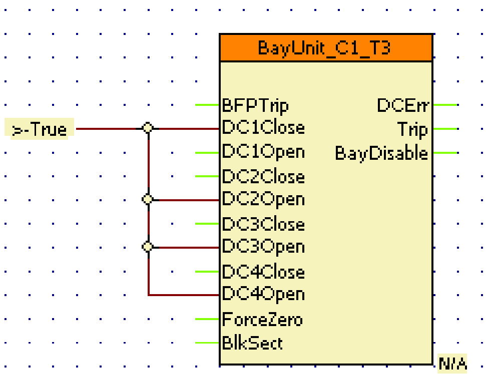
3.1.1.6.1.1. Example 1: Bay connected to a single busbar



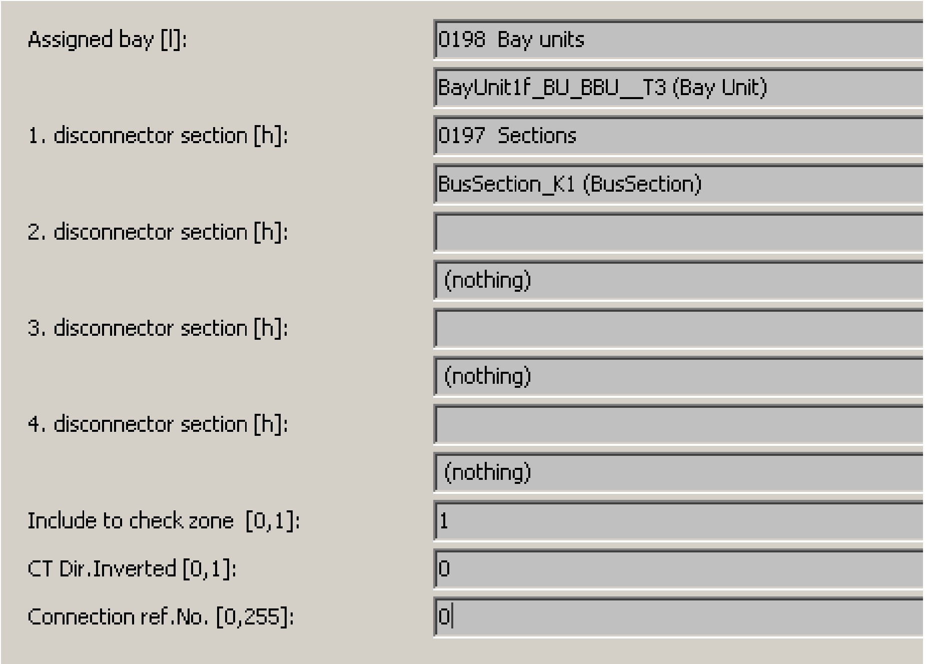
In this simple bay configuration the status signals indicating the closed and open state of the disconnector are connected to “DC1Close” and “DC1Open inputs”. All other “DCOpen” inputs are connected to logic “True”.

In the second indicated solution the connection of the bay is fixed to “DC1Close” of the function block. All other “DCOpen” inputs are also connected to logic “True”.



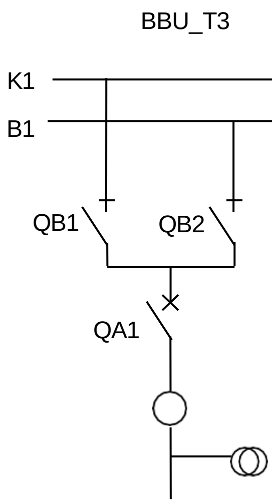


The parameters describing the topology are shown in Figure below:

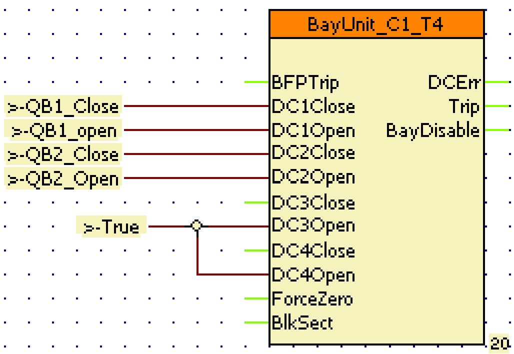


Assigned bay [l]:	0198 Bay units
	BayUnit1f_BU_BBU__T3 (Bay Unit)
1. disconnector section [h]:	0197 Sections
	BusSection_K1 (BusSection)
2. disconnector section [h]:	
	(nothing)
3. disconnector section [h]:	
	(nothing)
4. disconnector section [h]:	
	(nothing)
Include to check zone [0,1]:	1
CT Dir.Inverted [0,1]:	0
Connection ref.No. [0,255]:	0

3.1.1.6.1.2. Example 2: Bay connected to a double busbar



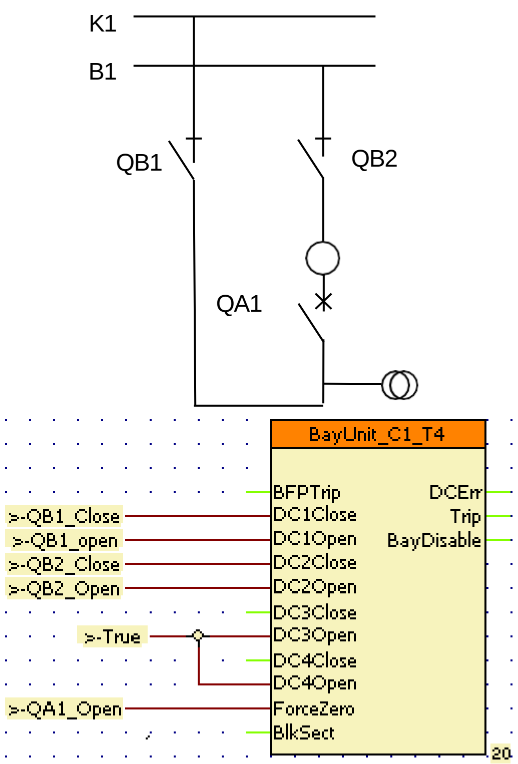
The function block:



The parameters describing the topology are shown in Figure below:

Assigned bay [I]:	0198 Bay units
	BayUnit1f_BU_BBU__T3 (Bay Unit)
1. disconnector section [h]:	0197 Sections
	BusSection_K1 (BusSection)
2. disconnector section [h]:	0197 Sections
	BusSection_B1 (BusSection)
3. disconnector section [h]:	
	(nothing)
4. disconnector section [h]:	
	(nothing)
Include to check zone [0,1]:	1
CT Dir.Inverted [0,1]:	0
Connection ref.No. [0,255]:	0

3.1.1.6.1.3. Example 3: Bus coupler bay with one current transformer



There are two topology elements assigned to this bus coupler bay: one for the side of QB1 and one for the side of QB2, the current positive direction for the second one must be inverted.

Both topology elements refer to the same bay unit.

In this application also the state of the circuit breaker is considered: in its open state the measured current must be disclosed to correctly clear the dead zone faults between the circuit breaker and the current transformer.

The algorithm automatically disclosed the current measured by this current transformer if the connected busbar sections are interconnected also by any other element of the busbar system. This bypass is identified if two topology elements refer to the same bay unit.

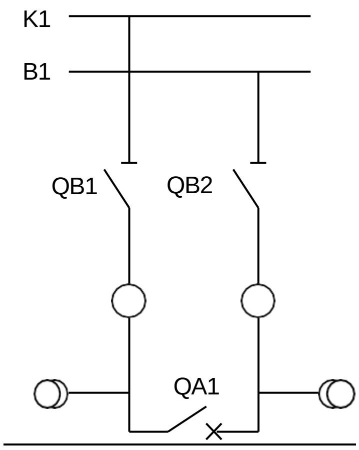
The topology element related to QB1 is as follows:

Assigned bay [I]:	0198 Bay units
	BayUnit1f_BU_BBU__T3 (Bay Unit)
1. disconnector section [h]:	0197 Sections
	BusSection_K1 (BusSection)
2. disconnector section [h]:	
	(nothing)
3. disconnector section [h]:	
	(nothing)
4. disconnector section [h]:	
	(nothing)
Include to check zone [0,1]:	0
CT Dir.Inverted [0,1]:	1
Connection ref.No. [0,255]:	0

The topology element related to QB2 is as follows:

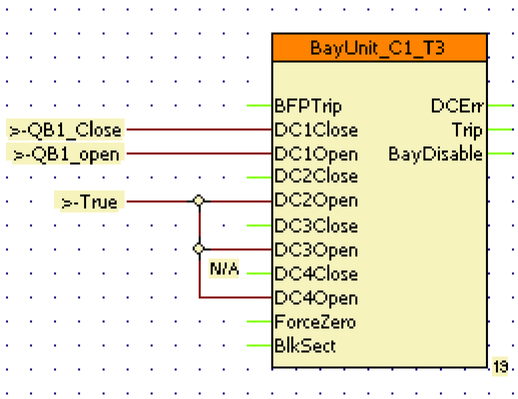
Assigned bay [I]:	0198 Bay units
	BayUnit1f_BU_BBU__T3 (Bay Unit)
1. disconnector section [h]:	
	(nothing)
2. disconnector section [h]:	0197 Sections
	BusSection_B1 (BusSection)
3. disconnector section [h]:	
	(nothing)
4. disconnector section [h]:	
	(nothing)
Include to check zone [0,1]:	0
CT Dir.Inverted [0,1]:	0
Connection ref.No. [0,255]:	0

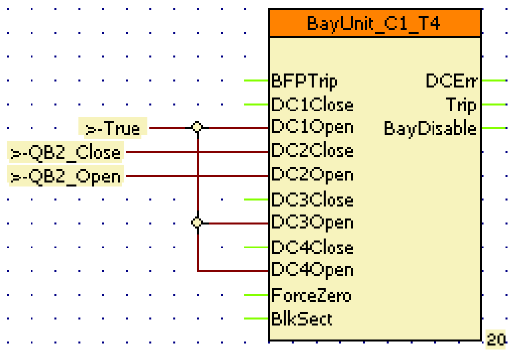
3.1.1.6.1.4. Example 4: Bus coupler bay with two current transformers



To describe this configuration two “Bay unit” function blocks are applied. The current transformers must be connected in overlapping arrangement. Because of overlapping, the “Open” state of the circuit breaker need not disclose the current.

When however the bus sections are interconnected also by any other element of the busbar system, then the automatic disclosing the current is also needed. For this purpose the algorithm must be informed about the bypass of the bus coupler bay. For this purpose the parameter “Connection ref.No” is applied. If the identifiers of these two bay units have identical (but not 0) identifier then these bays are considered to be interconnected.





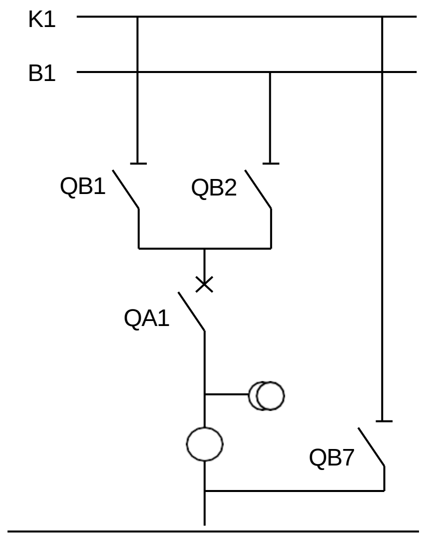
The topology element related to QB1 is as follows:

Assigned bay [l]:	0198 Bay units
	BayUnit1f_BU_BBU__T3 (Bay Unit)
1. disconnector section [h]:	0197 Sections
	BusSection_K1 (BusSection)
2. disconnector section [h]:	
	(nothing)
3. disconnector section [h]:	
	(nothing)
4. disconnector section [h]:	
	(nothing)
Include to check zone [0,1]:	0
CT Dir.Inverted [0,1]:	0
Connection ref.No. [0,255]:	100

The topology element related to QB2 is as follows:

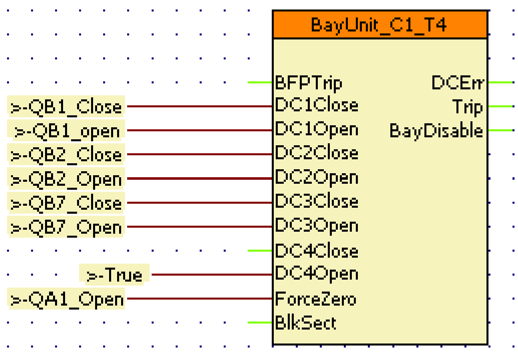
Assigned bay [l]:	0198 Bay units
	BayUnit1f_BU_BBU__T4 (Bay Unit)
1. disconnector section [h]:	
	(nothing)
2. disconnector section [h]:	0197 Sections
	BusSection_B1 (BusSection)
3. disconnector section [h]:	
	(nothing)
4. disconnector section [h]:	
	(nothing)
Include to check zone [0,1]:	0
CT Dir.Inverted [0,1]:	0
Connection ref.No. [0,255]:	100

3.1.1.6.1.5. Example 5: Double bus connection with bypass



This bay can serve as bus coupler or as a feeder bay.

The graphical connections of the applied bay unit are as follows:

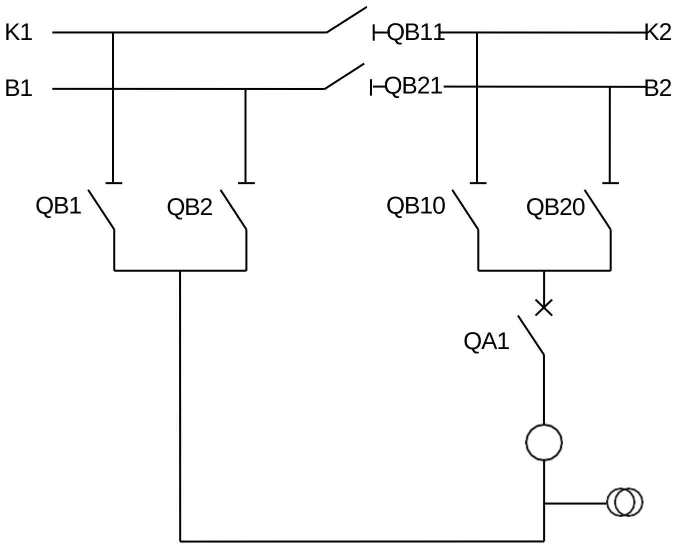


The related topology elements are as follows:

Assigned bay [I]:	0198 Bay units
	BayUnit1f_BU_BBU__T4 (Bay Unit)
1. disconnector section [h]:	0197 Sections
	BusSection_K1 (BusSection)
2. disconnector section [h]:	0197 Sections
	BusSection_B1 (BusSection)
3. disconnector section [h]:	
	(nothing)
4. disconnector section [h]:	
	(nothing)
Include to check zone [0,1]:	1
CT Dir.Inverted [0,1]:	0
Connection ref.No. [0,255]:	0

Assigned bay [l]:	0198 Bay units
	BayUnit1f_BU_BBU__T4 (Bay Unit)
1. disconnector section [h]:	
	(nothing)
2. disconnector section [h]:	
	(nothing)
3. disconnector section [h]:	0197 Sections
	BusSection_K1 (BusSection)
4. disconnector section [h]:	
	(nothing)
Include to check zone [0,1]:	1
CT Dir.Inverted [0,1]:	1
Connection ref.No. [0,255]:	0

3.1.1.6.1.6. Example 6: Bus coupler in a double busbar system



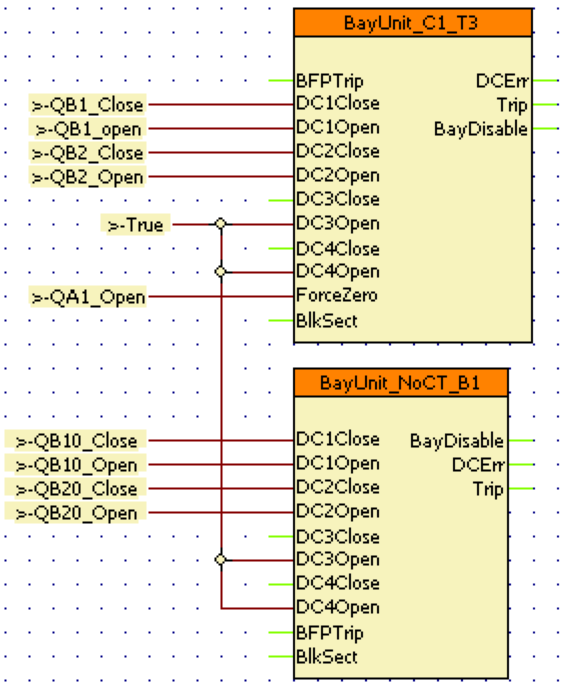
This configuration can be describes in two ways:

If the description is realized with a single bay unit, then the method is the same as a bay single bay coupler with a single current transformer. The only difference is that two disconnectors are applied in both sides. One of them is connected to the inputs DC1-DC2, the other side applies the inputs DC3-DC4.

If the description applies two bay units, or if the number of busbars is more than two (e.g. triple bay system) then the solution is as follows:

Here a function block is to be applied which operates without current transformer. With this solution a quadruple system (consisting of four busbars) can be described.

c



The setting of the topology elements is as follows:

Assigned bay [l]:	0198 Bay units
	BayUnit1f_BU_BBU__T3 (Bay Unit)
1. disconnector section [h]:	0197 Sections
	BusSection_K1 (BusSection)
2. disconnector section [h]:	0197 Sections
	BusSection_B1 (BusSection)
3. disconnector section [h]:	
	(nothing)
4. disconnector section [h]:	
	(nothing)
Include to check zone [0,1]:	0
CT Dir.Inverted [0,1]:	0
Connection ref.No. [0,255]:	101

Assigned bay [l]:	0198 Bay units
	BayUnitNoCT_BU_BBU__B1 (Bay Unit)
1. disconnector section [h]:	0197 Sections
	BusSection_K2 (BusSection)
2. disconnector section [h]:	0197 Sections
	BusSection_B2 (BusSection)
3. disconnector section [h]:	
	(nothing)
4. disconnector section [h]:	
	(nothing)
Include to check zone [0,1]:	0
CT Dir.Inverted [0,1]:	0
Connection ref.No. [0,255]:	101

3.2. Measuring functions

The measured values can be checked on the touch-screen of the device in the "On-line functions" page, or using an Internet browser of a connected computer. The displayed values are secondary voltages and currents, except the block "Line measurement". This specific block displays the measured values in primary units, using VT and CT primary value settings.

Analog value	Explanation
VT4 module	
Voltage Ch – U1	RMS value of the Fourier fundamental harmonic voltage component in phase L1
Angle Ch – U1	Phase angle of the Fourier fundamental harmonic voltage component in phase L1*
Voltage Ch – U2	RMS value of the Fourier fundamental harmonic voltage component in phase L2
Angle Ch – U2	Phase angle of the Fourier fundamental harmonic voltage component in phase L2*
Voltage Ch – U3	RMS value of the Fourier fundamental harmonic voltage component in phase L3
Angle Ch – U3	Phase angle of the Fourier fundamental harmonic voltage component in phase L3*
Voltage Ch – U4	RMS value of the Fourier fundamental harmonic voltage component in Channel U4
Angle Ch – U4	Phase angle of the Fourier fundamental harmonic voltage component in Channel U4*
CT4 module	
Current Ch - I1	RMS value of the Fourier fundamental harmonic current component in phase L1
Angle Ch - I1	Phase angle of the Fourier fundamental harmonic current component in phase L1*
Current Ch - I2	RMS value of the Fourier fundamental harmonic current component in phase L2
Angle Ch - I2	Phase angle of the Fourier fundamental harmonic current component in phase L2*
Current Ch - I3	RMS value of the Fourier fundamental harmonic current component in phase L3
Angle Ch - I3	Phase angle of the Fourier fundamental harmonic current component in phase L3*
Current Ch - I4	RMS value of the Fourier fundamental harmonic current component in Channel I4
Angle Ch - I4	Phase angle of the Fourier fundamental harmonic current component in Channel I4*
Distance protection function (DIS21_HV)	
Fault location	Measured distance to fault
Fault react.	Measured reactance in the fault loop
L1N loop R	Resistive component value of impedance in L1-N loop
L1N loop X	Reactive component value of impedance in L1-N loop
L2N loop R	Resistive component value of impedance in L2-N loop
L2N loop X	Reactive component value of impedance in L2-N loop
L3N loop R	Resistive component value of impedance in L3-N loop
L3N loop X	Reactive component value of impedance in L3-N loop
L12 loop R	Resistive component value of impedance in L12 loop
L12 loop X	Reactive component value of impedance in L12 loop
L23 loop R	Resistive component value of impedance in L23 loop
L23 loop X	Reactive component value of impedance in L23 loop
L31 loop R	Resistive component value of impedance in L31 loop
L31 loop X	Reactive component value of impedance in L31 loop

Synchrocheck function (SYN25)	
Voltage Diff	Voltage different value
Frequency Diff	Frequency different value
Angle Diff	Angle different value
Line measurement (MXU_L) (here the displayed information means primary value)	
Active Power – P	Three-phase active power
Reactive Power – Q	Three-phase reactive power
Apparent Power – S	Three-phase power based on true RMS voltage and current measurement
Current L1	True RMS value of the current in phase L1
Current L2	True RMS value of the current in phase L2
Current L3	True RMS value of the current in phase L3
Voltage L1	True RMS value of the voltage in phase L1
Voltage L2	True RMS value of the voltage in phase L2
Voltage L3	True RMS value of the voltage in phase L3
Voltage L12	True RMS value of the voltage between phases L1 L2
Voltage L23	True RMS value of the voltage between phases L2 L3
Voltage L31	True RMS value of the voltage between phases L3 L1
Frequency	Frequency
Metering (MTR)	
Forward MWh	Forward MWh
Backward MWh	Backward MWh
Forward MVArh	Forward MVArh
Backward MVArh	Backward MVArh
Line thermal protection (TTR49L)	
Calc. Temperature	Calculated line temperature

* *The reference angle is the phase angle of “Voltage Ch - U1”*

Table 3-146 Measured analog values

3.2.1. Line and frequency measurement functions

3.2.1.1.Application

The input values of the EuroProt+ devices are the secondary signals of the voltage transformers and those of the current transformers when they are available in the actual configuration.

These signals are pre-processed by the “VT4 module” voltage input function block and by “CT4 module” the current input function block. These function blocks are described in separate documents. The pre-processed values include the Fourier basic harmonic phasors of the voltages and currents and the true RMS values. Additionally, it is in these function blocks that parameters are set concerning the voltage ratio of the primary voltage transformers and current ratio of the current transformers.

Based on the pre-processed values and the measured transformer parameters, the measurement function blocks calculate - depending on the hardware and software configuration - the primary RMS values of the voltages and currents and some additional values such as active and reactive power, symmetrical components of voltages and currents. These values are available as primary quantities and they can be displayed on the on-line screen of the device or on the remote user interface of the computers connected to the communication network and they are available for the SCADA system using the configured communication system.

3.2.1.2. Mode of operation

The **inputs** of the line measurement function are

- the Fourier components and true RMS values of the measured voltages and currents,
- frequency measurement,
- parameters.

The **outputs** of the line measurement function are

- displayed measured values,
- reports to the SCADA system.

NOTE: the scaling values are entered as parameter setting for the “Voltage transformer input” function block and for the “Current transformer input” function block.

3.2.1.3. The measurement

3.2.1.3.1. The measured values; variants of the function

There are six variants of the MXU function, based on their **measured values**. Parameters and measurements are alike for each. The **type of the variant** is shown in the *function block name*:

- Line Measurement (*MXU_**LM***)
- Frequency Measurement (*MXU_**F***)
- Voltage measurement (*MXU_**V***)
- Voltage measurement (*MXU_**V1***) (single voltage)
- Current measurement (*MXU_**C***)
- Current measurement (*MXU_**C1***) (single current)

Table 1-1 Measured values of each variant

ON-LINE MEASURED VALUE	EXPLANATION	MXU FUNCTION BLOCK VARIANT					
		LM	F	V	V1	C	C1
MXU_P_OLM_	Active Power – P (Fourier base harmonic value)	X					
MXU_Q_OLM_	Reactive Power – Q (Fourier base harmonic value)	X					
MXU_S_OLM_	Apparent Power – S (Fourier base harmonic value)	X					
MXU_Fi_OLM_	Power factor	X					
MXU_I1_OLM_	Current L1	X				X	X
MXU_I2_OLM_	Current L2	X				X	
MXU_I3_OLM_	Current L3	X				X	
MXU_Ipos_OLM_	Calculated positive seq. current	X				X	
MXU_Ineg_OLM_	Calculated negative seq. current	X				X	
MXU_3Io_OLM_	Calculated 3Io	X				X	
MXU_U1_OLM_	Voltage L1	X		X	X		
MXU_U2_OLM_	Voltage L2	X		X			
MXU_U3_OLM_	Voltage L3	X		X			
MXU_U12_OLM_	Voltage L12	X		X			
MXU_U23_OLM_	Voltage L23	X		X			
MXU_U31_OLM_	Voltage L31	X		X			
MXU_Upos_OLM	Calculated positive seq. voltage	X		X			
MXU_Uneg_OLM_	Calculated negative seq. voltage	X		X			
MXU_3Uo_OLM_	Calculated 3Uo	X		X			
MXU_f_OLM_	Frequency		X	X			

3.2.1.3.2. The measurement modes

Regarding the power measurements there are two possibilities for the measurement modes. The first one is the “ThreePhase”-method, where all three measured voltages and currents are considered in the power calculation. The second one is the “Aron”-method, where two phase-to-phase voltages and two phase currents are taken into the calculation. This method has correct results only in case when the voltages and currents are symmetrical. The user can choose the mode with the “Measurement mode” parameter. For the “Aron”-method there are three options:

Table 1-2 Explanation for the Aron measurement modes

Measurement mode	Used phase-currents	Used phase-to-phase voltages
Aron L2-L3	L2, L3	L1-L2, L3-L1
Aron L3-L1	L1, L3	L1-L2, L2-L3
Aron L1-L2	L1, L2	L2-L3, L3-L1

If the “Connection U1-3” parameter of the *VT4 module* function block is set to “Ph-Ph”, the “ThreePhase”-method cannot be used for the power measurements here, so either of the “Aron” methods must be set for it. Otherwise, the device will provide a warning signal (yellow Status LED, “General param. error” message).

3.2.1.4. Reporting the measured values and the changes

It is usual for the SCADA systems that they sample the measured and calculated values in regular time periods and additionally they receive the changed values as reports at the moment when any significant change is detected in the primary system. The “Line measurement” function block performs such reporting for the SCADA system. Three parameters define this reporting:

- *Report Deadband* for choosing the type of reporting, or disabling the reporting
- *Deadband Value* for defining the deadband width
- *Range (value)* for evaluating the “out-of-range” condition

The usage of these parameters is explained in the following chapters.

3.2.1.4.1. “Amplitude” mode of reporting

If the “Amplitude” mode is selected for reporting, a report is generated if the measured value leaves the deadband around the previously reported value. As an example, Figure 1-1 shows that the current becomes higher than the value reported in “report1” PLUS the Deadband value, this results “report2”, etc.

For this mode of operation, the Deadband parameters are explained in the figure below.

NOTE: The “Range” parameters are needed to evaluate a measurement as “out-of-range”.

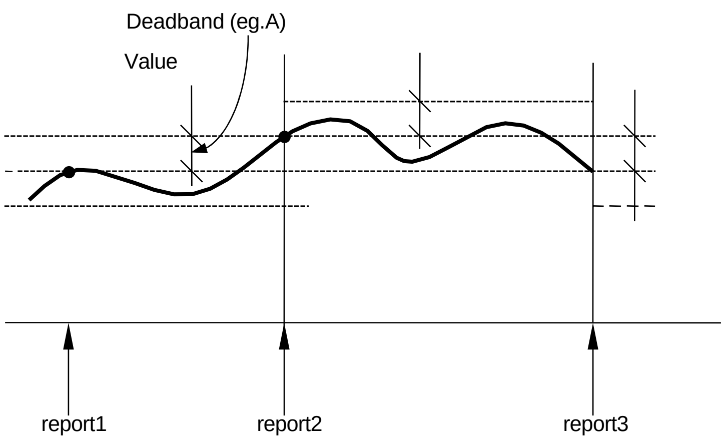


Figure 1-1 Reporting if “Amplitude” mode is selected

3.2.1.4.2. “Integrated” mode of reporting

If the “Integrated” mode is selected for reporting, a report is generated if the time integral of the measured value since the last report gets becomes larger, in the positive or negative direction, then the (deadband*1sec) area. As an example, Figure 1-2 shows that the integral of the current in time becomes higher than the Deadband value multiplied by 1sec, this results “report2”, etc.

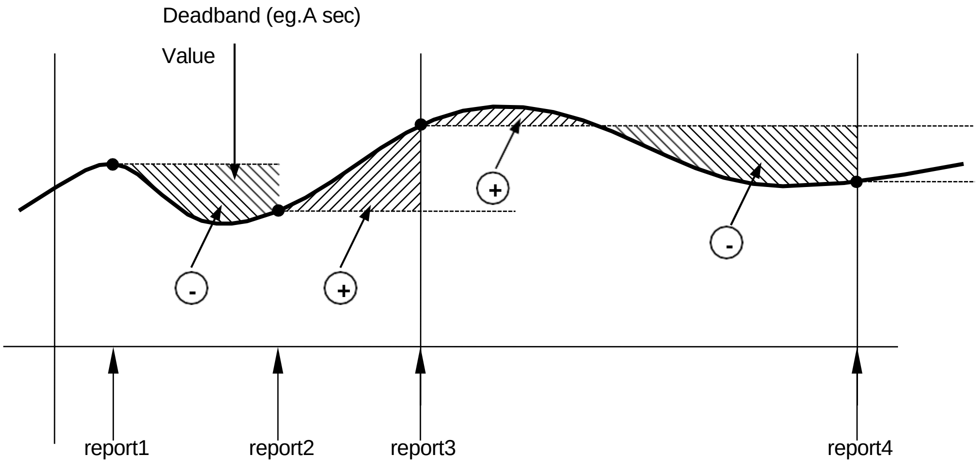


Figure 1-2 Reporting if “Integrated” mode is selected

3.2.1.4.3. Periodic reporting

Periodic reporting is generated independently of the changes of the measured values when the defined time period elapses. If the reporting time period is set to 0, then no periodic reporting is performed for this quantity.

*Applying periodic reporting and setting up its interval is done by using the **Communication configurator**, a part of the **EuroCAP** software (see its description for detailed information).*

Once the “**Trigger period**” property is set to “True”, the “**Integrity period**” setting becomes available to set (in milliseconds). As an example, see the picture below.

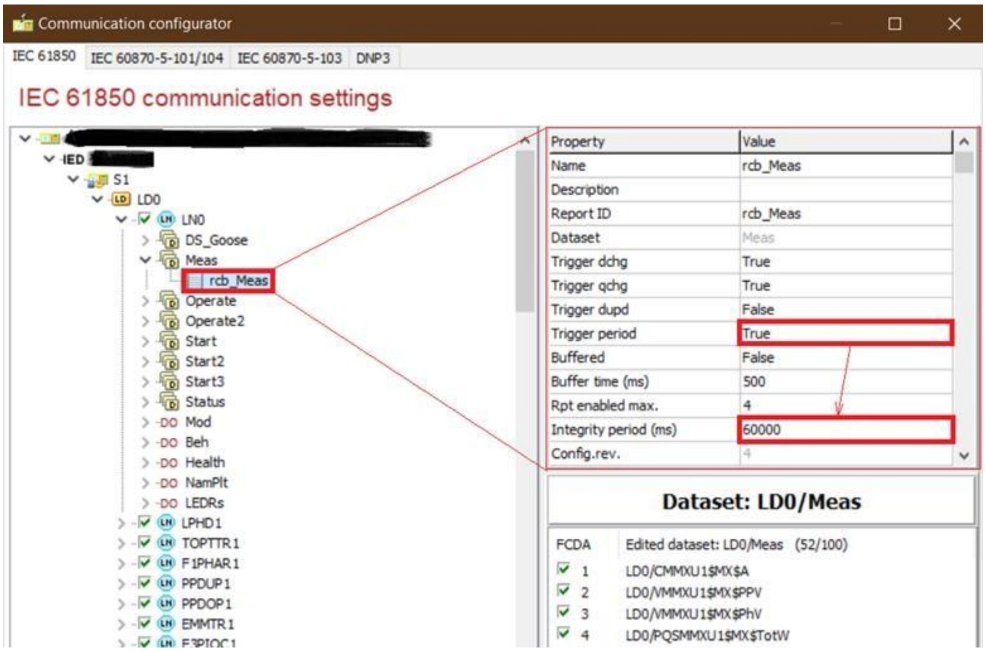


Figure 1-3 Setting up periodic reporting in EuroCAP

3.2.1.4.4. Zero-point clamping

A measured value under the zero-point clamping limit is cut off to zero.

- Three-phase current measurement *0.2%* of nominal (In)
- Three-phase voltage measurement *2%* of nominal (Un)
- Residual current measurement *0.2%* of nominal (In)
- Residual voltage measurement *2%* of nominal (Un)
- Phase sequence current measurement *0.2%* of the nominal (In)
- Phase sequence voltage measurement *2%* of the nominal (Un)
- Three-phase power and energy measurement *0.23%* of the nominal (Sn)

3.2.1.5.Line and frequency measurement functions overview

3.2.1.5.1. Settings

3.2.1.5.1.1. Parameters

The following parameters are the parameters of the Line Measurement and Frequency measurement function blocks (LM and F variants). The other functions' parameters follow the pattern of the corresponding measured values.

Table 2-1 Parameters of the line measurement function

TITLE	DIM	RANGE**	STEP	DEFAULT	EXPLANATION
Measurement mode	-	Aron L2-L3, Aron L3-L1, Aron L1-L2, ThreePhase	-	ThreePhase	Measurement mode
Report Deadband - U	-	Off, Amplitude, Integrated	-	Amplitude	Selection of the reporting mode for voltage measurement
Deadband Value - Uph-N	kV*	0.10 – 100.00	0.01	5	Deadband value for the phase-to-neutral voltage
Range Value - Uph-N	kV*	1.0 – 1000.0	0.1	231	Range value for the phase-to-neutral voltage
Deadband Value Uph-ph	kV*	0.10 – 100.00	0.01	5	Deadband value for the phase-to-phase voltage
Range Value - Uph-ph	kV*	1.0 – 1000.0	0.1	400	Range value for the phase-to-neutral voltage
Deadband Value - U Res	kV*	0.10 – 100.00	0.01	5	Deadband value for the residual voltage
Range Value - U Res	kV*	1.0 – 1000.0	0.1	20	Range value for the residual voltage
Deadband Value - Uneg	kV*	0.10 – 100.00	0.01	5	Deadband value for the negative seq. voltage
Range Value - Uneg	kV*	1.0 – 1000.0	0.1	231	Range value for the negative seq. voltage
Deadband Value - Upos	kV*	0.10 – 100.00	0.01	5	Deadband value for the positive seq. voltage
Range Value - Upos	kV*	1.0 – 1000.0	0.1	231	Range value for the positive seq. voltage
Report Deadband - I	-	Off, Amplitude, Integrated	-	Amplitude	Selection of the reporting mode for current measurement
Deadband Value - I	A	1 – 2000	1	10	Deadband value for the current
Range Value - I	A	1 – 5000	1	500	Range value for the current
Deadband Value - I Res	A	1 – 500	1	10	Deadband value for the residual current
Range Value - I Res	A	1 – 1000	1	100	Range value for the residual current
Deadband Value - Ineg	A	1 – 2000	1	10	Deadband value for the negative seq. current
Range Value - Ineg	A	1 – 5000	1	500	Range value for the negative seq. current
Deadband Value - Ipos	A	1 – 2000	1	10	Deadband value for the positive seq. current

Range Value - Ipos	A	1 – 5000	1	500	Range value for the positive seq. current
Report Deadband - P	-	Off, Amplitude, Integrated	-	Amplitude	Selection of the reporting mode for active power measurement
Deadband Value - P	kW*	0.10 – 10000.00	0.01	10	Deadband value for the active power
Range Value - P	kW*	1.00 – 100000.00	0.01	500	Range value for the active power
Report Deadband - Q	-	Off, Amplitude, Integrated	-	Amplitude	Selection of the reporting mode for reactive power measurement
Deadband Value - Q	kVAr*	0.10 – 10000.00	0.01	10	Deadband value for the reactive power
Range Value - Q	kVAr*	1.00 – 100000.00	0.01	500	Range value for the reactive power
Report Deadband - S	-	Off, Amplitude, Integrated	-	Amplitude	Selection of the reporting mode for apparent power measurement
Deadband Value - S	kVA*	0.10 – 10000.00	0.01	10	Deadband value for the apparent power
Range Value - S	kVA*	1.00 – 100000.00	0.01	500	Range value for the apparent power
Report Deadband	Hz	Off, Amplitude, Integrated	-	Amplitude	Selection of the reporting mode for frequency measurement
Deadband Value	Hz	0.01 – 1.00	0.01	0.03	Deadband value for the frequency
Range Value	Hz	0.05 – 10.00	0.01	5	Range value for the frequency

**the prefixes can change (i.e. kW→MW, kV→V etc.) depending on the configuration; changing these is done by Protecta personnel*
***if the setting range is to be extended, contact Protecta personnel*

3.2.1.5.2. Function I/O

This section describes briefly the analogue and digital inputs and outputs of the function block.

3.2.1.5.2.1. Analogue inputs

The analogue inputs of the measurement functions are

- the Fourier components and true RMS values of the measured and calculated secondary voltages
- the Fourier components and true RMS values of the measured secondary currents,

3.2.1.5.2.2. Analogue outputs (measurements)

See the next chapter (On-line data) for the listing of all measurements. Note again, that the measured values depend on the type of the actual measurement function block, see Chapter 1.3.1

3.2.1.5.2.3. On-line data

The **on-line data** of the line measurement function depend on the available analogue values which are referring to the applied hardware configuration.

Visible values on the on-line data page:

Table 2-2 On-line data of the line measurement function

SIGNAL TITLE	DIMENSION	EXPLANATION
Power - P	kW*	Calculated three-phase active power
Reactive Power - Q	kVAr*	Calculated three-phase reactive power
Apparent Power - S	kVA*	Calculated three-phase apparent power
Power factor	-	Calculated power factor
Current L1	A	Measured primary current L1 based on the nominal values of the CT4 current input function
Current L2	A	Measured primary current L2 based on the nominal values of the CT4 current input function
Current L3	A	Measured primary current L3 based on the nominal values of the CT4 current input function
Positive sequence current	A	Calculated positive sequence current from the three phase currents
Negative sequence current	A	Calculated negative sequence current from the three phase currents
Calculated 3Io	A	Calculated 3Io from the three phase currents
Voltage L1	kV*	Measured primary L1 phase voltage L1 based on the nominal values of the VT4 voltage input function
Voltage L2	kV*	Measured primary L2 phase voltage L2 based on the nominal values of the VT4 voltage input function
Voltage L3	kV*	Measured primary L3 phase voltage L3 based on the nominal values of the VT4 voltage input function
Voltage L12	kV*	Calculated L12 phase-to-phase voltage
Voltage L23	kV*	Calculated L23 phase-to-phase voltage
Voltage L31	kV*	Calculated L31 phase-to-phase voltage
Positive sequence voltage	kV*	Calculated positive sequence voltage from the three phase voltages
Negative sequence voltage	kV*	Calculated negative sequence voltage from the three phase voltages
Calculated 3Uo	kV*	Calculated 3Uo from the three phase voltages
Frequency	Hz	Measured frequency

**the prefixes may be different (i.e. kW→MW, kV→V etc.) depending on the configuration; changing these is done by Protecta personnel*

3.2.1.5.3. Technical data

Table 2-3 Technical data of the line measurement function (power)

POWER MEASUREMENT (P, Q, S)* HW MODULES	RANGE	ACCURACY
CT+/5115	0,002 – 0,01 In	±3%, ±1 digit
	0,01 – 0,03 In	±1%, ±1 digit
	0,03 – 5 In (max. 5 In for measurement purposes)	±0,5%, ±1 digit
CT+/1500**	0,002 – 0,005 In	±1,5%, ±1 digit
	0,005 – 0,02 In	±0,5%, ±1 digit
	0,02 – 2 In	±0,2%, ±1 digit
CT+/5151** CT+/5153 (Channel 1-3)	0,02 – 0,05 In	±3%, ±1 digit
	0,05 – 20 In	±0,5%, ±1 digit

** By using VT+/2211 with nominal voltage.*

*** The defined accuracy regarding the CT+/1500 and CT+/5151 modules are valid from 2020/Q2 or on customer request. For the values before this date, see Table 2-7 in the next chapter.*

Table 2-4 Technical data of the line measurement function (currents)

CURRENT MEASUREMENT (PHASE AND SEQUENTIAL) HW MODULES	RANGE	ACCURACY
CT+/5115	0,002 – 0,01 In	±3%, ±1 digit
	0,01 – 0,03 In	±1%, ±1 digit
	0,03 – 5 In (max. 5 In for measurement purposes)	±0,5%, ±1 digit
CT+/1500*	0,002 – 0,005 In	±1,5%, ±1 digit
	0,005 – 0,02 In	±0,5%, ±1 digit
	0,02 – 2 In	±0,2%, ±1 digit
CT+/5151* CT+/5153 (Channel 1-3)	0,02 – 0,05 In	±3%, ±1 digit
	0,05 – 20 In	±0,5%, ±1 digit

** The defined accuracy regarding the CT+/1500 and CT+/5151 modules are valid from 2020/Q2 or on customer request. For the values before this date, see Table 2-7 in the next chapter.*

Table 2-5 Technical data of the line measurement function (voltages)

VOLTAGE MEASUREMENT (PHASE , PHASE-TO-PHASE, SEQUENTIAL) HW MODULES	RANGE	ACCURACY
VT+/2211	0,05 – 1,5 Un	±0,5%, ±1 digit

Table 2-6 Technical data of the frequency measurement function

FREQUENCY MEASUREMENT	VALUE	ACCURACY
Frequency	40 - 60 Hz (50 Hz system) 50 - 70 Hz (60 Hz system)	± 2 mHz

3.2.1.5.3.1. Notes for testing

If there are no measurements seen on the SCADA software, check the Report Deadband parameter and/or the settings of the periodic reporting in the Communication Configurator. The former's default value is 'Off', and the latter's is 'False', which means that by default, the reporting is disabled. It must be enabled first.

The **periodic reporting** is defined in the device configuration file (.epc/.epcs) using EuroCAP. See Chapter 1.4.3. This also means that changing the properties of this will require loading a new configuration file to the device (hence a full device restart).

If the "Connection U1-3" parameter of the *VT4 module* function block is set to "Ph-Ph", the "ThreePhase"-method cannot be used for the power measurements here, so either of the "Aron" methods must be set for it. Otherwise, the device will provide a warning signal (yellow Status LED, "General param. error" message).

For the devices shipped with modules manufactured before 2020/Q2, the technical data table is different:

Table 2-7 Technical data of the line measurement function

HARDWARE MODULE	RANGE	ACCURACY
CT+/5151 or CT+/5102	0,2 In – 0,5 In	±2%, ±1 digit
	0,5 In – 20 In	±1%, ±1 digit
CT+/1500	0,03 In – 2 In	±0,5%, ±1 digit

3.2.2. Average and maximum measurement function

3.2.2.1. The measurement

The input values of the EuroProt+ devices are the secondary signals of the voltage transformers and those of the current transformers.

These signals are pre-processed by the “Voltage transformer input” function block and by the “Current transformer input” function block. These function blocks are described in separate documents. The pre-processed values include the Fourier basic harmonic phasors of the voltages and currents and the true RMS values. Additionally, it is in these function blocks that parameters are set concerning the voltage ratio of the primary voltage transformers and current ratio of the current transformers.

Based on the pre-processed analog signals, several function blocks perform additional calculation, e.g.: active and reactive power, frequency, temperature, impedances, higher harmonics, symmetrical components, etc.

The “Average and maximum” function block calculates average values and locates maximum values of the assigned (measured and calculated) analog signals.

3.2.2.2. Operation of the function block

The **input** of the function can be:

- Any single calculated analog value: active and reactive power, frequency, temperature, impedances, higher harmonics, symmetrical components, etc. depending on the assignment in the configuration.

The **outputs** of the function are:

- Average of the analog value,
- Maximum of the analog value.

The average and the maximum values are automatically reported to the SCADA system. The maximum is logged and is sent automatically to the HMI, the average however is logged only if a binary input of the function block enables this activity.

3.2.2.3. Reporting the values

The average calculation needs a time span for calculation; this is given as a parameter value, set in minutes (or the function is switched off). When the timer expires, the calculated average is reported automatically to the SCADA system. Depending on the requirements, this value is also logged and is sent to the local HMI. This activity is controlled by a binary input of the function block.

The identification of the maximum value needs also a time span; this is given as a parameter value, set in days. When the timer expires, the found maximum value is reported automatically to the SCADA system. Additionally this value is also logged and is sent to the local HMI.

The starting of the timer is controlled by the internal real-time clock of the device. The moment of time for the starting of the processing cycles is set by a parameter value.

3.2.2.4. Parameters of the function block

Enumerated parameter

Parameter name	Title	Selection range	Default
Time window for averaging			
MXU_TimWin_EPar_T _	Average TimeWindow	Off,5min,10min,15min,30min,60min	Off

Table 1-1 The enumerated parameters of the average and maximum measurement function

Integer parameter

Parameter name	Title	Unit	Min	Max	Step	Default
Time window for finding the maximum value						
MXU_MaxResInt_IPar_T	MaxReset Interval	day	0	365	1	1
Moment of time for reporting and reset						
MXU_MaxResTime_IPar_T	MaxReset Time	hour	0	23	1	12

Table 1-2 The integer parameters of the average and maximum measurement function

3.2.2.5. Status signals of the function block

The average and maximum measurement function block has **binary input signals**, which serve the purpose of resetting the values and enabling logging the average value**. The conditions are defined by the user, applying the graphic equation editor.**

Binary status signal	Explanation
MXU_**Reset**_GrO_IL1 *	This signal resets both the calculated average and the found maximum value. At the end of the running cycles, the values found during the shortened cycle will be processed.
MXU_**DemHMIEna**_GrO_IL1	During the active state of this signal also the calculated average value is logged

** Note: In this example "IL1" is indicating that in the instant of the function block processes the RMS value of the current in line 1*

Table 1-3 The binary input signal for the average and maximum measurement function block

The average and maximum measurement function block **has no binary output signals**.

3.2.2.6. The function block

The function block of the average and maximum measurement function is shown in Figure *1-1*. This block shows all binary input (and output) status signals that are applicable in the graphic equation editor.

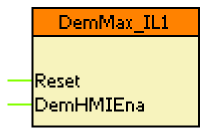


Figure 1-1 The function block of the average and maximum measurement function block

3.2.3. Metering

3.2.3.1. Application

The metering function can be applied to calculate the active and reactive energy supply and demand values based on the own measurement of the device or the energy meter impulses.

3.2.3.1.1. Mode of operation

There is an “Input selection” parameter to select the input of energy the calculation “Measurement” or “Impulse”. Chapter 1.1.1 and Chapter 1.1.2 describe the difference of operation.

3.2.3.1.2. Measurement mode

The input values of the EuroProt+ devices are the secondary signals of the voltage transformers and those of the current transformers.

These signals are pre-processed by the “Voltage transformer input” function block and by the “Current transformer input” function block. These function blocks are described in separate documents. The pre-processed values include the Fourier basic harmonic phasors of the voltages and currents. Additionally, it is in these function blocks that parameters are set concerning the voltage ratio of the primary voltage transformers and current ratio of the current transformers.

Based on the pre-processed values and the transformer parameters, the “Line measurement” function block calculates “P” and “Q” values in every process cycle and based on these values the “Metering” function block calculates the active and reactive power supply and demand. These values are accumulated to obtain, separately:

- Active power demand,
- Active power supply,
- Reactive power demand.
- Reactive power supply,

This means that the positive and negative values are accumulated separately.

The time period of the accumulation is defined by parameter setting. It can be selected in a broad range. The start of the accumulation is based on the integrated real-time clock of the device. For example, for the “Time Interval” setting of 15min, the trigger is: at 0h0min, 0h15min, 0h30min, 0h45 min, 1h0min, etc.

When the accumulation time is over, the calculated values are reported to the SCADA system. The displayed values change continuously.

The calculated values are available as primary quantities, and they can be displayed on the on-line screen of the device or on the webpage of the device and they are available for the SCADA system using the configured communication system.

The **inputs** of the metering function are:

- the Fourier components of the measured voltages and currents,
- parameters.

The **output** of the metering function is:

- displayed measured values.

NOTE: the scaling values are entered as parameter setting for the “Voltage transformer input” function block and for the “Current transformer input” function block.

3.2.3.1.3. Impulse mode

Based on the external energy meter impulses. These impulse outputs of the meter connect as binary inputs. Metering function block calculates the active and reactive power supply and demand. These values are accumulated to obtain, separately:

- Active power demand,
- Active power supply,
- Reactive power demand.
- Reactive power supply,

Impulse scaling values are entered as parameters named “Active pulse scale” and “ Reactive pulse scale”.

The time period of the accumulation is defined by parameter setting. It can be selected in a broad range. The start of the accumulation is based on the integrated real-time clock of the device. For example, for the “Time Interval” setting of 15min, the trigger is: at 0h0min, 0h15min, 0h30min, 0h45 min, 1h0min, etc.

When the accumulation time is over, the calculated values are reported to the SCADA system. The displayed values change continuously.

The calculated values are available as primary quantities and they can be displayed on the on-line screen of the device or on the webpage of the device and they are available for the SCADA system using the configured communication system

The **inputs** of the metering function are:

- the impulses of energy meter,
- parameters.

The **output** of the metering function is:

- displayed measured values.

3.2.3.1.4. Cumulation mode

“Cumulation mode” parameter defines the mode of operation. It can be “TRUE” or “FALSE”.

In “FALSE” mode the values set to zero after the values are reported to the SCADA system, based on the “Time Interval” settings.

In “TRUE” mode the values are cumulated after the report is sent to the SCADA system.

Maximum cumulated value depends on the CT module of IED and the primary nominals of CT and VT.

“Nominal primary power” = “Rated Primary U1-3” setting of VT module multiplied by “Rated Primary I1-3” setting of CT module. Unit prefix (**k**ilo- or **M**ega) depends on the configuration, the “Line measurement” function uses the same unit prefix as Metering.

Maximum cumulated power value with CT+/1500 module = 3 259 602 multiplied by “Nominal primary power”

Maximum cumulated power value with CT+/5151 module = 65 192 055 multiplied by “Nominal primary power”

Maximum cumulated power value with CT+/5115 module = 8 149 006 multiplied by “Nominal primary power”

User can reset cumulated value to zero either by initiating the reset input of Metering function block or by restarting the device.

3.2.3.1.5. The measurement

3.2.3.1.5.1. Reference direction

“Reference direction” parameter setting defines the direction when voltage and current vectors are in phase. Setting can be “Demand” or “Supply”.

3.2.3.1.5.2. The measured values

Unit prefix of the **measured values** of the metering function depends on the configuration: it can be **k**ilo or **M**ega. The “Line measurement” function uses the same unit prefix as the Metering.

MEASURED VALUE	EXPLANATION
MTR_PosP_OLM_	Demand kWh – active power consumption
MTR_NegP_OLM_	Supply kWh – active power supply
MTR_PosQ_OLM_	Demand kVArh – reactive power consumption
MTR_NegQ_OLM_	Supply kVArh – reactive power supply

Table 1-1 Measured values of the metering function

The measured values available are shown as on-line information, see the figure below.

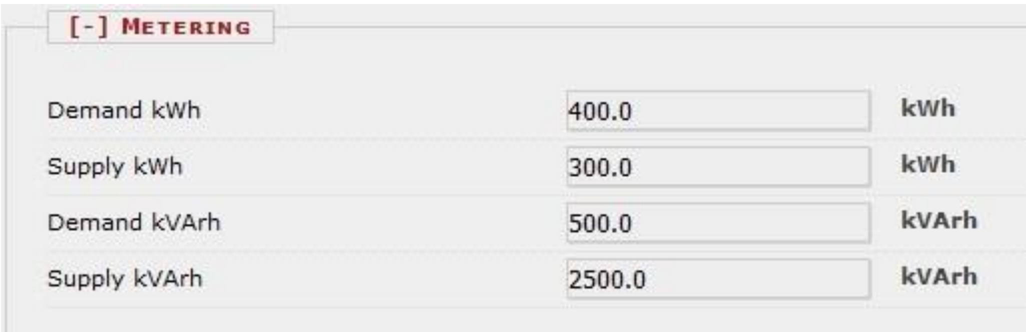


Figure 1-1 Measured values of the metering function

3.2.3.1.6. Parameter setting

The time period of accumulation is defined by parameter setting. This can be selected in a broad range, as it is shown in Table 1-2.

Enumerated parameter

PARAMETER NAME	TITLE	SELECTION RANGE	DEFAULT
Selection of the time period for power metering			
MTR_TimInt_EPar_	Time Interval	Off, 5min, 10min, 15min, 30min, 60min	30min

Table 1-2 The enumerated parameter of the metering function

3.2.3.2. Metering function overview

The graphic appearance of the function block of the metering function is shown below. The block shows all binary input and output status signals which are applicable in the graphic equation editor.

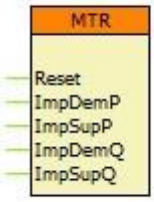


Figure 2-1 Graphic appearance of the function block of the metering function

3.2.3.2.1. Settings

3.2.3.2.1.1. Parameters

The available parameters are listed below in order of their appearance in the *parameters* menu. If the setting range of a parameter should be extended, contact Protecta Support.

Table 2-1 The available parameters of the metering function

TITLE	DIM.	RANGE	STEP	DEFAULT	EXPLANATION
Time Interval	-	Off, 5min (On), 10min , 15min , 30min , 60min	-	30min	Time period of accumulation parameter for general operation of the function:
Input selection	-	Measurement, Impulse,	-	Measurement	Input selection of energy calculation
Cumulation mode		FALSE,TRUE		FALSE	Cumulation mode is used
Reference direction	-	Demand, Supply	-	Demand	Energy direction reference selection.
Active pulse scale	kWh/ pulse	1 - 10000	1	100	One impulse of energy meter is equal to this setting
Reactive pulse scale	kVarh/ pulse	1 - 10000	1	100	One impulse of energy meter is equal to this setting

3.2.3.2.2. Function I/O

This section describes briefly the analogue and digital inputs and outputs of the function block.

3.2.3.2.2.1. Analogue inputs

The function uses the sampled values of a voltage and current inputs. This is defined in the configuration.

3.2.3.2.2.2. Analogue outputs (measurements)

The measured values of the metering function are listed in the table below.

Table 2-2 The measured analogue values of the metering function

MEASURED VALUE	DIMENSION	EXPLANATION
Demand P	kWh	*Demand P. Unit prefix can be kilo- or mega-, depends on the configuration*
Supply P	kWh	*Supply P. Unit prefix can be kilo- or mega-, depends on the configuration*
Demand Q	kVArh	*Demand Q. Unit prefix can be kilo- or mega-, depends on the configuration*
Supply Q	kVArh	*Supply Q. Unit prefix can be kilo- or mega-, depends on the configuration*

3.2.3.2.2.3. Binary input signals (graphed output statuses)

The conditions of the binary inputs are defined by the user, applying the graphic equation editor (*Logic Editor*). Parts written in **bold** are seen on the left side function block in the Logic editor.

Table 2-3 The binary input signal of the metering function

BINARY OUTPUT SIGNAL	EXPLANATION
MTR_**Reset**_GrO_	Reset input of the function has meaning only in cumulation mode
MTR_**ImpDemP**_GrO_	Demand P impulse of external energy meter input of the function has meaning only in impulse input mode
MTR_**ImpSupP**_GrO_	Supply P impulse of external energy meter input of the function has meaning only in impulse input mode
MTR_**ImpDemQ**_GrO_	Demand Q impulse of external energy meter input of the function has meaning only in impulse input mode
MTR_**ImpSupQ**_GrO_	Supply Q impulse of external energy meter input of the function has meaning only in impulse input mode

3.2.3.2.2.4. Events

The following events are generated in the event list, as well as sent to the SCADA according to the configuration.

Table 2-4 Generated events of the metering function

EVENT	DIMENSION	EXPLANATION
Demand P	Wh	*Demand P value*
Supply P	Wh	*Supply P value*
Demand Q	VArh	*Demand Q value*
Supply Q	VArh	*Supply Q value*

3.2.3.2.3. Technical data

Table 2-5 Technical data of the metering function

FUNCTION	RANGE	ACCURACY
Power accuracy	I > 15%In	±3%

3.2.3.2.4. Notes for testing

Time period of the accumulation is defined by parameter setting.

Starting accumulation is based on the integrated real-time clock of the device.

For example, for a “Time Interval” setting of 15min, the trigger is: at 0h0min, 0h15min, 0h30min, 0h45 min, 1h0min, etc.

Parameter changing resets the accumulation. Using the settings of the example above, setting new parameters at 0h07min will result in the following:

- the accumulated values are reset to zero,
- the new accumulation starts at 0h15min,
- the first report is sent at 0h30min. Measured values in Events list will also refresh at 0h30min.

3.2.3.2.5. 61850 LN

Instance number of Logical Node is not mentioned in the table below.

Table 2-6 Logical Node and Data Objects of the metering function

LN NAME	DO NAME	DA NAME	FC	EXPLANATION
EMMTR	DmdVArhPV	mag.f	MX	*Demand VArh value*
		q	MX	*quality*
		t	MX	*timestamp*
	DmdWhPV	mag.f	MX	*Demand Wh value*
		q	MX	*quality*
		t	MX	*timestamp*
	SupVArhPV	mag.f	MX	*Supply VArh value*
		q	MX	*quality*
		t	MX	*timestamp*
	SupWhPV	mag.f	MX	*Supply Wh value*
		q	MX	*quality*
		t	MX	*timestamp*

3.2.4. Voltage selection function block

3.2.4.1. Application

In several substation configurations with double busbar, the there is no voltage measurement in the bays, but voltage transformers are connected to the busbars only.

If the protection functions configured in the bay devices apply voltage measurement then the correct selection of the voltage sources is needed. The role of the voltage selection is that the protection functions get the voltage of the busbar section to which the feeder or the transformer is connected.

To solve this problem the device gets both three-phase voltages of both busbar sections, and a binary signal decides which one is valid for the protection function.

The “Voltage selection” function block assigns the correct voltages to the protection functions.

3.2.4.2. Mode of operation

The voltage selection is decided by a binary signal. **The conditions are defined by the user applying the graphic equation editor.**

If this input signal is FALSE then the voltages of the voltage input module configured as default input are assigned to the protection functions.

If however this input signal is TRUE then the voltages of the other voltage input module are assigned to the protection functions.

3.2.4.3. The binary status signals

The voltage selection function block has a binary input signal. **The conditions are defined by the user applying the graphic equation editor.**

The **binary input status signal** of the voltage selection function block is shown in Table 1-1.

Binary status signal	Title	Explanation
SelectVolt_USelect_GrO_	USelect	Binary signal controlling the voltage selection

Table 1-1 The binary input status signal of the voltage selection function block

The **binary output status signals** of the voltage selection function block.
The voltage selection function block has no binary output status signals.

3.2.4.4. The parameters

The voltage selection function block has no parameters.

3.2.4.5. The symbol of the function block in the graphic editor

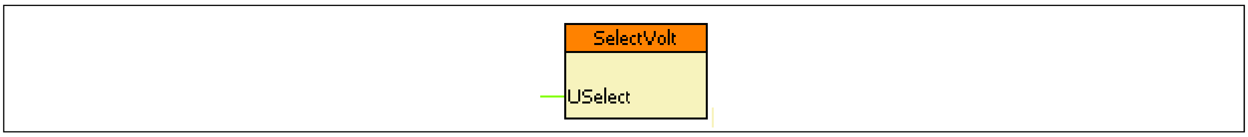


Figure 1-1 The function block of the voltage selection function block

The name of the input signal is a part of the “Binary status signal” name shown in Table 1-1.

3.2.4.6. Example

In this simple example the channel No.1 of the binary input module in position “F” is used as the signal controlling the selection.

If this input signal is FALSE then the voltages of the voltage input module configured as default input are assigned to the protection functions.

If however this input signal is TRUE then the voltages of the other voltage input module are assigned to the protection functions.

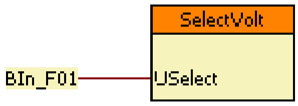


Figure 2-1 Example The simple application of the voltage selection function block

3.3. Disturbance recorder function

The disturbance recorder function can record analog signals and binary status signals. These signals are configured using the EuroCAP software tool.

The disturbance recorder function has a binary input signal, which serves the purpose of starting the function**. The conditions of starting are defined by the user, applying the graphic equation editor.** The disturbance recorder function keeps on recording during the active state of this signal but the total recording time is limited by the timer parameter setting.

The pre-fault time, max recording time and post-fault time can be defined by parameters.

3.3.1. Mode of recording

If the triggering conditions defined by the user - using the graphic equation editor – are satisfied and the function is enabled by parameter setting, then the disturbance recorder starts recording the sampled values of configured analog signals and binary signals.

The analog signals can be sampled values (voltages and currents) received via input modules or they can be calculated analog values (such as negative sequence components, etc.)

The number of the configured binary signals for recording is limited to 64, and up to 32 analog channels can be recorded.

The available memory for disturbance records is 12 MB.

There are two function blocks available. The first function (**DRE**) applies 20 sampling in a network period. Accordingly for 50 Hz, the sampling frequency is 1 kHz. (For 60 Hz the sampling frequency is 1.2 kHz). This is used in all configurations by default.

The second function (**DRE2**) is capable to be set by parameter to apply 20 or 40 sampling in a network period. This way accordingly for 50 Hz, the sampling frequency is 1 kHz or 2 kHz (and for 60 Hz the sampling frequency is 1.2 kHz or 2.4 kHz). *Except for this, the two function blocks are the same*.

As an example, for 50 Hz, if the duration of the record is 1000 ms then one analog channel needs about 7 kB and a binary channel needs 2 kB, Using the following formula the memory size can be estimated:

Memory size of a record = (n*7 kB+ m*2 kB)*record duration(s)

Here n,m: are the number of analog and binary channels respectively.

During the operation of the function, the pre-fault signals are preserved for the time duration as defined by the parameter “PreFault”.

The recording duration is limited by the parameter “Max Recording Time” but if the triggering signal resets earlier, this section is shorter.

The post-fault signals are preserved for the time duration as defined by the parameter “PostFault”.

During or after the running of the recording, the triggering condition must be reset for a new recording procedure to start.

3.3.2. Format of recording

The records are stored in standard COMTRADE format.

- The configuration is defined by the file .cfg,
- The data are stored in the file .dat,
- Plain text comments can be written in the file .inf.

3.3.3. Downloading and evaluating the disturbance records

The procedure for downloading the records is described in detail in the EuroProt+ manual “Remote user interface description”, Chapter 4.7. The three files are zipped in a file .zip. This procedure assures that the three component files (.cfg, .dat and .inf) are stored in the same location.

The evaluation can be performed using any COMTRADE evaluator software. Protecta offers the **“srEval”** software for this purpose. The application of this software is described in detail in the “srEval manual”. This manual can be downloaded from the following Internet address: http://www.softreal.hu/product/sreval_en.shtml.

3.3.4. Parameters of the disturbance recorder functions

Enumerated parameters

Parameter name	**Title**	**Selection range**	**Default**
Parameter for activation			
DRE_Oper_EPar_	Operation	Off, On	Off
DRE_Resolution_EPar_	Resolution *	1/1.2kHz, 2/2.4kHz	1/1.2kHz

*only on the optional 2/2.4 kHz disturbance recorder function

Table 1-1 The enumerated parameters of the disturbance recorder functions

Timer parameters

Parameter name	**Title**	**Unit**	**Min**	**Max**	**Step**	**Default**
Pre-fault time:						
DRE_PreFault_TPar_	PreFault	msec	100	1000	1	200
Post-fault time:						
DRE_PostFault_TPar_	PostFault	msec	100	1000	1	200
Overall-fault time limit:						
DRE_MaxFault_TPar_	Max Recording Time	msec	500	10000	1	1000

Table 1-2 The timer parameters of the disturbance recorder functions

NOTE: The device goes automatically in “Warning” state and sends a warning message (see Figure 1-1) if the sum of the pre-fault time and post-fault time is longer than the overall-fault time. The corresponding message in the RDSP log file is: „Wrong DR settings. PreFault + PostFault must be less than MaxFault. Check the parameters.”

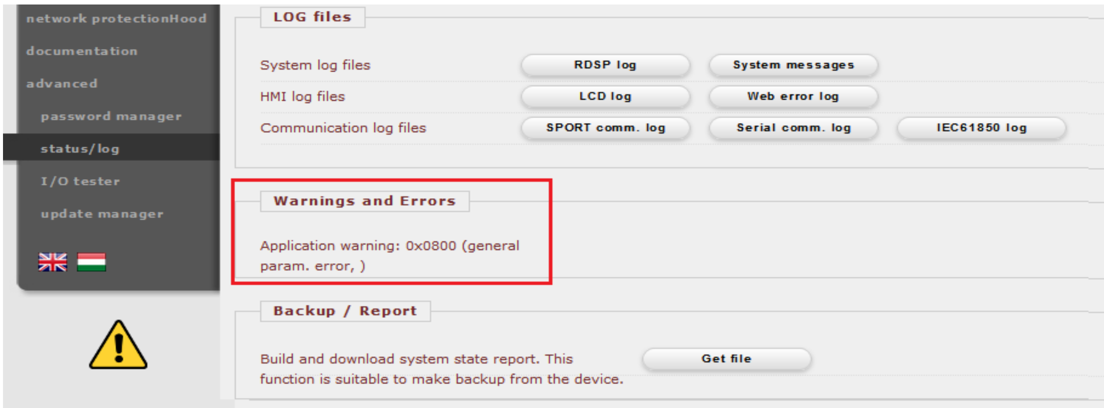


Figure 1-1 Warning message if the settings are invalid

3.3.5. The input signals of the disturbance recorder functions

Binary status signals

The disturbance recorder function has a binary input signal, which serves the purpose of starting the function**. The conditions of starting are defined by the user, applying the graphic equation editor.**

Binary status signal	Explanation
DRE_Start_GrO_	Output status of a graphic equation defined by the user to start the disturbance recorder function.

Table 1-3 The binary input signal of the disturbance recorder functions

The recording is performed if the function is enabled by the parameter setting AND the triggering condition as defined by the user is “True” as well.

3.3.6. The function blocks

The two function blocks of the disturbance recorder function is shown in Figure *1-2*. The block shows the binary input status signal, which serves the purpose of triggering the record. It is defined by the user in the graphic equation editor.

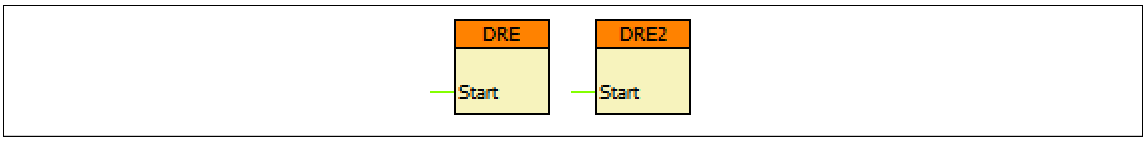


Figure 1-2 The function blocks of the disturbance recorder functions

3.3.7. The recorded signals

The analog and binary signals to be recorded are configured using the EuroCAP software tool in the menu item “Software configuration/Disturbance recorder”. (The access level of the user must be at least “Master”.) The application of this software is described in detail in the EuroCAP manual.

3.4. Event recorder

The events of the device and those of the protection functions are recorded with a time stamp of 1 ms time resolution. This information with indication of the generating function can be checked on the touch-screen of the device in the "Events" page, or using an Internet browser of a connected computer

4. Maintenance guide for EuroProt+ devices

4.1. Foreword

The EuroProt+ devices are designed with the most up-to-date and durable components available, to keep appliances in continuous operation for decades. For this range, the only type of components that can age and lead to equipment failure are the power supply capacitors. Therefore, this document, in addition to suggesting some general steps for planned inspections, contains important information on the inspection of power supply modules.

4.2. Safety precautions

The EP+ protection-family, depending on the type, operates at dangerous power supply voltages (220 VDC, 230 VAC, 60 VDC, 48 VDC).

In all cases where the connections of the appliance are to be installed or opened, the work must be carried out by a suitably qualified person.

In all cases, the first step of activity should be to switch off the power

The EuroProt+ protection family has a high operating internal temperature. Operations carried out immediately after operation may lead to dangerous burns.

The hardware and software of the EP+ protection family form a complex system. Setting, modifying, and mounting the individual components may severely affect the operation of the whole system.

In all cases where the device is to be operated or maintained, the activity must be carried out by qualified personnel only

4.2.1. General guidelines for a scheduled maintenance of EP+ devices

1. As a first step, it is recommended to send an email attaching a report.zip file to the Protecta Application Department on the email address application@protecta.hu. In the report file, the logs contain information that can indicate abnormal operation of a module before it causes an operational fault. Based on this information, Protecta can make recommendations for the replacement or repair of the modules concerned.

   The report.zip file can be downloaded from the device's web interface, in the Backup / Report section of the Advanced / Status / Log menu, by pressing the "Get file" button. Attention! The file size should be about 700kB. If the downloaded file size is significantly smaller than this, please try again or contact Protecta's Application Department via our web-based support system (https://support.protecta.hu/?language=English)!

2. It is usually recommended to update the firmware of the devices during scheduled maintenance. Information about the new firmware releases can be found in the Release Notes on the Protecta homepage. The information here can be used to consider upgrading the basic software for a single device, or all devices in a substation.

   Before starting the upgrade, always contact the Protecta Application Department or submit a ticket in the web-based support system from the following link: https://support.protecta.hu/

   For more details on the firmware update, please refer to Chapter 4.2.10.4 of the EuroProt+ Operating Manual.

4.3. Power supply maintenance

Power supplies are designed with the longest possible life electrolytic capacitors. Their expected lifetime depends significantly on the environmental conditions of the device. During a scheduled inspection, we recommend visual inspection of the power supply for any abnormalities in the capacitors. The most common phenomena are: bloating, electrolyte leakage, discoloration, which typically occurs on capacitors, but can also occur on the surface of the PCB board due to leakage. In case of abnormality, the capacitors should be replaced. In such a case, please contact Protecta's Application Department via our support page (https://support.protecta.hu/)!

The following figures illustrate the different capacitor states in several photos.

Figure 4-1 The capacitor on the right is already discolored

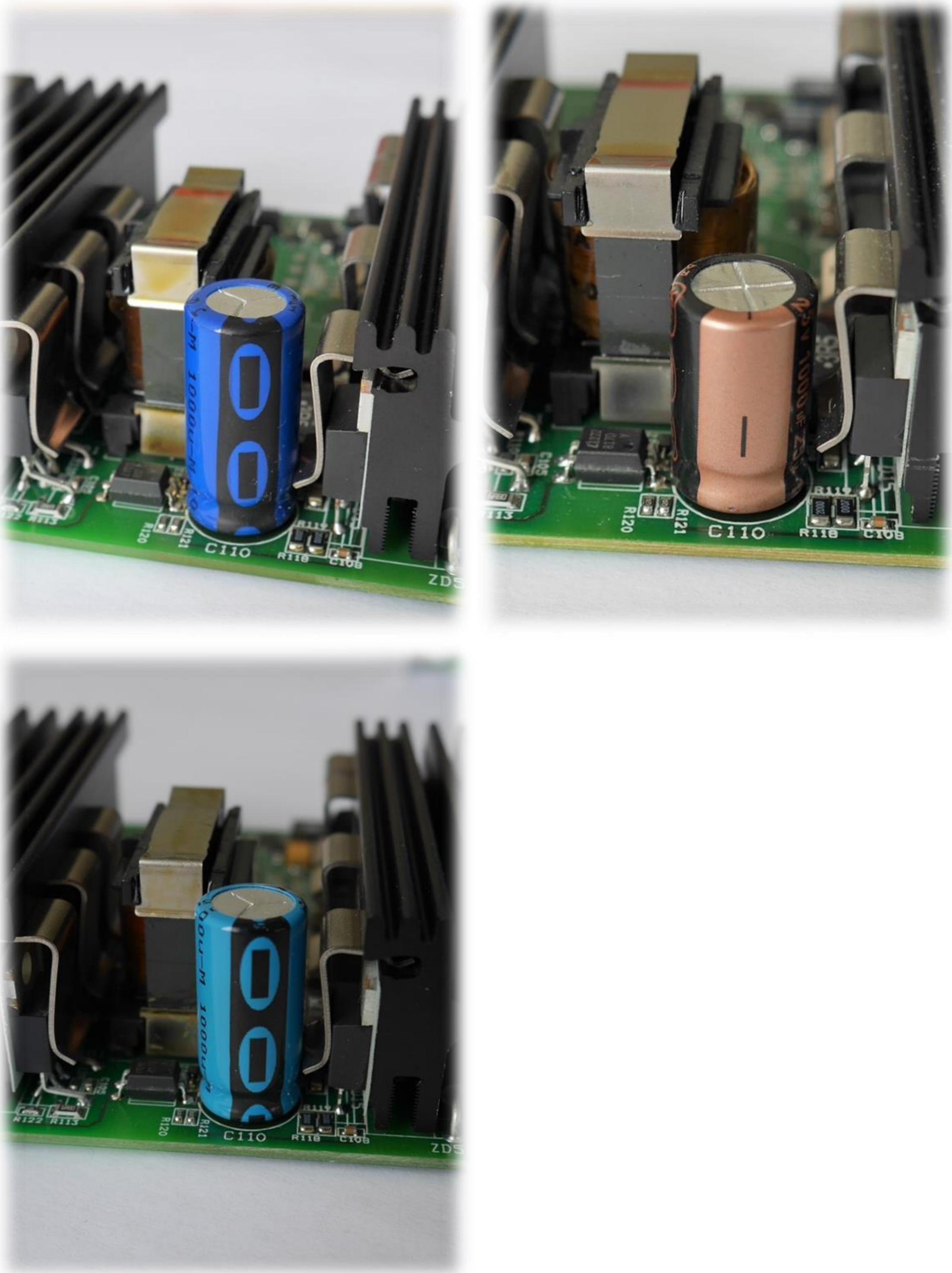
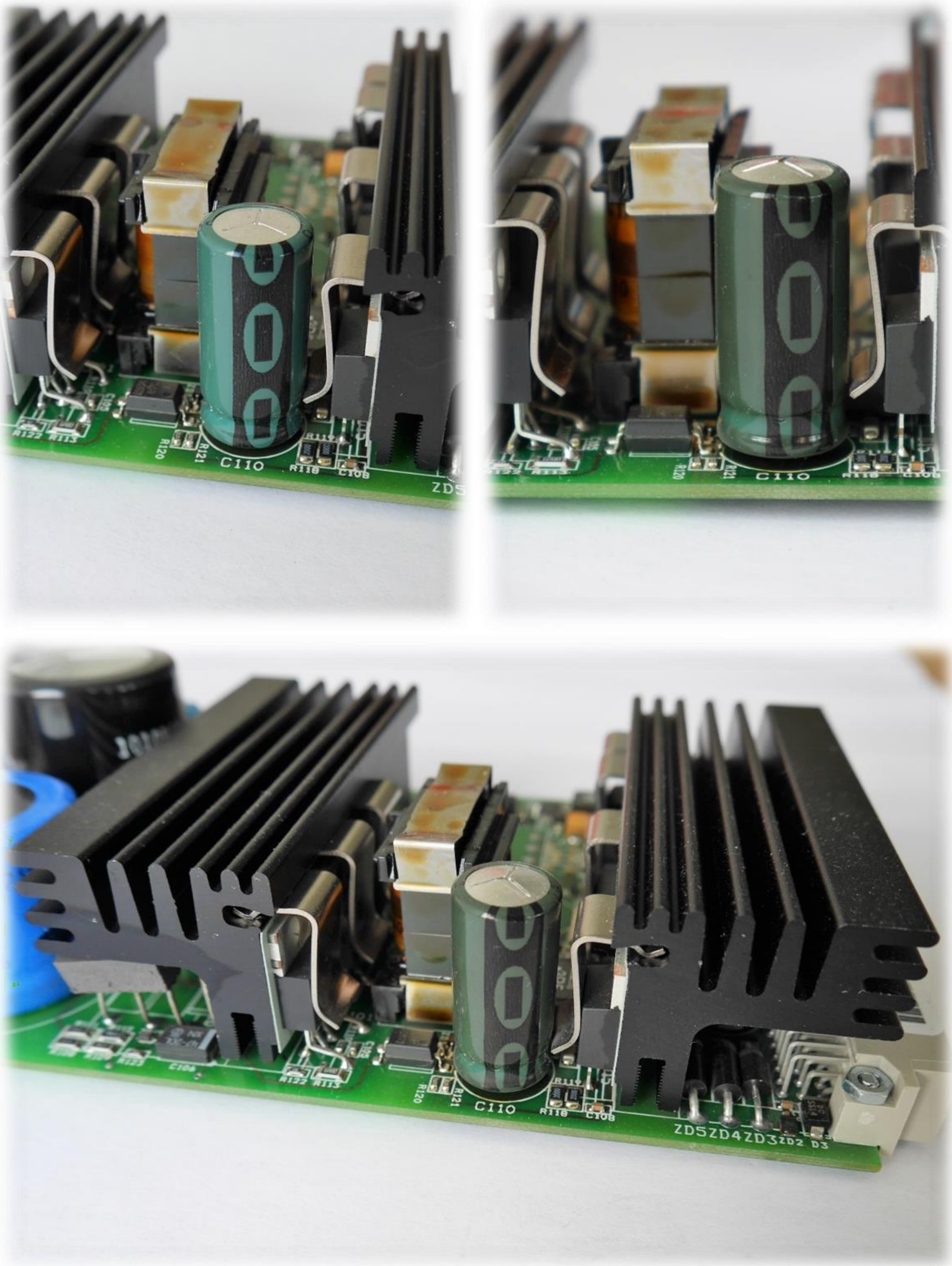


Figure 4-2 Healthy capacitors on visual inspection

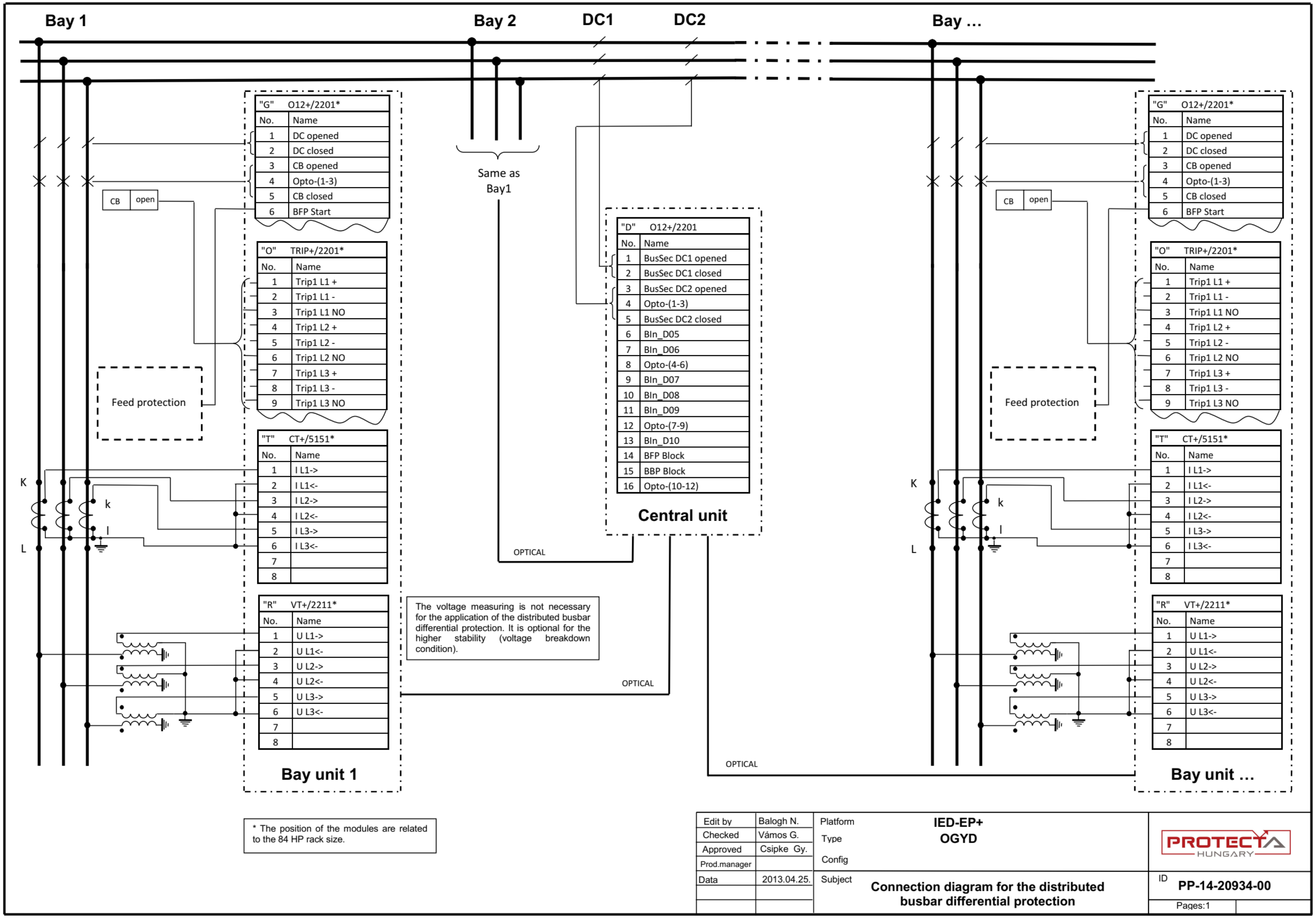


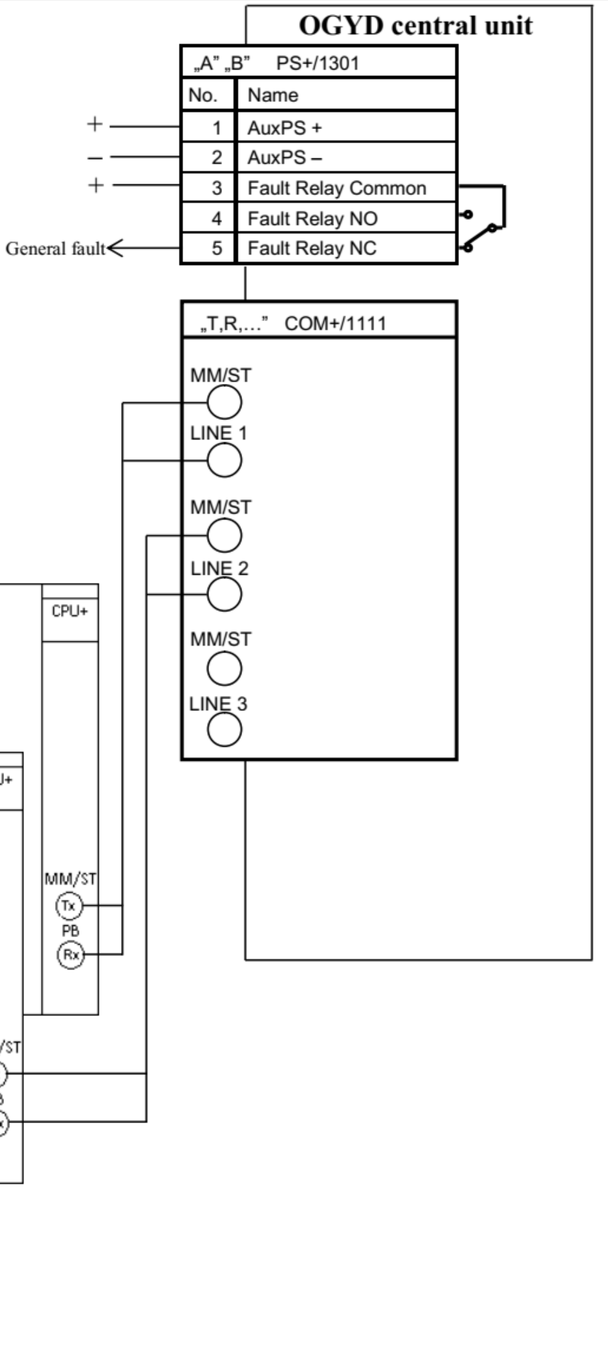
igure 4-3 Faulty capacitances on visual inspection. The discoloration compared to the original blue color is clearly visible, bloating can be seen on 2 of them

4.4. Elements and Batteries

Az EuroProt+ protection family devices do not contain either a single-use battery or a rechargeable battery.

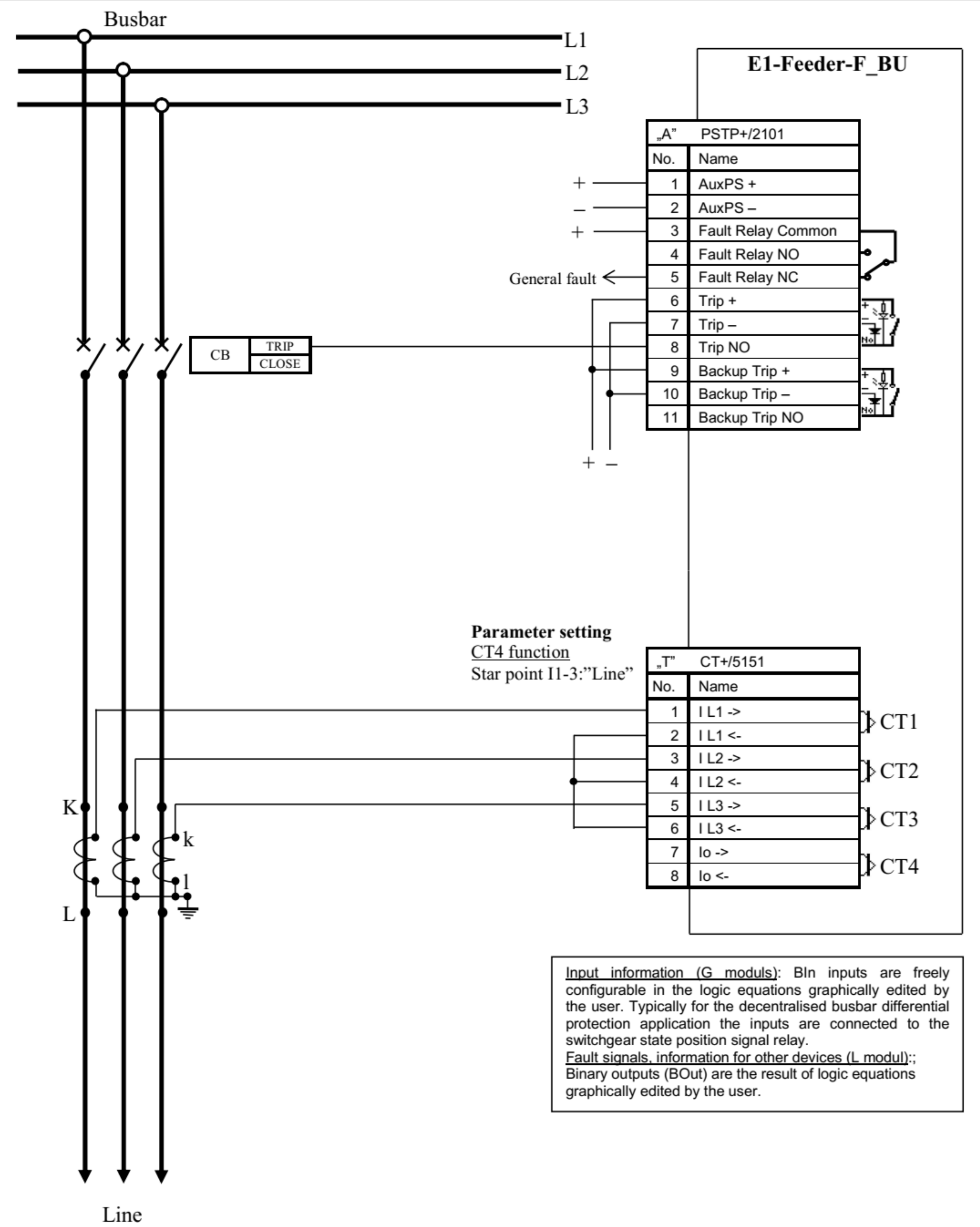
5. External Connections





<u>Input information (G modul)</u>:Typically the inputs are connected to the bussection disconnectors state position signal relay
<u>Fault signals, information for other devices (L modul)</u>: according to the inscriptions; BOut outputs are the result of logic equations graphically edited by the user.

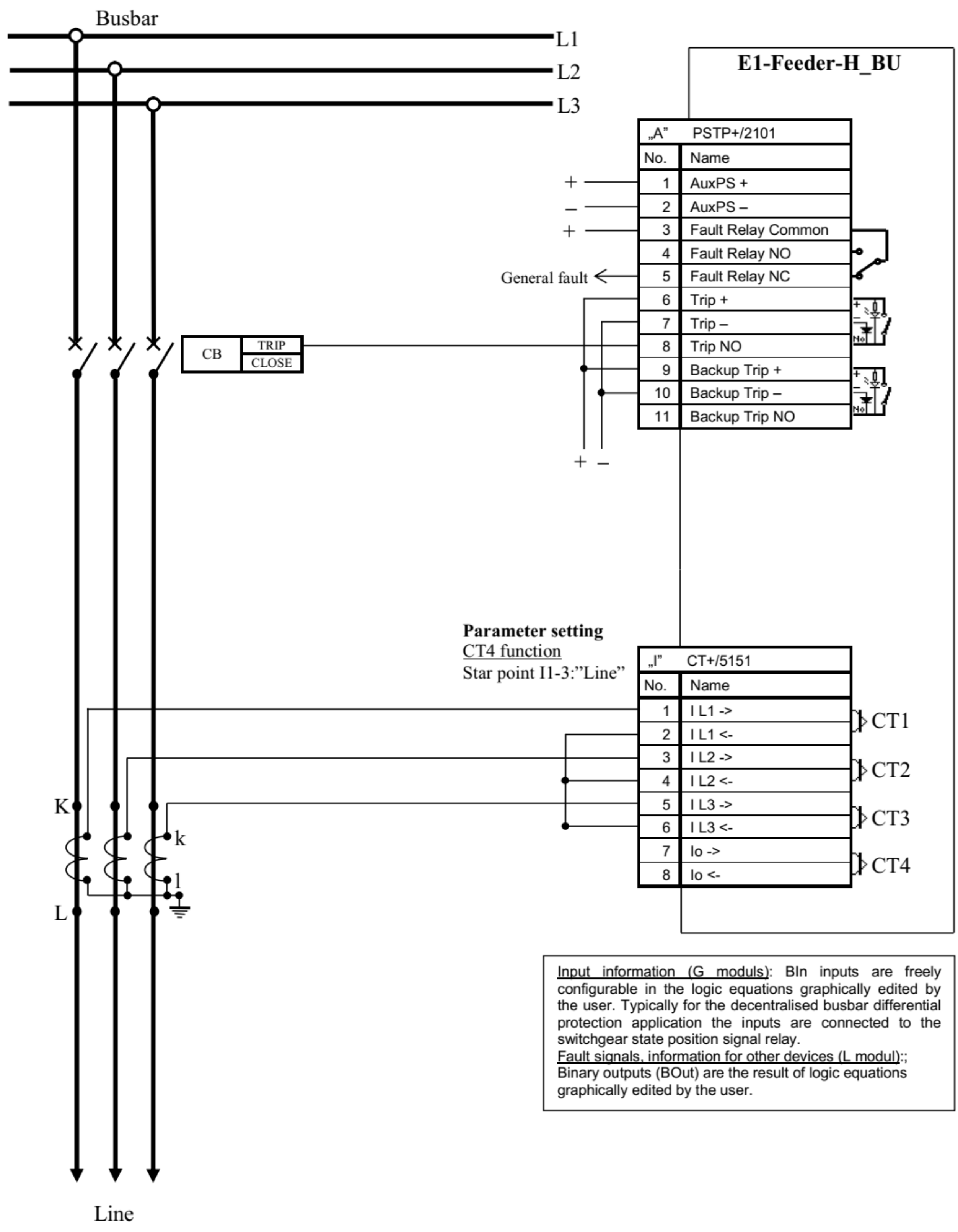
Edited by	Tóth J.	Platform	IED-EP+	PROTECTA HUNGARY
Checked		Type	OGYD	
Approved		Configuration		
Data	17.09.2014.	Subject	**Connection diagram for the optical cables between the central unit and the bay units**	ID **PP-14-20935-00**
				Pages:1/1



Input information (G moduls): BIn inputs are freely configurable in the logic equations graphically edited by the user. Typically for the decentralised busbar differential protection application the inputs are connected to the switchgear state position signal relay.
Fault signals, information for other devices (L modul):; Binary outputs (BOut) are the result of logic equations graphically edited by the user.

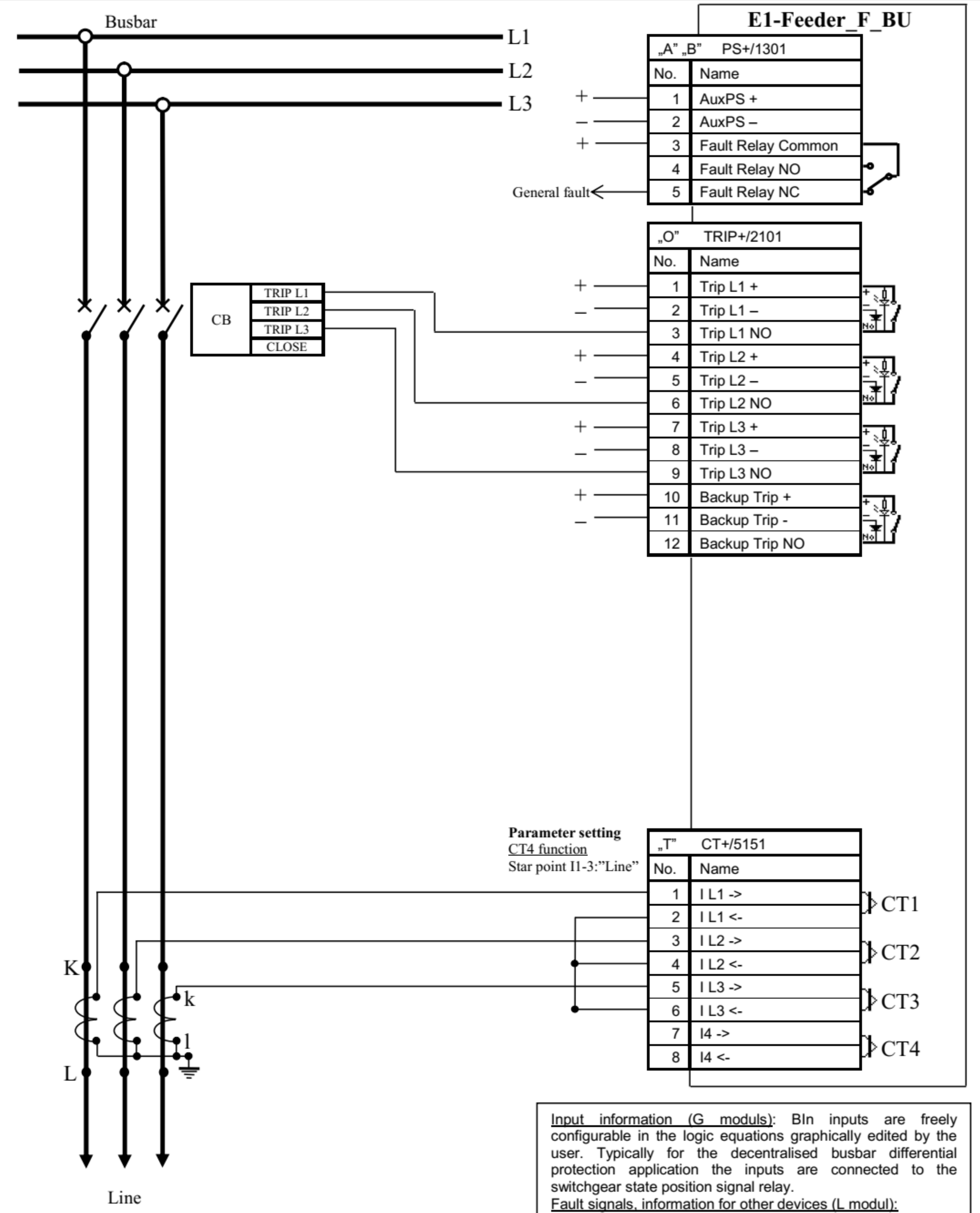
Edited by	Tóth J.	Platform	**IED-EP+**
Checked	Kazai N.	Type	**DTIVA**
Approved		Configuration	**E1-Feeder_F**
Data	2013.12.14.	Subject	**Connection diagram for the 84HP bay unit of the distributed busbar protection without voltage measuring and common trip contact**
ID	**PP-14-20930-00**	Pages:1/1	

PROTECTA HUNGARY



<u>Input information (G moduls)</u>: BIn inputs are freely configurable in the logic equations graphically edited by the user. Typically for the decentralised busbar differential protection application the inputs are connected to the switchgear state position signal relay.
<u>Fault signals, information for other devices (L modul)</u>:; Binary outputs (BOut) are the result of logic equations graphically edited by the user.

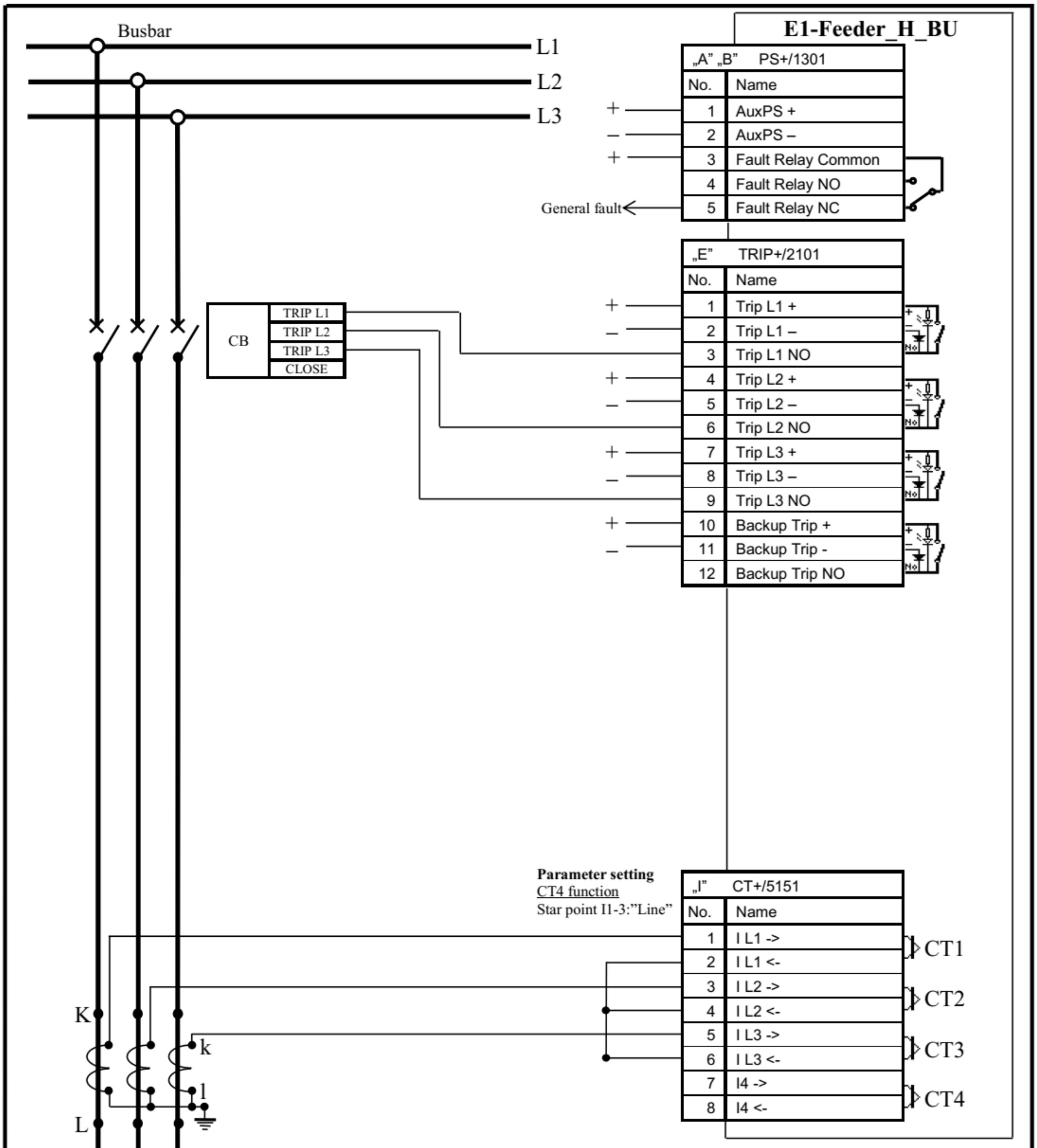
Edited by	Tóth J.	Platform	IED-EP+	PROTECTA HUNGARY
Checked	Kazai N.	Type	DTIVA	
Approved		Configuration	E1-Feeder_H	
Data	2013.12.14.	Subject	Connection diagram for the 42HP bay unit of the distributed busbar protection without voltage measuring and common trip contact	ID PP-14-20931-00
				Pages:1/1



Input information (G moduls): BIn inputs are freely configurable in the logic equations graphically edited by the user. Typically for the decentralised busbar differential protection application the inputs are connected to the switchgear state position signal relay.

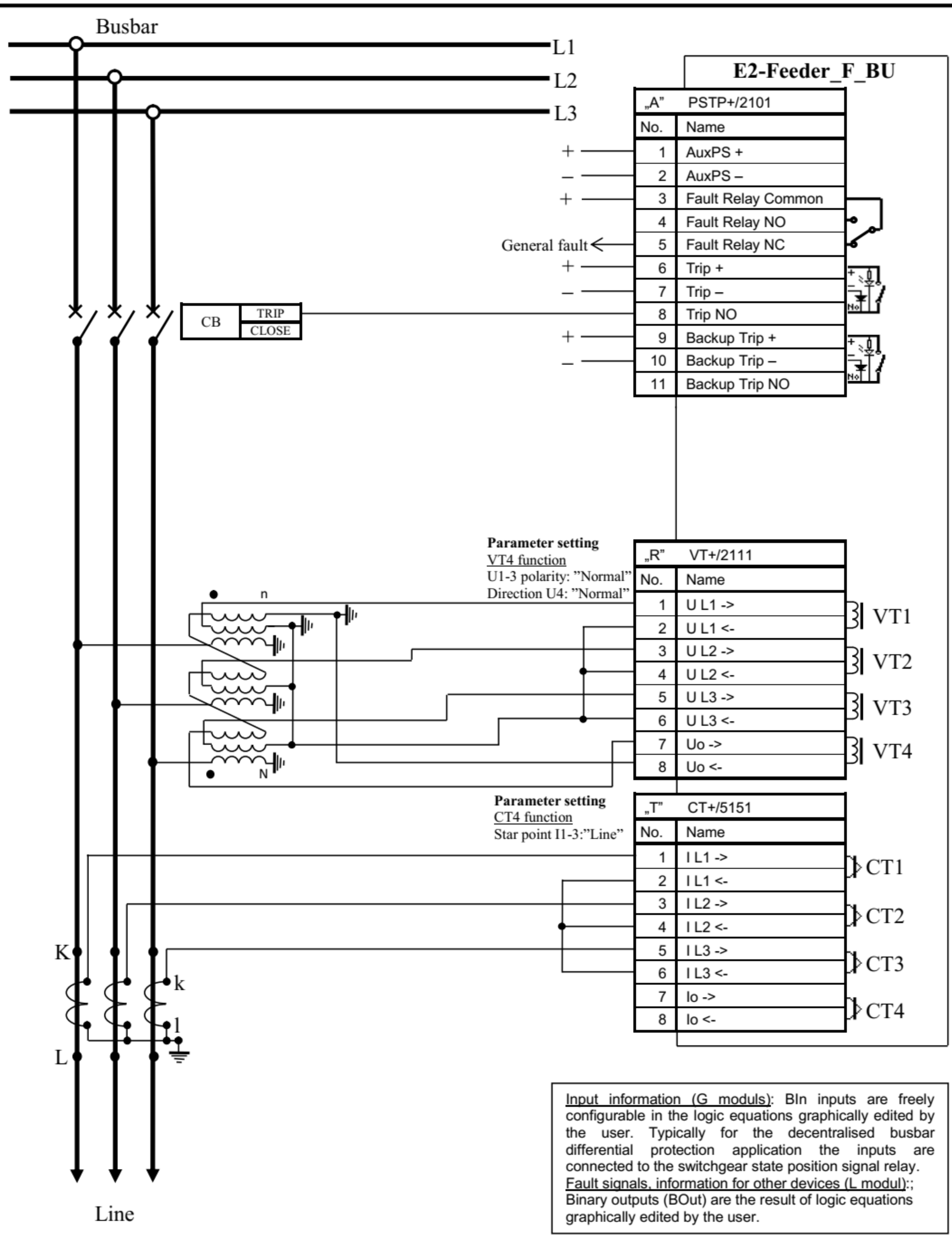
Fault signals, information for other devices (L modul): Binary outputs (BOut) are the result of logic equations graphically edited by the user.

Edited by	Tóth J.	Platform	IED-EP+	PROTECTA HUNGARY
Checked		Type	DTVA	
Approved		Configuration	E1-Feeder_F	
Data	26.01.2014.	Subject:	Connection diagram for the 84HP bay unit of the distributed busbar protection without voltage measuring and phase-selective trip contact	ID PP-14-20938-00
				Pages:1/1



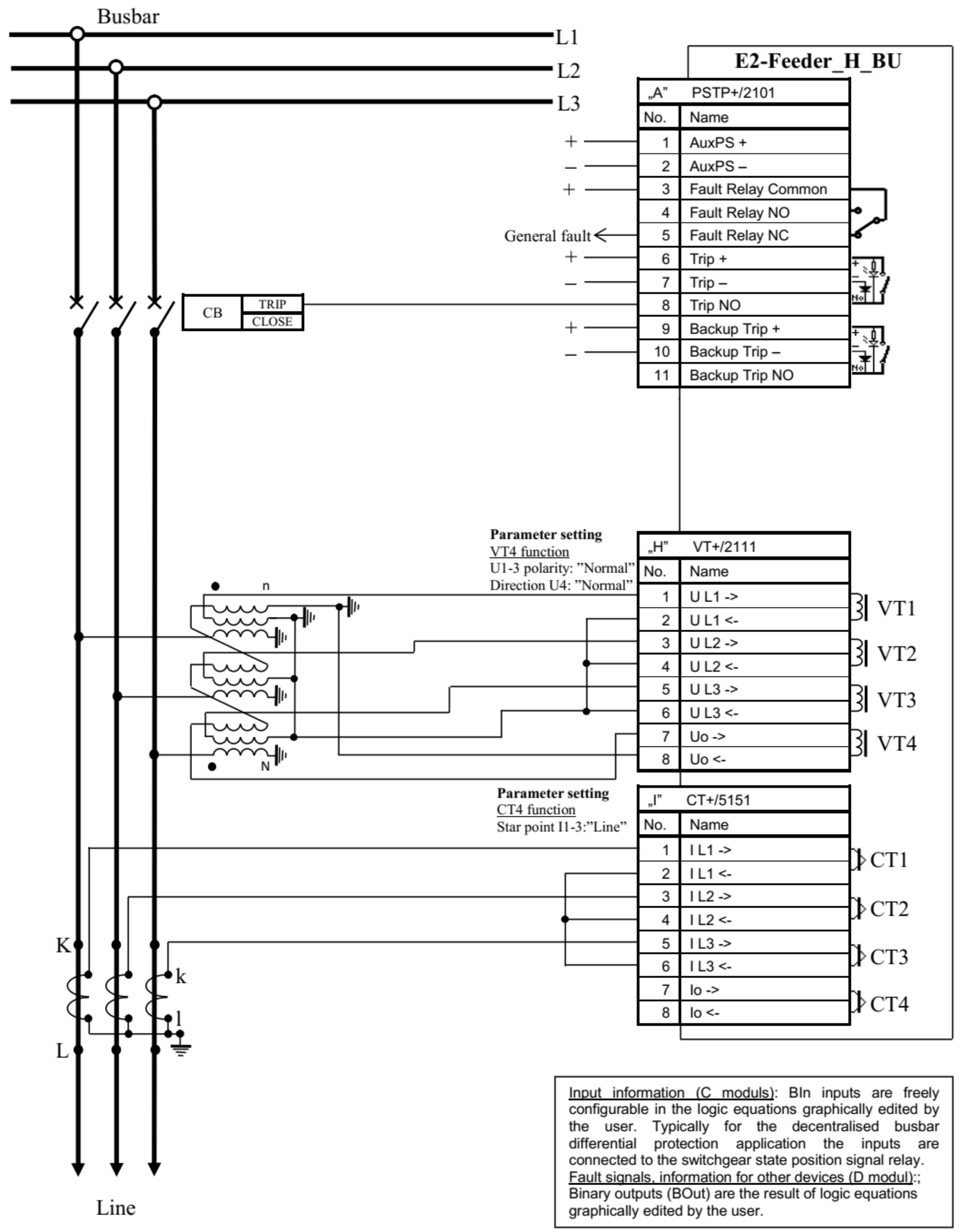
Input information (C moduls): BIn inputs are freely configurable in the logic equations graphically edited by the user. Typically for the decentralised busbar differential protection application the inputs are connected to the switchgear state position signal relay.
Fault signals, information for other devices (D modul): Binary outputs (BOut) are the result of logic equations graphically edited by the user.

Edited by	Tóth J.	Platform	**IED-EP+**	PROTECTA HUNGARY
Checked		Type	**DTVA**	
Approved		Configuration	**E1-Feeder_H**	
Data	26.01.2014.	Subject:	**Connection diagram for the 42HP bay unit of the distributed busbar protection without voltage measuring and phase-selective trip contact**	ID **PP-14-20939-00**
				Pages:1/1



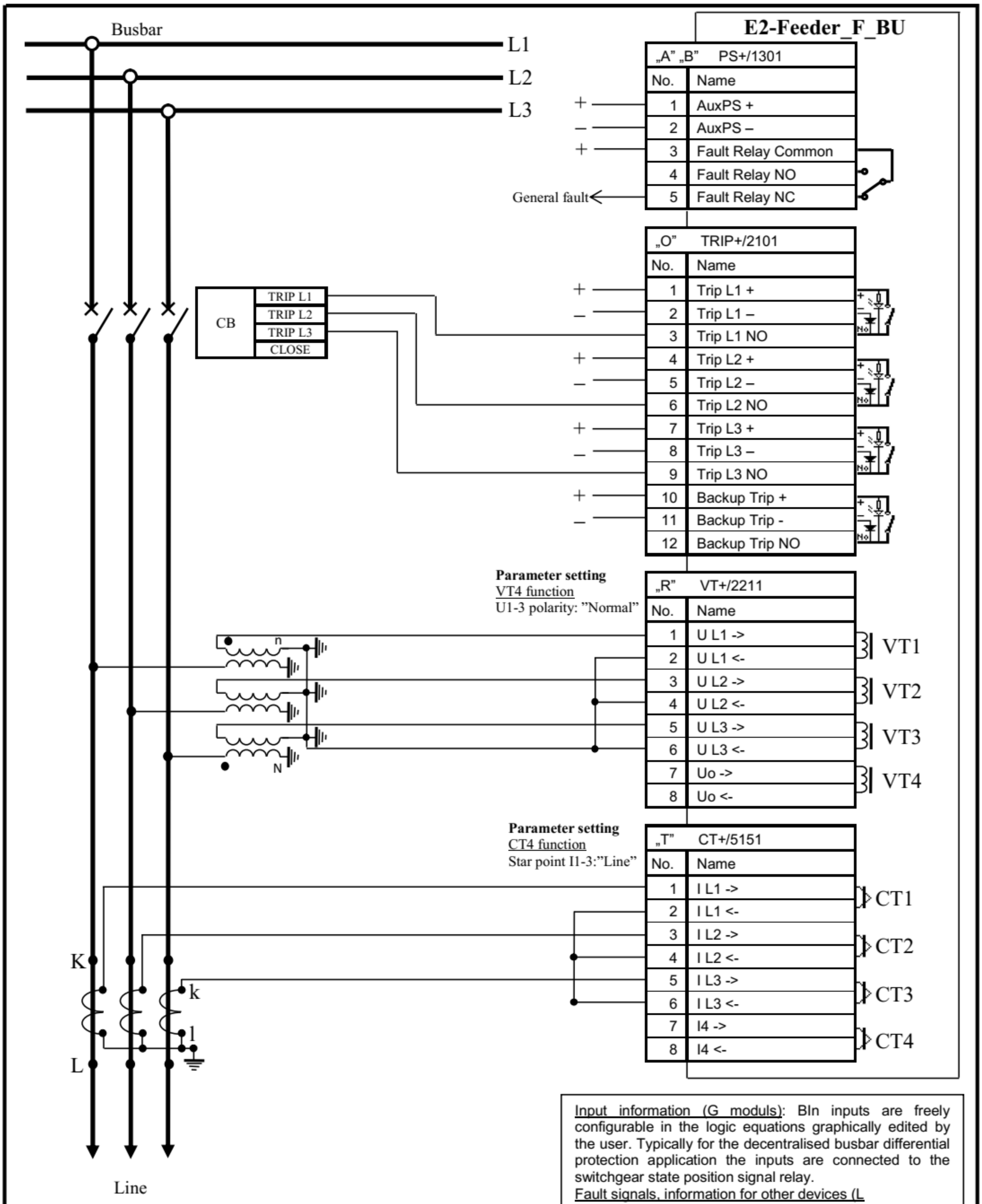
Input information (G moduls): BIn inputs are freely configurable in the logic equations graphically edited by the user. Typically for the decentralised busbar differential protection application the inputs are connected to the switchgear state position signal relay.
Fault signals, information for other devices (L modul):; Binary outputs (BOut) are the result of logic equations graphically edited by the user.

Edited by	Tóth J.	Platform	IED-EP+	PROTECTA HUNGARY	
Checked		Type	DTIVA		
Approved		Configuration	E2-Feeder_F		
Data	2014.10.22.	Subject	Connection diagram for the 84HP bay unit of the distributed busbar protection with voltage measuring and common trip contact	ID	PP-14-20932-00
				Pages:1/1	



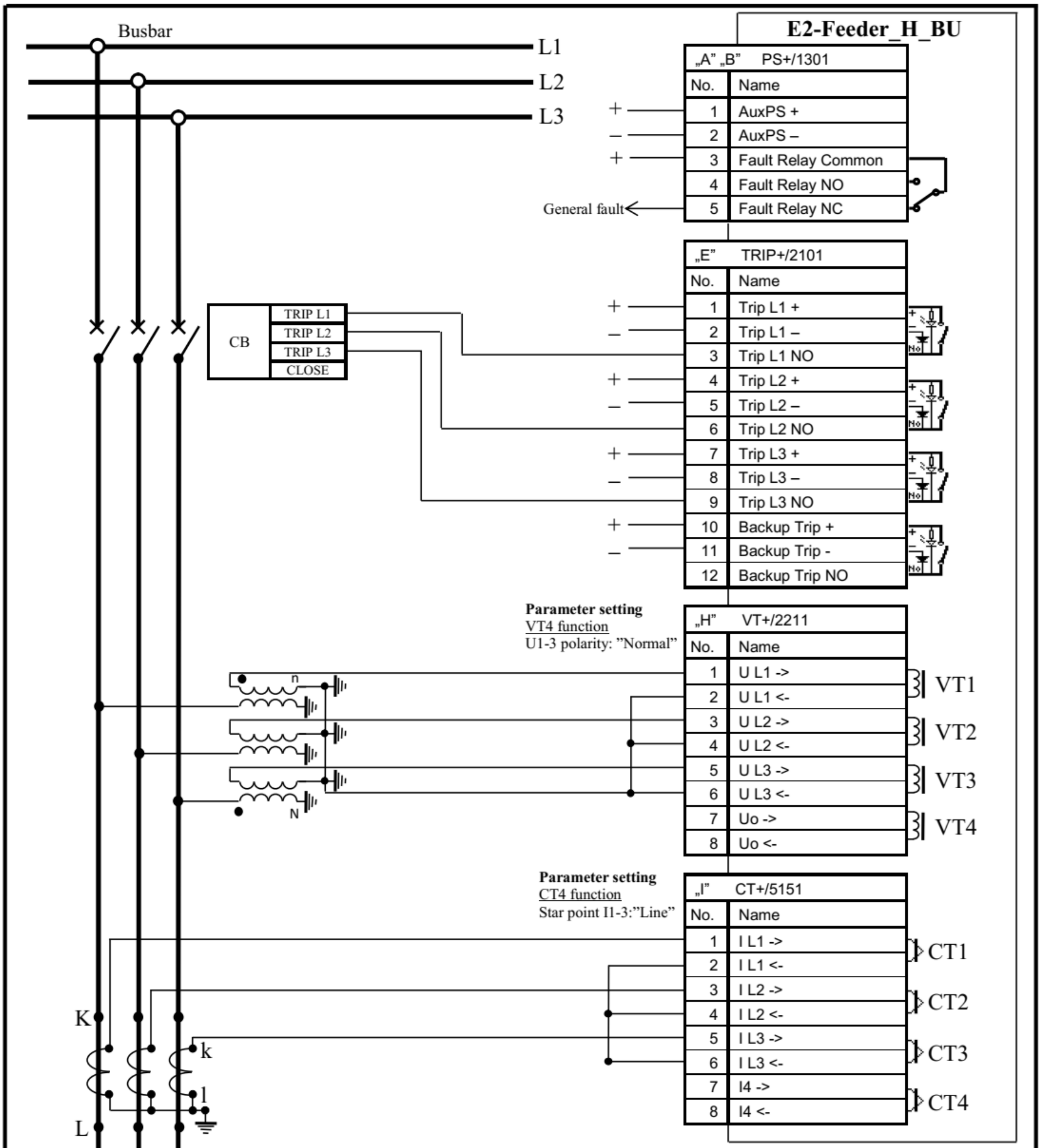
Input information (C moduls): BIn inputs are freely configurable in the logic equations graphically edited by the user. Typically for the decentralised busbar differential protection application the inputs are connected to the switchgear state position signal relay.
Fault signals, information for other devices (D modul):; Binary outputs (BOut) are the result of logic equations graphically edited by the user.

Edited by	Tóth J.	Platform	IED-EP+	PROTECTA HUNGARY	
Checked		Type	DTIVA		
Approved		Configuration	E2-Feeder_H		
Data	2014.10.22.	Subject	Connection diagram for the 42HP bay unit of the distributed busbar protection with voltage measuring and common trip contact	ID	PP-14-20933-00
				Pages:1/1	



Input information (G moduls): BIn inputs are freely configurable in the logic equations graphically edited by the user. Typically for the decentralised busbar differential protection application the inputs are connected to the switchgear state position signal relay.
Fault signals, information for other devices (L modul):;Binary outputs (BOut) are the result of logic equations graphically edited by the user.

Edited by	Tóth J.	Platform	IED-EP+	PROTECTA HUNGARY
Checked		Type	DTVA	
Approved		Configuration	E2-Feeder_F	
Data	26.01.2014.	Subject	**Connection diagram for the 84HP bay unit of the distributed busbar protection with voltage measuring and phase-selective trip contact**	ID **PP-14-20940-00**
				Pages:1/1



Input information (C modules): BIn inputs are freely configurable in the logic equations graphically edited by the user. Typically for the decentralised busbar differential protection application the inputs are connected to the switchgear state position signal relay.

Fault signals, information for other devices (Dmodul): Binary outputs (BOut) are the result of logic equations graphically edited by the user.

Edited by	Tóth J.	Platform	IED-EP+	PROTECTA HUNGARY
Checked		Type	DTVA	
Approved		Configuration	E2-Feeder_H	
Data	26.01.2014.	Subject	**Connection diagram for the 42HP bay unit of the distributed busbar protection with voltage measuring and phase-selective trip contact**	ID **PP-14-20941-00**
				Pages:1/1