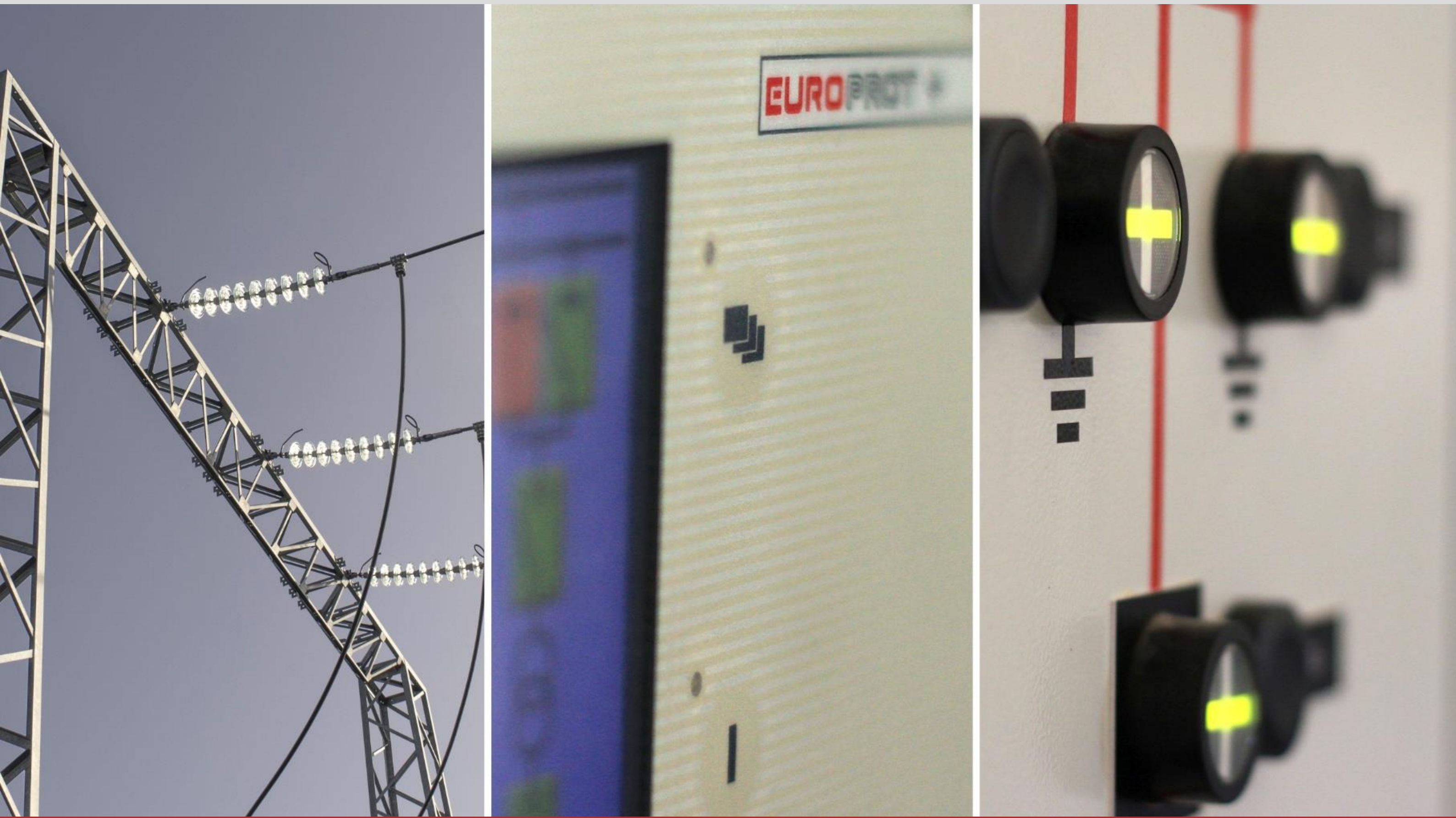

TYPE DESCRIPTION

EuroProt+ OGYD/DGYD type

OGYD: Distributed busbar protection
DGYD: Centralized busbar protection

PROTECTA HUNGARY

Document ID: PP-13-21887
Last version: 1.0
2019-04-04, Budapest

Protection, automation and control for power industry

VERSION INFORMATION

VERSION	DATE	MODIFICATION	COMPILED BY
1.0	2019-04-04	First edition	Erdős, Tóth

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 Meeting the device

Each configuration of has its own basic hardware arrangement according to the number of the handled bays. The remaining free slots are filled up according to the user's requirements during ordering.

The technical specification of the hardware of the device (detailed descriptions of the modules, compliance to the IEC standards, etc.) is in the document "***Hardware description***" which can be found on the protecta website:
https://www.protecta.hu/protecta_open/fileOpen.php?documentation=10

The busbar protection devices are made in one size only, see the pictures below.

*Figure 1-1 The 84HP (19") rack of **EuroProt+** family*

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***" which can be found on the Protecta website:
https://www.protecta.hu/protecta_open/fileOpen.php?documentation=9

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
HARDWARE				VT inputs	4(op.)	4(op.)	4(op.)	4(op.)	4(op.)	4(op.)	4(op.)	4(op.)	4(op.)
HARDWARE				Digital inputs (max)	120	108	96	84	72	60	48	36	24
HARDWARE				Signaling relay outputs (max)	120	108	96	84	72	60	48	36	24
HARDWARE				Fast Trip outputs (max)									
		Function name	IEC	ANSI	E1	E2	E3	E4	E5	E6	E7	E8	E10
FUNCTIONALITY	Protection	Low impedance busbar differential	3IdB >	87B	✔	✔	✔	✔	✔	✔	✔	✔	✔
FUNCTIONALITY	Protection	Voltage breakdown condition			Op.	Op.	Op.	Op.	Op.	Op.	Op.	Op.	Op.
FUNCTIONALITY	Protection	Breaker failure protection	CBFP	50BF	✔	✔	✔	✔	✔	✔	✔	✔	✔
FUNCTIONALITY	Control & supervision	Trip Logic		94	✔	✔	✔	✔	✔	✔	✔	✔	✔
FUNCTIONALITY	Control & supervision	Lockout trip logic		86	Op.	Op.	Op.	Op.	Op.	Op.	Op.	Op.	Op.
FUNCTIONALITY	Control & supervision	Ethernet Links			Op.	Op.	Op.	Op.	Op.	Op.	Op.	Op.	Op.
FUNCTIONALITY	Control & supervision	Trip Circuit Supervision		74TC	✔	✔	✔	✔	✔	✔	✔	✔	✔
FUNCTIONALITY	Control & supervision	Fuse failure (VTS)		60	Op.	Op.	Op.	Op.	Op.	Op.	Op.	Op.	Op.
FUNCTIONALITY	Control & supervision	Current transformer failure detection		60	✔	✔	✔	✔	✔	✔	✔	✔	✔
FUNCTIONALITY	Meas.	Current input			✔	✔	✔	✔	✔	✔	✔	✔	✔
FUNCTIONALITY	Meas.	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
HARDWARE				VT inputs	Op.	Op.	Op.	Op.	Op.	Op.	Op.	Op.
HARDWARE				Digital inputs (max)	96	96	96	96	144	144	102	90
HARDWARE				Signaling relay outputs (max)	53	53	53	53	113	105	88	80
HARDWARE				Fast Trip outputs (max)	24	24	24	24	24	24	24	24
		Function name	IEC	ANSI	E33	E34	E35	E36	E11	E14	E15	E16
FUNCTIONALITY	Protection	Low impedance busbar differential	3IdB >	87B	✔	✔	✔	✔	✔	✔	✔	✔
FUNCTIONALITY	Protection	Voltage breakdown condition			Op.	Op.	Op.	Op.	Op.	Op.	Op.	Op.
FUNCTIONALITY	Protection	Breaker failure protection	CBFP	50BF	✔	✔	✔	✔	✔	✔	✔	✔
FUNCTIONALITY	Control & supervision	Trip Logic		94	✔	✔	✔	✔	✔	✔	✔	✔
FUNCTIONALITY	Control & supervision	Lockout trip logic		86	Op.	Op.	Op.	Op.	Op.	Op.	Op.	Op.
FUNCTIONALITY	Control & supervision	Ethernet Links			Op.	Op.	Op.	Op.	Op.	Op.	Op.	Op.
FUNCTIONALITY	Control & supervision	Trip Circuit Supervision		74TC	✔	✔	✔	✔	✔	✔	✔	✔
FUNCTIONALITY	Control & supervision	Fuse failure (VTS)		60	Op.	Op.	Op.	Op.	Op.	Op.	Op.	Op.
FUNCTIONALITY	Control & supervision	Current transformer failure detection		60	✔	✔	✔	✔	✔	✔	✔	✔
FUNCTIONALITY	Meas.	Current input			✔	✔	✔	✔	✔	✔	✔	✔
FUNCTIONALITY	Meas.	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

3.1.1 Centralized busbar differential protection function and breaker failure protection

The algorithm in the busbar protection function 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.

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:

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.)

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

The biasing current calculation **is as follows:**

- From the absolute value of the sampled I_p momentary current values a predetermined "$Max.I\_load$" 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 sum of these values 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:

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

The differential characteristics*:* the trip characteristic for a measuring element is shown in the Figure below.

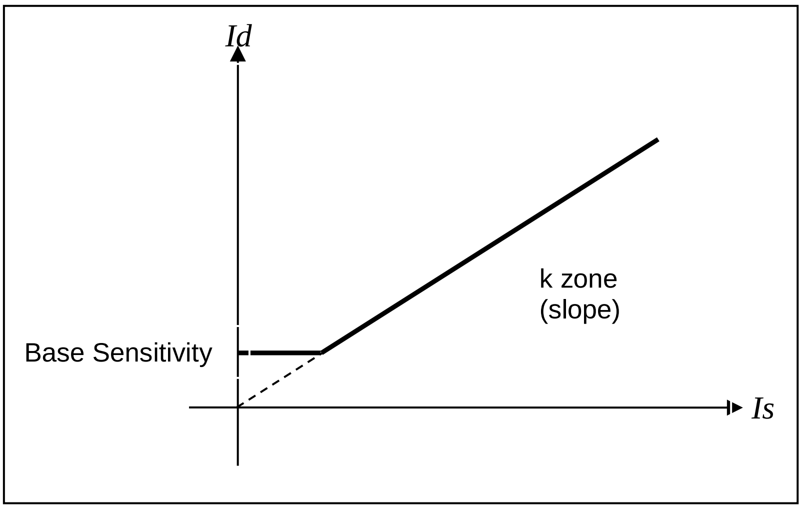

Figure 3-1 Busbar protection characteristics

In case of detected through fault, the slope of the characteristic is dynamically changed to 90%. When tested, the applied method results a constant 90% measured value for the slope.

Role of the subtracting the "$Max.I\_load$" value from all current samples: 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 above) is at once above the line described by the slope "k" (parameter setting “k zone”). 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 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.

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).

The parameters for the voltage breakdown condition are fix values (0.6Un), the function does not need any parameter setting.

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 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 parameter setting.

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”. The algorithm “keeps” the detected current peak till the end of the half period, decreasing the chanche for the false trip decision.

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.

***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 setting and a given slope.

If the measured currents result an Id–Is point above this characteristic, then after a time delay the “measuring element” gets blocked.

***Checking the disconnector status signals**:* the actual configuration of the busbar 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. 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. 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 (On), then the operation neglects the faulty status signal, and the last valid status is kept. In case of setting “false” (Off), 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 “Differential protection disabled” and “Breaker failure disabled” status signals as well.

The breaker failure protection function: The starting of the breaker failure protection is received on dedicated binary input channels. For operation, at least one of the phase currents of the bay must be above the level, as set an integer parameter value for each bay. Also the time delay of the function and the duration of the pulse are parameter values.

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.

Technical data

Function	Value	Accuracy
Current measurement		±2%
Current reset ratio	0.7*	
Operate time (Idiff>2 x In) (Idiff>5 x In)	 Typical 20 ms <15 ms	
Reset time	60 ms	

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

Table 3-1 Technical data of the centralized busbar differential protection function

The parameters of the centralized busbar differential protection function

Parameters of the "Busbar general" function block

Enumerated parameters

Parameter name	Title	Selection range	Default
Parameter to enable the centralized busbar differential protection function:			
Busbar_BBPOper_EPar__	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 3-2 Enumerated parameters of the busbar general function block

Integer parameters

Parameter name	Title	Unit	Min	Max	Step	Default
Percentage characteristic, base sensitivity						
Busbar_ZoneSens_IPar_	Base Sensitivity	A	100	10000	1	1000
Percentage characteristic, slope						
Busbar_ZoneK_IPar_	k zone	%	40	90	1	80
Checkzone percentage characteristic, base sensitivity						
Busbar_CheckSens_IPar_	CheckZone Sens.	A	100	10000	1	1000
Checkzone percentage characteristic, slope						
Busbar_CheckK_IPar_	k checkzone	%	40	80	1	50
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	80	1	40
Maximum load current						
Busbar_Offset_IPar_	Max.I_load	A	0	10000	1	1000

Table 3-3 Integer parameters of the busbar general function block

Timer parameters

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 3-4 Timer parameters of the busbar general function block

Parameters of the "Bus section" function block

The bus section units does not have parameters.

Parameters of the "Bay unit" function block

The different type of parameters for the centralized busbar differential protection function, bay unit are listed in the tables below. They are to be set for the bays individually. In the parameter names "##" is different for each connected bay:

Boolean parameters

Parameter name	Title	Default	Explanation
Disabling the bay			
BayUnit1f_BayDisable_BPar_##	Bay Disable	0	0 means enabling; 1 means that the current values and the status signals received from the bay are not considered (to be applied for maintenance purposes).

Table 3-5 Boolean parameter of the bay unit function block

Enumerated parameters

Parameter name	Title	Selection range	Default
CT secondary rated current			
BayUnit1f_Nom_EPar__##	Rated Secondary	1A, 5A	1A
Location of the CT star point for the CT-s in three lines			
BayUnit1f_Dir_EPar__##	Star point I1-3	Line, Bus	Line

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

Table 3-6 Enumerated parameters of the bay unit function block

Integer parameter

Parameter name	Title	Unit	Min	Max	Step	Default
CT primary rated current						
BayUnit1f_CTNom_IPar_##	CT nominal	A	100	10000	1	1000

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

Table 3-7 Integer parameter of the bay unit function block

Parameters of the breaker failure bay modules

Enumerated parameter for the breaker failure protection function for enabling or disabling the operation:

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

Table 3-8 Enumerated parameter for enabling the breaker failure function in the busbar function block

The breaker failure protection function needs parameters related to the bays individually.
In the parameter names "##" is different for each connected bays.

These parameters are as follows:

Enumerated parameters for the breaker failure protection function, bay modules:

Parameter name	Title	Selection range	Default
Enabling the bay to participate in the breaker failure protection function			
BRF50BB_Oper_EPar__##	Operation	Off,On	Off

Table 3-9 Enumerated parameters of the breaker failure function in the bays

Integer parameters

Parameter name	Title	Unit	Min	Max	Step	Default
Current condition for the breaker failure protection function						
BRF50BB_StCurrPh_IPar__##	Start Ph Current	%	20	200	1	30

Table 3-10 Integer parameters of the breaker failure function in the bays

Timer parameters

Parameter name	Title	Unit	Min	Max	Step	Default
Time delay for the breaker failure protection function						
BRF50BB_BUDel_TPar__##	Backup Time Delay	msec	60	1000	1	200
Pulse duration						
BRF50BB_Pulse_TPar__##	Pulse Duration	msec	0	60000	1	100

Table 3-11 Timer parameters of the breaker failure function in the bays

3.1.3 Distributed busbar differential protection function and breaker failure protection

The algorithm in the busbar protection function 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.

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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.)

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

The biasing current calculation **is as follows:**

- From the absolute value of the sampled I_p momentary current values a predetermined "$Max.I\_load$" 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 sum of these values 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:

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

The differential characteristics*:* the trip characteristic for a measuring element is shown in the Figure below.

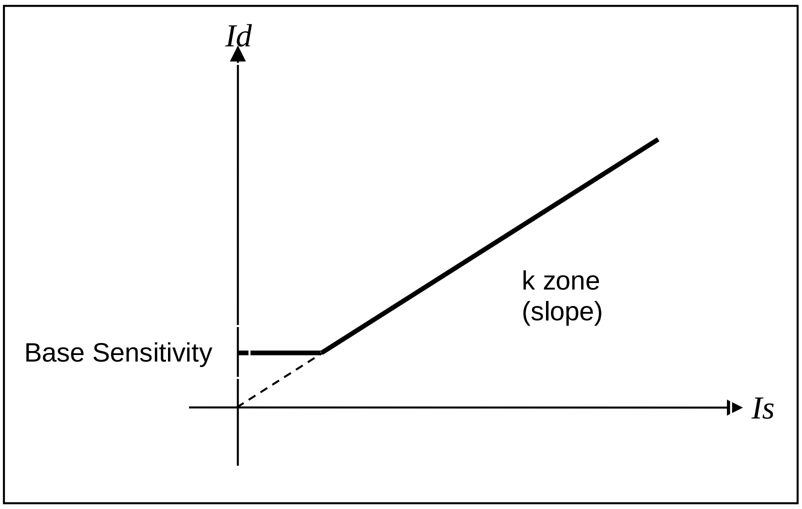


Figure 3-2 Busbar protection characteristics

In case of detected through fault, the slope of the characteristic is dynamically changed to 90%. When tested, the applied method results a constant 90% measured value for the slope.

Role of the subtracting the "$Max.I\_load$" value from all current samples: 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 above) is at once above the line described by the slope "k" (parameter setting “k zone”). 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 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.

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).

The parameters for the voltage breakdown condition are fix values (0.6Un), the function does not need any parameter setting.

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 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 parameter setting.

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”. The algorithm “keeps” the detected current peak till the end of the half period, decreasing the chanche for the false trip decision.

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.

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 setting and a given slope.

If the measured currents result an Id–Is point above this characteristic, then after a time delay the “measuring element” gets blocked.

Checking the disconnector status signals*:* the actual configuration of the busbar 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. 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. 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 (On), then the operation neglects the faulty status signal, and the last valid status is kept. In case of setting “false” (Off), 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 “Differential protection disabled” and “Breaker failure disabled” status signals as well.

The breaker failure protection function: The starting of the breaker failure protection is received on dedicated binary input channels. For operation, at least one of the phase currents of the bay must be above the level, as set an integer parameter value for each bay. Also the time delay of the function and the duration of the pulse are parameter values.

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.

Technical data

Function	Value	Accuracy
Current measurement		±2%
Current reset ratio	0.7*	
Operate time (Idiff>2 x In) (Idiff>5 x In)	 Typical 20 ms <15 ms	
Reset time	60 ms	

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

Table 3-12 Technical data of the distributed busbar differential protection function

The parameters of the distributed busbar differential protection function

Parameters of the "Busbar" function block in the central device

Enumerated parameters

Parameter name	Title	Selection range	Default
Parameter to enable the distributed busbar differential protection function:			
Busbar_BBPOper_EPar__	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 3-13 Enumerated parameters of the busbar general function block

Integer parameter

Parameter name	Title	Unit	Min	Max	Step	Default
Percentage characteristic, base sensitivity						
Busbar_ZoneSens_IPar_	Base Sensitivity	A	100	10000	1	1000
Percentage characteristic, slope						
Busbar_ZoneK_IPar_	k zone	%	40	90	1	80
Checkzone percentage characteristic, base sensitivity						
Busbar_CheckSens_IPar_	CheckZone Sens.	A	100	10000	1	1000
Checkzone percentage characteristic, slope						
Busbar_CheckK_IPar_	k checkzone	%	40	80	1	50
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	80	1	40
Maximum load current						
Busbar_Offset_IPar_	Max.I_load	A	0	10000	1	1000

Table 3-14 Integer parameters of the busbar general function block

Timer parameters

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 3-15 Integer parameters of the busbar general function block

Parameters of the bus section unit in the central device

The bus section units do not need parameter setting.

Parameters of the bay unit function block in the central device

The different type of parameters for the distributed busbar differential protection function, bay unit are listed in the tables below. They are to be set for the bays individually. In the parameter names "##" is different for each connected bays:

Boolean parameters

Parameter name	Title	Default	Explanation
Disabling the bay			
BayUnit1f_BayDisable_BPar_##	Bay Disable	0	0 means enabling; 1 means that the current values and the status signals received from the bay are not considered (to be applied for maintenance purposes).

Table 3-16 Boolean parameter of the bay unit function block

Enumerated parameters

Parameter name	Title	Selection range	Default
CT secondary rated current			
BayUnit1f_Nom_EPar__##	Rated Secondary	1A, 5A	1A
Location of the CT star point for the CT-s in three lines			
BayUnit1f_Dir_EPar__##	Star point I1-3	Line, Bus	Line

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

Table 3-17 Enumerated parameters of the bay unit function block

Integer parameter

Parameter name	Title	Unit	Min	Max	Step	Default
CT primary rated current						
BayUnit1f_CTNom_IPar_##	CT nominal	A	100	10000	1	1000

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

Table 3-18 Integer parameter of the bay unit function block

Parameters of the bay devices

Timer parameter

There is only one parameter in 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:

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

Parameters of the breaker failure module

Parameters for the breaker failure module in the central unit

Enumerated parameters

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

Table 3-19 Enumerated parameter for enabling the breaker failure function in the busbar function block

Parameters for the breaker failure module in the bay devices

Enumerated parameters

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 3-20 Enumerated parameters of the breaker failure function in the bays

Integer parameter

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 3-21 Integer parameters of the breaker failure function in the bays

Timer parameters

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 3-22 Timer parameters of the breaker failure function in the bays

3.2 Control & supervision functions

3.2.1 Phase-selective trip logic (TRC94_PhS)

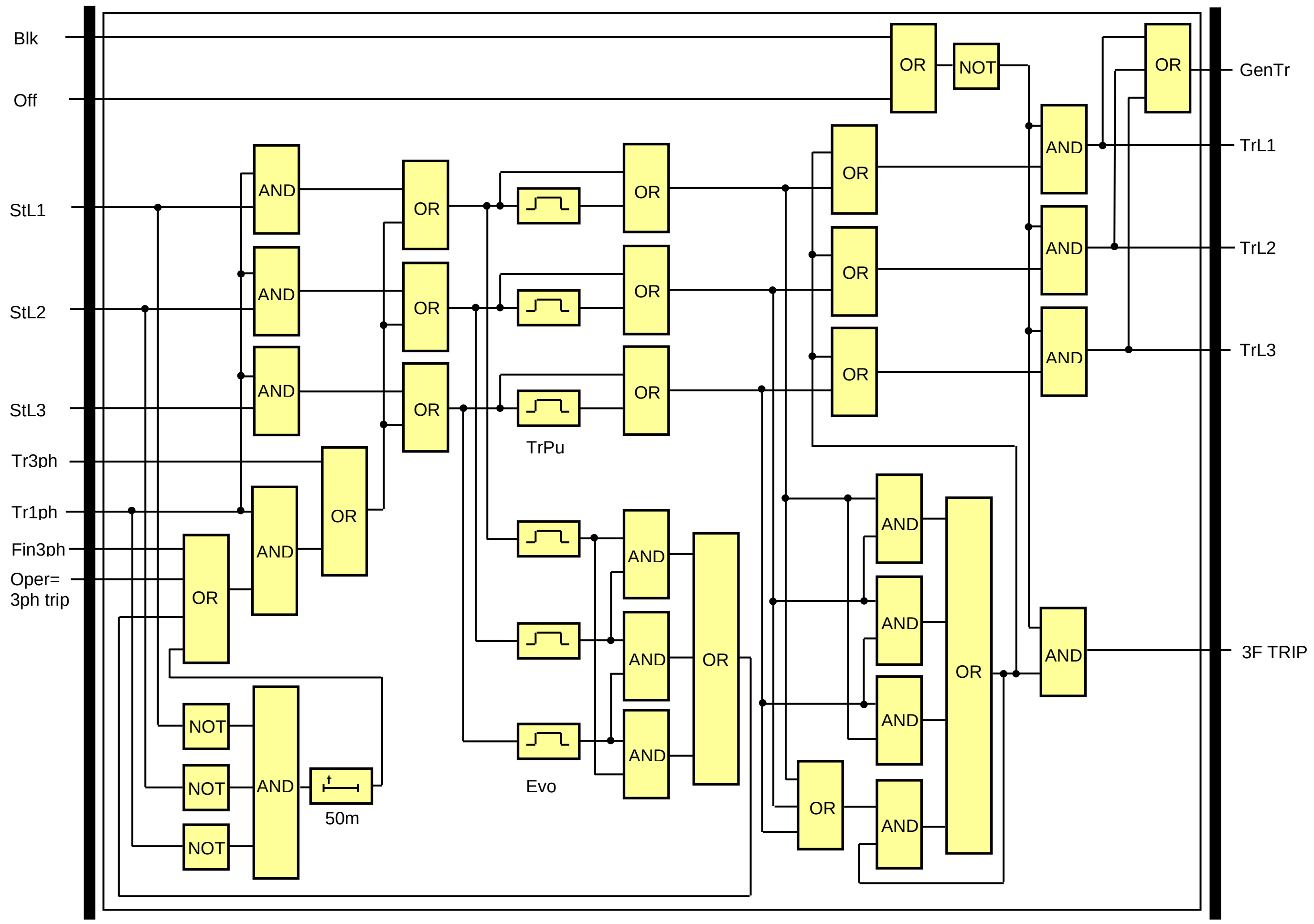
The phase-selective trip logic function operates according to the functionality required by the IEC 61850 standard for the "Trip logic logical node".

The function receives the trip requirements of the protective functions implemented in the device and combines the parameters and the binary signals into the outputs of the device.

The trip requirements are programmed by the user, using the graphic equation editor. The decision logic has the following aims:

- define a minimal impulse duration even if the protection functions detect a very short time fault,
- in case of phase-to-phase faults, involve the third phase in the trip command,
- fulfill the requirements of the automatic reclosing function to generate a three-phase trip command even in case of single-phase faults,
- in case of an evolving fault, during the evolving fault waiting time include all three phases into the trip command.

The decision logic module combines the status signals and enumerated parameters to generate the trip commands on the output module of the device.



Technical data

Function	Accuracy
Timer accuracy	±5% or ±15 ms, whichever is greater

Table 3-23 Technical data of the phase-selective trip logic function

Parameters

Enumerated parameter

Parameter name	Title	Selection range	Default
Selection of the operating mode			
TRC94_Oper_EPar_	Operation	Off, 3ph trip, 1ph/3ph trip	3ph trip

Tables 3-24 The enumerated parameter of the phase-selective trip logic function

Timer parameter

Parameter name	Title	Unit	Min	Max	Step	Default
Minimum duration of the generated impulse						
TRC94_TrPu_TPar_	Min Pulse Duration	msec	50	60000	1	150
Waiting time for evolving fault						
TRC94_Evo_TPar_	Evolving Fault Time	msec	50	60000	1	1000

Table 3-25 Timer parameter of the phase-selective trip logic function

3.2.2 Ethernet Links function (EthLinks)

The EuroProt+ device constantly checks the statuses of its connections to the outside world (wherever possible). These statuses can be seen on the **status/log** page in the advanced menu on the web page of the device.

When further indications are needed or the signals of the statuses (such as events, logic signals for the user logic, LEDs etc.), the Ethernet Links function block makes these available for the user.

Ports

The function can check the following types of communication ports:

- Fiber Optic (MM – multi mode)
- Fiber Optic (SM – single mode)
- RJ45
- PRP/HSR
- EOB (Ethernet On Board on the front HMI of the device)

See the EuroProt+ Hardware Description (different document) for the list of the CPU modules that contain any of these ports.

Ethernet Links function overview

The graphic appearance of the function block is shown on Figure 3-3. These blocks show all binary input and output status signals, which are applicable in the graphic equation editor.

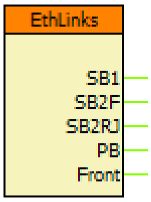


Figure 3-3 Graphic appearance of the function block of the ethernet links function

Function I/O

This section describes briefly the analogue and digital inputs and outputs of the function block.

This function block owns only binary output signals.

Binary output signals (graphed input statuses)

The binary output status signals of the Ethernet Links function. **P**arts written in **bold** are seen on the function block in the logic editor.

BINARY OUTPUT SIGNAL	SIGNAL TITLE	EXPLANATION
EthLnk_**SB1**_Grl_	Station Bus1	Active if the first (upper) fiber optic port of the CPU module has an active connection.
EthLnk_**SB2F**_Grl_	Station Bus2 – Fiber	Active if the second (middle) fiber optic port of the CPU module has an active connection.
EthLnk_**SB2RJ**_Grl_	Station Bus2 –RJ4	Active if the RJ45 port of the CPU module has an active connection.
EthLnk_**PB**_Grl_	Process Bus	Active if the third (lower) fiber optic port of the CPU module has an active connection
EthLnk_**Front**_Grl_	RJ45/EOB on front panel	Active if the front RJ45 port (or EOB) has an active connection

Table 3-26 The binary output status signals of the ethernet links function

On-line data

Visible values on the on-line data page:

SIGNAL TITLE	DIMENSION	EXPLANATION
Station Bus1	-	Active if the first (upper) fiber optic port of the CPU module has an active connection.
Station Bus2 – Fiber	-	Active if the second (middle) fiber optic port of the CPU module has an active connection.
Station Bus2 –RJ4	-	Active if the RJ45 port of the CPU module has an active connection.
Process Bus	-	Active if the third (lower) fiber optic port of the CPU module has an active connection
RJ45/EOB on front panel	-	Active if the front RJ45 port (or EOB) has an active connection

Table 3-27 The measured analogue values of the ethernet links function

Events

The following events are generated in the event list, as well as sent to SCADA according to the configuration.

EVENT	VALUE	EXPLANATION
Station Bus1	off, on	Active if the first (upper) fiber optic port of the CPU module has an active connection.
Station Bus2 – Fiber	off, on	Active if the second (middle) fiber optic port of the CPU module has an active connection.
Station Bus2 –RJ4	off, on	Active if the RJ45 port of the CPU module has an active connection.
Process Bus	off, on	Active if the third (lower) fiber optic port of the CPU module has an active connection
RJ45/EOB on front panel	off, on	Active if the front RJ45 port (or EOB) has an active connection

Table 3-28 Events of the ethernet links function

3.2.3 Dead line detection function (DLD)

The “Dead Line Detection” (DLD) function generates a signal indicating the dead or live state of the line. Additional signals are generated to indicate if the phase voltages and phase currents are above the pre-defined limits.

The task of the “Dead Line Detection” (DLD) function is to decide the Dead line/Live line state.

Criteria of “Dead line” state: all three phase voltages are below the voltage setting value AND all three currents are below the current setting value.

Criteria of “Live line” state: all three phase voltages are above the voltage setting value.

The details are described in the document ***Dead line detection protection function block description.***

Technical data

Function	Value	Accuracy
Pick-up voltage		1%
Operation time	<20ms	
Reset ratio	0.95	

Table 3-29 Technical data of the dead line detection function

Parameters

Integer parameters

Parameter name	Title	Unit	Min	Max	Step	Default
Integer parameters of the dead line detection function						
DLD_ULev_IPar_	Min. Operate Voltage	%	10	100	1	60
DLD_ILev_IPar_	Min. Operate Current	%	2	100	1	10

Table 3-30 The integer parameters of the dead line detection function

3.2.4 Voltage transformer supervision function (VTS60)

The voltage transformer supervision function generates a signal to indicate an error in the voltage transformer secondary circuit. This signal can serve, for example, as a warning, indicating disturbances in the measurement, or it can disable the operation of the distance protection function if appropriate measured voltage signals are not available for a distance decision.

The voltage transformer supervision function is designed to detect faulty asymmetrical states of the voltage transformer circuit caused, for example, by a broken conductor in the secondary circuit.

(Another method for detecting voltage disturbances is the supervision of the auxiliary contacts of the miniature circuit breakers in the voltage transformer secondary circuits. This function is not described here.)

The user has to generate graphic equations for the application of the signal of this voltage transformer supervision function.

This function is interconnected with the “dead line detection function”. Although the dead line detection function is described fully in a separate document, the explanation necessary to understand the operation of the VT supervision function is repeated also in this document.

The voltage transformer supervision function can be used in three different modes of application:

Zero sequence detection (for typical applications in systems with grounded neutral): “VT failure” signal is generated if the residual voltage (3Uo) is above the preset voltage value AND the residual current (3Io) is below the preset current value.

Negative sequence detection (for typical applications in systems with isolated or resonant grounded (Petersen) neutral): “VT failure” signal is generated if the negative sequence voltage component (U2) is above the preset voltage value AND the negative sequence current component (I2) is below the preset current value.

Special application: “VT failure” signal is generated if the residual voltage (3Uo) is above the preset voltage value AND the residual current (3Io) AND the negative sequence current component (I2) are below the preset current values.

The voltage transformer supervision function can be activated if “Live line” status is detected for at least 200 ms. This delay avoids mal-operation at line energizing if the poles of the circuit breaker make contact with a time delay. The function is set to be inactive if “Dead line” status is detected.

If the conditions specified by the selected mode of operation are fulfilled (for at least 4 milliseconds) then the voltage transformer supervision function is activated and the operation signal is generated. (When evaluating this time delay, the natural operating time of the applied Fourier algorithm must also be considered.)

NOTE: For the operation of the voltage transformer supervision function the “ Dead line detection function” must be operable as well: it must be enabled by binary parameter setting, and its blocking signal may not be active.

If, in the active state, the conditions for operation are no longer fulfilled, the resetting of the function depends on the mode of operation of the primary circuit:

- If the “Live line” state is valid, then the function resets after approx. 200 ms of time delay. (When evaluating this time delay, the natural operating time of the applied Fourier algorithm must also be considered.)
- If the “Dead line” state is started and the “VTS Failure” signal has been continuous for at least 100 ms, then the “VTS failure” signal does not reset; it is generated continuously even when the line is in a disconnected state. Thus, the “VTS Failure” signal remains active at reclosing.
- If the “Dead line” state is started and the “VTS Failure” signal has not been continuous for at least 100 ms, then the “VTS failure” signal resets.

Technical data

Function	Value	Accuracy
Pick-up voltage Io=0A I2=0A		 <1% <1%
Operation time	<20ms	
Reset ratio	0.95	

Table 3-31 Technical data of the voltage transformer supervision function

Parameters

Integer parameters

Parameter name	Title	Unit	Min	Max	Step	Default
Integer parameters of the dead line detection function						
DLD_ULev_IPar_	Min Operate Voltage	%	10	100	1	60
DLD_ILev_IPar_	Min Operate Current	%	2	100	1	10
Starting voltage and current parameter for residual and negative sequence detection:						
VTS_Uo_IPar_	Start URes	%	5	50	1	30
VTS_Io_IPar_	Start IRes	%	10	50	1	10
VTS_Uneg_IPar_	Start UNeg	%	5	50	1	10
VTS_Ineg_IPar_	Start INeg	%	10	50	1	10

Table 3-32 The integer parameters of the voltage transformer supervision function

Enumerated parameter

Parameter name	Title	Selection range	Default
Parameter for type selection			
VTS_Oper_EPar_	Operation	Off, Zero sequence, Neg. sequence, Special	Zero sequence

Table 3-33 The enumerated parameter of the voltage transformer supervision function

3.2.5 Current unbalance function (VCB60)

The current unbalance protection function (VCB60) can be applied to detect unexpected asymmetry in current measurement.

The applied method selects maximum and minimum phase currents (RMS value of the fundamental Fourier components). If the difference between them is above the setting limit, the function generates a start signal. It is a necessary precondition of start signal generation that the maximum of the currents be above 10 % of the rated current and below 150% of the rated current.

The Fourier calculation modules calculate the RMS value of the basic Fourier current components of the phase currents individually. They are not part of the VCB60 function; they belong to the preparatory phase.

The analog signal processing module processes the RMS value of the basic Fourier current components of the phase currents to prepare the signals for the decision. It calculates the maximum and the minimum value of the RMS values and the difference between the maximum and minimum of the RMS values of the fundamental Fourier components of the phase currents as a percentage of the maximum of these values (ΔI>). If the maximum of the currents is above 10 % of the rated current and below 150% of the rated current and the ΔI> value is above the limit defined by the preset parameter (Start Current Diff) an output is generated to the decision module.

The decision logic module combines the status signals to generate the starting signal and the trip command of the function.

The trip command is generated after the defined time delay if trip command is enabled by the Boolean parameter setting.

The function can be disabled by parameter setting, and by an input signal programmed by the user with the graphic programming tool.

Technical data

Function	Value	Accuracy
Pick-up starting accuracy at In		< 2 %
Reset ratio	0.95	
Operate time	70 ms	

Table 3-34 Technical data of the current unbalance function

Parameters

Enumerated parameter

Parameter name	Title	Selection range	Default
Selection of the operating mode			
VCB60_Oper_EPar_	Operation	Off, On	On

Table 3-35 The enumerated parameter of the current unbalance function

Boolean parameter

Parameter name	Title	Explanation	Default
Selection for trip command			
VCB60_StOnly_BPar_	Start Signal Only	0 to generate trip command	0

Table 3-36 The boolean parameter of the current unbalance function

Integer parameter

Parameter name	Title	Unit	Min	Max	Step	Default
Phase difference current setting						
VCB60_StCurr_IPar_	Start Current Diff	%	10	90	1	50

Table 3-37 The integer parameter of the current unbalance function

Timer parameter

Parameter name	Title	Unit	Min	Max	Step	Default
Time delay						
VCB60_Del_TPar_	Time Delay	msec	100	60000	100	1000

Table 3-38 The timer parameter of the current unbalance function

3.2.6 Trip Circuit Supervision (TCS)

The trip circuit supervision is utilized for checking the integrity of the circuit between the trip coil and the tripping output of the protection device.

It is realized by injecting a small DC current (around 1-5 mA) into the trip circuit. If the circuit is intact, the current flows, which lights up a LED that provides an active signal to the opto coupler input of the trip contact.

The state of the input is shown on the devices' binary input listing among the other binary inputs, and it can be handled like any other of them (it can be added to the user logic, etc.)

This document describes the applicable hardware and provides guidelines for usage in the device configuration.

Hardware application

Applicable modules

The following modules contain trip outputs with trip circuit supervision. The information here is restricted to the trip circuit supervision only. For more details please refer to the EuroProt+ Hardware description from which these were extracted. Note that there are other modules without trip circuit supervision, those are not listed here.

MODULE TYPE	TRIP+4201	TRIP+2101	TRIP+2201	PSTP+4201	PSTP+2101
CHANNEL NUMBER	4	4	4	2	2
RATED VOLTAGE	24 V DC and 48 V DC	110 V DC	220 V DC	24 V DC and 48 V DC and 60 V DC	110 V DC and 220 V DC
THERMAL WITHSTAND VOLTAGE	72 V DC	132 V DC	242 V DC	72 V DC	242 V DC

Table 3-39 Modules with Trip Circuit Supervision

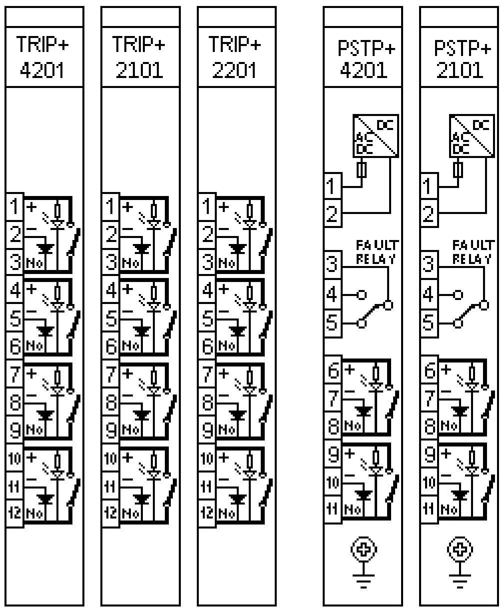


Figure 3-4 I/O arrangement of the modules with TCS

Wiring

The wiring of these modules can be 2-wire or 3-wire. (TCS function is active for both 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 made to switch DC circuits. **Using reversed polarity or AC voltage can cause the damage of the internal circuits.**

3-wire TRIP+ wiring methods

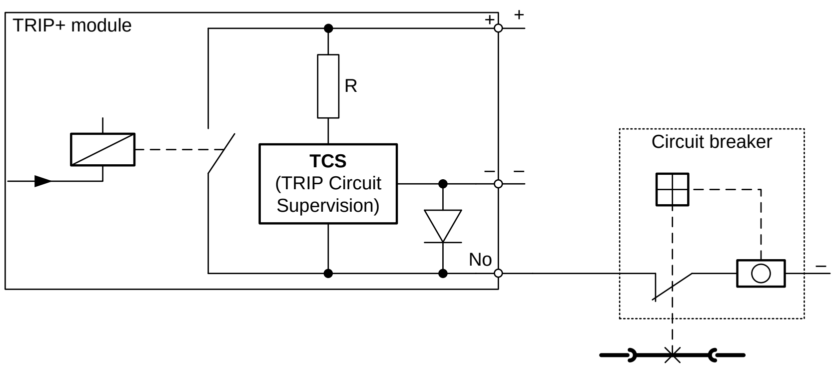


Figure 3-5 3-wire TRIP+ wiring

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

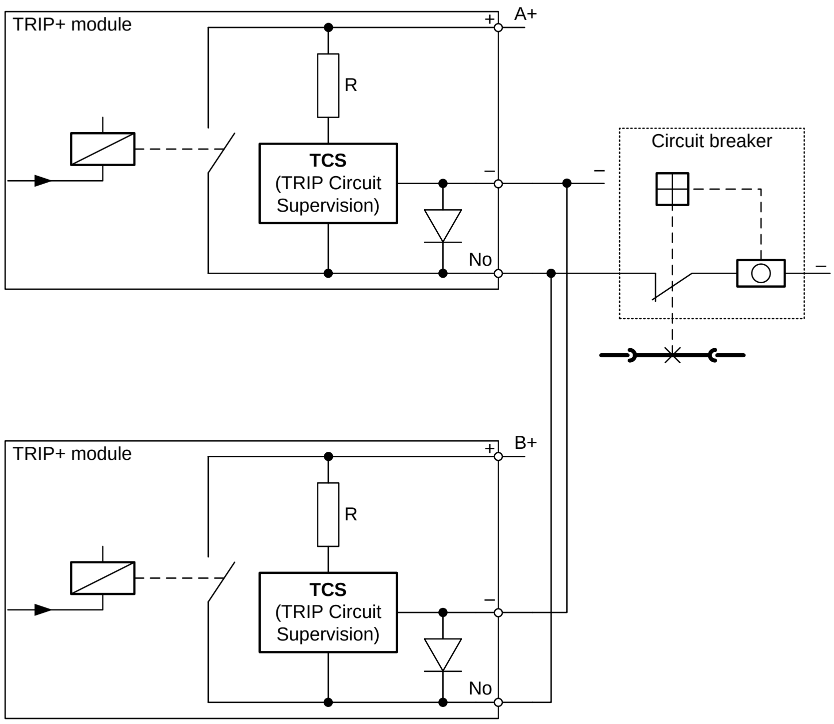


Figure 3-6 3-wire TRIP+ wiring using parallel connected TRIP+ modules

2-wire TRIP+ wiring methods

If it is necessary, you can also wire the TRIP+ modules using only the "+" and the "No" contacts.

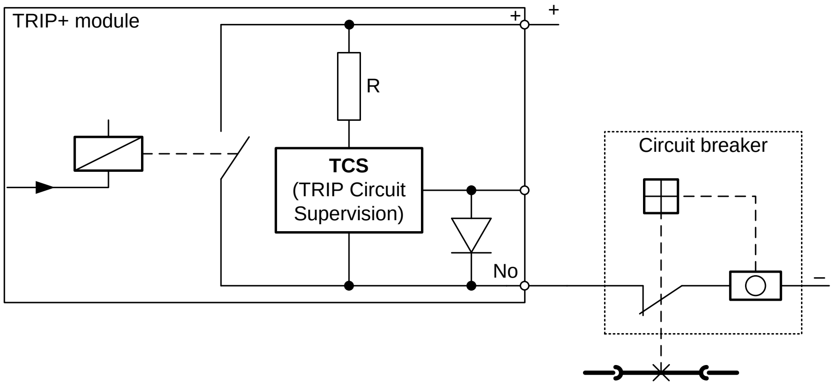


Figure 3-7 2-wire TRIP+ wiring

It is possible to use parallel connected TRIP+ modules.

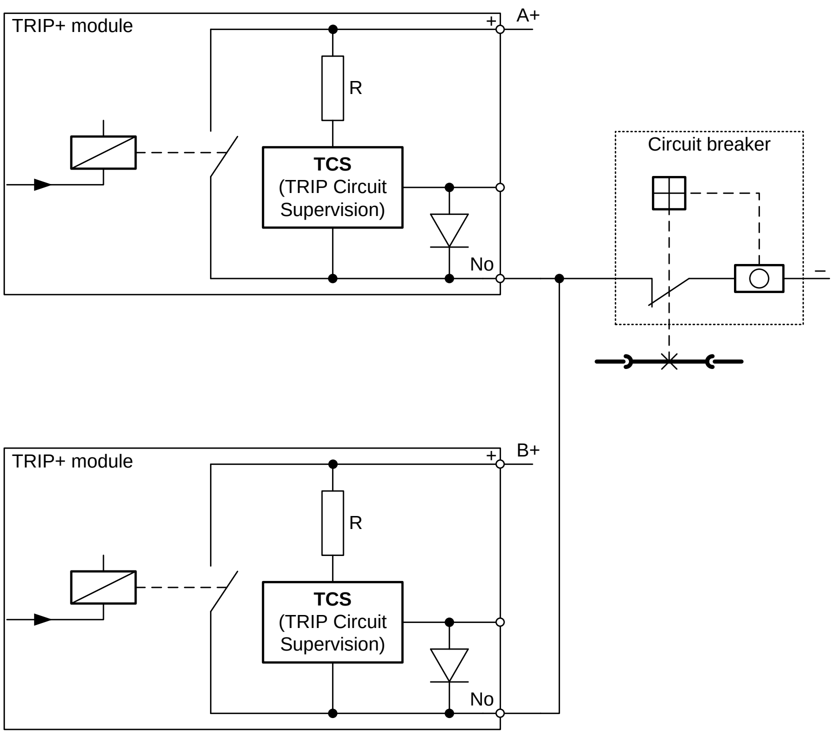


Figure 3-8 2-wire TRIP+ wiring using parallel connected TRIP+ modules

If the circuit breaker needs two-pole switching TRIP+ modules can be connected series as you can see in Figure 3-9.

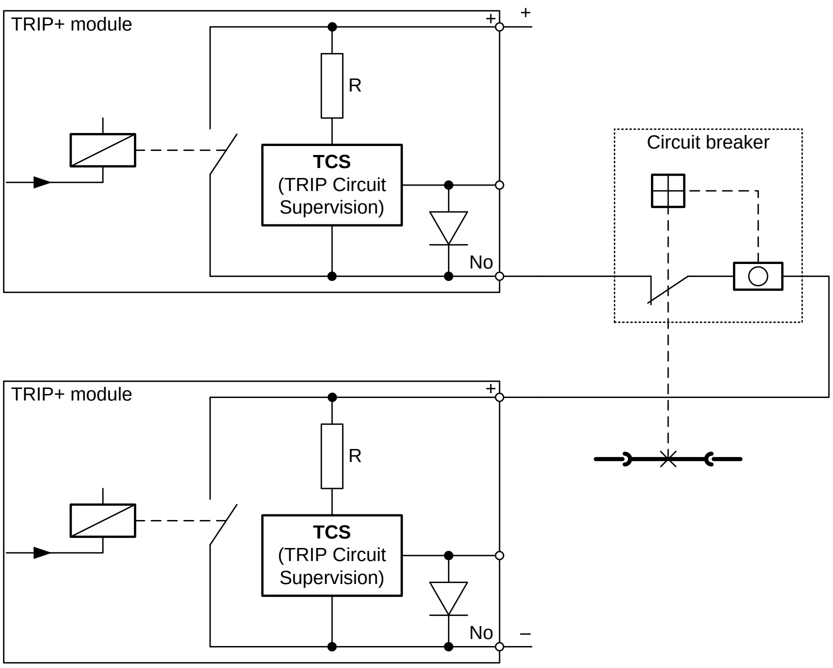


Figure 3-9 2-wire TRIP+ wiring using series connected TRIP+ modules

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

Figure 3-10 Technical data for the TRIP modules

Software application

Binary inputs

The **TCS input is active if the trip circuit is OK**, so the logical '0' or FALSE signal of the input means that either the trip circuit is broken (see Chapter 0 for the case when this is mandatory with the CB trip), or it connects to a high-resistance part.

The TCS signals are shown the same way as other binary inputs are in the device: they can be seen in the **on-line data** menu on the local HMI or the device web page, and they can be utilized just like any other binary input when editing the device configuration with EuroCAP software.

The names/titles of the inputs might be a bit different: it may be according to the corresponding TRIP outputs (if the TRIP module is in Slot **N**, the TCS contact is named BIn_**N**##), or if there is only one module with TRIP outputs, the TCS inputs might be named as TCS1, TCS2 etc. These can be checked (and the titles can be modified) in the devices' configuration file using the EuroCAP software.

The TCS macro

In several cases the trip circuit is tripped along with the circuit breaker as well. In situations like this the TCS input would signal a broken trip circuit (logical '0' or FALSE) unnecessarily. To avoid this, the status signals of the CB are to be used combined with the TCS input signal so that it will be evaluated only when the CB is closed.

The TCS macro incorporates this logic for two separate TCS inputs for one CB (see Figure 3-12 for the two TCS inputs and the CB status signal inputs). The outputs are the failure signals for each connected TCS input.

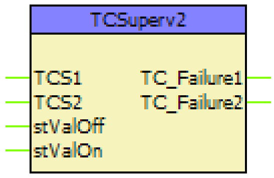


Figure 3-11 Graphic appearance of the Trip Circuit Supervision macro

The internal logic of the macro can be seen on Figure 3-12 below. Both outputs have a fixed pick delay of 1000 ms. Note that **here the outputs are active if the trip circuit is broken** (or there is a failure in it). For a CB with only 1 trip circuit it is enough to simply leave the **TCS2** input open.

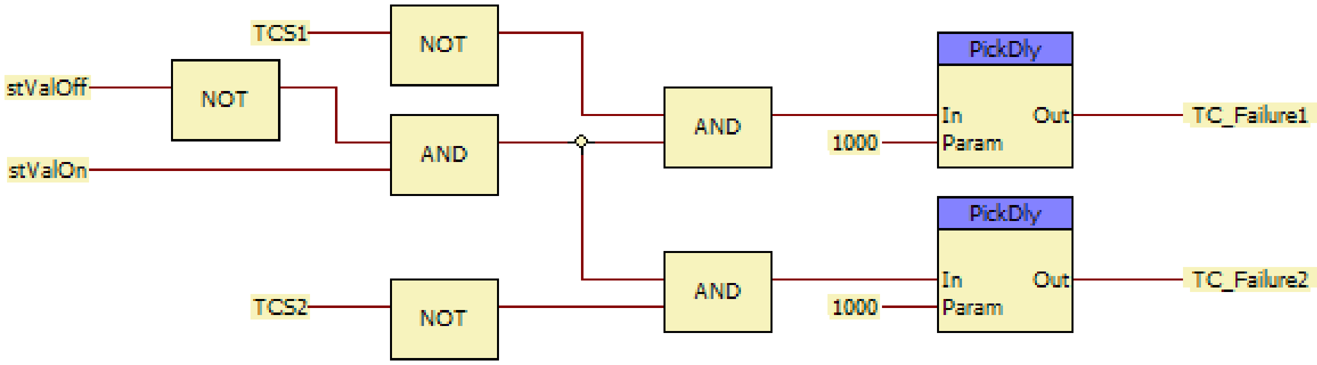


Figure 3-12 Internal logic of the Trip Circuit Supervision macro

Binary input signals

The following table explains the binary input signals of the macro.

BINARY INPUT SIGNAL	EXPLANATION
TCS1	Connect here the first TCS binary input
TCS2	Connect here the second TCS binary input
stValOff	CB Off/Open signal
stValOn	CB On/Closed signal

Table 3-40 Binary input signals of the Trip Circuit Supervision macro

Binary output signals

The following table explains the binary output signals of the macro.

BINARY OUTPUT SIGNAL	EXPLANATION
TC_Failure1	Failure on the first circuit
TC_Failure2	Failure on the second circuit

Table 3-41 Binary output signals of the Trip Circuit Supervision macro

Note that these are the outputs of a macro, and not a function block, so they must be connected to a physical or a logical output (ConnOut, create status) to make them usable in other parts of the configuration. For further information please refer to the EuroCAP software description.

3.3 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 3-42 Measured analog values

3.3.1 Current input function (CT4)

If the factory configuration includes a current transformer hardware module, the current input function block is automatically configured among the software function blocks. Separate current input function blocks are assigned to each current transformer hardware module.

A current transformer hardware module is equipped with four special intermediate current transformers. (See Chapter 5 of the EuroProt+ hardware description document.) As usual, the first three current inputs receive the three phase currents (IL1, IL2, IL3), the fourth input is reserved for zero sequence current, for the zero sequence current of the parallel line or for any additional current. Accordingly, the first three inputs have common parameters while the fourth current input needs individual setting.

The role of the current input function block is to

- set the required parameters associated to the current inputs,
- deliver the sampled current values for disturbance recording,
- perform the basic calculations
  - Fourier basic harmonic magnitude and angle,
  - True RMS value;
- provide the pre-calculated current values to the subsequent software modules,
- deliver the basic calculated values for on-line displaying.

Operation of the current input algorithm

The current input function block receives the sampled current values from the internal operating system. The scaling (even hardware scaling) depends on parameter setting. See parameters CT4_Ch13Nom_EPar_ (Rated Secondary I1-3) and CT4_Ch4Nom_EPar_ (Rated Secondary I4). The options to choose from are 1A or 5A (in special applications, 0.2A or 1A). This parameter influences the internal number format and, naturally, accuracy. (A small current is processed with finer resolution if 1A is selected.)

If needed, the phase currents can be inverted by setting the parameter CT4_Ch13Dir_EPar_ (Starpoint I1-3). This selection applies to each of the channels IL1, IL2 and IL3. The fourth current channel can be inverted by setting the parameter CT4_Ch4Dir_EPar (Direction I4). This inversion may be needed in protection functions such as distance protection, differential protection or for any functions with directional decision.

These sampled values are available for further processing and for disturbance recording.

The performed basic calculation results the Fourier basic harmonic magnitude and angle and the true RMS value. These results are processed by subsequent protection function blocks and they are available for on-line displaying as well.

The function block also provides parameters for setting the primary rated currents of the main current transformer. This function block does not need that parameter setting. These values are passed on to function blocks such as displaying primary measured values, primary power calculation, etc.

Technical data

Function	Range	Accuracy
Current accuracy	20 – 2000% of In	±1% of In

Table 3-43 Technical data of the current input

Parameters

Enumerated parameters

Parameter name	Title	Selection range	Default
Rated secondary current of the first three input channels. 1A or 5A is selected by parameter setting, no hardware modification is needed.			
CT4_Ch13Nom_EPar_	Rated Secondary I1-3	1A,5A	1A
Rated secondary current of the fourth input channel. 1A or 5A is selected by parameter setting, no hardware modification is needed.			
CT4_Ch4Nom_EPar_	Rated Secondary I4	1A,5A (0.2A or 1A)	1A
Definition of the positive direction of the first three currents, given by location of the secondary star connection point			
CT4_Ch13Dir_EPar_	Starpoint I1-3	Line,Bus	Line
Definition of the positive direction of the fourth current, given as normal or inverted			
CT4_Ch4Dir_EPar_	Direction I4	Normal,Inverted	Normal

Table 3-44 The enumerated parameters of the current input function

Floating point parameters

Parameter name	Title	Dim.	Min	Max	Default
Rated primary current of channel1					
CT4_PriI1_FPar_	Rated Primary I1	A	100	4000	1000
Rated primary current of channel2					
CT4_PriI2_FPar	Rated Primary I2	A	100	4000	1000
Rated primary current of channel3					
CT4_PriI3_FPar_	Rated Primary I3	A	100	4000	1000
Rated primary current of channel4					
CT4_PriI4_FPar_	Rated Primary I4	A	100	4000	1000

Table 3-45 The floating point parameters of the current input function

NOTE: The rated primary current of the channels is not needed for the current input function block itself. These values are passed on to the subsequent function blocks.

The **measured values** of the current input function block.

Measured value	Dim.	Explanation
Current Ch - I1	A(secondary)	Fourier basic component of the current in channel IL1
Angle Ch - I1	degree	Vector position of the current in channel IL1
Current Ch – I2	A(secondary)	Fourier basic component of the current in channel IL2
Angle Ch – I2	degree	Vector position of the current in channel IL2
Current Ch – I3	A(secondary)	Fourier basic component of the current in channel IL3
Angle Ch – I3	degree	Vector position of the current in channel IL3
Current Ch – I4	A(secondary)	Fourier basic component of the current in channel I4
Angle Ch – I4	degree	Vector position of the current in channel I4

Table 3-46 The measured analogue values of the current input function

NOTE1: The scaling of the Fourier basic component is such that if pure sinusoid 1A RMS of the rated frequency is injected, the displayed value is 1A. (The displayed value does not depend on the parameter setting values “Rated Secondary”.)

NOTE2: The reference of the vector position depends on the device configuration. If a voltage input module is included, then the reference vector (vector with angle 0 degree) is the vector calculated for the first voltage input channel of the first applied voltage input module. If no voltage input module is configured, then the reference vector (vector with angle 0 degree) is the vector calculated for the first current input channel of the first applied current input module.

Figure 3-13 shows an example of how the calculated Fourier components are displayed in the on-line block. (See the document “EuroProt+ Remote user interface description”.)

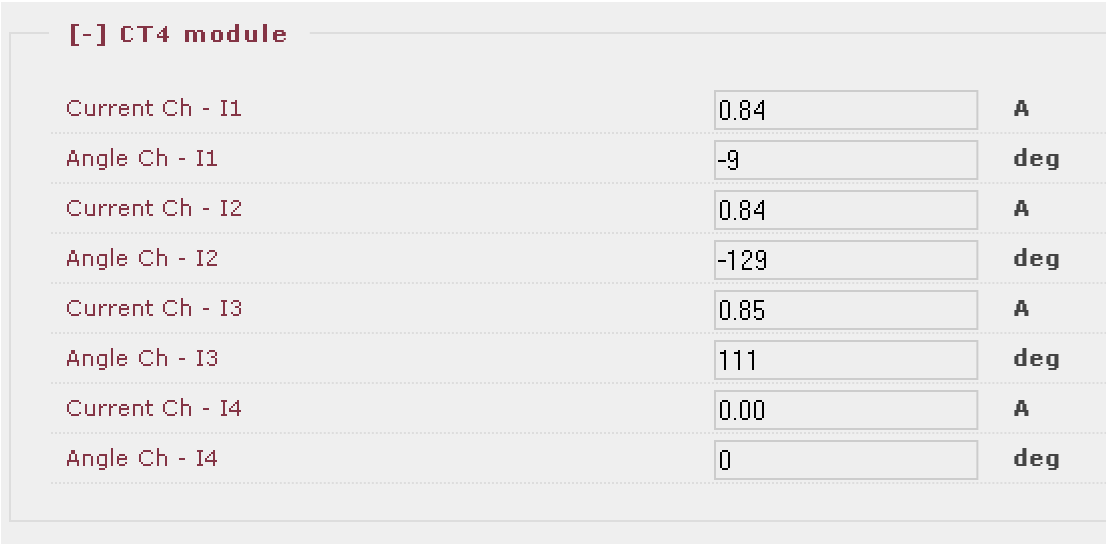


Figure 3-13 Example: On-line displayed values for the current input module

3.3.2 Voltage input function (VT4)

If the factory configuration includes a voltage transformer hardware module, the voltage input function block is automatically configured among the software function blocks. Separate voltage input function blocks are assigned to each voltage transformer hardware module.

A voltage transformer hardware module is equipped with four special intermediate voltage transformers. (See Chapter 6 of the EuroProt+ hardware description document.) As usual, the first three voltage inputs receive the three phase voltages (UL1, UL2, UL3), the fourth input is reserved for zero sequence voltage or for a voltage from the other side of the circuit breaker for synchron switching. All inputs have a common parameter for type selection: 100V or 200V.

Additionally, there is a correction factor available if the rated secondary voltage of the main voltage transformer (e.g. 110V) does not match the rated input of the device.

The role of the voltage input function block is to

- set the required parameters associated to the voltage inputs,
- deliver the sampled voltage values for disturbance recording,
- perform the basic calculations
  - Fourier basic harmonic magnitude and angle,
  - True RMS value;
- provide the pre-calculated voltage values to the subsequent software modules,
- deliver the basic calculated values for on-line displaying.

Operation of the voltage input algorithm

The voltage input function block receives the sampled voltage values from the internal operating system. The scaling (even hardware scaling) depends on parameter setting. See the parameter VT4_Type_EPar_ (Range). The options to choose from are 100V or 200V. This parameter influences the internal number format and, naturally, accuracy. (A small voltage is processed with finer resolution if 100V is selected.)

The connection of the first three VT secondary winding must be set to reflect actual physical connection. The associated parameter is VT4_Ch13Nom_EPar_ (Connection U1-3). The selection can be: Ph-N, Ph-Ph or Ph-N-Isolated.

The Ph-N option is applied in solidly grounded networks, where the measured phase voltage is never above 1.5-Un. In this case the primary rated voltage of the VT must be the value of the rated PHASE-TO-NEUTRAL voltage.

The Ph-N option is applied in compensated or isolated networks, where the measured phase voltage can be above 1.5-Un even in normal operation. In this case the primary rated voltage of the VT must be the value of the rated PHASE-TO-PHASE voltage.

If phase-to-phase voltage is connected to the VT input of the device, then the Ph-Ph option is to be selected. Here, the primary rated voltage of the VT must be the value of the rated PHASE-TO-PHASE voltage. This option must not be selected if the distance protection function is supplied from the VT input.

The fourth input is reserved for zero sequence voltage or for a voltage from the other side of the circuit breaker for synchron switching. Accordingly, the connected voltage must be identified with parameter setting VT4_Ch4Nom_EPar_ (Connection U4). Here, phase-to-neutral or phase-to-phase voltage can be selected: Ph-N,Ph-Ph

If needed, the phase voltages can be inverted by setting the parameter VT4_Ch13Dir_EPar_ (Direction U1-3). This selection applies to each of the channels UL1, UL2 and UL3. The fourth voltage channel can be inverted by setting the parameter VT4_Ch4Dir_EPar_ (Direction U4). This inversion may be needed in protection functions such as distance protection, differential protection or for any functions with directional decision, or for checking the voltage vector positions.

Additionally, there is a correction factor available if the rated secondary voltage of the main voltage transformer (e.g. 110V) does not match the rated input of the device. The related parameter is VT4_CorrFact_IPar_ (VT correction). As an example: if the rated secondary voltage of the main voltage transformer is 110V, then select Type 100 for the parameter "Range" and the required value to set here is 110%.

These sampled values are available for further processing and for disturbance recording.

The performed basic calculation results the Fourier basic harmonic magnitude and angle and the true RMS value of the voltages. These results are processed by subsequent protection function blocks and they are available for on-line displaying as well.

The function block also provides parameters for setting the primary rated voltages of the main voltage transformer. This function block does not need that parameter setting. These values are passed on to function blocks such as displaying primary measured values, primary power calculation, etc. Concerning the rated voltage, see the instructions related to the parameter for the connection of the first three VT secondary winding.

Parameters

Enumerated parameters

Parameter name	Title	Selection range	Default
Rated secondary voltage of the input channels. 100 V or 200V is selected by parameter setting, no hardware modification is needed.			
VT4_Type_EPar_	Range	Type 100,Type 200	Type 100
Connection of the first three voltage inputs (main VT secondary)			
VT4_Ch13Nom_EPar_	Connection U1-3	Ph-N, Ph-Ph, Ph-N-Isolated	Ph-N
Selection of the fourth channel input: phase-to-neutral or phase-to-phase voltage			
VT4_Ch4Nom_EPar_	Connection U4	Ph-N,Ph-Ph	Ph-Ph
Definition of the positive direction of the first three input channels, given as normal or inverted			
VT4_Ch13Dir_EPar_	Direction U1-3	Normal,Inverted	Normal
Definition of the positive direction of the fourth voltage, given as normal or inverted			
VT4_Ch4Dir_EPar_	Direction U4	Normal,Inverted	Normal

Table 3-47 The enumerated parameters of the voltage input function

Integer parameter

Parameter name	Title	Unit	Min	Max	Step	Default
Voltage correction						
VT4_CorrFact_IPar_	VT correction	%	100	115	1	100

Table 3-48 The integer parameter of the voltage input function

Floating point parameters

Parameter name	Title	Dim.	Min	Max	Default
Rated primary voltage of channel1					
VT4_PriU1_FPar	Rated Primary U1	kV	1	1000	100
Rated primary voltage of channel2					
VT4_PriU2_FPar	Rated Primary U2	kV	1	1000	100
Rated primary voltage of channel3					
VT4_PriU3_FPar	Rated Primary U3	kV	1	1000	100
Rated primary voltage of channel4					
VT4_PriU4_FPar	Rated Primary U4	kV	1	1000	100

Table 3-49 The floating point parameters of the voltage input function

NOTE: The rated primary voltage of the channels is not needed for the voltage input function block itself. These values are passed on to the subsequent function blocks.

Function	Range	Accuracy
Voltage accuracy	30% … 130%	< 0.5 %

Table 3-50 Technical data of the voltage input

Measured values

Measured value	Dim.	Explanation
Voltage Ch - U1	V(secondary)	Fourier basic component of the voltage in channel UL1
Angle Ch - U1	degree	Vector position of the voltage in channel UL1
Voltage Ch – U2	V(secondary)	Fourier basic component of the voltage in channel UL2
Angle Ch – U2	degree	Vector position of the voltage in channel UL2
Voltage Ch – U3	V(secondary)	Fourier basic component of the voltage in channel UL3
Angle Ch – U3	degree	Vector position of the voltage in channel UL3
Voltage Ch – U4	V(secondary)	Fourier basic component of the voltage in channel U4
Angle Ch – U4	degree	Vector position of the voltage in channel U4

Table 3-51 The measured analogue values of the voltage input function

NOTE1: The scaling of the Fourier basic component is such if pure sinusoid 57V RMS of the rated frequency is injected, the displayed value is 57V. (The displayed value does not depend on the parameter setting values “Rated Secondary”.)

NOTE2: The reference vector (vector with angle 0 degree) is the vector calculated for the first voltage input channel of the first applied voltage input module.

The figure below shows an example of how the calculated Fourier components are displayed in the on-line block. (See the document EuroProt+ “Remote user interface description”.)

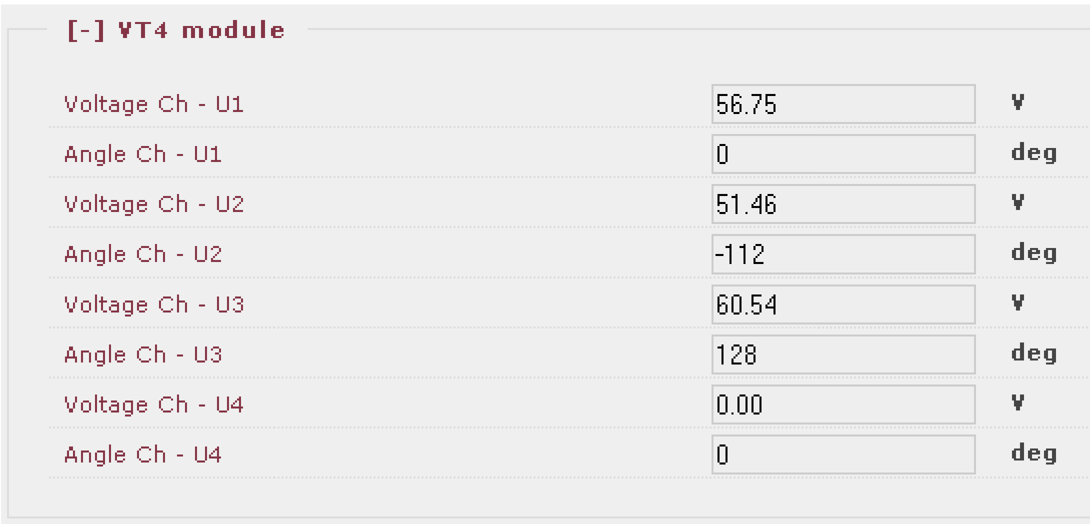


Figure 3-14 Example: On-line displayed values for the voltage input module

3.4 Disturbance recorder

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.

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.

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.

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.

Parameters

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 3-52 The enumerated parameter 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 3-53 The timer parameters of the disturbance recorder functions

NOTE: The device goes automatically in “Warning” state and sends a warning message (see below) 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.”

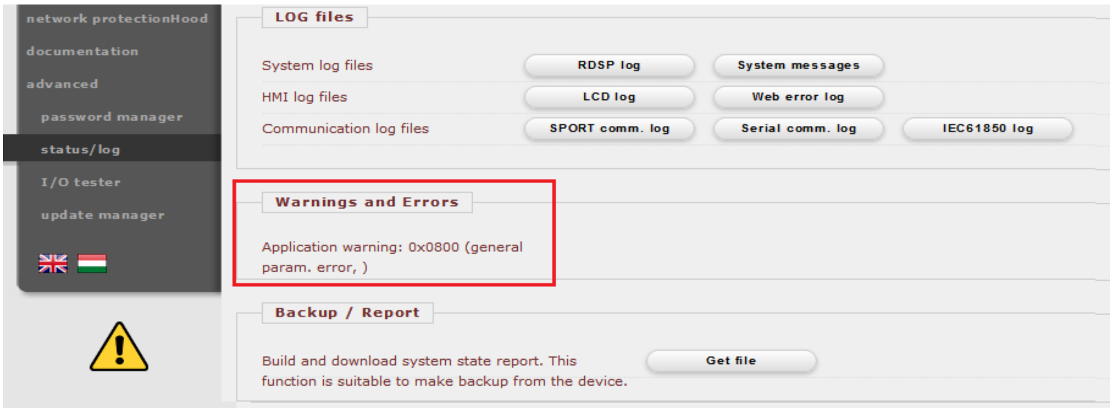


Figure 3-15 Checking the warning message on the status/log page

Binary output status signals

Binary status signal	Explanation
DRE_Start_GrO_	Output status of a graphic equation defined by the user to start the disturbance recorder function.

Table 3-54 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.

The function blocks

The two function blocks of the disturbance recorder function is shown below. 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.

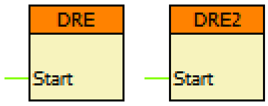


Figure 3-16 Graphic representations of the disturbance recorder functions

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.

3.5 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.