# E2-TRIM configuration description (Type: DAUT)

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User's manual version information

| Version | Date | Modification | Compiled by |
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| Version 1.0 | 2014-04-04 | | Z. Seida |
| Version 1.1 | 2014-04-07 | Chapter 1.1.3 – basic HW configuration has been changed | Z. Seida |
| Version 1.2 | 2015-03-05 | Figure 1-5, Table 22, 23 (– Disturbance recorder), table 26 (- LED assignment), external connection diagrams have been corrected, some other minor corrections. | Z. Seida |
| Version 1.3 | 2022-10-14 | **Added**: Information about the optional PoW Switching function. | B. Kubovics, Z. Seida |
| Version 2.0 | 2023-01-10 | The title changed from TRIM3 to E2-TRIM through the whole document according to the latest name of the configuration type. Minor changes. | Z. Seida |
| | | | |

CONTENTS

# 1 Configuration description

The E2-TRIM automation device is a member of the ***EuroProt+*** product line, made by Protecta Co. Ltd. The ***EuroProt+*** type complex protection and automation devices in respect of hardware and software are modular. The modules are assembled and configured according to the requirements, and then the software determines the functions. This manual describes the specific application of the E2-TRIM factory configuration.

## 1.1 Application

The members of the DAUT product line are configured for different type of automation purposes of the electric power system, like supply change-over, voltage measuring point change-over, transformer inrush minimizer automations, etc.

### 1.1.1 Control functions

The main function of the E2-TRIM configuration is the TRIM function (**TR**ansformer **I**nrush current **M**inimizer, three phase version), which is designed to prevent the high peaks of the transformer inrush current, using controlled energizing switching. In that way it is applicable for increasing the lifespan of the transformer. As an option, the Point-of-Wave Switching function can be also added to the configuration, which realizes similar controlled switching operation but for shunt reactors, capacitor banks, power lines and cables. Moreover, the Point-on-Wave function is applicable also for controlled de-energizing commands to decrease the quickly increasing transient recovery voltage causing overvoltages and restriking.

The TRIM function needs the three phase voltages of both sides of the circuit breaker which is on the supply side of the transformer. The voltage transformer on the transformer side of the circuit breaker can be connected on the primary, on the secondary or even on the tertiary side of the transformer.

The Point-on-Wave Switching function works only with one voltage signal, which is measured on the bus side of the circuit breaker, and it can be either a phase-to-ground or a phase-to-phase voltage.

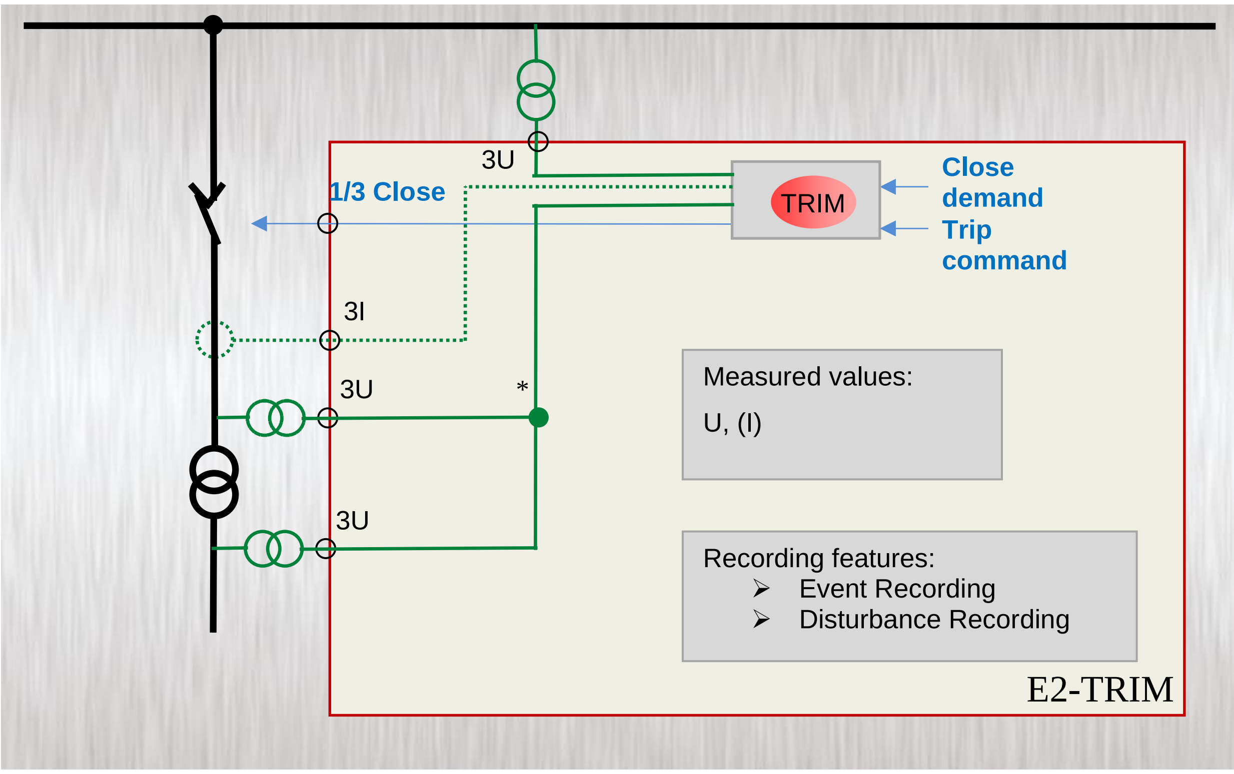
The current measurement is an option only for the TRIM function, it can give information about the efficiency of the controlled switching. However, it is obligatory for the Point-on-Wave function, as it is needed there for the correct operation, as well.

Both functions can give phase-selective close commands to get more efficiency in inrush current minimization, and the Point-on-Wave Switching function can give also phase-selective open commands. For controlled energizing of transformers, if single-pole circuit breaker with phase-selective close command opportunity is available, it is recommended to order the device with 4 fast trip contacts, in other cases 2 trip contacts are needed. For the Point-on-Wave function with single-pole circuit breaker with phase-selective open command opportunity 8 fast trip contacts are recommended.

| **Control functions** | **E2-TRIM** |
|---|---|
| Transformer inrush current minimizer function (Trim) | X |
| Point-on-Wave Switching function (PoWSw) | Op.. |

*Table 1 The control functions of the E2-TRIM configuration*

The TRIM function is drawn symbolically in the Figure below.




**The primary voltage transformer on the transformer side of the circuit breaker can be connected on the primary, on the secondary or on the tertiary side of the transformer. The current measurement is an option only.*

*Figure 1 Implemented control function*

## 1.1.2 Hardware configuration

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

| Hardware configuration | E2-TRIM |
|---|---|
| Mounting | Op. |
| Panel instrument case | X |
| Current inputs | *4 |
| Voltage inputs | 8 |
| Digital inputs | 12 |
| Digital outputs | 8 |
| Fast trip outputs | **2 |

**The current measurement is an option only.*

***In case of single-pole circuit breaker 4 or 8 fast trip outputs are recommended, depending on the applied control function: 4 for Trim and 8 for PowSw*

*Table 2 The basic hardware configuration of the E2-TRIM configuration*

The basic module arrangements of the E2-TRIM configuration are shown below. (Related to 42TE rack size.)

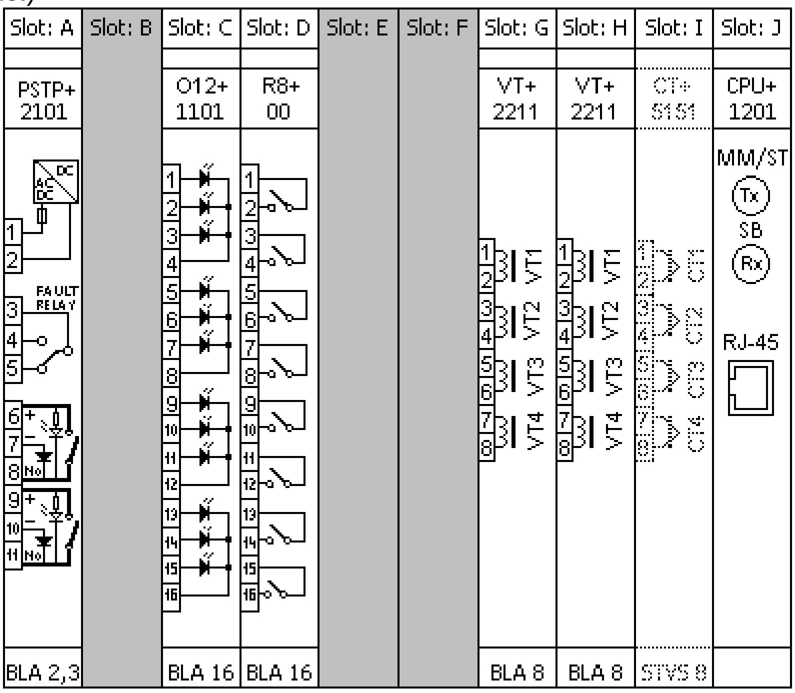



*Figure 2 Basic module arrangement of the E2-TRIM configuration for common-drive circuit breakers (42HP, rear view)*

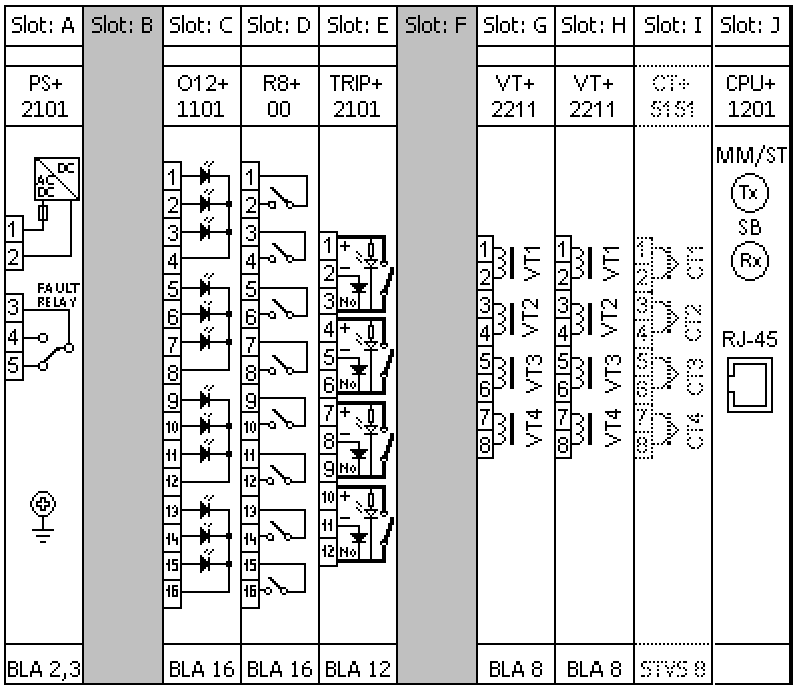



*Figure 3 Basic module arrangement of the E2-TRIM configuration for single-pole circuit breakers with phase selective close command opportunity, only for energizing (42HP, rear view)*

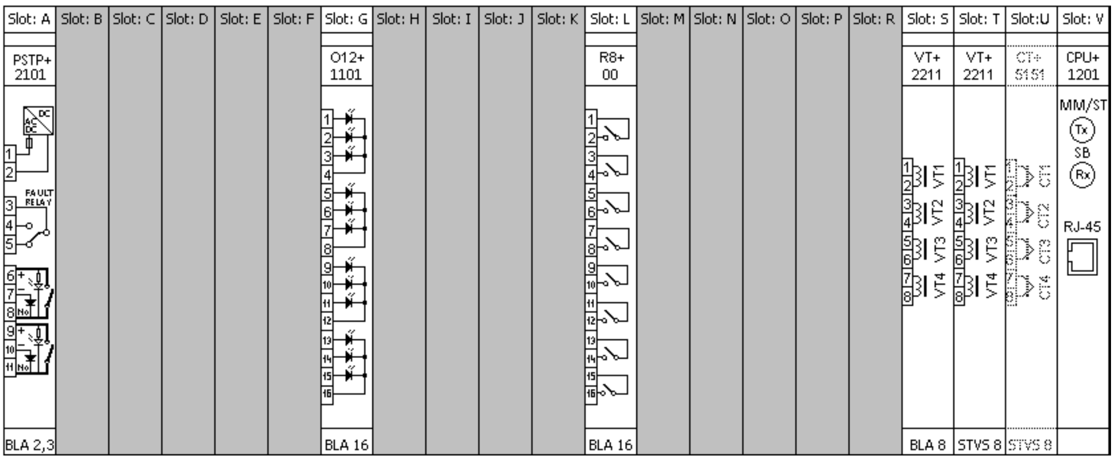



*Figure 4 Basic module arrangement of the E2-TRIM configuration for common-drive circuit breakers (84HP, rear view)*

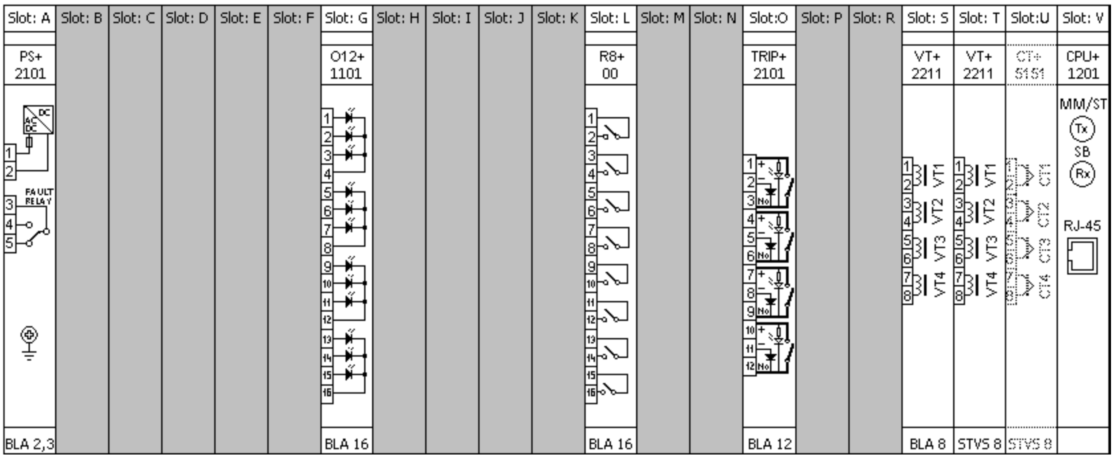



*Figure 5 Basic module arrangement of the E2-TRIM configuration for single-pole circuit breakers with phase selective close command opportunity,* only for energizing *(84HP, rear view)*

### 1.1.3 The applied hardware modules

The technical specification of the device and that of the modules are described in the document "***Hardware description***".

| Module identifier | Explanation |
|---|---|
| PS+ 2101 OR<br>PSTP+ 2101 | Power supply unit OR<br>Power supply unit with two trip contacts |
| O12+ 1101 | Binary input module |
| R8+ 00 | Signal relay output module |
| TRIP+ 2101* | Trip relay output module |
| VT+ 2211 | Analog voltage input module |
| CT + 5151* | Analog current input module |
| CPU+ 1201 | Processing and communication module |

**optionally modules*

*Table 3 The applied modules of the E2-TRIM configuration*

## 1.2 Meeting the device

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

*Figure 6 The 84HP rack of* ***EuroProt+*** *family*


*Figure 7 The 42HP rack of* ***EuroProt+*** *family*

## 1.3 Software configuration

### 1.3.1 Control functions

The implemented control functions are listed in Table 4. The function blocks are described in details in separate documents. These are referred to also in this table.

| Name | Title | Document |
|---|---|---|
| Trim | Trim | ***TRIM Inrush current minimizer function*** |
| CB1Pol | Circuit breaker | ***Circuit breaker control function block description*** |

*Table 4 Implemented control functions*

#### 1.3.1.1 Transformer inrush current minimizer (TRIM)

The inrush current of the transformers is the consequence of the transient saturation of the magnetic core, caused by the energizing voltage. The induced flux starts from the residual flux values of the iron core limbs, and according to the phase angle of the applied phase voltages, it can exceed the saturation flux value. The residual flux values are the result of the former disconnection process.

The saturated iron core needs high and distorted magnetizing current, the peak values of which can be several times higher than the rated current peaks. These high current values in the fault current range can overstress the mechanical fixing of the coils and the heating effect can decrease the life span of the transformer, resulting internal faults.

The TRIM (**TR**ansformer **I**nrush current **M**inimizer) function can prevent these high current peaks of the inrush current, using controlled switching.

The details of the principle of operation are described in the PROTECTA document "EuroProt+, Numerical transformer inrush current minimizer, Principle of the operation"

The TRIM function minimizes the inrush current of any kinds of three-phase (or single phase) transformers, applying controlled switching. The close command is synchronized to the momentary values of the supply side voltage. The appropriate moment of closing the circuit breaker is determined using the voltage values, sampled during the preceding disconnection process. Based on these values the residual flux values of the individual transformer iron cores are calculated and these values determine the optimal closing moment.

The application of the function is explained with Figure below.

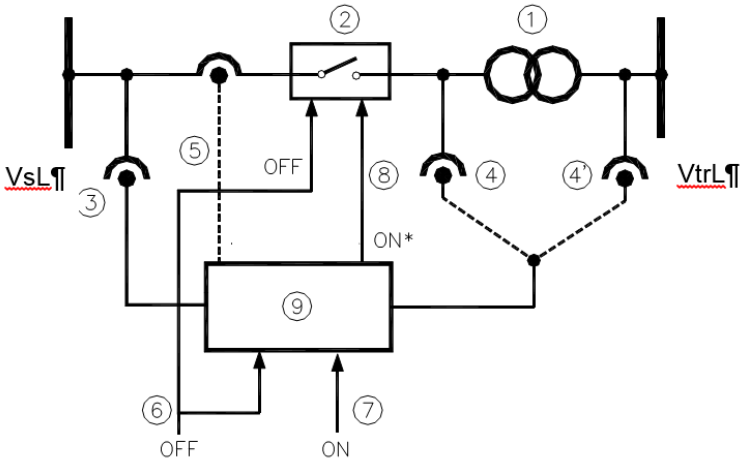



*Figure 8 Application of the TRIM function*

The device performing the TRIM function (9) minimizes the inrush current of (single or three-phase) transformer (1) by synchronized energizing command to the circuit breaker (2). The moment of closing the contacts of the circuit breaker is synchronized to the positive zero crossing of the signal from the voltage transformer (3) on the supply side of the circuit breaker. To determine the appropriate moment of closing the contacts of the circuit breaker, the values of the “residual flux” in the iron cores of the transformer are needed. The residual flux can be determined with the integration of the voltage signal from the voltage transformer (4), which can be on the primary or secondary (or tertiary) side of the transformer. This voltage transformer must measure the decaying voltage after the OFF command (6) disconnects the transformer. When the measured voltage on the transformer decays to zero, the calculated residual flux values are stored in the memory of the device.

The optimal moment of closing the circuit breaker is (or the optimal moments in case of individual drives for the three phases are) calculated with the aim that after energizing, the flux-time function could continue as a steady state function. In this case the flux cannot reach the saturation value, and no inrush current can arise.

If input (7) of the device receives the intent to energize the transformer, then the output (8) delivers the synchronized common or individual ON* command to the phases of the circuit breaker.

To measure the current signals from the current transformer (5) is an option only, it is not necessary for the operation of the algorithm, but during the commissioning the displayed peak current is a useful information to check the correct operation of the device.

The device calculates the moment of the close command generation with milliseconds accuracy, and the close command for the circuit breaker is started considering the closing time of the circuit breaker too, in order to control the closing to the calculated moment. If the deviation of the subsequent closing times of the circuit breaker is too high, then the efficiency of the controller is low. In order to optimize the effect, it is required that the deviation of the closing time should be within the range of ±2 ms.

The device can control three-phase circuit breakers with individual drives for all three phases. In this case the efficiency is high, practically no switching transient is generated; the steady state can be started without considerable transients. In this case no inrush current can be detected.

If the phases are operated with a common drive, and the individual phases are mechanically delayed to each other, the inrush current is suppressed below the peak value of the transformer rated current. The mechanical time delay should be defined in milliseconds (e.g.: 5-0-5 ms, 0-6.66-3.33 ms or 0-0-0 ms).

The energizing of transformers with different connection groups needs different closing strategies. Based on the dedicated parameter “Vector group” the algorithm automatically selects the optimal closing moment for the circuit breaker poles.

The primary voltage measurement signed as VsL is supposed to be on the supply side of the circuit breaker. This is the prospective voltage, after closing the circuit breaker this voltage energizes the transformer. The positive zero crossing of phase VsL1 voltage is the time reference to delay the closing moments of the circuit breaker phases.

The transformer side voltage (VtrL) is measured by a voltage transformer which is continuously connected to the transformer even in de-energized state. The location of the voltage transformer can be either between the circuit breaker and the transformer or on the secondary side of the transformer. Depending on the connection group of the transformer, the algorithm calculates the coil voltages.

The algorithm does not apply the measured current for control purposes. They are only needed for disturbance recording to check the efficiency of the controlled switching.

In some applications the rated voltages of the transformer do not match exactly the rated voltage of the VT-s. For these cases the matching factors to be set as parameter values serve the purpose of more accurate operation.

The transformer inrush current minimizer function has binary input status signals. The conditions are defined by the user applying the graphic equation editor.

The operation of the algorithm needs the information if the circuit breaker gets a trip command. Of course, the circuit breaker gets this command directly too, the device does not delay the trip command.

The device receives the intent to energize the transformer, and if the parameter for operation is set to “On” then it passes the close command to the circuit breaker applying the calculated time delay. In inactive state (“Bypass”) the command is passed over without calculated time delay. If the operation mode of the function is “Off” then the command is not transmitted to the circuit breaker at all.

The operation can be blocked if the “Block” status is active. During this time no close command is passed to the circuit breaker.

Unsuccessful command is signed by the function block after close demand has arrived to the device, in the following cases:

- All of the three line voltages on the supply side of the controlled circuit breaker are below the set „U limit”.
- Any of the voltages on the transformer side of the controlled circuit breaker are above the set „U limit”.
- With one second after the TRIM function has operated (close command is given) the voltages on the transformer side of the controlled circuit breaker are below the set “U limit”

Commissioning of the device is an easy procedure, supported by the on-line information.

The on-line blocks for the voltage inputs (VT4) display the magnitude and phase angle of the measured phase voltages. Check the correct phase sequence and phase assignment.

Check the correct parameter setting according to the application. At this stage the value of the parameter “CB TravTime” is not defined, leave it for the first energizing as the default value.

Among the on-line information of the TRIM function the “winding voltages” can be found. In energized state of the transformer the supply side and the transformer side voltages are expected to be in good coincidence. If not then set the “PrimSideCorr” and/or “SecSideCorr” multiplication factors to result approximately equal calculated voltage values.

The first energizing of the transformer via the TRIM function is uncontrolled, but the program measures the circuit breaker operating time (“CB TravTime”). This operating time is an input parameter as well, which must be set correctly, according to the measured and displayed value. (Remark: additionally to the CB pole travel time this measured time includes the internal time delay of the algorithm as well.)

During the next OFF switching, the device determines the residual flux values, and the subsequent ON commands are synchronized, so no high inrush current peak values are expected.

The integrated event recorder function stores the measured circuit breaker operating time for several events, if it is needed then the average of the stored information can be a basis for a subsequent parameter correction.

The event recorder stores the measured current peak values for evaluation. The value is in %, related to the rated peak value of the CT.

The integrated disturbance recorder function supports the detailed analysis of the transformer energizing and disconnecting phenomena.

**Technical data**

| Function | Effective range | Accuracy |
|---|---|---|
| Measurement | | |
| Current effective range | 20 – 2000% of In | ±1% of In |
| Voltage effective range | 2-110 % of Un | ±1% of Un |
| Effectiveness of control | | |
| Single pole control | by ± 2ms CB time inaccuracy | Ipeak < 0.5x In_peak |
| Three-phase control | by ± 2ms CB time inaccuracy | Ipeak < In_peak |

**Parameters**

**Enumerated parameters**

| Parameter name | Title | Selection range | Default |
|---|---|---|---|
| Selection of the operating mode | | | |
| Trim_Oper_EPar_ | Operation | Off, On, ByPass | Off |
| Selection of the transformer vector group (seen from the switched side) | | | |
| Trim_VGroup_EPar_ | Vector group | Yd1,Yd5,Yd7,Yd11,Yy0,Yy6, Dy1,Dy5,Dy7,Dy11,Dd0,Dd6 | Yd11 |
| Circuit breaker lag type* | | | |
| Trim_LagType_EPar_ | Lag type | SinglePole, Lag-0-0-0, Lag-3-0-3, Lag-5-0-5 | SinglePole |
| Location of the transformer side voltage measurement | | | |
| Trim_SecSide_EPar_ | Utr Side | Primary, Secondary * | Primary |

** the transformer is expected to be energized from the primary side*

**Integer parameter**

| Parameter name | Title | Unit | Min | Max | Step | Default |
|---|---|---|---|---|---|---|
| Voltage, below this level the transformer is considered to be switched off | | | | | | |
| Trim_ULimit_IPar_ | U limit | % | 5 | 30 | 1 | 10 |
| Correction factor for the supply side voltage measurement Untr_pr/UnVT | | | | | | |
| Trim_PrimCorr_IPar_ | PrimSideCorr | % | 85 | 115 | 1 | 100 |
| Correction factor for the transformer side voltage measurement Untr_sec/UnVT | | | | | | |
| Trim_SecCorr_IPar_ | SecSideCorr | % | 85 | 115 | 1 | 100 |

**Timer parameters**

| Parameter name | Title | Unit | Min | Max | Step | Default |
|---|---|---|---|---|---|---|
| Traveling time of the circuit breaker when closing as it is displayed by the function | | | | | | |
| Trim_TravTime_TPar_ | CB TravTime | msec | 30 | 500 | 1 | 80 |

### 1.3.1.2 Point-on-Wave Switching function block (PoWSw)

The Point-on-Wave function gets one phase voltage of the busbar as analogue input for reference voltage, the other two are assumed to be shifted with ±120°. The phase of the connected voltage should be set as a parameter ("Connected Ref. Voltage") – it can be a phase-to-phase voltage as well. All closing and opening decisions are based on that, adjusted to its zero crossings. The function uses the phase currents of the object to be switched for two purposes: for detection of the energized or de-energized state, and for displaying the resulting inrush current.

The proper switching strategy depends on the following factors:

- What kind of object should be switched: capacitor/line/cable or reactor
- How is the system grounded: solidly earthed or isolated
- What type of drive the circuit breaker has: single pole or common

## Point-on-Wave Switching of capacitors, power lines and cables

### Energization

The voltage of a capacitor cannot change instantaneously. This means that if the voltage switched on the discharged capacitor differs largely from 0, it leads to transient balancing processes like overvoltages and inrush currents. Therefore, the best moment for energizing a grounded capacitor is the voltage zero crossing. If the poles of the circuit breaker can be driven individually (single-pole type), it can be done for each phase. However, if the drive is common for all phases (three-pole type), then the switching will be optimal only for one phase, and the transients, although in a limited manner, will still occur in the other two phases, this is inevitable. The type of the circuit breaker drive can be set by the parameter “CB drive type”.
As all these statements can be applied also for power lines and cables, the Point-on-Wave Switching function can be used for switching of loaded and unloaded power lines and cables when “Capacitor/Line/Cable” is selected for the Object Type parameter. Its overall effectiveness depends on the amount of charge remaining on the power line/cable to be switched on. It is ideal in cases when the line has been switched off for more than 20 seconds, but it can reduce overvoltages in all other cases as well when compared with random switching.
If the capacitor bank or power line or cable is isolated from the ground, then different strategy shall be applied for the energizing, see details in chapter **Error! Reference source not found.**.
If the capacitor/ power line / cable is charged, then the moment of the zero voltage does not ensure the transient free continuity of the voltage of the object to be switched. That’s why the closing is prohibited by the function until the timer set by the parameter “Discharging time” expires after the circuit breaker is switched off. The circuit breaker is handled as open if all phase currents decrease below the value set by “Current limit”, and the open status signals got active in all phases, as well. Until the closing command is prohibited due to the discharging process, the PoW_**Discharging**_Grl_ output gets active, which can be used for any purposes in the graphical Logic editor of EuroCAP.

### De-energization

Breaking currents different from 0 results in quickly increasing transient recovery voltage causing overvoltages and restriking. This can be prevented by choosing the zero current crossing for the moment of de-energizing. It happens when the voltage is at maximum point. Similarly to the energization process, the effectiveness of the control process depends also on the circuit breaker drive type.

## Point-on-Wave Switching of reactors

### Energization

The current of a reactor cannot change instantaneously. It means that if the voltage is switched on it near to the zero crossing, to which a near to maximum current belongs in a coil, high overvoltages and inrush currents can occur. Therefore, the best moment for energizing a grounded reactor is the voltage maximum point. If the poles of the circuit breaker can be driven individually (single-pole type), it can be done for each phase. However, if the drive is common for all phases (three-pole type), then the switching will be optimal only for one phase, and the transients, although in a limited manner, will still occur in the other two phases, this is inevitable. The type of the circuit breaker drive can be set by the parameter “CB drive type”.
If the reactor is isolated from the ground, then different strategy shall be applied for the energizing, see details in chapter **Error! Reference source not found.**.

### De-energization

For de-energization the same aspects should be considered as for capacitors, resulting in the same strategy, see above!

## Effect of the grounding

The considerations about finding the optimal moment for energizing of a capacitor/line/cable or reactor written in chapters **Error! Reference source not found.**. and **Error! Reference source not found.** are valid for solidly grounded systems. However, if it is isolated, the strategy must be different. In that case, the current cannot flow via the ground, but only via the capacitors/lines/cables or reactors of the different phases. So, the criteria defined for phase-to-ground voltages must be applied for the phase-to-phase voltages in isolated systems.
E.g., in case of capacitors, the energizing of the first two phases should not happen at the zero crossing of the phase-to-ground voltages, but at that of the phase-to-phase voltages between them, and only the 3rd phase should be switched on its own zero crossing.
The other difference is the consequence of the previous statement: the first two phases should be energized at the same time and not separately, even if the circuit breaker has single pole drive.
Because of the different switching strategy, the system grounding must be set for the function by the parameter “Object grounding”.

## Calculating with the operation times of the circuit breaker

In the previous chapters the optimal moments of energizing and de-energizing were defined. To reach these moments by the circuit breaker, its operating times should be brought into the calculation.

In case of energizing, the make time of the CB shall be considered, which is the time between the issuing of the close command to the circuit breaker and the beginning of the arcing (current flow start). The difference between the make time and the total closing time is the pre-arcing time. In the function the following parameters can be set:

- CB Closing time (L1)
- Closing L2 time adjustment and Closing L3 time adjustment: the differences of the closing times in phases L2 and L3 against phase L1. If these are set to 0, all three phases are considered to have the same closing time, which is set for L1.
- CB Pre-arcing time

The function calculates from these parameters the make time in each phase as:

$$Make\ time = Closing\ time - Pre\text{–}arcing\ time$$

The Make time is also measured by the function in each energizing process for each phase and displayed among its online measurements. So, if no data is available for the closing and pre-arcing times of the circuit breaker, then these measured values can be set for the closing time parameters, and 0 for the pre-arcing time parameter.
In case of de-energizing, the brake time of the CB shall be considered, which is the time between the issuing of the open command to the circuit breaker and the arc extinguishing (current flow end). The difference between the brake time and the opening time is the arcing time.

In the function the following parameters can be set:

- CB Opening time (L1)
- Opening L2 time adjustment and Opening L3 time adjustment: the differences of the opening times in phases L2 and L3 against phase L1. If these are set to 0, all three phases are considered to have the same opening time, which is set for L1.
- CB Arcing time

The function calculates from these parameters the brake time in each phase as:

$$Brake\ time = Opening\ time + Arcing\ time$$

The Brake time is also measured by the function in each de-energizing process for each phase and it is displayed among its online measurements. So if no data is available for the opening and arcing time of the circuit breaker, then these measured values can be set for the opening time parameters, and 0 for the arcing time parameter.

## Parameters

| Title | Dim. | Range | Step | Default | Explanation |
|---|---|---|---|---|---|
| Operation | - | Off,<br>On,<br>Bypass | - | Off | General operation of the function. Bypass means that the function forwards the received commands to its outputs without delay. |
| Object Type | - | Capacitor/Line/<br>Cable,<br>Reactor | - | Capacitor | The object to be switched |
| Object Grounding | - | Solidly earthed,<br>Isolated, | - | Solidly earthed | Grounding of the object to be switched |
| CB Drive Type | - | Single poles,<br>Common drive | - | Single poles | The drive type of the circuit breaker |
| Connected Ref. Voltage | - | L1-N,<br>L2-N,<br>L3-N,<br>L1-L2,<br>L2-L3,<br>L3-L1, | - | L1-N | The phase(s) of the primary VT which is connected to the first channel of the VT in the IED. |
| CB Closing Time (L1) | msec | 30 – 500 | 1 | 80 | The time between the issuing of the close command to the circuit breaker and the closing of the mechanical contact in phase L1 |
| CB Pre-arcing Time | msec | 0 – 20 | 1 | 0 | The time interval in which the arc is active in the circuit breaker |
| Closing L2 Time Adjustment | msec | -5 – 5 | 1 | 0 | The difference of the closing time of phase L2 against phase L1 |
| Closing L3 Time Adjustment | msec | -5 – 5 | 1 | 0 | The difference of the closing time of phase L3 against phase L1 |
| CB Opening Time (L1) | msec | 30 – 500 | 1 | 80 | The time between the issuing of the open command to the circuit breaker and the mechanical separation in phase L1 |
| CB Arcing Time | msec | 0 – 20 | 1 | 0 | The time interval in which the arc is active in the circuit breaker during opening |
| Opening L2 Time adjustment | msec | -5 – 5 | 1 | 0 | The difference of the opening time of phase L2 against phase L1 |
| Opening L3 Time adjustment | msec | -5 – 5 | 1 | 0 | The difference of the opening time of phase L3 against phase L1 |
| Command Pulse | msec | 30 - 500 | 1 | 150 | Command pulse length for both of close and open commands |
| Voltage Limit | % | 25 – 100 | 1 | 70 | Limit regarding the busbar voltage, below which the controlled switch is not allowed. The percentage is referred to the rated secondary value of the VT4 module. |
| Current Limit | % | 1 – 5 | 1 | 2 | The object to be switched is considered to be de-energized if all measured phase currents are below this value. If the object is not energized, the close commands are prohibited.<br>The percentage value is referred to the rated secondary value of the CT4 module. |
| Discharging Time | sec | 1 – 300 | 1 | 10 | Discharging time of the capacitor. The prohibition of the close |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | commands to the capacitor is prolonged by this time after the currents are decreased below the value of the Current limit and the open statuses of the CB got active. Appears only if the Object Type parameter is set to Capacitor. |

*Table 5 Parameters of the Point-on-Wave Switching function*

## Analogue inputs

The function uses

- the sampled values of one phase-to-ground or one phase-to-phase voltage of the voltage transformer on the busbar, according to its parameter setting "Connected Ref. Voltage”,
- the sampled values of the three phase currents measured at the object side of the circuit breaker.

## Analogue outputs

| Measured value | Dimension | Explanation |
|---|---|---|
| Last Make Time L1 | ms | The make time in phase L1 during the last energizing process. |
| Last Make Time L2 | ms | The make time in phase L1 during the last energizing process. |
| Last Make Time L3 | ms | The make time in phase L2 during the last energizing process. |
| Last Brake Time L1 | ms | The brake time in phase L1 during the last de-energizing process. |
| Last Brake Time L2 | ms | The brake time in phase L2 during the last de-energizing process. |
| Last Brake Time L3 | ms | The brake time in phase L3 during the last de-energizing process. |
| Last Inrush L1 | % | The inrush current in phase L1 during the last energizing process. |
| Last Inrush L2 | % | The inrush current in phase L2 during the last energizing process. |
| Last Inrush L3 | % | The inrush current in phase L3 during the last energizing process. |

*Table 6 Analogue outputs of the Point-on-Wave Switching function*

## Binary input signals (graphed output statuses)

The conditions of the inputs are defined by the user, applying the graphic equation editor (logic editor). The part written in **bold** is seen on the function block in the logic editor.

| Binary status signal | Title | Explanation |
|---|---|---|
| PoW_**Blk**_GrO_ | Blk | Blocking of the function |
| PoW_**CloseReq**_GrO_ | CloseCmd | Close command request |
| PoW_**OpenedL1**_GrO_ | OpenedL1 | Phase L1 is in opened state |
| PoW_**OpenedL2**_GrO_ | OpenedL2 | Phase L2 is in opened state |
| PoW_**OpenedL3**_GrO_ | OpenedL3 | Phase L3 is in opened state |
| PoW_**OpenReq**_GrO_ | OpenCmd | Open command request |
| PoW_**ClosedL1**_GrO_ | ClosedL1 | Phase L1 is in closed state |
| PoW_**ClosedL2**_GrO_ | ClosedL2 | Phase L2 is in closed state |
| PoW_**ClosedL3**_GrO_ | ClosedL3 | Phase L3 is in closed state |

*Table 7 Binary inputs of the Point-on-Wave Switching function*

## Binary output signals (graphed input statuses)

The binary output status signals of the Point-on-Wave function. **Parts** written in **bold** are seen on the function block in the logic editor. The signals can be used for several purposes (e.g. for LED sources, disturbance recorder, etc.), but not these are meant for connection to the trip contacts! Trip Logic output objects of the functionblock serve this purpose, see the next paragraph!

| Binary status signal | Title | Explanation |
|---|---|---|
| PoW_CloseL1_Grl_ | Close L1 | Close command in phase L1 |
| PoW_CloseL2_Grl_ | Close L2 | Close command in phase L2 |
| PoW_CloseL3_Grl_ | Close L3 | Close command in phase L3 |
| PoW_**CloseUnsucc**_Grl_ | Closing unsuccessful | Closing unsuccessful – the current is analyzed for this decision |
| PoW_OpenL1_Grl_ | Open L1 | Open command in phase L1 |
| PoW_OpenL2_Grl_ | Open L2 | Open command in phase L2 |
| PoW_OpenL3_Grl_ | Open L3 | Open command in phase L3 |
| PoW_**OpenUnsucc**_Grl_ | Opening unsuccessful | Opening unsuccessful – the current is analyzed for this decision |
| PoW_**Discharging**_Grl_ | Discharging time is running | The close command is blocked due to the discharging process of the capacitor. |

*Table 8 Binary outputs of the Point-on-Wave Switching function*

## Trip Logic output objects

Although the Point-on-Wave functionblock is not a trip logic, it has Trip Logic output objects for having a fast, synchronized connection to the trip contacts. The factory assignment of these outputs to the trip contacts can be modified in the Trip definition \ Assignment menu of EuroCAP.

| Trip Logic output | Title | Explanation |
|---|---|---|
| PoW_CloseL1_TLO_ | Close L1 | Close command in phase L1 |
| PoW_CloseL2_TLO_ | Close L2 | Close command in phase L2 |
| PoW_CloseL3_TLO_ | Close L3 | Close command in phase L3 |
| PoW_OpenL1_TLO_ | Open L1 | Open command in phase L1 |
| PoW_OpenL2_TLO_ | Open L2 | Open command in phase L2 |
| PoW_OpenL3_TLO_ | Open L3 | Open command in phase L3 |

*Table 9 Trip logic output objects of the Point-on-Wave Switching function*

## On-line data

Visible values on the on-line data page:

| Signal title | Dimension | Explanation |
|---|---|---|
| Last Make Time L1 | ms | The make time in phase L1 during the last energizing process. |
| Last Make Time L2 | ms | The make time in phase L2 during the last energizing process. |
| Last Make Time L3 | ms | The make time in phase L3 during the last energizing process. |
| Last Brake Time L1 | ms | The brake time in phase L1 during the last de-energizing process. |
| Last Brake Time L2 | ms | The brake time in phase L2 during the last de-energizing process. |
| Last Brake Time L3 | ms | The brake time in phase L3 during the last de-energizing process. |

| | | |
|---|---|---|
| Last Inrush L1 | % | The inrush current in phase L1 during the last energizing process. |
| Last Inrush L2 | % | The inrush current in phase L2 during the last energizing process. |
| Last Inrush L3 | % | The inrush current in phase L3 during the last energizing process. |
| Close L1 | - | Close command in phase L1 |
| Close L2 | - | Close command in phase L2 |
| Close L3 | - | Close command in phase L3 |
| Closing unsuccessful | - | Closing unsuccessful – the current is analyzed for this decision |
| Open L1 | - | Open command in phase L1 |
| Open L2 | - | Open command in phase L2 |
| Open L3 | - | Open command in phase L3 |
| Opening unsuccessful | - | Opening unsuccessful – the current is analyzed for this decision |

*Table 10 Online data of the Point-on-Wave Switching function*

## Events

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

| **Event** | **Value** | **Explanation** | **IEC 61850 Logical Node / Data Object / Data Attribute** |
|---|---|---|---|
| General close command | off,on | Close command in any phases. This event is not recorded to the event list of the IED by default, but can be reported to the SCADA. | LCCPOW / OpCls / general |
| General open command | off,on | Open command in any phases. This event is not recorded to the event list of the IED by default, but can be reported to the SCADA. | LCCPOW / OpOpn / general |
| CB Close command in L1 | off,on | Close command in phase L1 | - |
| CB Close command in L2 | off,on | Close command in phase L2 | - |
| CB Close command in L3 | off,on | Close command in phase L3 | - |
| CB Open command in L1 | off,on | Open command in phase L1 | - |
| CB Open command in L2 | off,on | Open command in phase L2 | - |
| CB Open command in L3 | off,on | Open command in phase L3 | - |
| Last Inrush L1 | % | The value of the inrush current in phase L1 during the last energizing process. | - |
| Last Inrush L2 | % | The value of the inrush current in phase L2 during the last energizing process. | - |
| Last Inrush L3 | % | The value of the inrush current in phase L3 during the last energizing process. | - |
| Switching unsuccessful (timeout) | off,on | The state of the CB has not been changed 500ms after the command given – the current is analyzed for this decision. | LCCPOW / TmExc / stVal |

*Table 11 Events of the Point-on-Wave Switching function*

#### 1.3.1.3 Circuit breaker control function block (CB1Pol)

The Circuit breaker control function block can be used to integrate the circuit breaker control of the EuroProt+ device into the station control system and to apply active scheme screens of the local LCD of the device.

The Circuit breaker control function block receives remote commands from the SCADA system and local commands from the local LCD of the device, performs the prescribed checking and transmits the commands to the circuit breaker. It processes the status signals received from the circuit breaker and offers them to the status display of the local LCD and to the SCADA system.

Main features:

- Local (LCD of the device) and Remote (SCADA) operation modes can be enabled or disabled individually.
- The signals and commands of the synchro check / synchro switch function block can be integrated into the operation of the function block.
- Interlocking functions can be programmed by the user applying the inputs “EnaOff” (enabled trip command) and “EnaOn” (enabled close command), using the graphic equation editor.
- Programmed conditions can be used to temporarily disable the operation of the function block using the graphic equation editor.
- The function block supports the control models prescribed by the IEC 61850 standard.
- All necessary timing tasks are performed within the function block:
    - Time limitation to execute a command
    - Command pulse duration
    - Filtering the intermediate state of the circuit breaker
    - Checking the synchro check and synchro switch times
    - Controlling the individual steps of the manual commands
- Sending trip and close commands to the circuit breaker (to be combined with the trip commands of the protection functions and with the close command of the automatic reclosing function; the protection functions and the automatic reclosing function directly gives commands to the CB). The combination is made graphically using the graphic equation editor
- Operation counter
- Event reporting

The Circuit breaker control function block has binary input signals. The conditions are defined by the user applying the graphic equation editor. The signals of the circuit breaker control are seen in the binary input status list.

**Technical data**

| Function | Accuracy |
|---|---|
| Operate time accuracy | ±5% or ±15 ms, whichever is greater |

*Table 12 Technical data of the circuit breaker control function*

## Parameters

### Enumerated parameter

| Parameter name | Title | Selection range | Default |
|---|---|---|---|
| The control model of the circuit breaker node according to the IEC 61850 standard | | | |
| CB1Pol_ctlMod_EPar_ | ControlModel* | Direct normal, Direct enhanced, SBO enhanced | Direct normal |

**ControlModel*

- Direct normal: only command transmission
- Direct enhanced: command transmission with status check and command supervision
- SBO enhanced: Select Before Operate mode with status check and command supervision

*Table 13 Enumerated parameter of the circuit breaker control function*

### Boolean parameter

| Boolean parameter | Title | Explanation |
|---|---|---|
| CB1Pol_DisOverR_BPar_ | Forced check | If true, then the check function cannot be neglected by the check attribute defined by the IEC 61850 standard |

*Table 14 Boolean parameter of the circuit breaker control function*

### Timer parameters

| Parameter name | Title | Unit | Min | Max | Step | Default |
|---|---|---|---|---|---|---|
| Timeout for signaling failed operation | | | | | | |
| CB1Pol_TimOut_TPar_ | Max.Operating time | msec | 10 | 1000 | 1 | 200 |
| Duration of the generated On and Off impulse | | | | | | |
| CB1Pol_Pulse_TPar_, | Pulse length | msec | 50 | 500 | 1 | 100 |
| Waiting time, at expiry intermediate state of the CB is reported | | | | | | |
| CB1Pol_MidPos_TPar_ | Max.Intermediate time | msec | 20 | 30000 | 1 | 100 |
| Length of the time period to wait for the conditions of the synchron state. After expiry of this time, the synchro switch procedure is initiated (see synchro check/ synchro switch function block description) | | | | | | |
| CB1Pol_SynTimOut_TPar_ | Max.SynChk time | msec | 10 | 5000 | 1 | 1000 |
| Length of the time period to wait for the synchro switch impulse (see synchro check/ synchro switch function block description). After this time the function resets, no switching is performed | | | | | | |
| CB1Pol_SynSWTimOut_TPar_ | Max.SynSW time* | msec | 0 | 60000 | 1 | 0 |
| Duration of the waiting time between object selection and command selection. At timeout no command is performed | | | | | | |
| CB1Pol_SBOTimeout_TPar_ | SBO Timeout | msec | 1000 | 20000 | 1 | 5000 |

* If this parameter is set to 0, then the “StartSW” output is not activated

*Table 15 Timer parameters of the circuit breaker control function*

**Available internal status variable and command channel**

To generate an active scheme on the local LCD, there is an internal status variable indicating the state of the circuit breaker. Different graphic symbols can be assigned to the values.

| Status variable | Title | Explanation |
|---|---|---|
| CB1Pol_stVal_Ist_ | Status | Can be:<br>0: Intermediate<br>1: Off<br>2: On<br>3: Bad |

*Table 16 The internal status variable of the function indicating the state of the circuit breaker*

The available control channel to be selected is:

| Command channel | Title | Explanation |
|---|---|---|
| CB1Pol_Oper_Con_ | Operation | Can be:<br>On<br>Off |

*Table 17 The control channel of the circuit breaker control function*

Using this channel, the pushbuttons on the front panel of the device can be assigned to close or open the circuit breaker. These are the “Local commands”.

### 1.3.2 Measuring functions

The measured values can be checked on the touch-screen of the device in the “On-line functions” page, or using an internet browser of a connected computer. The displayed values are secondary voltages and currents, except the displayed values of the TRIM function block, which displays the measured last inrush current and the and the transformer winding voltages in %, using the “Rated secondary I1-3” parameter setting of the “CT4 module” function block and the “PrimSide Correction”, “SecSide Correction” parameter settings of TRIM function block.

| Analog value | Explanation |
|---|---|
| *VT4 module Supply* | |
| Voltage Ch Sply – U1 | RMS value of the Fourier fundamental harmonic voltage component in phase L1 (Supply side of the circuit breaker) |
| Angle Ch Sply – U1 | Phase angle of the Fourier fundamental harmonic voltage component in phase L1* (Supply side of the circuit breaker) |
| Voltage Ch Sply – U2 | RMS value of the Fourier fundamental harmonic voltage component in phase L2 (Supply side of the circuit breaker) |
| Angle Ch Sply – U2 | Phase angle of the Fourier fundamental harmonic voltage component in phase L2* (Supply side of the circuit breaker) |
| Voltage Ch Sply – U3 | RMS value of the Fourier fundamental harmonic voltage component in phase L3 (Supply side of the circuit breaker) |
| Angle Ch Sply – U3 | Phase angle of the Fourier fundamental harmonic voltage component in phase L3* (Supply side of the circuit breaker) |
| Voltage Ch Sply – U4 | RMS value of the Fourier fundamental harmonic voltage component in Channel U4 (Supply side of the circuit breaker) |
| Angle Ch Sply – U4 | Phase angle of the Fourier fundamental harmonic voltage component in Channel U4* (Supply side of the circuit breaker) |
| *VT4 module Demand* | |
| Voltage Ch Dmd – U1 | RMS value of the Fourier fundamental harmonic voltage component in phase L1 (Demand side of the circuit breaker) |
| Angle Ch Dmd – U1 | Phase angle of the Fourier fundamental harmonic voltage component in phase L1* (Demand side of the circuit breaker) |

| Analog value | Explanation |
|---|---|
| Voltage Ch Dmd – U2 | RMS value of the Fourier fundamental harmonic voltage component in phase L2(Demand side of the circuit breaker) |
| Angle Ch Dmd – U2 | Phase angle of the Fourier fundamental harmonic voltage component in phase L2* (Demand side of the circuit breaker) |
| Voltage Ch Dmd – U3 | RMS value of the Fourier fundamental harmonic voltage component in phase L3(Demand side of the circuit breaker) |
| Angle Ch Dmd – U3 | Phase angle of the Fourier fundamental harmonic voltage component in phase L3* (Demand side of the circuit breaker) |
| Voltage Ch Dmd – U4 | RMS value of the Fourier fundamental harmonic voltage component in Channel U4 (Demand side of the circuit breaker) |
| Angle Ch Dmd– U4 | Phase angle of the Fourier fundamental harmonic voltage component in Channel U4* (Demand side of the circuit breaker) |
| *CT4 module (optional)* | |
| 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* |
| *Trim* | |
| Last CBClose | CB travelling time measured during the last performed close command** |
| Last Inrush | Max current peak measured during the last performed close command*** |
| U Supply Winding A | Calculated voltage of the winding on limb A, based on the source side phase voltage |
| U Supply Winding B | Calculated voltage of the winding on limb B, based on the source side phase voltage |
| U Supply Winding C | Calculated voltage of the winding on limb C, based on the source side phase voltage |
| U Transformer Winding A | Calculated voltage of the winding on limb A, based on the transformer side phase voltage |
| U Transformer Winding B | Calculated voltage of the winding on limb B, based on the transformer side phase voltage |
| U Transformer Winding C | Calculated voltage of the winding on limb C, based on the transformer side phase voltage |

* *The reference angle is the phase angle of “Voltage Ch Sply - U1”*

** *The measured time includes also the contact operating time in the device and the transient time of the circuit breaker. In case of correct setting this value should coincide with the parameter setting “CB TravTime”.*

*** *The value is in %, related to the rated peak value of the CT.*

*Table 18 Measured analog values*

### 1.3.2.1 Current input function (CT4) - optional

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.

The fourth current channel is not used in the E2-TRIM configuration.

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 19 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<br>(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 20 The enumerated parameters of the current input function*

**Floating point parameters**

| Parameter name | Title | Dim. | Min | Max | Default |
|---|---|---|---|---|---|
| Rated primary current of channel 1-3 | | | | | |
| CT4_PriI13_FPar_ | Rated Primary I1-3 | A | 100 | 4000 | 1000 |
| Rated primary current of channel 4 | | | | | |
| CT4_PriI4_FPar_ | Rated Primary I4 | A | 100 | 4000 | 1000 |

*Table 21 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.

### 1.3.2.2 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. The fourth voltage channel is not used in the E2-TRIM configuration.

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 22 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 23 The integer parameter of the voltage input function*

**Floating point parameters**

| Parameter name | Title | Dim. | Min | Max | Default |
|---|---|---|---|---|---|
| Rated primary voltage of channel1 | | | | | |
| VT4_PriU13_FPar | Rated Primary U1-3 | kV | 1 | 1000 | 100 |
| Rated primary voltage of channel4 | | | | | |
| VT4_PriU4_FPar | Rated Primary U4 | kV | 1 | 1000 | 100 |

*Table 24 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.

## Technical data

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

*Table 25 Technical data of the voltage input*

### 1.3.3 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.

| **Event** | **Explanation** |
|---|---|
| *Common* | |
| Mode of device | Operating mode of the device |
| Health of device | Health state of the device |
| *Circuit breaker (CB1Pol)* | |
| Status | State of the circuit breaker function |
| Enable Close | Close command is enabled |
| Enable Open | Open command is enabled |
| Local | Local mode of operation |
| Operation counter | Operation counter |
| CB OPCap | |
| *Trim* | |
| Timeout | With 1 sec after the CB Close command of the TRIM function the voltages on the transformer side of the circuit breaker are below the set “U limit”. |
| Last Inrush | Max current peak measured during the last performed close command* |
| CB Close | The TRIM function has operated. |

* *The value is in %, related to the rated peak value of the CT*

*Table 26 List of the possible events*

## 1.3.4 Disturbance recorder

The E2-TRIM configuration contains a disturbance recorder function. The details are described in the document shown in Table 27.

| Name | Title | Document |
|---|---|---|
| DRE | Disturbance Rec | ***Disturbance recorder function block description*** |

*Table 27 Implemented disturbance recorder function*

**The recorded analog channels:**

| Recorded analog signals | Explanation |
|---|---|
| UL1 Source | Measured voltage of phase L1 on the supply side of the circuit breaker |
| UL2 Source | Measured voltage of phase L2 on the supply side of the circuit breaker |
| UL3 Source | Measured voltage of phase L3 on the supply side of the circuit breaker |
| UL1 Demand | Measured voltage of phase L1 on the demand side of the circuit breaker |
| UL2 Demand | Measured voltage of phase L2 on the demand side of the circuit breaker |
| UL3 Demand | Measured voltage of phase L3 on the demand side of the circuit breaker |
| IL1 | Measured current in phase L1 |
| IL2 | Measured current in phase L2 |
| IL3 | Measured current in phase L3 |

*Table 28 Disturbance recorder, recorded analog channels*

**The recorded binary channels:**

| Recorded binary signal | Explanation |
|---|---|
| Close Demand | Close demand received by the TRIM function block |
| Close Cmd L1 | Close command given by the TRIM function block to the L1 phase of the CB. |
| Close Cmd L2* | Close command given by the TRIM function block to the L2 phase of the CB. |
| Close Cmd L3* | Close command given by the TRIM function block to the L3 phase of the CB. |
| Open Cmd L1** | Close command given by the TRIM function block to the L1 phase of the CB. |
| Open Cmd L2*,** | Close command given by the TRIM function block to the L2 phase of the CB. |
| Open Cmd L3*,** | Close command given by the TRIM function block to the L3 phase of the CB. |

** These binary channels are added in the factory made configuration only in version which handles single-pole CB*
*** These binary channels are activated only by the optional PoW Switching function*

*Table 29 Disturbance recorder, recorded binary channels*

**Enumerated parameter:**

| Parameter name | Title | Selection range | Default |
|---|---|---|---|
| Parameter for activation | | | |
| DRE_Oper_EPar_ | Operation | Off, On | Off |

*Table 30 The enumerated parameter of the disturbance recorder function*

**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_ | MaxFault | msec | 500 | 10000 | 1 | 1000 |

*Table 31 The timer parameters of the disturbance recorder function*

## 1.4 LED assignment

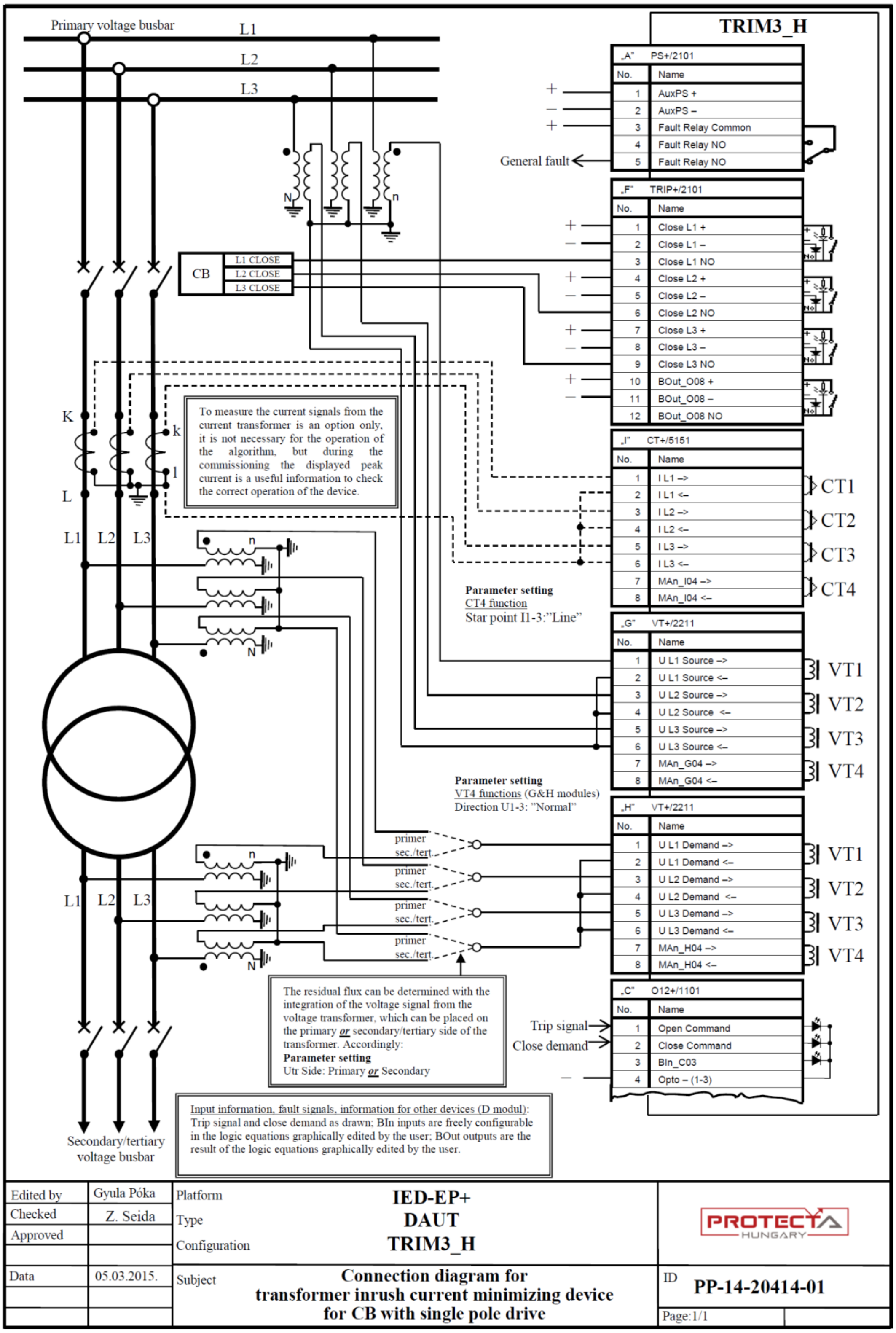
On the front panel of the device there are “User LED”-s with the “Changeable LED description label” (See the document “**Quick start guide to the devices of the EuroProt+ product line**”). Some LED-s are factory assigned, some are free to be defined by the user. The following tables shows the LED assignment of the E2-TRIM configuration.

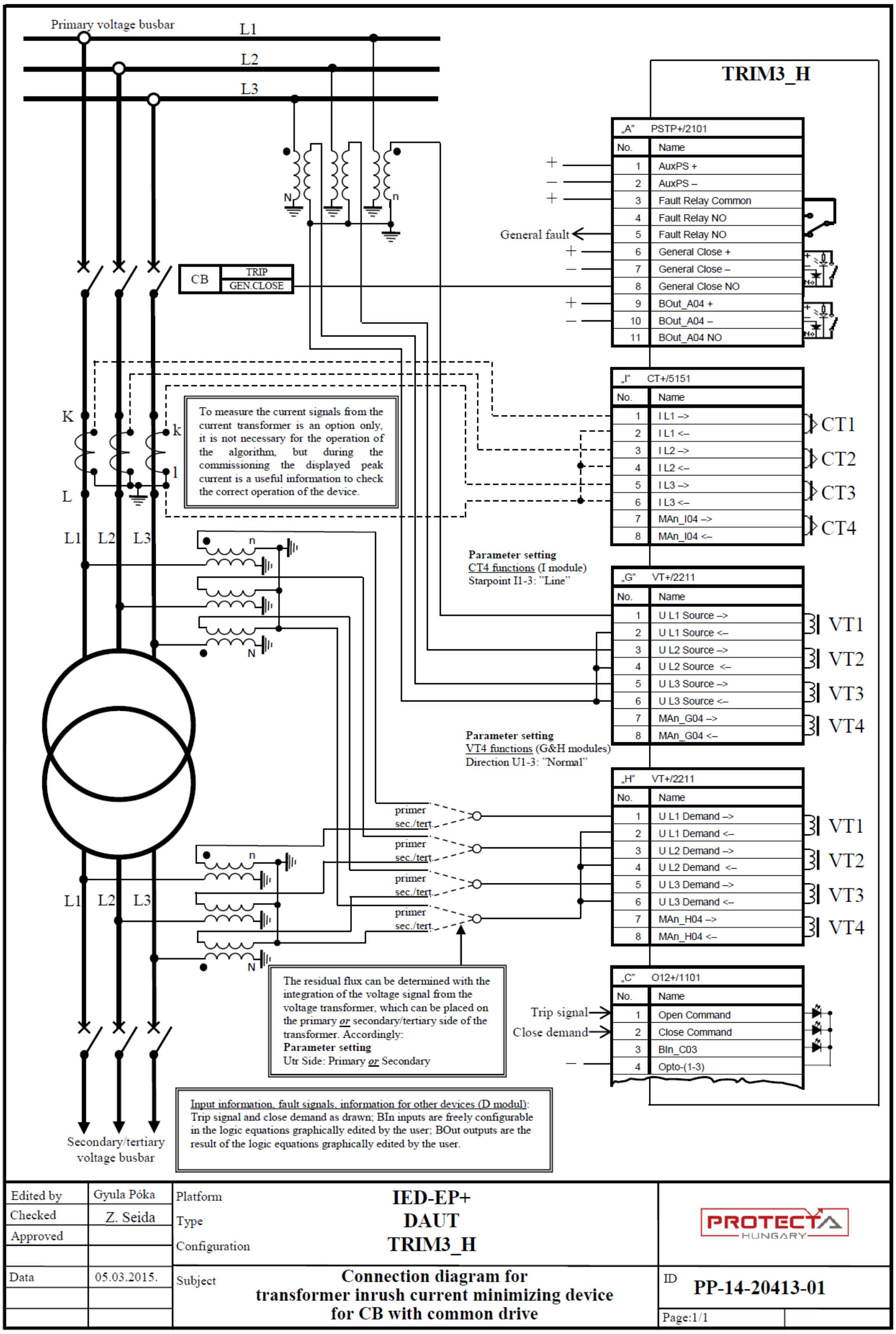
| LED | Explanation |
|---|---|
| LED1 | Free LED |
| LED2 | Free LED |
| LED3 | Free LED |
| LED4 | Free LED |
| LED5 | Free LED |
| LED6 | Free LED |
| LED7 | Free LED |
| Uns. Command | No command can be given or the given command was not executed by the circuit breaker. |
| LED9 | Free LED |
| LED10 | Free LED |
| LED11 | Free LED |
| LED12 | Free LED |
| LED13 | Free LED |
| LED14 | Free LED |
| LED15 | Free LED |
| LED16 | Free LED |

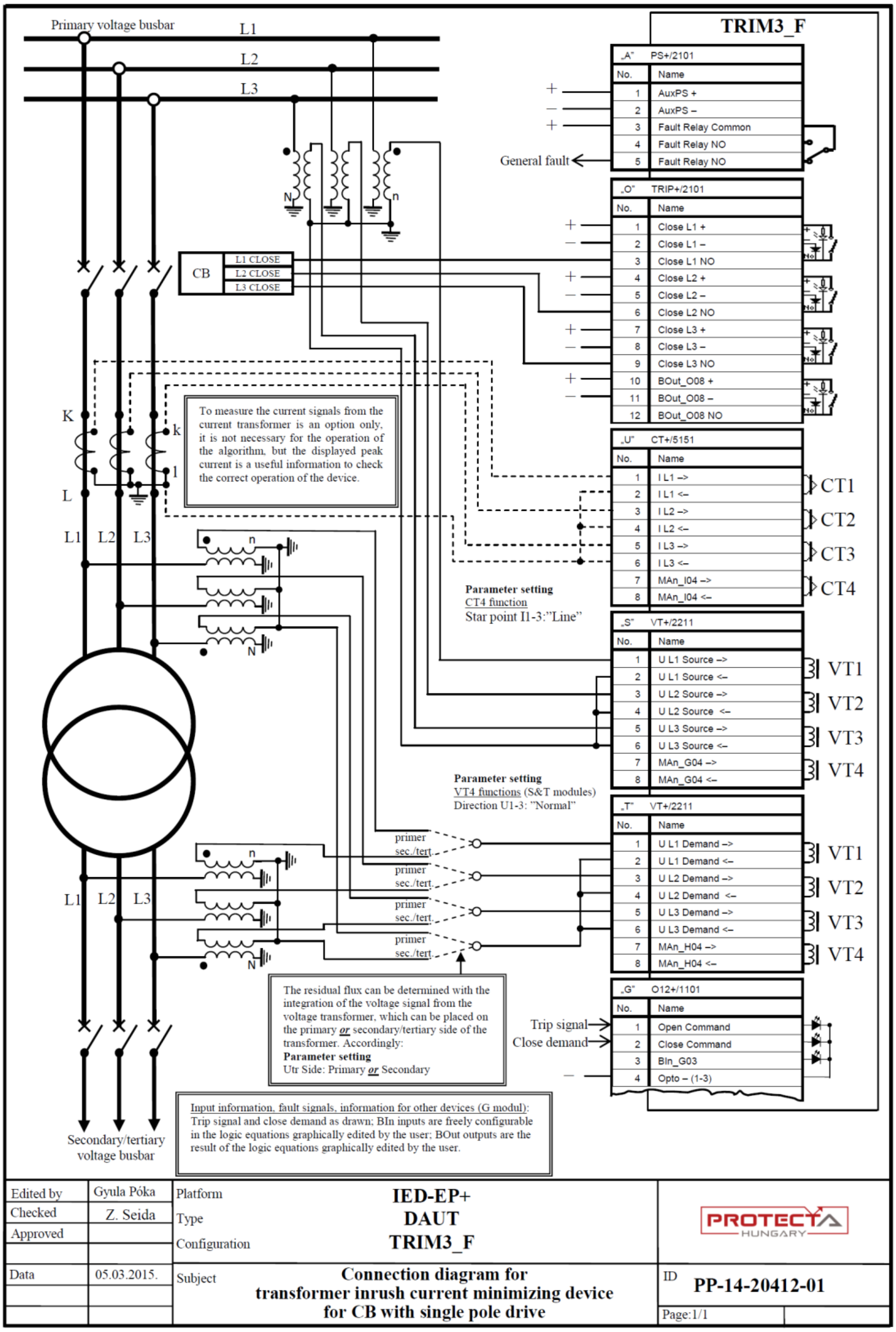
**In the factory made configuration for common-drive circuit breaker version only one LED is assigned for the general close command.*

*Table 32 The LED assignment*

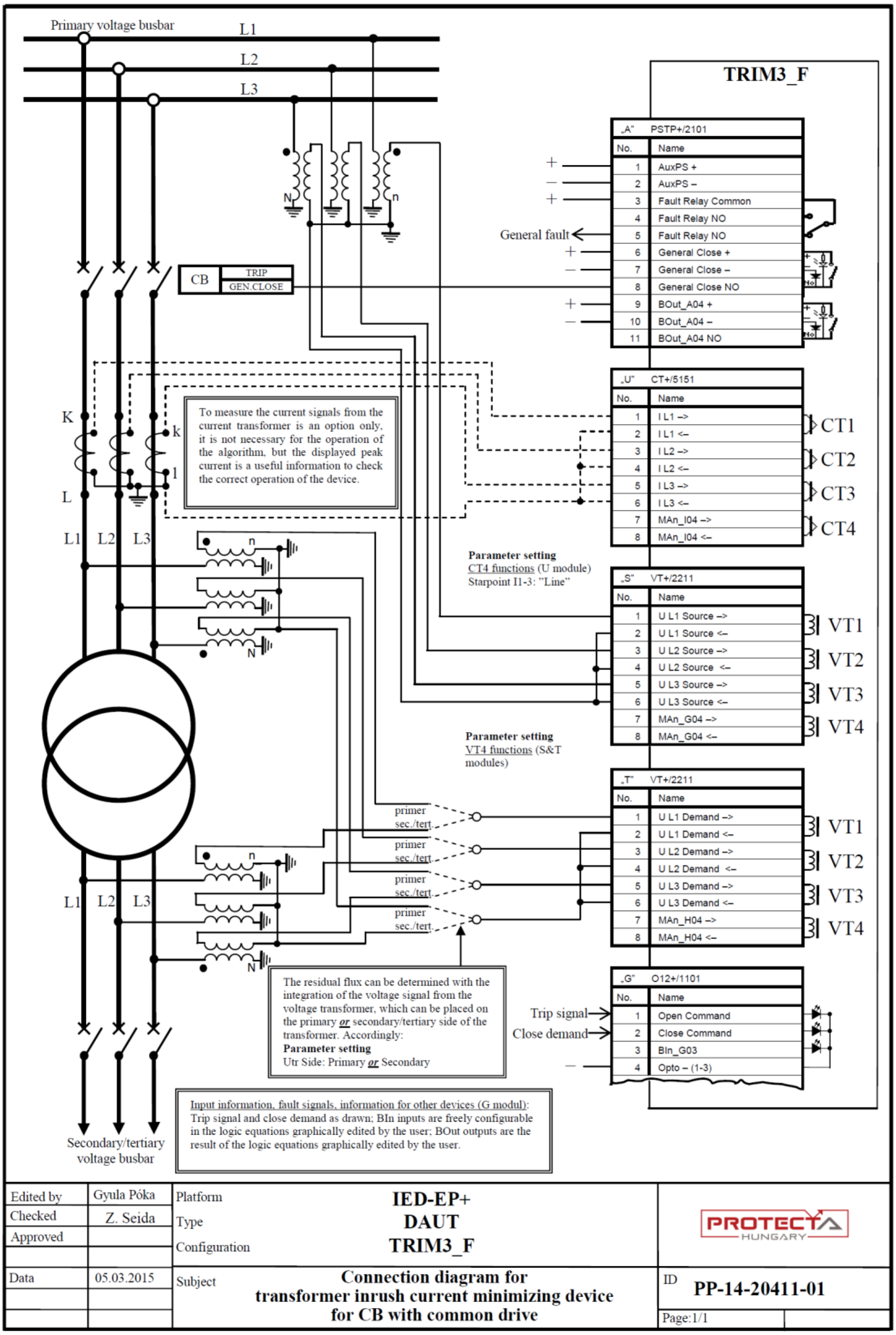
# 2 External connections




Primary voltage busbar
L1
L2
L3
TRIM3_H
„A" PSTP+/2101
No. Name
1 AuxPS +
2 AuxPS –
3 Fault Relay Common
4 Fault Relay NO
5 Fault Relay NO
6 General Close +
7 General Close –
8 General Close NO
9 BOut_A04 +
10 BOut_A04 –
11 BOut_A04 NO
General fault
CB
TRIP
GEN.CLOSE
„I" CT+/5151
No. Name
1 I L1 –>
2 I L1 <–
3 I L2 –>
4 I L2 <–
5 I L3 –>
6 I L3 <–
7 MAn_I04 –>
8 MAn_I04 <–
CT1
CT2
CT3
CT4
K
k
L
l
To measure the current signals from the current transformer is an option only, it is not necessary for the operation of the algorithm, but during the commissioning the displayed peak current is a useful information to check the correct operation of the device.
Parameter setting
CT4 functions (I module)
Starpoint I1-3: "Line"
„G" VT+/2211
No. Name
1 U L1 Source –>
2 U L1 Source <–
3 U L2 Source –>
4 U L2 Source <–
5 U L3 Source –>
6 U L3 Source <–
7 MAn_G04 –>
8 MAn_G04 <–
VT1
VT2
VT3
VT4
Parameter setting
VT4 functions (G&H modules)
Direction U1-3: "Normal"
„H" VT+/2211
No. Name
1 U L1 Demand –>
2 U L1 Demand <–
3 U L2 Demand –>
4 U L2 Demand <–
5 U L3 Demand –>
6 U L3 Demand <–
7 MAn_H04 –>
8 MAn_H04 <–
primer
sec./tert.
The residual flux can be determined with the integration of the voltage signal from the voltage transformer, which can be placed on the primary or secondary/tertiary side of the transformer. Accordingly:
Parameter setting
Utr Side: Primary or Secondary
„C" O12+/1101
No. Name
1 Open Command
2 Close Command
3 BIn_C03
4 Opto-(1-3)
Trip signal
Close demand
Input information, fault signals, information for other devices (D modul):
Trip signal and close demand as drawn; BIn inputs are freely configurable in the logic equations graphically edited by the user; BOut outputs are the result of the logic equations graphically edited by the user.
Secondary/tertiary voltage busbar
Edited by Gyula Póka
Checked Z. Seida
Approved
Data 05.03.2015.
Platform IED-EP+
Type DAUT
Configuration TRIM3_H
Subject Connection diagram for transformer inrush current minimizing device for CB with common drive
PROTECTA HUNGARY
ID PP-14-20413-01
Page:1/1



TRIM3_F
Primary voltage busbar
L1
L2
L3
„A" PS+/2101
No. Name
1 AuxPS +
2 AuxPS –
3 Fault Relay Common
4 Fault Relay NO
5 Fault Relay NO
General fault
„O" TRIP+/2101
No. Name
1 Close L1 +
2 Close L1 –
3 Close L1 NO
4 Close L2 +
5 Close L2 –
6 Close L2 NO
7 Close L3 +
8 Close L3 –
9 Close L3 NO
10 BOut_O08 +
11 BOut_O08 –
12 BOut_O08 NO
CB
L1 CLOSE
L2 CLOSE
L3 CLOSE
K
L
k
l
To measure the current signals from the current transformer is an option only, it is not necessary for the operation of the algorithm, but the displayed peak current is a useful information to check the correct operation of the device.
„U" CT+/5151
No. Name
1 I L1 –>
2 I L1 <–
3 I L2 –>
4 I L2 <–
5 I L3 –>
6 I L3 <–
7 MAn_I04 –>
8 MAn_I04 <–
CT1
CT2
CT3
CT4
Parameter setting
CT4 function
Star point I1-3:"Line"
„S" VT+/2211
No. Name
1 U L1 Source –>
2 U L1 Source <–
3 U L2 Source –>
4 U L2 Source <–
5 U L3 Source –>
6 U L3 Source <–
7 MAn_G04 –>
8 MAn_G04 <–
VT1
VT2
VT3
VT4
Parameter setting
VT4 functions (S&T modules)
Direction U1-3: "Normal"
„T" VT+/2211
No. Name
1 U L1 Demand –>
2 U L1 Demand <–
3 U L2 Demand –>
4 U L2 Demand <–
5 U L3 Demand –>
6 U L3 Demand <–
7 MAn_H04 –>
8 MAn_H04 <–
VT1
VT2
VT3
VT4
primer
sec./tert.
The residual flux can be determined with the integration of the voltage signal from the voltage transformer, which can be placed on the primary or secondary/tertiary side of the transformer. Accordingly:
Parameter setting
Utr Side: Primary or Secondary
„G" O12+/1101
No. Name
1 Open Command
2 Close Command
3 BIn_G03
4 Opto – (1-3)
Trip signal
Close demand
Input information, fault signals, information for other devices (G modul):
Trip signal and close demand as drawn; BIn inputs are freely configurable in the logic equations graphically edited by the user; BOut outputs are the result of the logic equations graphically edited by the user.
Secondary/tertiary voltage busbar
Edited by Gyula Póka
Checked Z. Seida
Approved
Data 05.03.2015.
Platform IED-EP+
Type DAUT
Configuration TRIM3_F
Subject Connection diagram for transformer inrush current minimizing device for CB with single pole drive
PROTECTA HUNGARY
ID PP-14-20412-01
Page:1/1



Primary voltage busbar
L1
L2
L3
TRIM3_F
„A" PSTP+/2101
No. Name
1 AuxPS +
2 AuxPS –
3 Fault Relay Common
4 Fault Relay NO
5 Fault Relay NO
6 General Close +
7 General Close –
8 General Close NO
9 BOut_A04 +
10 BOut_A04 –
11 BOut_A04 NO
General fault
CB
TRIP
GEN.CLOSE
„U" CT+/5151
No. Name
1 I L1 –>
2 I L1 <–
3 I L2 –>
4 I L2 <–
5 I L3 –>
6 I L3 <–
7 MAn_I04 –>
8 MAn_I04 <–
CT1
CT2
CT3
CT4
To measure the current signals from the current transformer is an option only, it is not necessary for the operation of the algorithm, but the displayed peak current is a useful information to check the correct operation of the device.
Parameter setting
CT4 functions (U module)
Starpoint I1-3: "Line"
„S" VT+/2211
No. Name
1 U L1 Source –>
2 U L1 Source <–
3 U L2 Source –>
4 U L2 Source <–
5 U L3 Source –>
6 U L3 Source <–
7 MAn_G04 –>
8 MAn_G04 <–
VT1
VT2
VT3
VT4
Parameter setting
VT4 functions (S&T modules)
„T" VT+/2211
No. Name
1 U L1 Demand –>
2 U L1 Demand <–
3 U L2 Demand –>
4 U L2 Demand <–
5 U L3 Demand –>
6 U L3 Demand <–
7 MAn_H04 –>
8 MAn_H04 <–
primer
sec./tert.
The residual flux can be determined with the integration of the voltage signal from the voltage transformer, which can be placed on the primary or secondary/tertiary side of the transformer. Accordingly:
Parameter setting
Utr Side: Primary or Secondary
„G" O12+/1101
No. Name
1 Open Command
2 Close Command
3 BIn_G03
4 Opto – (1-3)
Trip signal
Close demand
Input information, fault signals, information for other devices (G modul):
Trip signal and close demand as drawn; BIn inputs are freely configurable in the logic equations graphically edited by the user; BOut outputs are the result of the logic equations graphically edited by the user.
Secondary/tertiary voltage busbar
Edited by Gyula Póka
Checked Z. Seida
Approved
Data 05.03.2015
Platform IED-EP+
Type DAUT
Configuration TRIM3_F
Subject Connection diagram for transformer inrush current minimizing device for CB with common drive
ID PP-14-20411-01
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