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SIPROTEC 5 Application Note

SIP5-APN-015:
Device and Power System Configuration

Answers for infrastructure and cities.

SIPROTEC 5 - Application: SIP5-APN-015 Device and Power System Configuration

Content

1 Application Device and Power System Configuration

1.1 Introduction

This application example covers the details with regard to applying the General device and power system data settings. Numerous screen shots from DIGSI are used to help the reader apply the information to his own project. The general configuration of SIPROTEC 5 is described in the overview separately.

The applicable SIPROTEC5 device Manual should be consulted for detailed information. This application description provides a graphic road map for a typical application with current and voltage measurement.

Related subjects such as e.g. general application and distance protection etc. are covered in separate application descriptions.

1.2 Overview

After adding the device to the project the general applications (selection of Function Groups, Measuring Points and Function) must be done – see General Application. This document describes the next steps, General device and Power system settings, which must be applied before the individual functions are configured:

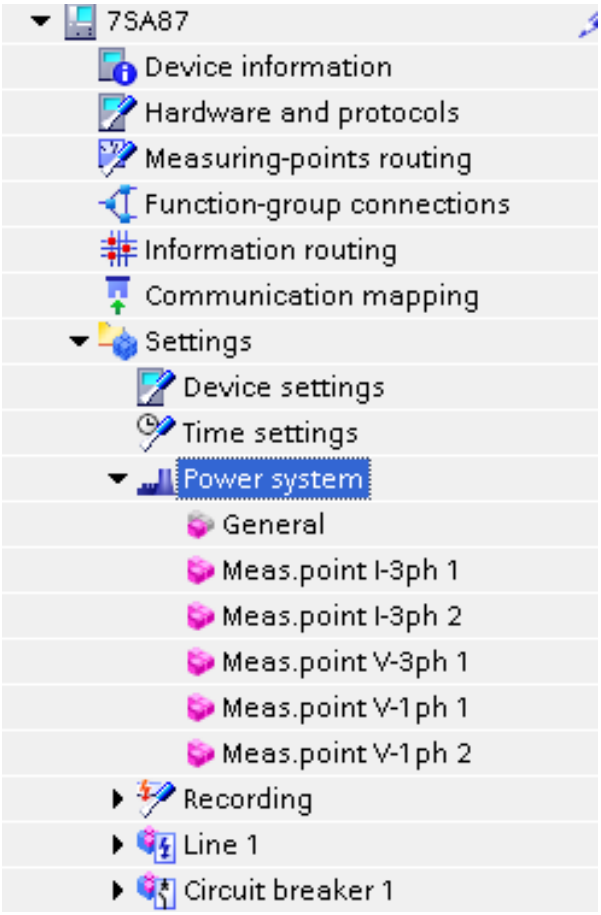

Figure 1: Device settings

1.3 Application Data

The following example data is used to illustrate the application of the Power system settings:

	Parameter	Value
System data	Nominal system voltage phase-phase	400 kV
	Power system frequency	50 Hz
	Maximum positive sequence source impedance	10 + j100
	Maximum zero sequence source impedance	25 + j200
	Minimum positive sequence source impedance	1 + j10
	Minimum zero sequence source impedance	2.5 + j20
	Maximum ratio remote infeed / local infeed (I_{Rem}/I_{Loc})	3
Instrument transformers	Voltage transformer ratio (LINE) (VT2)	380 kV / 100 V
	Voltage transformer ratio (BUS) (VT1)	400 kV / 110 V
	CT1 and CT2: Current transformer ratio	1000 A / 1 A
	CT1 and CT2: Current transformer data	5P20 20VA P_i=3VA
	CT1 and CT2 secondary connection cable	2.5 mm^2 50m
	CT ratio / VT ratio for impedance conversion	0.2632
	Line 1 - length	80 km
	Maximum load current	250% of full load
Line data	Minimum operating voltage	85% nominal voltage
	Sign convention for power flow	Export = negative
	Full load apparent power (S)	600 MVA
	Line 1 – positive seq. impedance per km Z1	0.025 + j0.21 /km
	Line 1 – zero seq. impedance per km Z0	0.13 + j0.81 /km
	Line 2 – total positive seq. impedance	3.5 + j39.5
	Line 2 – total zero seq. impedance	6.8 + j148
	Line 3 – total positive seq. impedance	1.5 + j17.5
	Line 3 – total zero seq. impedance	7.5 + j86.5
	Maximum fault resistance, Ph-E	250
	Average tower footing resistance	15
	Earth Wire	60 mm^2 steel
Tower data	Distance: Conductor to tower (ground)	5 m
	Distance: Conductor to conductor (phase-phase)	12 m
Circuit breaker 1 and 2	Trip operating time	60 ms
	Close operating time	70 ms

Table 1: Power system and line parameters

1.4 Device Settings

The device settings are the first item under settings and cover general device settings:

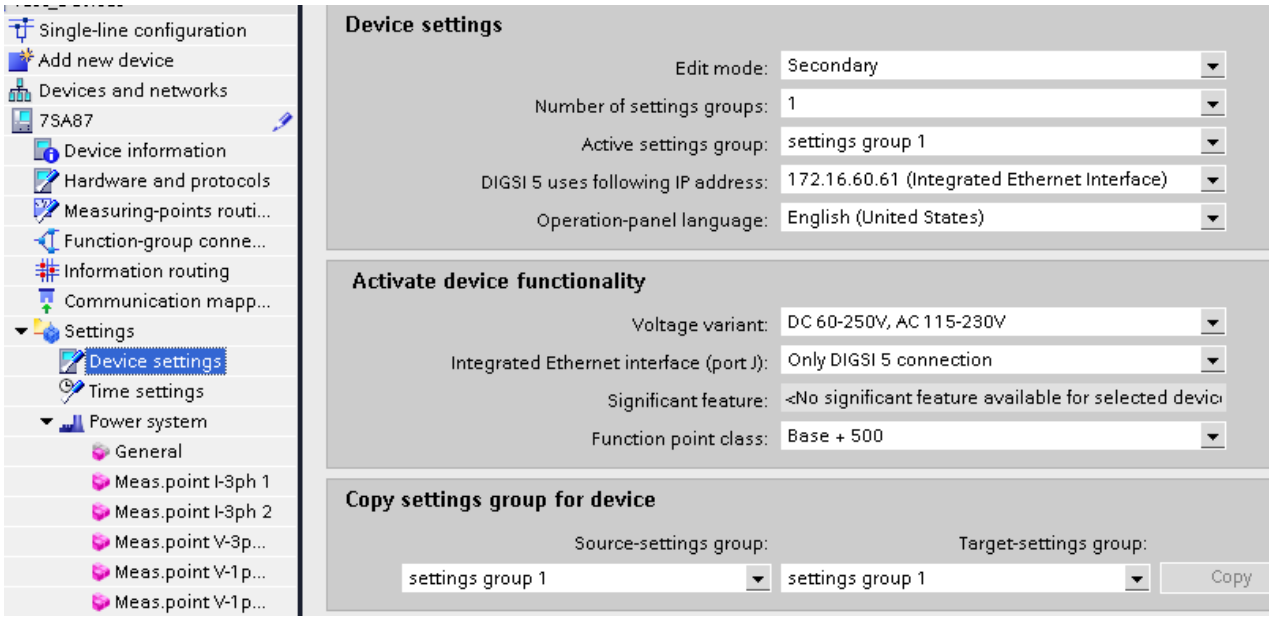

Figure 2: Device Settings

Edit mode:

In the Edit mode the selection “Primary”, “Secondary” or “Percent” is made. In order to maintain default settings that are in relation to the rated secondary current/voltage, it is recommended to select “Secondary” before CT and VT parameters are changed. This prevents overwriting all current/voltage threshold settings when the CT/VT ratios are set. When the CT/VT data has been entered the Edit mode can be set according to the individual preference (it may also be changed at any time during application of the settings).

Number of setting groups / Active setting group and Copy settings group for device:

If more than one setting group is required, this can be set here (up to 8 setting groups are possible). A separate application description is available for the application of multiple setting groups.

DIGSI 5 IP Address:

DIGSI can access the device via Ethernet or USB interfaces. As the device may have more than one Ethernet interface this setting can be used to select the IP address of the Ethernet interface in the device that DIGSI must use when connecting to the device. In most cases the Integrated Ethernet Interface (Plug-in module position J) is used. The IP address of this port is set under Hardware and protocols – see General Application note.

Operating-panel language:

Select the language that must be used for display in the device.

Voltage variant:

This indicates the power supply variant (type) used in the device. It cannot be changed.

Integrated Ethernet interface (port J):

This interface is typically only used for DIGSI communication, but may be set to allow other communication protocols in parallel.

Significant feature:

A significant feature such as 2-end protection in the 7SD87 is defined in the ordering code. In some cases this significant features may be changed here.

Function point class

The number of function points available in the device is defined in the ordering code.

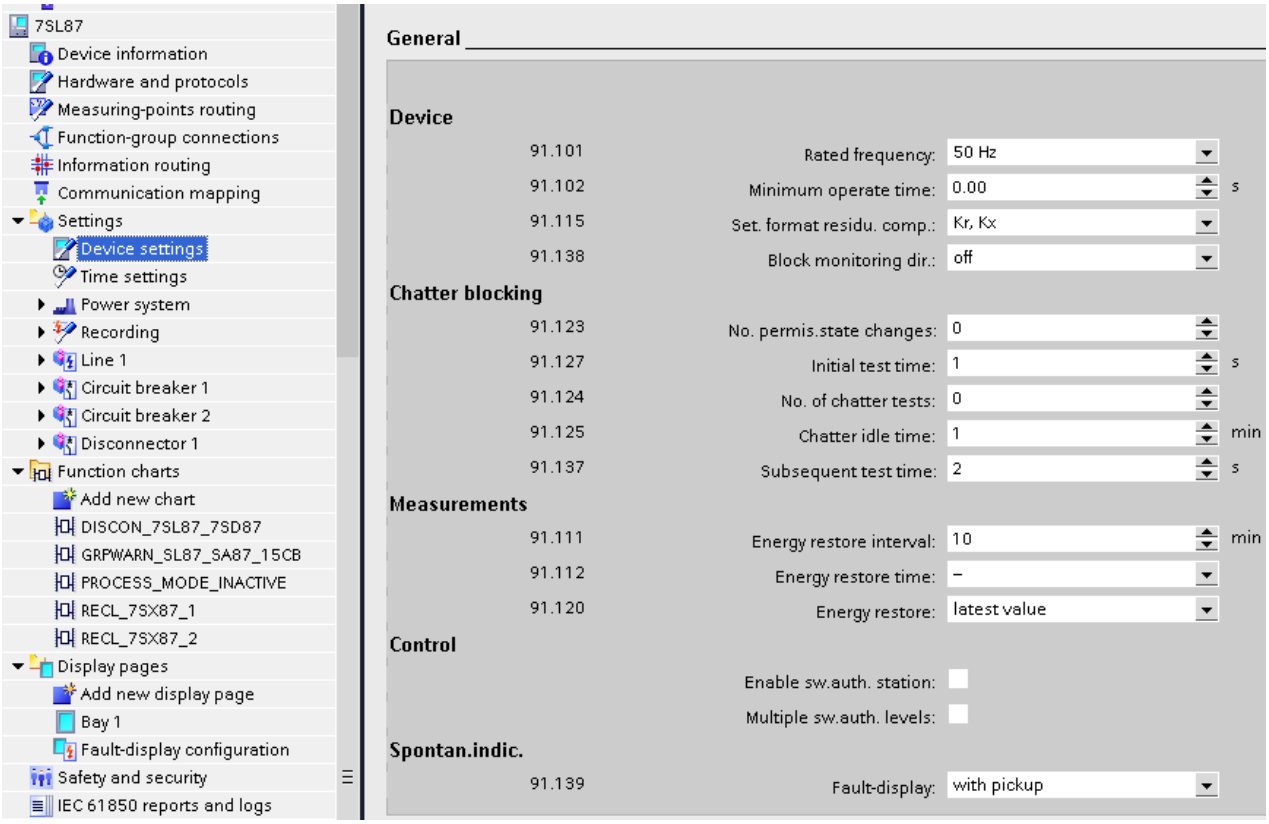

Figure 3: Device Settings-General

1.4.1 General - Device

Rated frequency:

Select the desired rated frequency, either 50 or 60 Hz.

Minimum operate time:

As the trip of the circuit breaker is done via the FG circuit breaker, the minimum trip duration is set in the circuit breaker with parameter "output time". The minimum operate time set here is relevant to the operate of functions (e.g. distance protection). As these operate signals do not require a minimum duration to ensure secure response by the circuit breaker the default and recommended setting is 0.00 s. A different minimum operate time may be required when the operate of a function is routed directly to an output , e.g. in generator protection applications.

Setting format for residual compensation

Impedance based protection functions require a residual compensation factor setting for the ground loop measurement. This setting can be applied in two different formats:

- 1. Kr, Kx: in this format the ratio of RE/RL = Kr and XE/XL = Kx are set
- 2. K0 in this format the complex ratio of ZE/ZL is set.

Note: when the K0 setting format is used, the Line angle setting is applied together with the K0 setting to convert to Kr and Kx for the internal computation.

Block monitoring direction

During testing and commissioning it is sometimes necessary to prevent signals resulting from the tests from flooding the control centre. With this setting it is possible to activate a block of signals going out on the interface towards the control centre. It is also possible to activate this blocking via binary input.

1.4.2 General - Chatter blocking

For certain signals it may be advisable to activate a chatter blocking to avoid flooding the control centre when there are too many state changes of a binary input. For this purpose the following setting parameters are available:

- No of permissible state changes
- Initial Test Time
- No. of chatter tests
- Chatter idle time
- Subsequent test time

For details on the setting and function of these parameters please refer to the device manual. The chatter blocking is only active for a binary input (or circuit breaker position status) when this is selected under the properties of the particular signal (see diagram below:

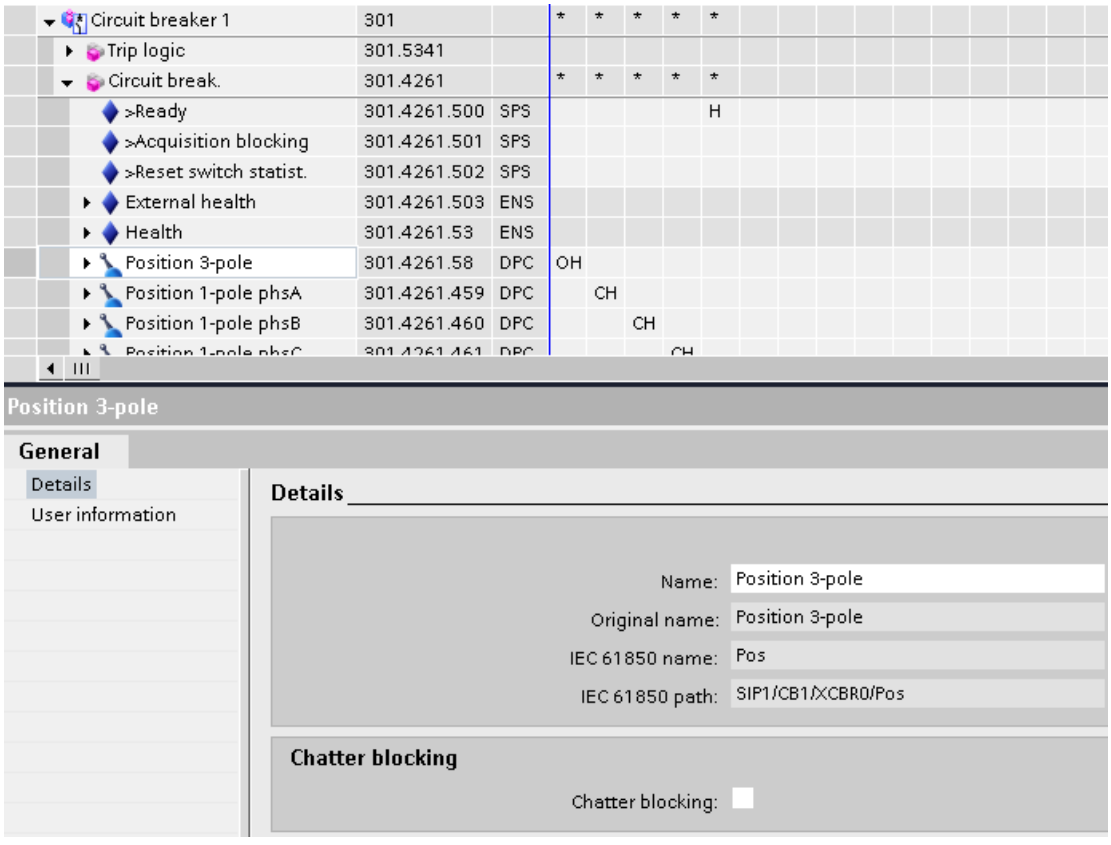

Figure 4: Activation of Chatter Blocking under “Properties” in the Matrix

1.4.3 General - Measurements

The setting options visible here depend on the measurement functions applied in the device. If for example the average value measurement is selected, additional parameters that are specifically relevant appear in addition:

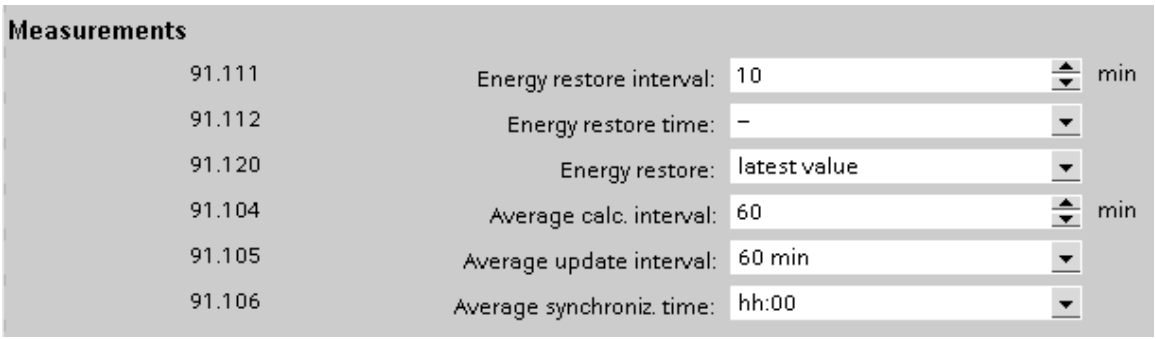

Figure 5: Additional setting option for average measurement function

For more detailed information on the setting of these parameters, please refer of the relevant section of the device manual.

1.4.4 General - Control

Selection for switching authority can be applied here. A separate application note for Control Functions is available.

1.4.5 Localization

The user may select the units used in the device. In general a choice between **SI** (metric) and ANSI (miles instead of km) units is provided.

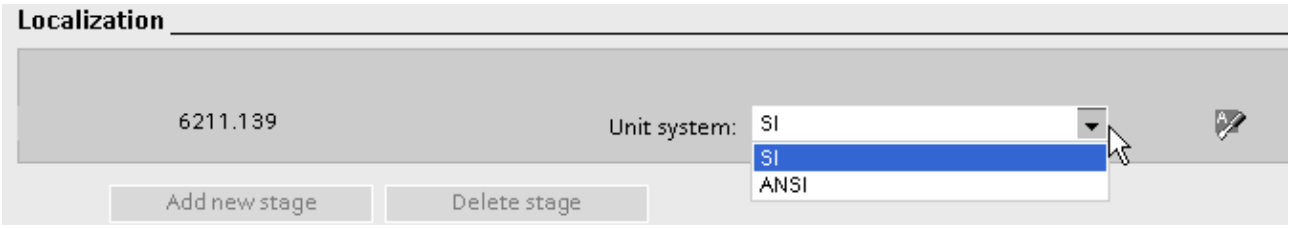

Figure 6: Localization

1.5 Power System Settings

All the Measuring Point settings are provided here. The number of available measuring points depends on the selection under Measuring-points routing – see separate application note for information regarding this.

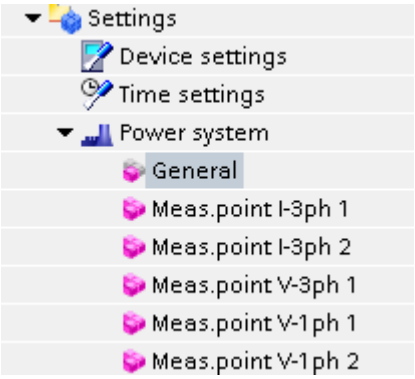

Figure 7: Initial Settings in the setting tree

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1.5.1 General

Under General it is only possible to select the phase rotation

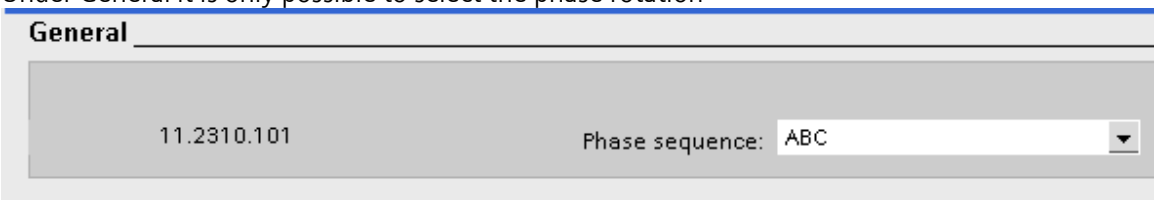

Figure 8: Setting Phase Rotation under General **Phase sequence**

The phase sequence, typically ABC, must be set here. For applications where a change of the phase sequence is possible depending on the plant condition (e.g. pumped storage with change between generation and motoring by means of a phase swap) this can be done by switching (swapping) phases. For this purpose the “Inverted phases” setting described below for each measuring point must be used. If a phase reversal is possible without a physical swap, the binary input “>Phs-rotation reversal” under Power system/General should be used.

1.5.2 Meas. point CT Settings

These must be set according to the given data. Please note that the device may have several current and voltage measuring points. Be sure to select the correct one for the application of the following settings.

The setting mask for the CT parameters (e.g. Meas. Point I-3ph 1) is as follows (refer to the comment above regarding “Edit mode” – it is recommended to be in “secondary” when changing CT ratio parameters):

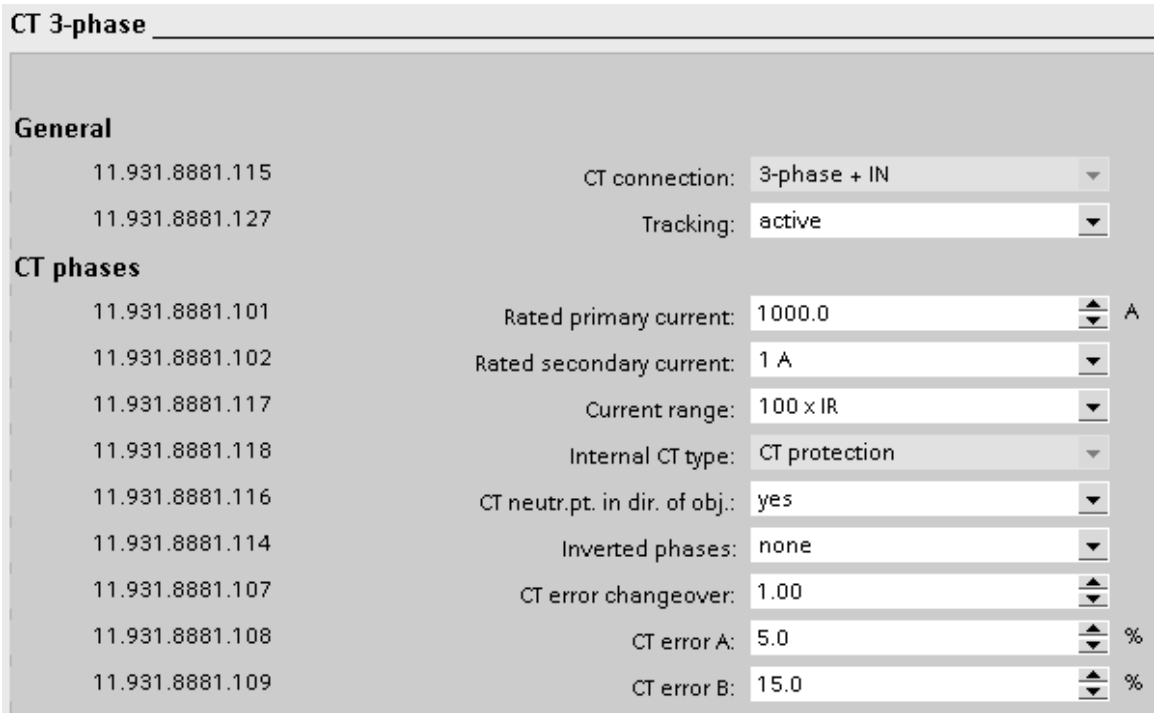

Figure 9: CT setting entry

Tracking

Some functions in the device may utilize a measuring technique that “tracks” the system frequency. This measurement is then based on a fixed number of samples per cycle. The setting here only determines if this particular signal may be applied to determine the power system frequency for purpose of tracking.

The power system frequency determined in this manner is then used to establish the re-sampling frequency so that a fixed number of samples per cycle are available for those functions that require this. Functions that have a fixed sampling rate (compensation of frequency deviation by means of adapted filter coefficients) are not affected by this setting.

Rated primary and secondary current

These are set according to the application data given in Table 2.

Current range

This setting is fixed at 100 x IR for distance protection because the distance protection my not “clip” the large currents as this could cause under-reach. For other applications a different setting may be possible.

Note: Only permitted setting options are available so that the user can not accidentally set a too small range.

CT neutral point in direction of protected object

The CT polarity is selected by correct application of the star point. This is done with the selection of the CT neutral point direction which may be towards the protected object (line) or not. The correct setting must be checked during commissioning or with “on-load” direction check.

Inverted phases

The setting "Inverted phases" is only relevant when there is a phase swapping switch, e.g. on a pumped storage feeder where the phase rotation is changed when going from generation to motoring (pumping). In all other applications the default setting = none must be maintained.

CT error changeover, CT error A and B

These parameters are relevant to the feeder and stub differential protection. A description and setting recommendation is provided in the device manual.

Magnitude Correction

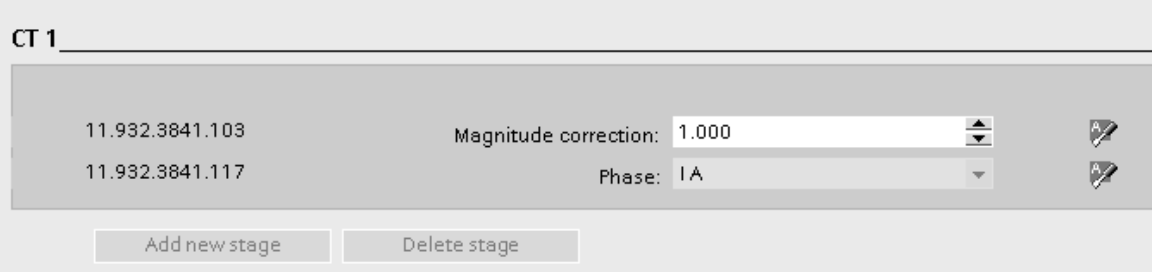

Figure 10: Magnitude correction

For each physical measuring input a magnitude correction factor can be applied. Please note that this setting should only be modified when there is a known linear deviation in the primary current transformer measurement. This setting is not intended to accommodate normal transformation ratios or typical CT measuring errors.

The settings for the 2nd CT, Meas.point I-3ph 2, are exactly the same as the CT's are identical.

1.5.3 Meas.point VT Settings

For the VT the mask for applying the settings is as follows:

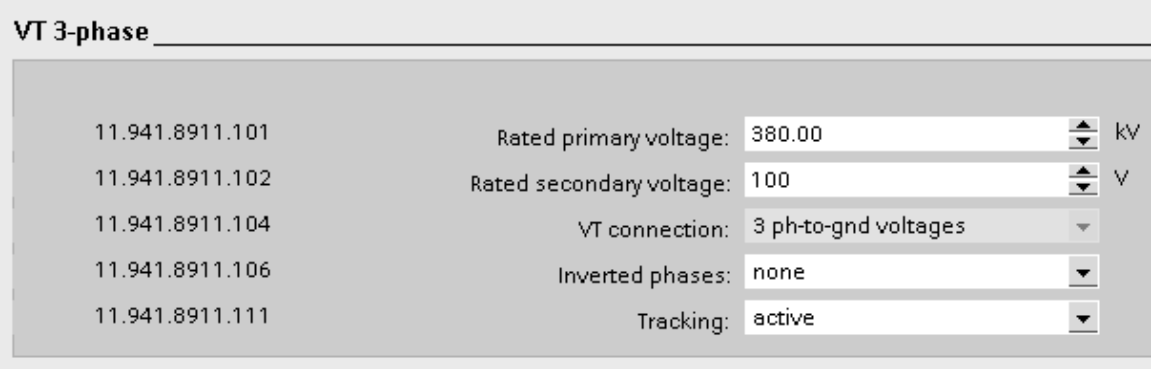

Figure 11: Line VT setting entry

Rated primary and secondary voltage

These parameters must be set according to the given data, and must reflect the actual VT rated values.

Inverted phases

The setting "Inverted phases" is only relevant when there is a phase swapping switch, e.g. on a pumped storage feeder where the phase rotation is changed when going from generation to motoring (pumping). In all other applications the default setting = none must be maintained.

Tracking

Some functions in the device may utilize a measuring technique that "tracks" the system frequency. This measurement is then based on a fixed number of samples per cycle. The setting here only determines if this particular signal may be applied to determine the power system frequency for purpose of tracking. The power system frequency determined in this manner is then used to establish the re-sampling frequency so that a fixed number of samples per cycle are available for those functions that require this. Functions that have a fixed sampling rate (compensation of frequency deviation by means of adapted filter coefficients) are not affected by this setting

Magnitude Correction

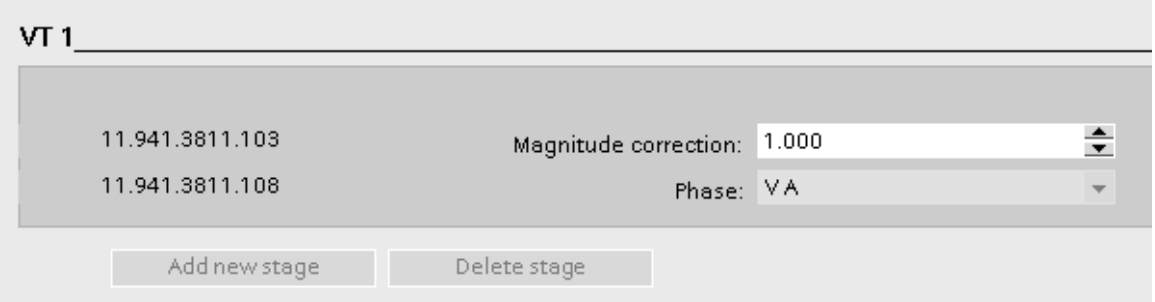

Figure 12: Magnitude correction

For each physical measuring input a magnitude correction factor can be applied. Please note that this setting should only be modified when there is a known linear deviation in the primary voltage transformer measurement. This setting is not intended to accommodate normal transformation ratios or typical VT measuring errors.

The settings for the further VT measuring points, eg. Sync Check voltage from a bus connected VT are set in the same manner.

1.6 Conclusion

The application of the power system parameters, mainly consisting of the measuring point configuration, allows for clear definition of the plant interface.

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Siemens AG

Infrastructure & Cities Sector

Smart Grid Division

Humboldtstr. 59

90459 Nuremberg, Germany

Siemens AG

Infrastructure & Cities Sector

Smart Grid Division

Energy Automation

Humboldtstr. 59

90459 Nuremberg, Germany

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