EUROPROT+

# Primary measurement

*Setting guide*

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# 1 Primary measurement

If primary values (current, voltage, power) are to be displayed or transferred to the SCADA-system from EuroProt+ devices, then the Line measurement function block can be used for this purpose. The description of the parameters of this function block can be found in its manual. However, the calculation of the primary values depends also on parameters of other function blocks, like the Current input and Voltage input function blocks. This setting guide describes these dependencies.

## 1.1 Influence of the different parameters of the Current and Voltage input modules

The Line measurement function block uses

- the Rated secondary and primary parameters of the Current input function block,
- the Range and Rated primary parameters of the Voltage input function block

for the calculation of the primary values from the secondary measured currents and voltages.

Moreover, the rated secondary values of the voltage channels depend not just on the Range parameter of the Voltage input function block, but also on the Connection parameters. The following tables show the effects of the setting of the Connection U1-3 and Connection U4 parameters.

| ***Setting of the parameter "Connection U1-3"*** | ***The Rated secondary values for the phase-to-neutral voltages of the channels 1-3 equals to...*** | ***The Rated secondary values for the phase-to-phase voltages of the channels 1-3 equals to...*** | ***The parameter "Rated primary U1-3" refers to the…*** |
|---|---|---|---|
| Ph-N | $\frac{"Range"}{\sqrt{3}}$ | $"Range"$ | phase-to-neutral voltage. |
| Ph-Ph | n/a (The primary values for the phase-to-neutral voltages cannot be calculated with this setting.) | $"Range"$ | phase-to-phase voltage. |
| Ph-N-Isolated | $"Range"$ | $\sqrt{3} \cdot "Range"$ | phase-to-phase voltage. |

*Table 1-1 Effects of the "Connection U1-3" parameter*

| ***Setting of the parameter "Connection U4"*** | ***The Rated secondary values for the primary Uo measurement equals to...*** |
|---|---|
| Ph-N | $\frac{"Range"}{\sqrt{3}}$ |
| Ph-Ph | $"Range"$ |

*Table 1-2 Effects of the "Connection U4" parameter*

***NOTE:*** The $"Range"$ means in these tables the value set by the parameter "Range", i.e. 100V for setting value "Type 100" and 200V for setting value "Type 200".

The following table summarizes the formulas which are the basis for the conversion of secondary values to primary. Here the Rated secondary values for the voltage conversions are given in Table 1-1 and Table 1-2.

| ***Primary values*** | ***Secondary values*** | ***Conversion formula for the primary values*** |
|---|---|---|
| Current L1<br>Current L2<br>Current L3 | Current Ch – I1<br>Current Ch – I2<br>Current Ch – I3 | $\frac{\text{Rated Primary I1}-3}{\text{Rated Secondary I1}-3} \cdot \text{Current Ch} - \text{I}$ |
| I4 | Current Ch – I4 | $\frac{\text{Rated Primary I4}}{\text{Rated Secondary I4}} \cdot \text{Current Ch} - \text{I4}$ |
| 3Io calculated | ** 3Io calculated$_{sec}$ | $\frac{\text{Rated Primary I4}}{\text{Rated Secondary I4}} \cdot \text{3Io calculated}_{sec}$ |
| Voltage L1<br>Voltage L2<br>Voltage L3 | Voltage Ch – U1<br>Voltage Ch – U2<br>Voltage Ch – U3 | $\frac{\text{Rated Primary U}_{1-3}}{\text{Rated Secondary U}_{1-3}} \cdot \text{Voltage Ch} - \text{U}$ |
| U4 | Voltage Ch – U4 | $\frac{\text{Rated Primary U}_4}{\text{Rated Secondary U}_4} \cdot \text{Voltage Ch} - \text{U4}$ |
| 3Uo calculated | ** 3Uo calculated$_{sec}$ | $\frac{\text{Rated Primary U}_4}{\text{Rated Secondary U}_4} \cdot \text{3Uo calculated}_{sec}$ |

*Table 1-3 Conversion formulas for the primary values*

*** Internal values, not displayed anywhere*

The power values are calculated from the primary currents and voltages.

***NOTE:*** The residual voltage and current is either measured directly or calculated from the measured secondary phase-to-neutral voltages, phase currents. The secondary calculated values come from the following equations:

$$\overline{\text{3Io calculated}_{sec}} = \overline{\text{Current Ch} - \text{I1}} + \overline{\text{Current Ch} - \text{I2}} + \overline{\text{Current Ch} - \text{I3}}$$

$$\overline{\text{3Uo calculated}_{sec}} = \overline{\text{Voltage Ch} - \text{U1}} + \overline{\text{Voltage Ch} - \text{U2}} + \overline{\text{Voltage Ch} - \text{U3}}$$

If phase-to-phase secondary voltages are connected to the VT input module (the „Connection U1-3" parameter is set to „Ph-Ph"), the value of Uo can not be determined.

The following table collects the parameters which influences the calculation of the primary measurands.

| ***Parameter title*** | ***Parameter name*** | ***Parameter defined by*** |
|---|---|---|
| Rated Secondary I1-3 | CT4_Ch13Nom_EPar_ | Current input function (CT4) |
| Rated Secondary I4 | CT4_Ch4Nom_EPar_ | |
| Rated Primary I1-3 | CT4_PriI13_FPar_ | |
| Rated Primary I4 | CT4_PriI4_FPar_ | |
| Range | VT4_Type_EPar_ | Voltage input function (VT4) |
| Connection U1-3 | VT4_Ch13Nom_EPar_ | |
| Connection U4 | VT4_Ch4Nom_EPar_ | |
| VT correction | VT4_CorrFact_IPar_ | |
| Rated Primary U1-3 | VT4_PriU13_FPar_ | |
| Rated Primary U4 | VT4_PriU4_FPar_ | |

*Table 1-4 Relevant parameters for the calculations of the primary values*

***NOTE:*** the Rated primary parameters of the Current input and Voltage input function blocks do not have any effect on the protection functions, only to the Line measurement function!

## 1.2 Examples

The following examples demonstrate the effect of the different “Connection U1-3” parameter values:

**Settings and the injected values**

The following table shows the “VT4 module” and “CT4 module” functions’ parameter settings. Only the “Connection U1-3” parameter value is modified in the following three examples. The other parameters are unchanged.

| **VT4 module** | |
|---|---|
| Range | Type 100 |
| **Connection U1-3** | **Ph-N** |
| Connection U4 | Ph-N |
| Direction U1-3 | Normal |
| Direction U4 | Normal |
| VT correction | 100 % |
| Rated Primary U1-3 | 100.00 kV |
| Rated Primary U4 | 100.00 kV |

| **CT4 module** | |
|---|---|
| Rated Secondary I1-3 | 1A |
| Rated Secondary I4 | 1A |
| Starpoint I1-3 | Line |
| Direction I4 | Normal |
| Rated Primary I1-3 | 1000 A |
| Rated Primary I4 | 1000 A |

*Table 1-5 Parameter settings of the VT4 and CT4 module function blocks for the examples*

***NOTE:*** The Measurement mode of the Line measurement function is indifferent in the examples because the current and voltage vectors are symmetrical.

The currents and the voltages which are measured by the VT and CT modules can be seen below. These analogue secondary values are same in the discussed three examples.

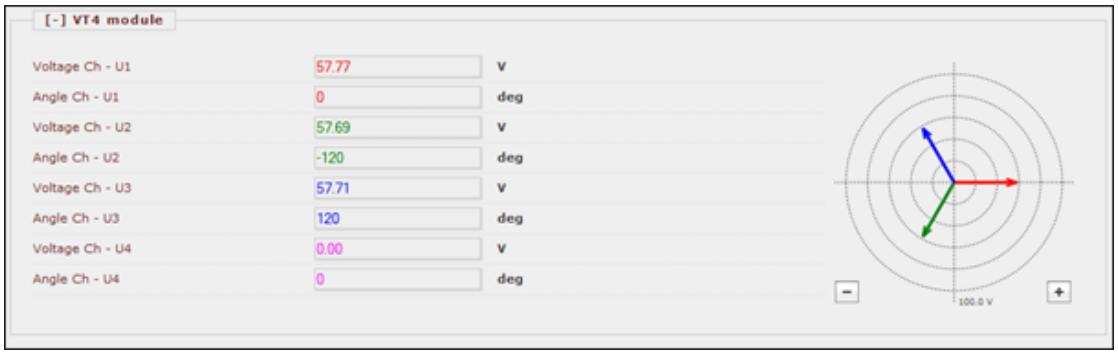


*Figure 1-1 The measured secondary voltages and the vector diagram*

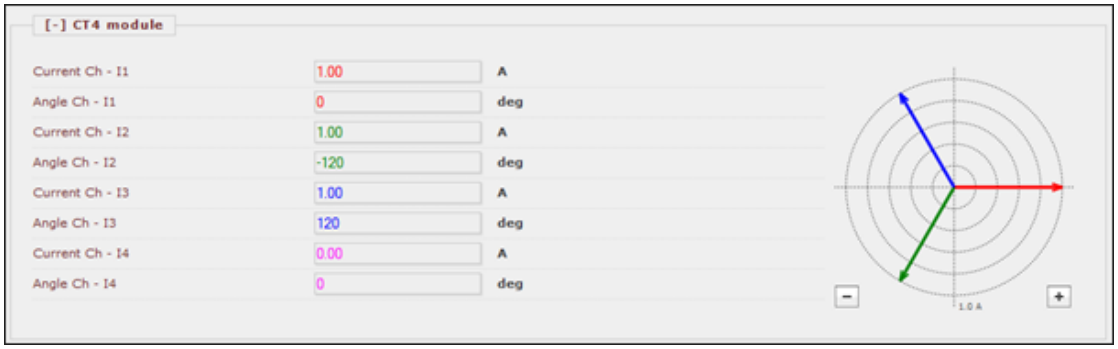


*Figure 1-2 The measured secondary currents and the vector diagram*

**EXAMPLE 1:**
**Connection U1-3: Ph-N**

In the first example the “Connection U1-3” parameter is set “Ph-N”. The displayed information of the “Line measurement” function can be seen below.

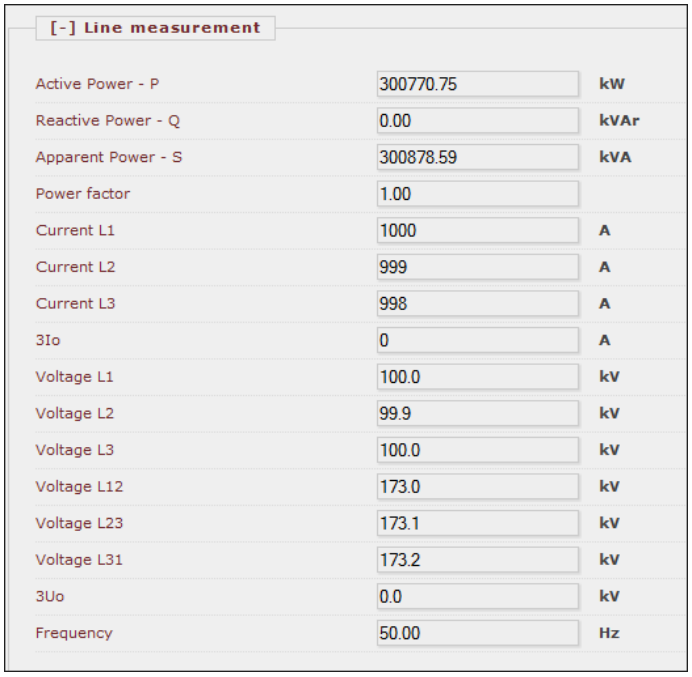


*Figure 1-3 The displayed information of the Line measurement function*

The set 100kV value of the “Rated primary U1-3” parameter refers to the phase-to-neutral voltage, according to setting Ph-N of the “Connection U1-3”. So for injection with *rated secondary* phase-to-neutral voltages the primary value of the phase-to-neutral voltages is the *rated primary* value. The primary value of the phase-to-phase voltages is a $\sqrt{3}$-times higher value.

**EXAMPLE 2:**
**Connection U1-3: Ph-Ph**

The “Ph-Ph” option is set to the “Connection U1-3” parameter.

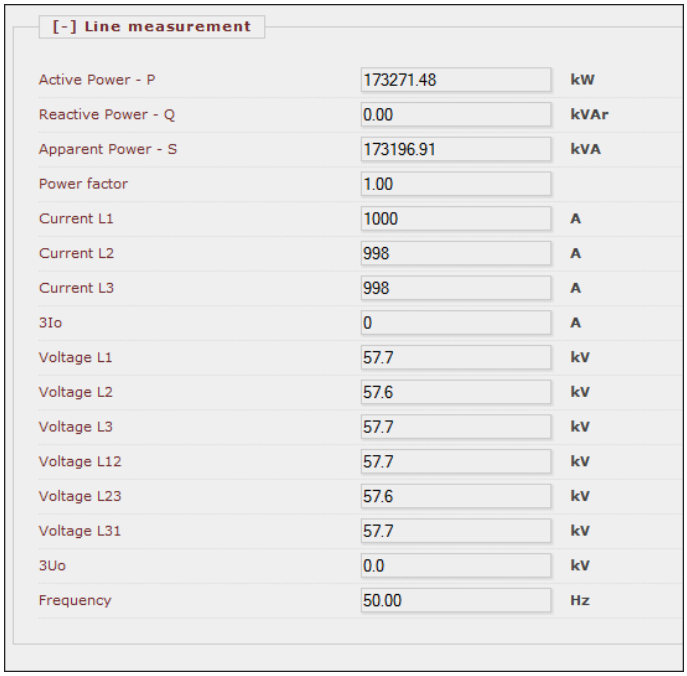


*Figure 1-4 The displayed information of the Line measurement function*

The “Rated Primary U1-3” parameter refers to the phase-to-phase voltage. The value of the injected voltages is $\sqrt{3}$-times lower than the rated secondary phase-to-phase voltage, so the primary phase-to-phase voltages are also $\sqrt{3}$-times lower than the value set by the parameter “Rated primary U1-3”. The phase-to-neutral voltages can not be calculated in this case, the displayed phase-to-neutral voltages get the same value as the phase-to-phase voltages – so they should be neglected. Consequently, the power measurands (P, Q, S) are also irrelevant.

**EXAMPLE 3:**
**Connection U1-3: Ph-N-Isolated**

The “Connection U1-3” parameter of the VT module is set to the “Ph-N-Isolated” in the third example.

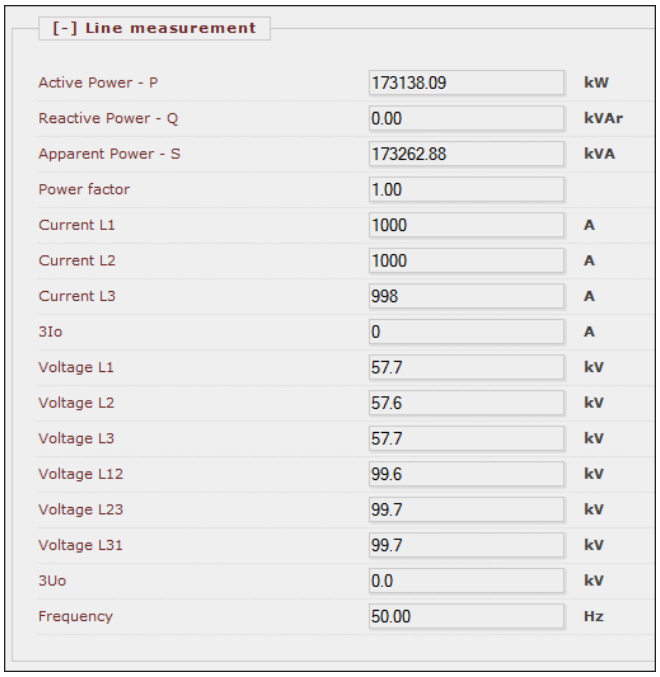


*Figure 1-5 The displayed information of the Line measurement function*

If the “Ph-N-Isolated” option is selected, the “Rated Primary U1-3” parameter of the VT module refers to the phase-to-phase voltage, however, the primary *phase-to-phase* voltage will take this value if the secondary measured voltage is equal to the rated *phase-to-neutral* voltage (Range/$\sqrt{3}$). The primary phase-to-neutral voltages are calculated simply by the formula $\frac{\text{Rated Primary } U_{1-3}}{\text{Range}} \cdot \text{Voltage Ch} - \text{U}$. So the primary phase-to-neutral and the phase to phase voltages are both relevant and proper values, as well as the power measurands (like in Ph-N mode).