SIEMENS

SIGUARD PDP
Phasor Data Processing

V2.11

Manual

E50417-H1076-C419-A4

NOTE

For your own safety, please observe the warnings and safety instructions contained in this manual.

Document version: E50417-H1076-C419-A4.00

Release status: 01.2012

Version of the product described: V2.11

Preface

Purpose of the Manual

This manual is a set of instructions for the software SIGUARD PDP. You obtain an overview of the possibilities for use and configuration.

Target Audience

This manual is addressed mainly to the operating crew, commissioning engineers, and quality managers who are responsible for the configuration, parameterization, and monitoring of power systems and their components.

Scope of Application of this Manual

This manual applies to SIGUARD PDP V2.10.

Standards

SIGUARD PDP was developed in compliance with guidelines in DIN EN ISO 9001:2008.

Additional Support

For questions about the system, please contact your Siemens sales partner.

Support

Our Customer Support Center provides a 24-hour service.

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Training Courses

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Safety Information

This manual is not a complete index of all safety measures required for operation of the equipment (module, device). However, it comprises important information that must be noted for purposes of personal safety, as well as in order to avoid material damage. Information is highlighted and illustrated as follows according to the degree of danger.

DANGER

DANGER means that death or severe injury **will** result if the measures specified are not taken.

✧ Comply with all instructions, in order to avoid death or severe injuries.

WARNING

WARNING means that death or severe injury **may** result if the measures specified are not taken.

✧ Comply with all instructions, in order to avoid death or severe injuries.

CAUTION

CAUTION means that medium-severe or slight injuries **can** occur if the specified measures are not taken.

✧ Comply with all instructions, in order to avoid medium-severe or slight injuries.

NOTICE

NOTICE means that material damage **can** result if the measures specified are not taken.

✧ Comply with all instructions, in order to avoid material damage.

NOTE

Important information about the product, product handling, or a certain section of the documentation, which must be given particular attention.

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1 SIGUARD PDP System Overview

1.1 Overview

SIGUARD PDP (Phasor Data Processing) is software for **monitoring the status** of power transmission in extensive power-supply systems. When critical states are approached (frequency stability, voltage stability, transmission stability, and power swing), this is detected early and displayed. The threshold as of which a critical state is reached and requires intervention can be defined and subsequently changed at any time.

In addition, SIGUARD PDP supports you in the **analysis** of the power-supply system.

SIGUARD PDP works together with PMUs (phasor measurement units). These measuring devices are installed in the power distribution systems and connected to the current and voltage transformers. The time of the PMUs must be synchronized via GPS with an accuracy of < 5 μs. This enables the PMUs to acquire the measured values with amplitude and phase as phasors (indicator values) with high precision and to transmit them via the communication interface. These time-synchronized measured values from regionally widely distributed measuring points can be collected and evaluated using SIGUARD PDP.

Software Components

SIGUARD PDP consists of 5 software components. They can run on one computer, but also be distributed over 3 computers. If the components are distributed over several computers, they communicate using SSI (SIGUARD Service Interface). SSI requires a functional TCP connection.

The SIGUARD PDP components are:

- **SIGUARD PDP Server with SIGUARD PDP Archive**

  The SIGUARD PDP Server stores the information of the PMU devices and makes it available to the other components. The SIGUARD PDP Server stores the information (measured values, events, and warning indications) in a ring archive and makes it available to further processing components, for example, SIGUARD PDP UI. The **IEEE C37.118** protocol is used for communication with the devices.

- **SIGUARD PDP ISD (Island Detection)**

  This component evaluates frequency deviations and thereby detects the formation of an island within the network.

- **SIGUARD PDP PSR (Power Swing Recognition)**

  This component detects active power swings in the power system. The parameters of the active power and the voltage angle difference that is proportional to the active power (frequency, magnitude, damping, and criticality), for several swings (modes) are observed and evaluated. In the overview diagram, a swing is marked with colored points, and on the map they are displayed with circular areas.

- **SIGUARD PDP COM (Communication)**
  - C37.118

    This component conveys the data and information via an IEEE C37.118 connection to another PDP system (for example, a second SIGUARD PDP).
  - ICCP

    With the Inter-Control Center Communications Protocol, information from SIGUARD PDP can be relayed to a SCADA-System in order to be able to display the data to the network control personnel there and to be able to process the data further in the more significant functions of the control system (EMS).
  - OPC

    An OPC DA-Server (V3) is made available with this component. Selected information from SIGUARD PDP can be read out and processed further by OPC Clients.

- **SIGUARD PDP UI (User Interface)**

  This component is the SIGUARD PDP user interface. You can use it to display and analyze the information.

- **SIGUARD PDP Engineer**

  This component is the SIGUARD PDP parameterizing tool.

Recommendation: Install SIGUARD PDP server on a server computer, for example, in a server room with secure power supply, and also set up the archive on it. Install SIGUARD PDP UI on a different computer.

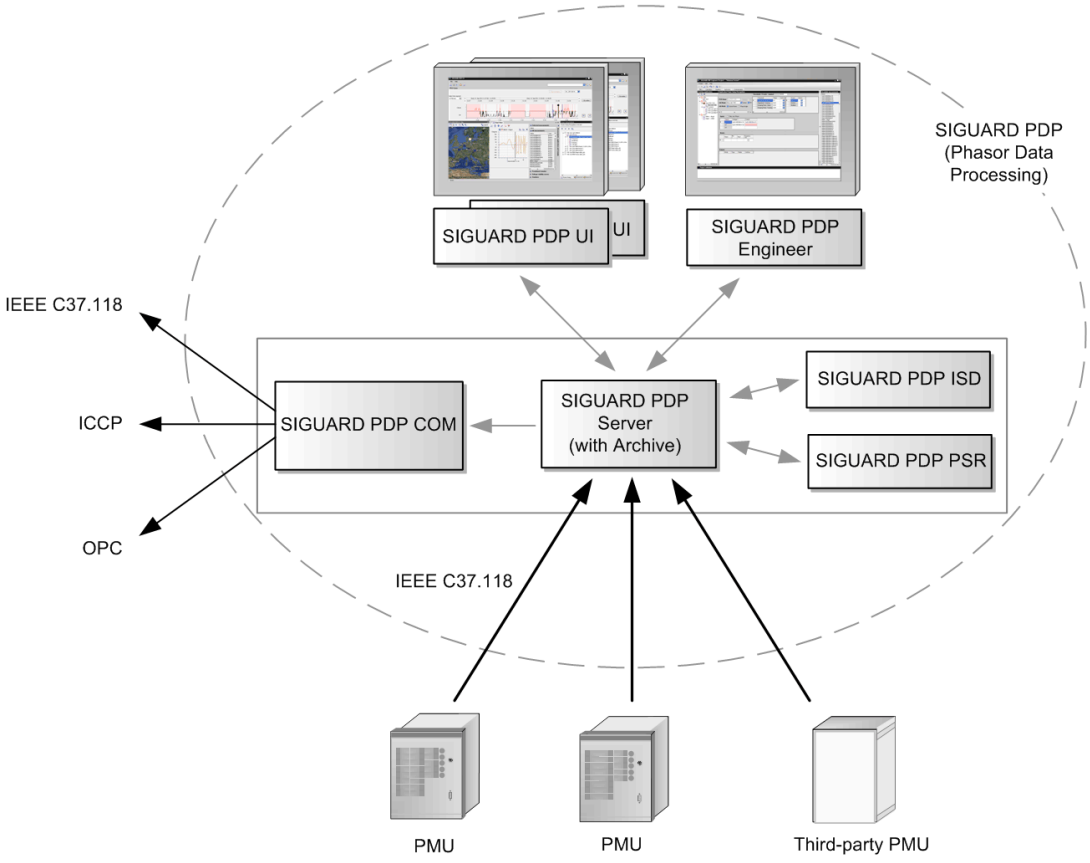


Figure 1-1 Software Components of SIGUARD PDP

SIGUARD PDP UI (User Interface)

The SIGUARD PDP user interface consists of several **window sections**:

- **Menu and Toolbar**

  You can call up general functions via the menu and the toolbar.

- **PSS Curve (Power System Status)**

  This window section displays the combined status of the entire measured or monitored power-supply system. An exceeded critical threshold is marked in color.

- **SIGUARD PDP UI - Map**

  This window section shows the network topology of the power-supply system on a map. Objects in a critical state are marked in color:

  - Island recognition as areas between the stations
  - Power swing recognition as circular areas around the stations

- **Chart View**

  This window section displays the detailed curves of individual measured values or calculated values over a defined time range. With the aid of these diagrams, you can analyze the power-supply system.

- **Measurements, applications and formulas**

  This window section lists the measuring points, applications, formulas, and statistics. You can create diagrams from these lists.

- **Event list, Alarm list**

  In this window section, events and alarm indications are listed.

- **Power Swing Analysis**

  In this window section, the PSR jobs for the stations in the power system are listed with the corresponding phase angle and PSR modes.

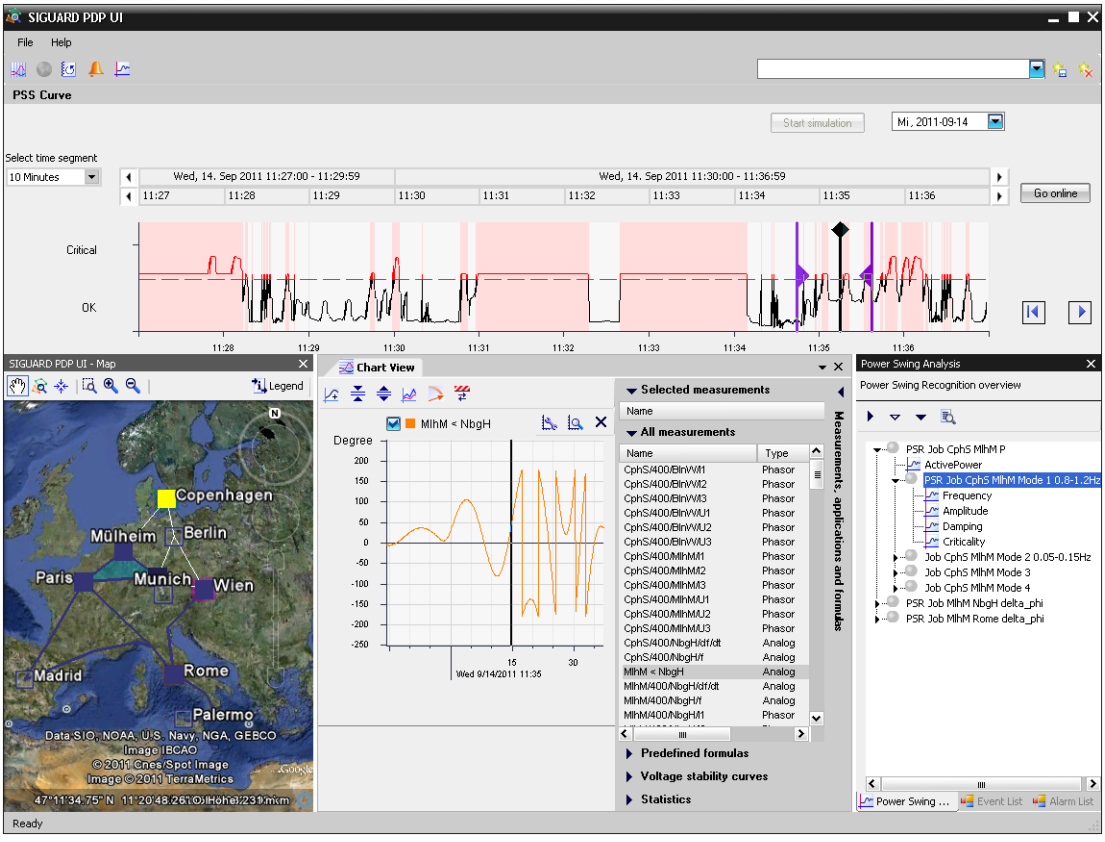


Figure 1-2 SIGUARD PDP UI, Main Window

- **Limit Editor**

  In the **Limit Editor**, you define the limiting values/thresholds for the individual measuring point of the power-supply system that are to play a role in the evaluation.

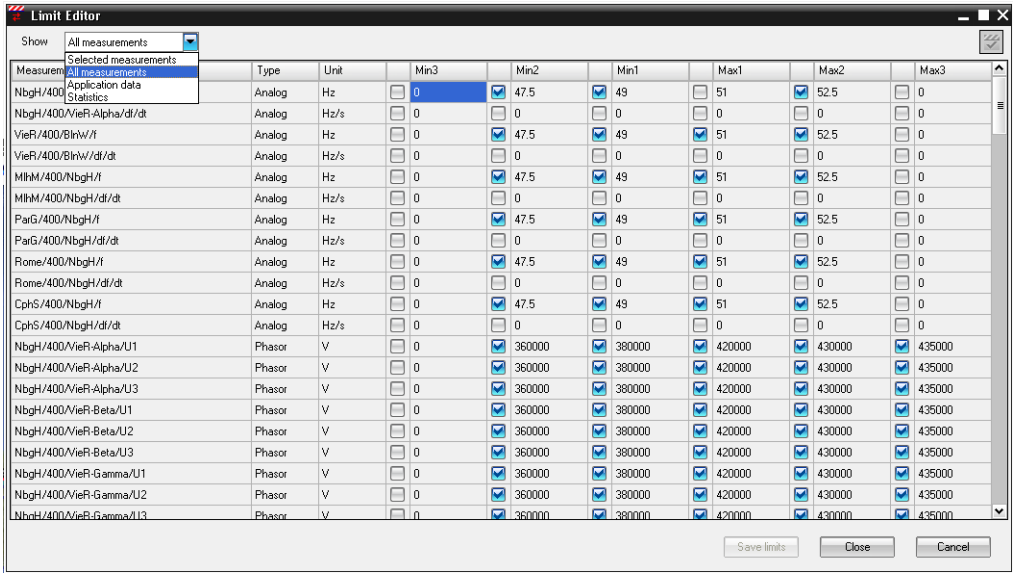


Figure 1-3 SIGUARD PDP, Limit Editor

SIGUARD PDP Engineer

With **SIGUARD PDP Engineer**, you configure the complete SIGUARD PDP system. Here you can configure PMUs, calculated values, the graphical display, applications, and the data distribution in separate, respective windows.

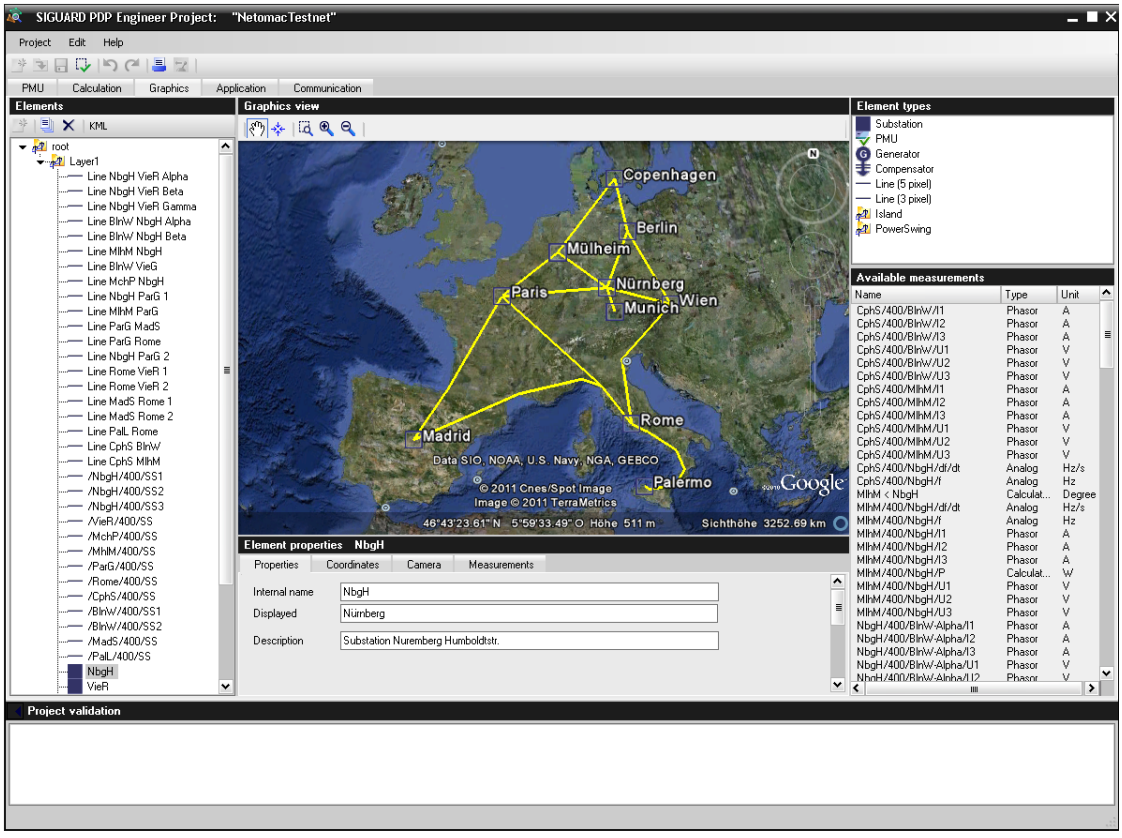


Figure 1-4 SIGUARD PDP, SIGUARD PDP Engineer

1.2 Performance Features

SIGUARD PDP is self-standing software and runs independent of other applications.

Data Volume

SIGUARD PDP processes the data from up to 4,000 measuring channels (for example, phasors, analog/digital measured values) and 1,000 calculated values.

The measured values can originate in PMU devices or PMUs from third parties. The devices must be able to use the communication protocol IEEE C37.118. A maximum of 100 PMUs can be connected to the SIGUARD PDP Computer.

Free hard disk drive capacity for the ring archive of approx. 14 GB is required for the following configuration:

- 64 channels (for example, 8 PMUs with 8 channels each)
- A repetition rate of 10 values per second (reporting rate)
- A storage duration of 7 days

For storage of events, alarms, and time ranges, additional hard disk drive capacity is required.

The performance of SIGUARD PDP can be improved by setting up the archive on a hard disk drive separate from the one on which the SIGUARD PDP Server is set up. The performance can be further improved by setting up the ring archive and the permanent archive on different hard disks.

The archive is designed as a ring archive and can store data for a duration of 7 days, for instance. After 7 days have passed, the oldest data are overwritten. Archived data can be saved permanently in the permanent archive or exported to a CSV file and then processed further.

SIGUARD PDP UI

Up to 8 SIGUARD PDP UIs can be operated by a SIGUARD PDP Server. The associated licenses are required.

Time Synchronization

For the assignment of measured values detected simultaneously from locations that lie far apart, the measured values must have a precise timestamp. For this reason, all connected devices must have an accurate time base. No high-precision time base is required for the actual SIGUARD PDP software. However, you can synchronize the SIGUARD PDP Computer, for example, with the GPS/DCF 77 time signal receiver by Hopf or NTP (Network Time Protocol). This would also ensure highly precise timestamps assigned by the SIGUARD PDP Computer via NTP, for example, for communication monitoring. Furthermore, measuring devices erroneously synchronized with the wrong time, for example, measuring devices using local time instead of (Universal Time Coordinated), can be recognized.

Interfaces

The PMUs are connected via Ethernet (optionally TCP or UDP (User Datagram Protocol)) and the communication protocol IEEE C37.118 with the SIGUARD PDP computer.

Function Monitoring

SIGUARD PDP monitors:

- the communication between the SIGUARD PDP software components
- the communication with the devices
- the function of important software components

Events and alarms are saved and can be displayed in lists (see *2.7.1 Overview*).

1.3 Configuration Example

The configuration example shown below contains the following components:

- **PMU**

  The PMU devices are installed at strategically important points in the power-supply system and supply the measured values.

- **SIGUARD PDP Server**

  SIGUARD PDP server collects data from the PMU devices, stores them in an archive, and makes them available to SIGUARD PDP UI, for example.

- **SIGUARD PDP UI** (User Interface)

  With SIGUARD PDP UI, you can display archived data and analyze it. On a SIGUARD PDP server, you can simultaneously access several SIGUARD PDP UIs.

In the example, the PMU devices are in 2 local networks (LAN - Local Area Network). These are connected with a local network on the office level via a WAN (Wide Area Network).

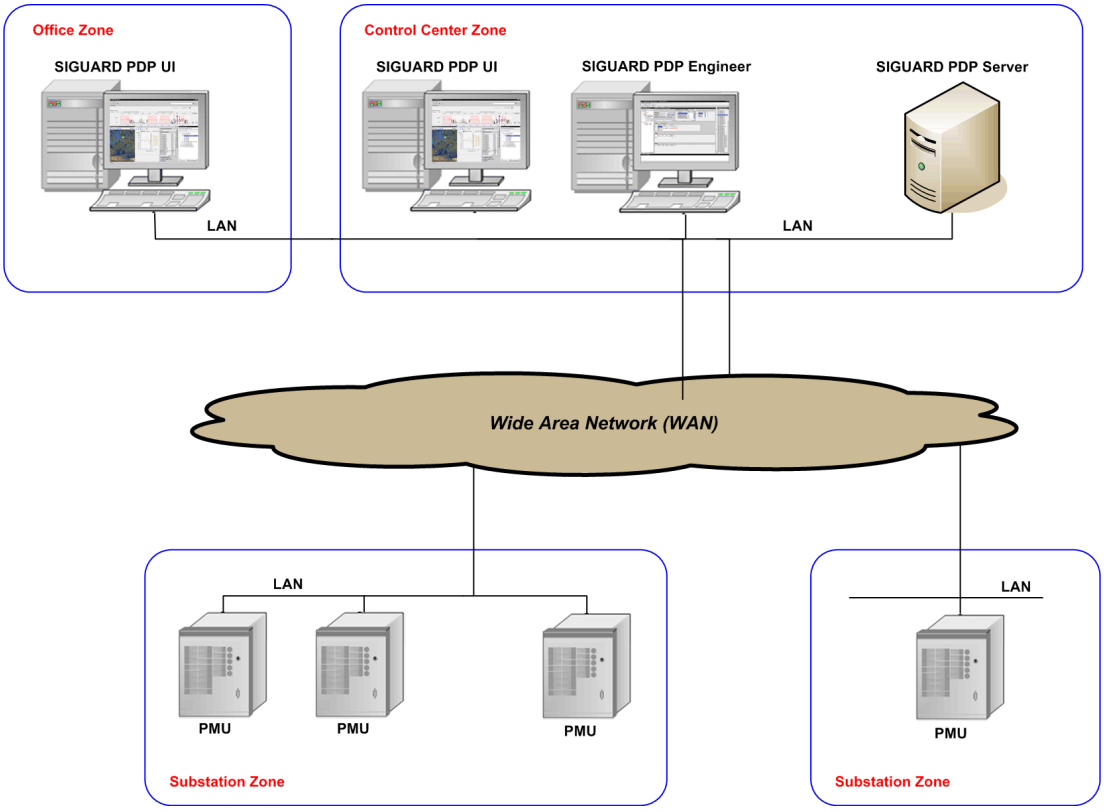


Figure 1-5 System Configuration with SIGUARD PDP, Example

1.4 Calculate Power System Status

1.4.1 Overview

All measured values of a system are evaluated by SIGUARD PDP UI with the aid of an algorithm and analyzed in such a way as to allow the point in time of a failure to be detected. The measured values are shown graphically with the PSS curve. The time range for the analysis can be selected as desired.

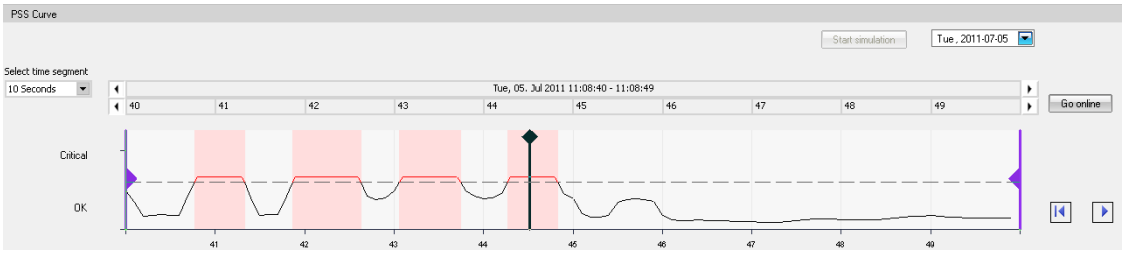


Figure 1-6 PSS Curve with Critical Measured Values (Red Curve)

The algorithm combines the measured values of the determined criteria and calculates the display height with it.

For this, the algorithm evaluates the following questions:

- How large is the difference between individual measured values and the set limiting value?
- How many measured values have approached the limiting value up to a defined limit?
- How is the significance of the measured values defined in comparison to other measured values (PSS factor)?
- How many measured values deviate from the set limiting value?

If the set limiting value of the curve is exceeded, it is displayed as critical (red curve, highlighted in red).

Further information on calculating the PSS curve can be found in chapter *1.4.3 Calculations*.

1.4.2 Configuration of the measured value evaluation

The parameters of the measuring points are required to calculate the PSS curve. These can be configured with SIGUARD PDP Engineer:

- Amount of a phasor or an analog value
- Rated value
- 1 to 3 upper limiting values (H1 to H3)
- 1 to 3 lower limiting values (L1 to L3)
- Weighting (PSS factor)

NOTE

In order to be able to perform the calculation of the PSS curve, at least the rated value and a limiting value must be specified. Here the following must apply: H1 < H2 < H3 and L3 < L2 < L1.

The specification of the limiting values relates to the rated value. The current measured values are compared with the limiting values.

The various limiting values have different significance regarding the rated value:

Figure 1-7 Limiting Values and Critical Ranges

(1) Limiting value H3
(2) Limiting value H2
(3) Limiting value H1
(4) Rated value
(5) Limiting value L1
(6) Limiting value L2
(7) Limiting value L3

- Measured values between H1 and L1 lie in the **normal** operating range
- Measured values between H1 and H2 or L1 and L2 lie in the **questionable** operating range
- Measured values between H2 and H3 or L2 and L3 lie in the **critical** operating range

NOTE

Only 1 alarm is always pending. If the value exceeds the limit from H1 to H2, there are 2 events: H1 outgoing and H2 incoming.

1.4.3 Calculations

The calculation of the PSS curve is performed according to a defined algorithm in 5 steps.

Step 1: Scaling of the Measured Values to Their Limiting Value

A measured value is scaled to its upper and lower limiting values (bands). This scaled value is shown as a percentage. The percentage states how highly loaded the corresponding band is.

- For measured values larger than the rated value, the following applies:

  0 % = current measured value lies below the band.

  100 % = current measured value is larger than or equal to the upper limit of the band

  Scaled value X = (current value – lower limit of band)/(band upper limit – band lower limit)
- For measured values smaller than the rated value, the following applies:

  0 % = current measured value lies above the band.

  100 % = current measured value is smaller than or equal to the lower limit of the band

  Scaled value X = (current value – upper limit of band)/(band upper limit – band lower limit)

Example:

The PSS value should be composed of the 3 measured values M1, M2, and M3. Here the current values are M1 = 157, M2 = 120, and M3 = 135.

Table 1-1 Scaling of the Measured Values to Their Limiting Value

	M1		**X_{M1}**	**M2**		**X_{M2}**	**M3**		**X_{M3}**	**GD_B**
H3	160	H3 - H2	**70.00 %**	160	< H2	0 %	160	< H2	0 %	**23.33 %**
H2	150	> H2	100 %	150	< H1	0 %	150	H2 - H1	**25.00 %**	**41.67 %**
H1	130	> H1	100 %	130	H1 - N	**66.67 %**	130	> H1	100 %	**88.89 %**
Rated value	100			100			100			
Current measured value	**157**			**120**			**135**			

In this example, only the rated value and 3 upper limiting values H1 to H3 are defined. With the measured values M1 to M3, the scaled value X_{M1} to X_{M3} are shown as a percentage.

- The first measured value M1 (157) lies between the upper limiting values H2 (150) and H3 (160). Since the scaled value X_{M1} is larger than the rated value, it is calculated from:

  X = (current value – band lower limit H2)/(band upper limit H3 – band lower limit H2) = (157 – 150) / (160 – 150) = 7 / 10 = 0.7000

  The band between H2 and H3 is loaded with 70.00 %.
- The second measured value M2 (120) lies between the rated value and the upper limiting value H1 (130). Since the scaled value X_{M2} is larger than the rated value, it is calculated from:

  X = (current value – band lower limit N)/(band upper limit H1 – band lower limit N) = (120 – 100) / (130 – 100) = 20 / 30 = 0.6667

  The band between the rated value and H1 is loaded with 66.67 %.
- The third measured value M3 (135) lies between the upper limiting values H1 (130) and H2 (150). Since the scaled value X_{M3} is larger than the rated value, it is calculated from:

  X = (current value – band lower limit H1)/(band upper limit H2 – band lower limit H1) = (135 – 130) / (150 – 130) = 5 / 20 = 0.25

  The band between H1 and H2 is loaded with 25.00 %.

These percentages enter into the further calculation of the PSS curve.

Step 2: Global Average Per Band (GD_B)

GD_B = Sum of all ($value_B$ * weighting) / (sum of the weightings)

$GD_B = (X_{M1} + X_{M2} + X_{M3}) / 3$

In the example, the weightings of the measured values are (PSS factor) = 1.

In table 1-1, the 3 values GD_B are calculated for the 3 bands, for example, in band H3: GD_B = (70 % + 0 % + 0 %) / 3 = 23.33 %.

Step 3: Definition of the Local Maximum (LM)

The largest value in the highest band defines the local maximum.

Example: X_{M1}

Table 1-2 Definition of the Local Maximum

	X_{M1}	X_{M2}	X_{M3}
H3	**70.00 %**	0 %	0 %
H2	100 %	0 %	25 %
H1	100 %	66.67 %	100 %

NOTE

If all values are 0% in the highest band H3, the highest value (deviation from 0%) in the second-highest band H2 defines the local maximum.

Step 4: Calculation of the Average Between GD_B and LM

A single failure should also be evident in the global maximum.

$T_B = (LM_B + GD_B) / 2$

Table 1-3 Definition of the Local Maximum

	X_{M1}	GD_B	T_B
H3	70.00 %	23.33 %	**46.67 %**
H2	100 %	41.67 %	**70.84 %**
H1	100 %	88.89 %	**94.45 %**

Step 5: Calculation of the Global Indicator

The global indicator is the average value of the sum of T_B of all bands and is calculated as follows:

$(T_B(H1) + T_B(H2) + T_B(H3)) / 3 = 70.65$ %

If the limiting value of 60 % is exceeded, as in the example, the PSS curve is displayed in red and is highlighted with a red area. The red coloring represents the critical range.

NOTE

The algorithm for calculating the PSS curve has a patent pending.

1.5 SIGUARD PDP Power Swing Recognition (PSR)

The SIGUARD PDP Power swing recognition (PSR) can recognize, evaluate, and display active power swings in the power system. In this way, critical power swings in the energy supply network are recognized and reported automatically.

The SIGUARD PDP Power swing recognition can execute several **PSR jobs** simultaneously. There are 2 different kinds of jobs, which differ regarding input variables:

- Angle difference between 2 voltage phasors which are measured at 2 different points in the power system (also see UI: **Phase Angle Difference**).

  This variant requires 2 Phasor-Measurement Units (PMUs) that each supply at least voltage phasors.
- Active power that is measured as the product of the voltage phasor and current phasor at one point in the power system (see also UI: **Active Power**).

  This requires a PMU which supplies the voltage and current phasors.

Different **Jobs** for swing recognition are defined, depending on the selected input variables and the corresponding PMU combination. The PSR executes these jobs simultaneously.

The input signals in the form of angle difference or active power, are written back to the PDP Server continually for comparison with the later events of the swing recognition in order to display them for subsequent analysis of swing processes in SIGUARD PDP UI. Within the PSR, these values are accumulated over preselected time ranges. If the data are complete, these values are transformed into the frequency range in order to recognize the characteristic frequencies for the observed swing process. Since several frequencies can be picked up simultaneously, the PSR can identify and calculate several modes simultaneously. The maximum number of the expected modes and their typical frequency ranges are defined in SIGUARD Engineer.

For every pickup frequency, the current value of the magnitude is calculated. It may be necessary to measure over a longer period of time, depending on swing frequency. For this reason, errors can occur during the increasing or decreasing process that is typical for power swings.

A quantity that is essential regarding the possible effects is the damping factor ξ (zeta) with respect to the swing frequency. In the following, it is referred to as damping for simplicity. The variable is dimensionless and stated in the following as percentages. It gives a relative measure – independent of the frequency of the power swing – for the change in magnitude of the swing from any given maximum to the next.

Negative damping ξ is characteristic of a power swing that is decreasing in magnitude. The following figure shows a corresponding change in magnitude with time for the sake of illustration.

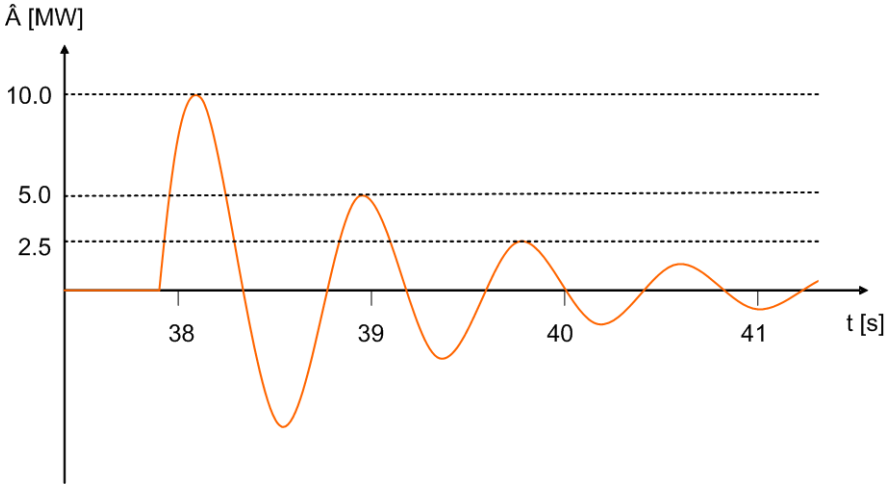


Figure 1-8 Pickup of a subsequently decreasing power swing for a job of the type Active Power

The damping ξ of the power swing shown is -10 %. The frequency is 1.2 Hz.

A power swing with a damping ξ below -5 % is considered uncritical if the magnitude is not too high.

NOTE

Take special note of swing events above a damping of -3 %, since further pickups in the power system can lead to a quick rise in the magnitude.

Unattenuated power swings are particularly critical. A damping of 0 % corresponds to a magnitude that is not changing with time. Increasingly positive values are accompanied by an increasing magnitude trend that gets steeper over time. The following figure shows, as an example, a power swing with this behavior.

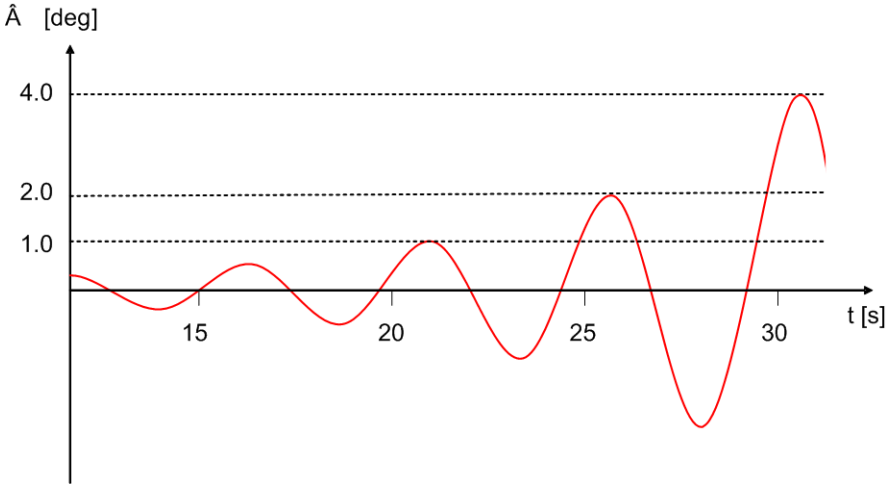


Figure 1-9 Increasing power swing for a job of the type Phase Angle Difference

The damping ξ of the power swing shown is +10 %. The frequency is 0.2 Hz.

In order to judge the consequences of a swing event, a quantity that characterizes the potential hazard is determined from the damping ξ (damping ratio) in conjunction with the current swing magnitude Â. This quantity is designated in the following as DOE (Degree of Exposure). The increase in the damping factor and swing magnitude is accompanied by a hazard. This hazard is indicated by an increasing value of the DOE. The following figure illustrates determination of the DOE value.

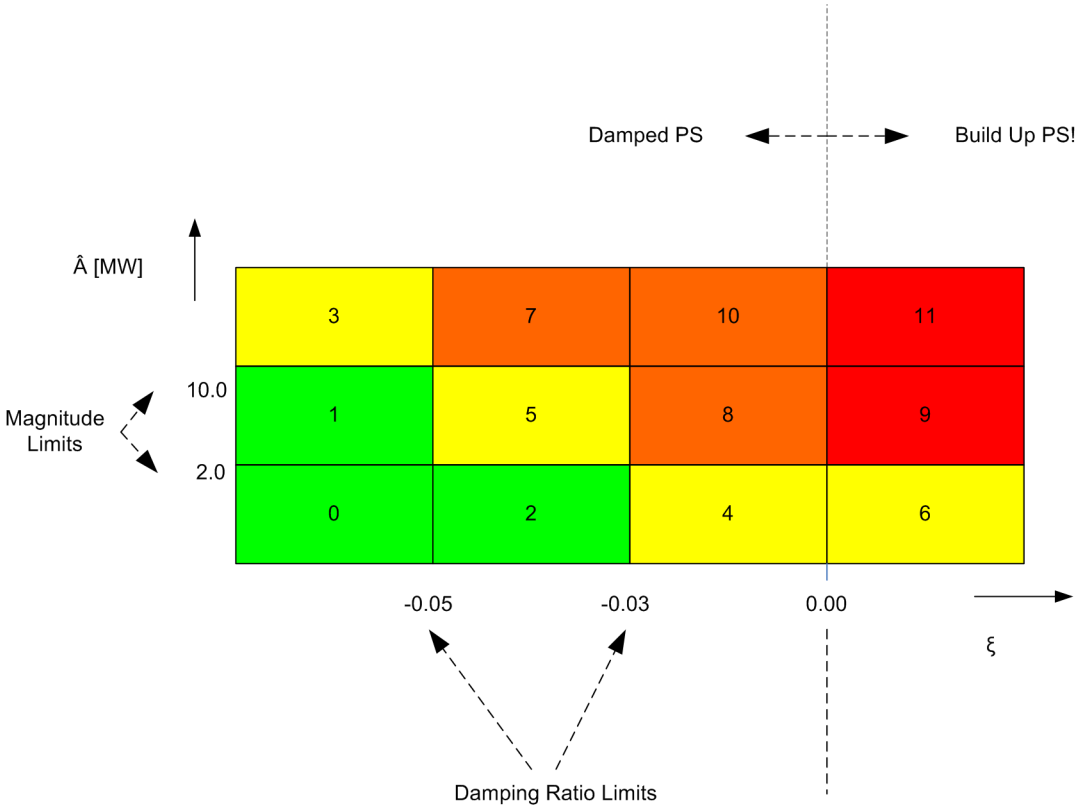


Figure 1-10 Calculating the DOE

The calculation of the DOE is based on limits of damping (damping ratio limits) and magnitude (magnitude limits). These limits are determined in SIGUARD Engineer (see chapter *4.7.3 Power Swing Recognition PSRs*) for each job.

■

2 SIGUARD PDP UI

2.1 Overview

The program interface of SIGUARD PDP consists of the following interface components:

- **Menu and Toolbar**

  You can call up general functions via the menu and the toolbar (see *2.2 Menu and Toolbar*).

- **PSS Curve**

  This window section displays the combined status of the entire measured or observed power-supply system as **Power System Status**.

- **SIGUARD PDP UI - Map**

  This window section shows the network topology of the power-supply system on a map.

- **Chart View**

  This window section displays the detailed curves of individual measured values or calculated values over a defined time range.

- **Measurements, applications and formulas**

  This window section contains lists than can be shown and hidden:

  - Measuring points used
  - All available measuring points
  - Predefined formulas
  - Voltage stability curves
  - Statistics

  You can find further information on this in chapter *Measured values, applications and formulas*.

- **Event list, Alarm list**

  In this window section, events and alarm indications are listed.

- **PSR Analysis**

  In this window section, the PSR jobs for the stations in the power system are listed with the corresponding phase angles and PSR modes.

You can change the size and arrangement of the window sections to meet your requirements, see *2.8 Arranging Program Interface*.

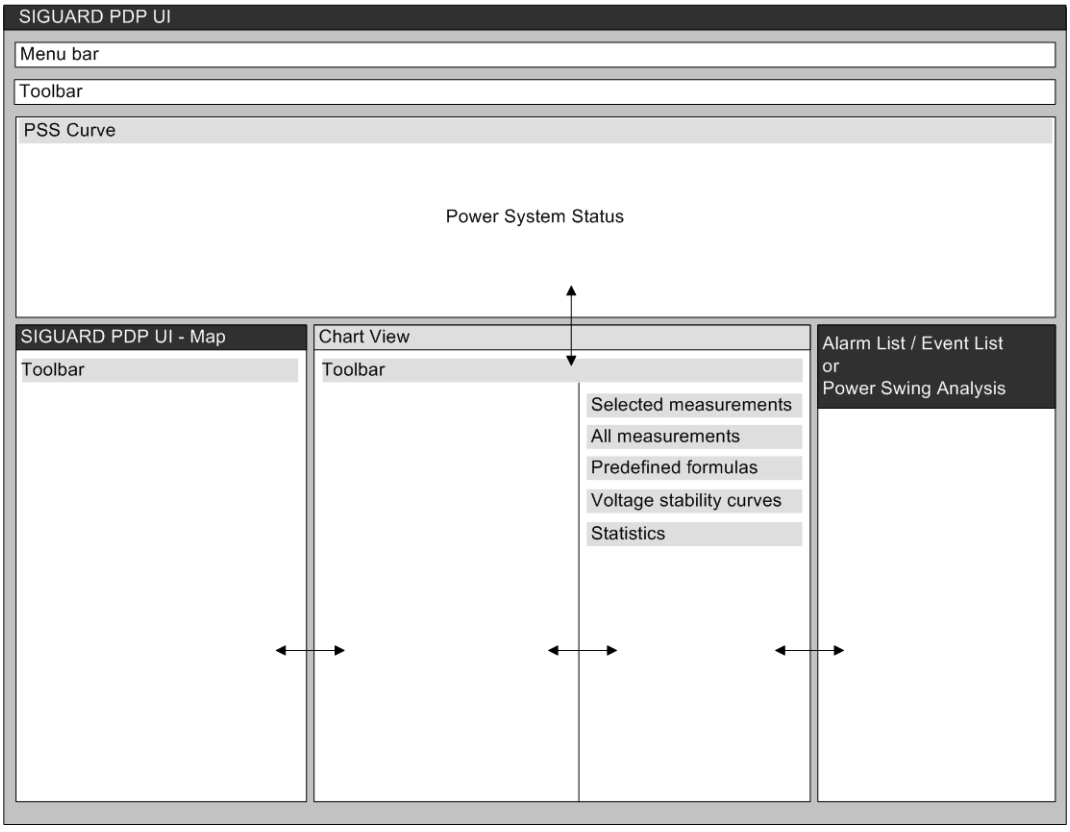


Figure 2-1 Schematic Representation of the User Interface

2.2 Menu and Toolbar

Menu Entries

You can call up the following functions via the menu:

- **File > Save to CSV ...**

  With this menu item, you can save the measured values of the current time range as a CSV file, see *2.10 Reporting*.

- **File > Save time range...**

  With this menu item, you can save the measured values of the current time range in the permanent archive, see *3.4.1 Exporting of Time Ranges*.

- **File > Load time range...**

  With this menu item, you can load the measured values of a previously saved time range from the permanent archive, see *3.4.2 Importing Time Ranges*.

- **File > Delete time range...**

  With this menu item, you can delete the measured values of a previously saved time range from the permanent archive, see *3.4.3 Deleting Time Ranges*.

- **File > Exit**

  With this menu item, you close SIGUARD PDP UI.

- **Help > Contents...**

  With the menu item, you call up the online manual.

- **Help > Index**

  With the menu item, you call up Online Help. The functionality of SIGUARD PDP discussed. It also contains instructions for working with the various components of SIGUARD PDP.

- **Help > About SIGUARD PDP UI...**

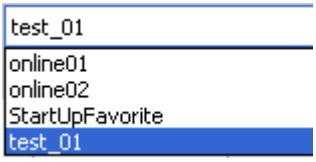
  With this menu item, you query the current SIGUARD PDP UI program version.

Toolbar

Via the toolbar in the main window, you can call up the following functions:

Table 2-1 Main Window Toolbar

Icon	Explanation
	Click this icon in order to open a new chart view.
	Click this icon in order to display the map **SIGUARD PDP UI - Map**.
	Click this icon in order to open a new event list.
	Click this icon in order to open a new alarm list.
	Click this icon to open the window section **Power Swing Analysis**.
	Click this icon in order to save the current UI as a favorite.

Icon	Explanation
	The selected favorite will be displayed in the text box. The list box displays all saved favorites.
	Click this icon in order to delete a favorite.

Status of Limiting Values

Beneath the menu bar, there is a bar with the designation **PSS Curve**. The color of this bar shows the status of the limiting values.

- **Gray**

  All entered limiting values are in effect and are accounted for in the display.

- **Orange**

  At least one limiting value was changed. The change affects the local computer, but not the entire system. You can find information on how to enter limiting values in the section *2.9 Limit Editor*.

- **Pink**

  SIGUARD PDP UI has lost the connection to the SIGUARD PDP Server. Wait until the connection is re-established or contact the administrator of the server.

2.3 Power System Status

In the **Power System Status** window section, you see a curve displaying the state of the complete power system. The curve can be calculated from all available measured values for which the limiting values are defined, see *1.4.1 Overview*. With the tool **SIGUARD PDP Engineer**, you can assign parameters for which measured values are to be included in the calculation, see *4.4 Phasor Measurement Unit (PMU)*. The curve is calculated from the weighted distances between the measured values and their limiting values.

You can define the displayed time range of the curve. It is divided into defined time steps, for example, hours. The right end of the diagram shows the current value.

Displaying Current Values

Display the current values as described in the following:

✧ Click the **Go online** button to the right of the selection list.

The curve is continuously updated with current values.

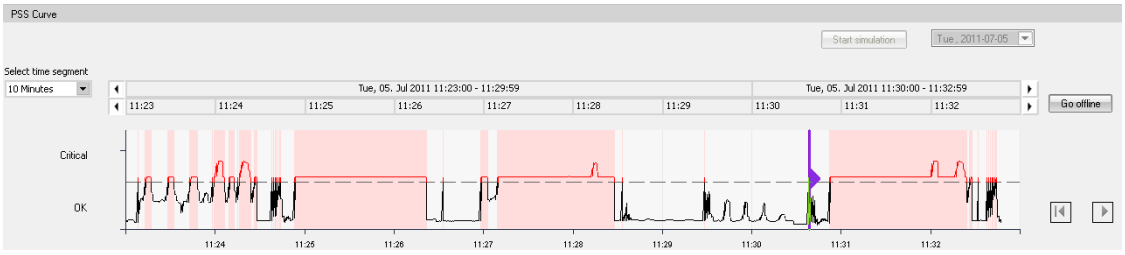


Figure 2-2 Power System Status, current values (online mode)

The set time range, for example, day, is represented as a curve and updated continuously. Values that have already been displayed are moved to the left. The latest value is shown on the right side.

If not enough values are available yet, for example, in the start phase, the left side of the curve is empty. It is completed by newly arriving values.

Displaying Values from the Past

For subsequent analysis, you can display values from the past (archive values) as curves in the **PSS Curve** and **Chart View** sections of the window.

Set the values from the past as follows:

✧ Click the **Go offline** button to the right of the selection list.

The curve is no longer updated with current values.

Switching to **Offline mode** only affects SIGUARD PDP UI. SIGUARD PDP continues to archive the incoming values, but they are not displayed in this SIGUARD PDP UI. You can launch a second instance of SIGUARD PDP UI on the same computer and thereby stay online.

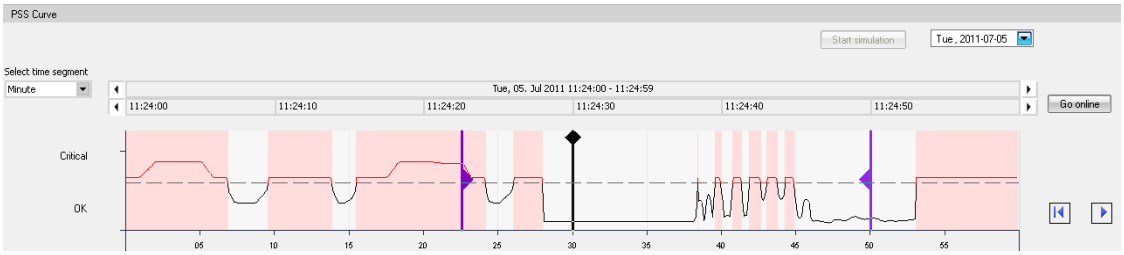


Figure 2-3 Power System Status, Offline Values

The selected time interval is set by 2 **sliders**. A **cursor** is displayed within the time interval. You can move the sliders and the cursor on the time line with the mouse.

An enlarged display of selected values, for example, voltage and power of this time interval is possible in the **Chart View** window section.

The position of the cursor in the time interval has the following effects:

- Its time position is automatically transferred to the cursors in the line charts.
- Both phasors in vector diagrams and stability curves are displayed for the instant determined with the cursor.
- The state of the objects is shown in the window section **SIGUARD PDP UI - Map** depending on the cursor position.
- In the **Event list**, a black horizontal line is shown, which separates the range of the events already entered from those that will arrive in the future, as seen from the cursor.
- The **Alarm list** displays the events that have been queued at this time point.

Setting options/displays

✧ Change the display of the curve in the window section **PSS Curve** using buttons and list boxes.

The following table explains the setting options and displays for the **PSS Curve** window section.

Table 2-2 Window Section PSS Curve

Element	Explanation
Di , 2011-09-13	You can select the date from a calendar.
10 Minutes	You can select the time range to be represented as a curve from a list: • Month • Week • Day • Quarter day (6 hours) • Hour • 10 Minutes • Minute • 10 Seconds You can also change the time range shown by clicking the time bar, see below.
	1) When offline display is activated, the top arrows enable you to scroll forward or backward through the value archive page by page. 2) With the aid of the bottom arrows, you can move forward or backward through the archive in small steps.
Go online	Use this button to set online mode. The current values are displayed as a curve.

Element	Explanation
Go offline	Use this button to set offline mode. Values from the archive are displayed as a curve. Using the arrows, you can scroll through the archive.
OK	Non-critical values of the power-supply system are displayed as a black curve in the lower section of the display.
Critical	Critical values of the power-supply system are displayed as a red curve in the top part of the display. The higher the value is represented on the y-axis, the more critical it is. The critical time range is highlighted in light red.
	Use this button to move the cursor to the start of the selected time range. This function is available only in **offline mode**.
	Use this button to start the sequence. The cursors in the charts move along automatically. In addition, the status of the objects at the respective instant is displayed on the map. This function is available only in **offline mode**.
	Use this button to stop the sequence. This function is available only in **offline mode** with launched sequence.
Start simulation	Use this button to start simulating the PSS curve. This function is available only if: • a connection to the SIGUARD PDP server is established • the offline mode is set • limiting values were changed locally

You can zoom in on the time range shown by clicking the **upper line of the time bar**, for example, from 1 min to 10 min.

You can zoom out of the time range shown by clicking the **lower line of the time bar**, for example, from 1 hour to 10 min.

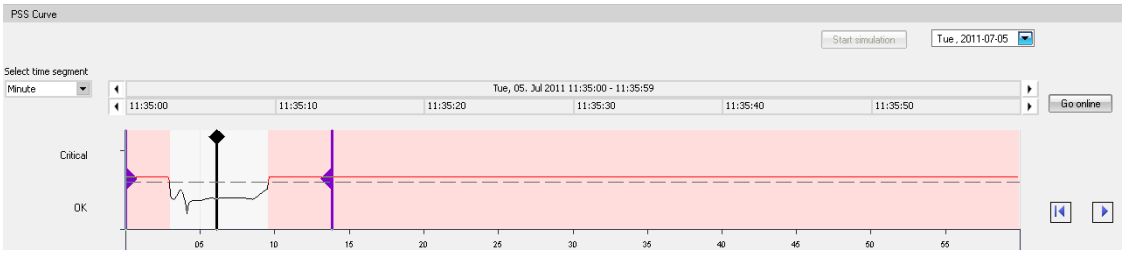


Figure 2-4 Power System Status, Change Time Range

Simulation of the PSS Curve

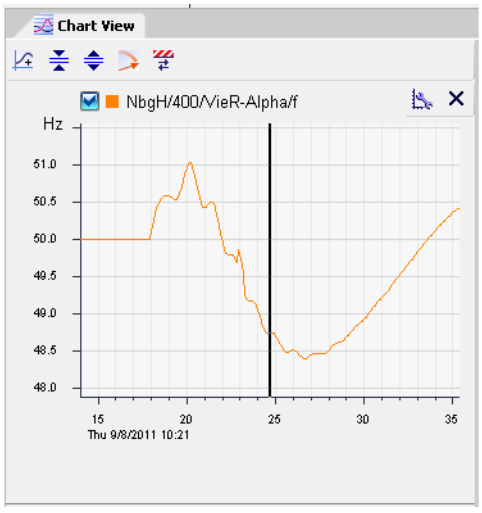
If you would like to test what effect the changed limiting values of the measured values have on the PSS curve, you can perform a simulation of the PSS curve. In this way, you can optimize the settings of the limiting values, such that the PSS curve shows the appropriate sensitivity for your power system. The simulation shows the effect a change in the limiting values has on the PSS curve. The simulated PSS curve is placed as a red line on the current PSS curve (black line).

Requirements for the simulation of the PSS curve (button **Start simulation** is active):

- A connection to the SIGUARD PDP server is established (status row: online).
- The offline mode is set.
- Limiting values were changed locally.

You simulate a PSS curve in this way:

✧ Select any measured value, for example, a frequency, from the list **All measurements**, and display these as a diagram.



✧ Display the limiting values for the displayed diagram.

✧ Change one or several limiting values.

NOTE

Do not save the changes with **Save limits**, since otherwise the previous PSS curve would be changed in the system.

✧ For the simulation of the PSS curve, close the dialog for changing the limiting values with **Close**.

The color of the **PSS bar** bar changes from gray to orange.

✧ Start the simulation by clicking the button **Start Simulation**.

The simulated PSS curve is calculated. The original PSS curve is a black line; the simulated PSS curve with the changed limiting values is displayed as a red curve.

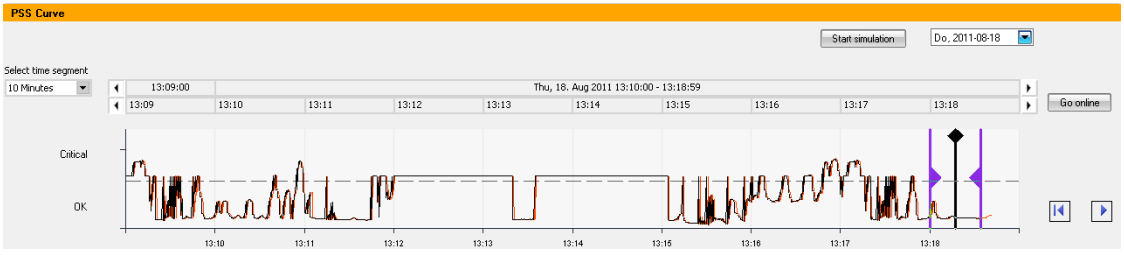


Figure 2-5 PSS Curve (Original and Simulated Curve)

2.4 Map

In the window section **SIGUARD PDP UI - Map**, the network topology of the power-supply system is displayed on a map. The individual objects/measuring points of the power-supply system, such as generators and lines, for example, are shown as icons.

The parameters of the power-supply system shown on the map can be assigned in the tool **SIGUARD PDP Engineer**, see *4.6.1 Overview*.

The map is taken from Google Earth and the objects of the power-supply system are shown. The navigation and the zoom functions are standard functions of Google Earth. In addition, further special functions are available.

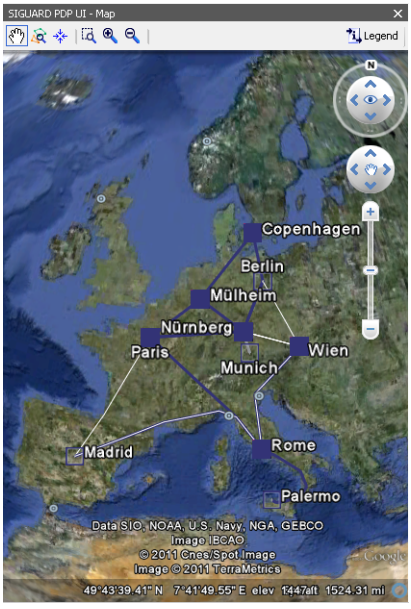


Figure 2-6 Map, Map with Topology of the Power-Supply System

✧ If no map is open yet, click the button  to display the map.

Google Earth is started and appears in the window section **SIGUARD PDP UI - Map**.

The current status of the objects is displayed in color. The general meaning of the color is:

- **Blue**

  The object is in normal operation, the measured values for this object lie within the defined range, the status is OK.

- **Yellow**

  The measured values for this object lie above the limiting value **Max1** or below the limiting value **Min1**, the status is not critical yet.

- **Red**

  The measured values for this object lie above the limiting value **Max2** or below the limiting value **Min2**, the status is critical.

- **Gray**

  No current measured values are available for this graphical object.

- **Edge only**

  No measuring device is present.

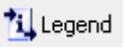
You can find a more detailed description of the meaning in the following table.

Setting Options/Displays

✧ Change the display of the map in the window section **SIGUARD PDP UI - Map** with the help of the icons.

The following table explains the setting options and displays available in the **SIGUARD PDP UI - Map** window section.

Table 2-3 Window section SIGUARD PDP UI - Map

Element	Setting options
	Click this icon on the toolbar of SIGUARD PDP UI to start Google Earth.
	Click this icon in order to navigate with the standard functions of Google Earth.
	Click this icon in order to select an area on the map. The measuring points that lie within the selected area are listed under **Selected measurements**.
	Click this icon in order to bring an object into the middle of the map section. An object is displayed in the middle of the map section by clicking with the mouse pointer on the object. If you point to a substation symbol with the mouse pointer in this mode, the associated measured values are shown in a tooltip.
	Click this icon in order to zoom in on an area on the map.
	Zoom function: Zoom in
	Zoom function: Zoom out
	Click this icon, in order to display the legend of the objects. The legend is explained as follows.
	Line The displayed colors mean: Red =The line is overloaded. Yellow =The line is heavily loaded. Dotted =The line is out of order. Blue =The line is operating normally. Gray =The values of the line are not captured.
	Generator The displayed colors mean: Red =The generator is overloaded. Yellow =The generator is heavily loaded. Blue =The generator is operating normally. Unfilled =The values of the generator are not captured.

Element	Setting options
	Substation The displayed colors mean: Red =In the substation, a voltage was measured that deviated strongly from the rated value. The limiting value Max2 or Min2 was violated. Yellow =In the substation, a voltage was measured that deviated considerably from the rated value. The limiting value Max1 or Min1 was violated. Blue =In the substation, a voltage was measured that is in the normal range. Gray =The substation is out of order. Unfilled =The values of the substation are not captured.
	Compensator The displayed colors mean: Red =The compensator is overloaded. Yellow =The compensator is heavily loaded. Blue =The compensator is operating normally. Gray =The compensator is out of order. Dotted =The values of the compensator are not captured.

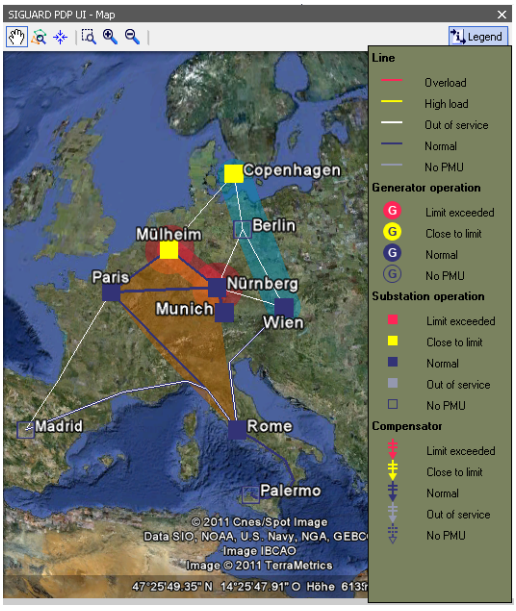


Figure 2-7 Window section SIGUARD PDP UI - Map with a legend displayed

Display of island-state detection (ISD)

If an island is formed between 2 or more substations, then the detected islands are displayed in the map as colored areas. The color scale corresponds to that of the diagrams (1st island shown in orange, 2nd island shown is blue, etc.).

- ✧ Open the event list.
- ✧ Filter this list with **Island Detection**.
- ✧ Select an event in order to display the corresponding islanding.

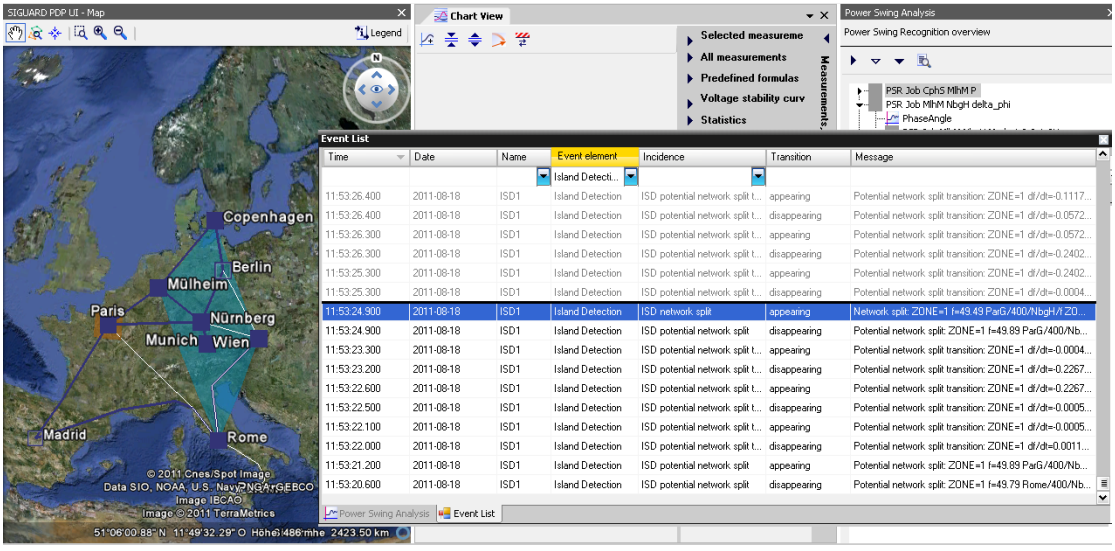


Figure 2-8 Islanding with a certain event

Display of power swing recognition (PSR)

A swing detected in the power system is shown in the map as red circular areas around the substations. The circular areas can also be connected by red, rectangular areas, if the swing affects several substations.

- ✧ Open the event list.
- ✧ Filter this list with **Power Swing Recognition**.
- ✧ Select an event in order to display the corresponding power swing recognition.

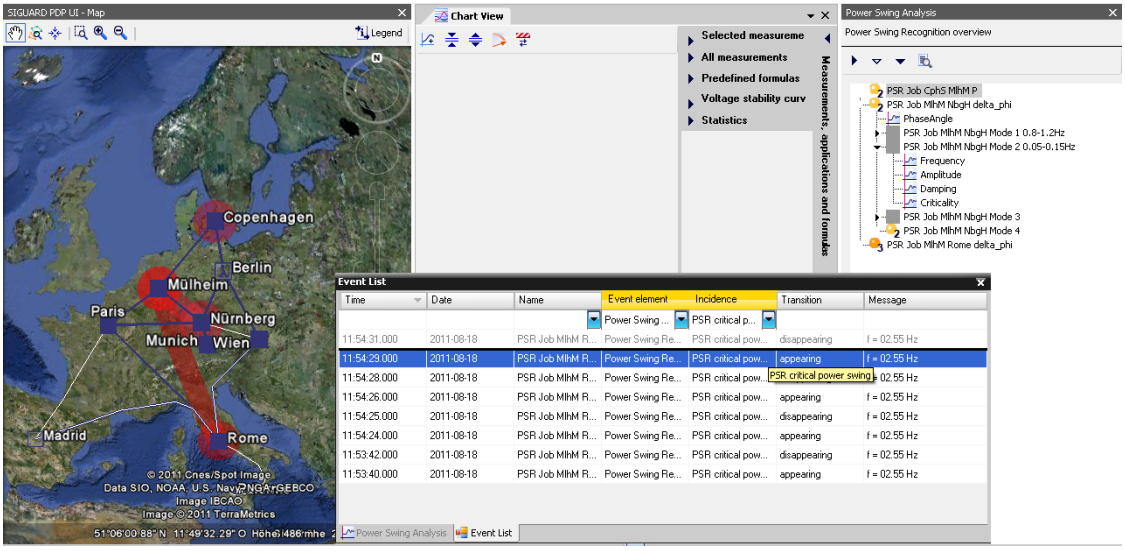


Figure 2-9 Power swing recognition with a certain event

You can find further information on the analysis of power swing detection in chapter *2.11.3 Power Swing Recognition*.

NOTE

The application **Island Detection** creates an event in case of detecting an island. The event contains information about frequencies in all detected islands. The calculated value resulting from the mean value may differ from the value displayed in the chart.

2.5 Chart View

In the **Chart View** window section, you can simultaneously display several **diagram groups**. The diagram groups are separated from one another by horizontal lines. Within a diagram group, the displayed time range is identical, for example, values of an instant are listed exactly one below the other. In order to group the display of measured values, you can open several Chart views.

The time lines of the diagrams of a diagram group are always scaled identically to ensure comparability of the values. Depending on the width of the y-axis label, however, diagrams in different diagram groups can be scaled slightly differently.

Depending on whether you drop a measuring point above or below the horizontal line, a new diagram is created within the diagram group (when you place the object above the line) or a new diagram group is generated (when you place the object below the line).

Every diagram group can contain several **Line diagrams** but only one **Vector diagram**.

The **Diagram type** is determined by the type of the first curve. An analog curve is displayed in a line diagram, a phasor in a vector diagram. In order to represent the change in the magnitude of a phasor with time in a line diagram without an additional analog value, first create an empty line diagram and pull the phasor into it. To generate a blank line diagram, use the  button.

You can display several **curves** in each diagram. To represent an additional curve in an existing diagram, drag and drop a measuring point to the diagram. The curve adapts to the diagram type. A line diagram shows only the amplitude of a phasor.

In real time display mode, the curves in a line diagram move to the left. New values are added on the right side.

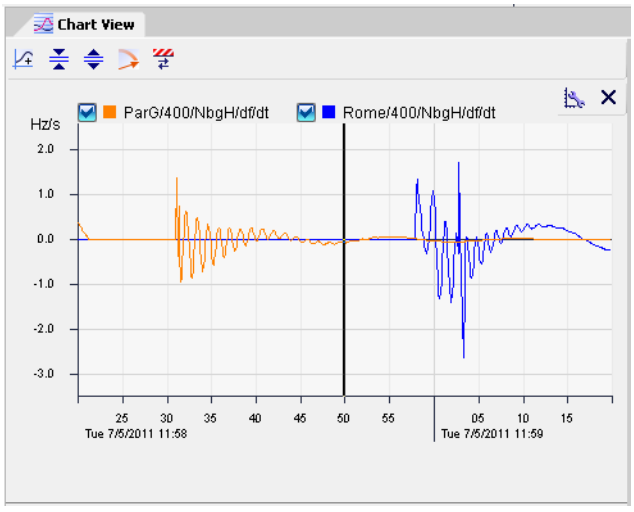


Figure 2-10 Chart View, display mode of several curves of a time range

The diagrams display the time range that has been selected with the slider in the **PSS Curve** window section. The cursor position on the time line corresponds to the cursor position in the **PSS Curve** window section.

In **offline mode**, a past event can be rerun repeatedly to analyze the underlying dynamic processes. A cursor then runs through the line diagrams.

Parameter of displayed curves

The measured values displayed are listed with the respective colors next to or above the diagram. The corresponding curve can be shown/hidden via the check box selections.

Right-click an entry in the list to open a context menu. The menu items mean:

- **Signals**

  Use this menu item to show/hide individual curves.
- **Copy to clipboard ....**

  Select this menu item to copy the diagram to the Microsoft Windows clipboard.
- **Show measure line** (only in offline mode)

  With this menu item, you can show a horizontal line for a certain measuring point. The precise measured value is shown at the intersection of the horizontal line with the diagram.
- **Show second cursor** (only in offline mode)

  With this menu item, you can show a second cursor (vertical line). The difference from the first measured value is shown at intersection of this line with the diagram.
- **Edit limits**

  With this menu item, you can open the Limit Editor for this signal. The limiting values are displayed.

  Alternately you can display the limiting values of a curve by double-clicking the corresponding entry in the curve list.
- **Show average value** (only for line diagrams, no formulas)

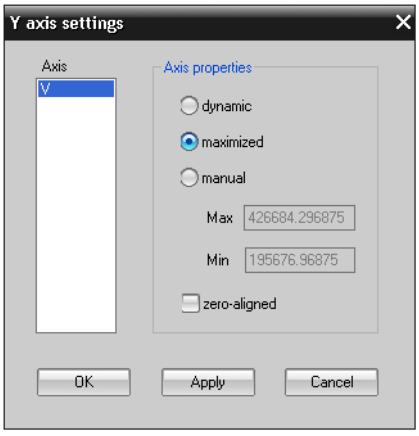
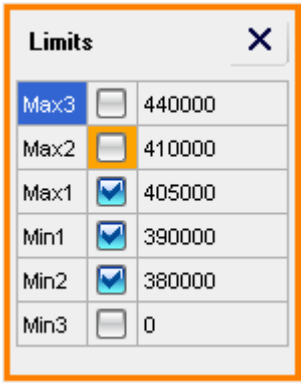
  With this menu item, an average is generated for every measured value of the curve and the curve is thus smoothed. The smoothed curve is identified by **[Avg]** in the name.

Setting Options/Displays

The following table explains the setting options and displays for the **Chart View** window section.

Table 2-4 Window Section Chart View

Element	Explanation
	Click this element in order to generate an empty line diagram.
	A click on the left element successively reduces the height of all diagrams (for overview).
	A click on the right element successively enlarges the height of all diagrams (for details).
	With a click on this element, the average values of the curve are displayed (smoothing average generation).
	This element is only active in online operation. Click this element in order to open a dialog in which you can switch on/switch off the trace of the tie point and change the chronological length of the tie point.
	Click this element to start the editor for all limiting values.
	Click this element in the Limit Editor to activate changed limiting values in the overall system. The color of the **PSS Curve** bar changes from orange to gray. This element is visible only if a limiting value was changed Limit Editor or if the Limit Editor is opened for an individual curve. It is opened by double-clicking a curve/legend entry.

Element	Explanation
	Click this element, in order to change the scale of the y-axis.  • Axis The following properties are to be set for the selected axis: • dynamic With the setting **dynamic**, the scaling of the y-axis is always automatically selected such that the displayed curves are displayed at the maximum scale. • maximized With the setting **maximized**, the scaling is corrected such that the displayed curves are displayed at the maximum scale. • manual With the setting **manual** the scaling of the curves is set to the entered minimum and maximum values. • zero-aligned If zero-alignment is selected, the y-axis is displayed from the zero point and the curves are re-scaled correspondingly.
	This element is active only with the setting **maximized**. Click this element in order to correct the scaling one time, such that the displayed curves are shown at maximum scale.
	Click this element to delete the relevant diagram, including all curves represented in it. All following diagrams move up by one line.
 	This element is called by double-clicking a measured value above the diagram. The border color correlates with the curve color. The element shows the currently valid limiting values for the associated curve. You can change and enable/disable the limiting values. Enabled limiting values are represented as a horizontal line in line diagrams and as a circular line in phasor diagrams. Effective limiting values are indicated by a blue background. Changed limiting values that are not yet effective are indicated by an orange background. When clicking the cross, the element is closed and the changes are saved locally. An active limiting value must be plausible (for example, Max2 > Max1), otherwise saving it is rejected.

2.6 Measured Values, Applications and Formulas

2.6.1 Overview

In the window section **Measurements, applications and formulas**, you will find:

- **Selected measurements**

  The list contains measuring points that belong to the selected objects in the window section **SIGUARD PDP UI - Map**.

- **All measurements**

  The list contains all measuring points that are available in the power-supply system. In this list, you can also define whether the measuring points are listed in alphabetical order, sorted by unit or type.

- **Predefined formulas**

  The list contains all predefined formulas.

  These formulas can be applied to the measured values.

- **Voltage stability curves**

  The list contains special curves (applications), for example, voltage stability curves.

- **Statistics**

  Values that can be displayed in diagrams are gathered for each PMU.

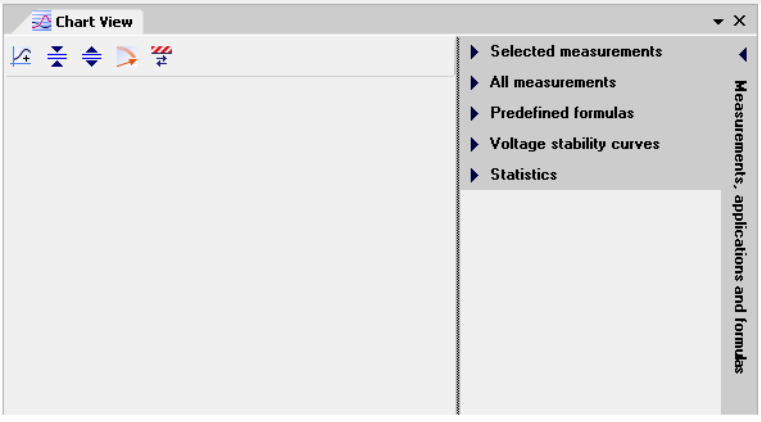


Figure 2-11 Listings of Measuring Points, Measuring-Point Applications, and Formulas

You can define whether these are listed in alphabetical order, sorted by unit or type by clicking once or twice on the corresponding column heading.

Up to 10 measuring points/formulas/VSCs/statistics can be displayed in a diagram.

To do this, drag and drop the selected measuring point into the window section **Chart View**. A measuring point of the **Phasor** type is represented as a vector diagram unless you drag and drop it to a previously created line diagram. A measuring point of the **Analog** type is always displayed as a line diagram. You can insert measuring points into existing diagrams of the same type. You can select several measuring points and simultaneously drag and drop them into a diagram.

In the measurements window section, right-click a measuring point of the **Phasor** type to define it as a reference phasor or to delete it.

All phasors displayed in the window section **Chart View** refer to the reference phasor. This means that all phase angles are displayed relative to the phase of the reference phasor.

With the aid of the arrows, you can show or hide the complete window section or a listing.

Information on the use of predefined formulas can be found at *3.3 Displaying Curves*.

2.6.2 Selected Measurements

The list **Selected measurements** contains all measuring points selected in the map. In this way, the number of measuring points can be limited to one substation, for example.

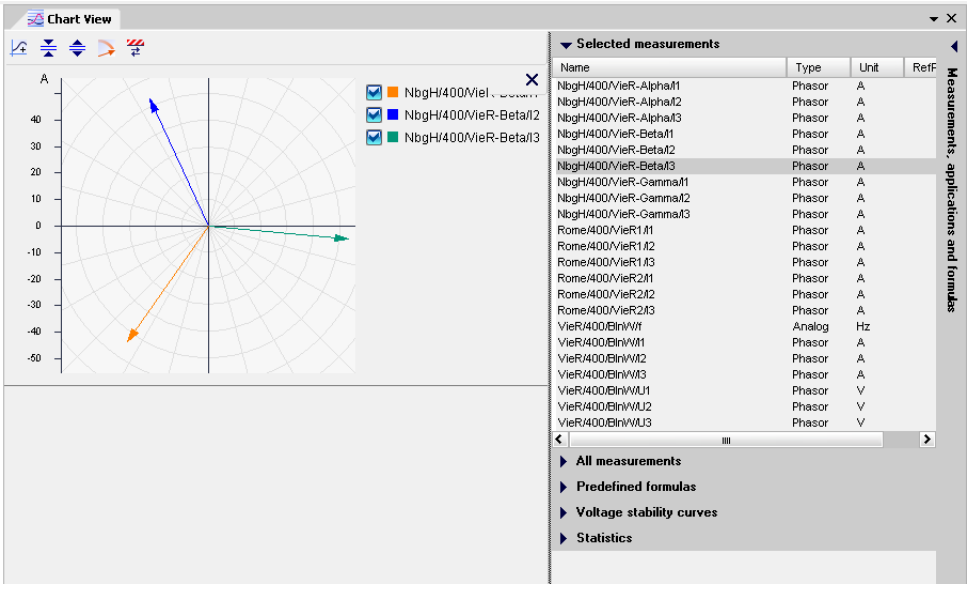


Figure 2-12 Listing of the Selected Measuring Points

2.6.3 All Measurements

The list **All measurements** contains all measuring points that are available in the power-supply system.

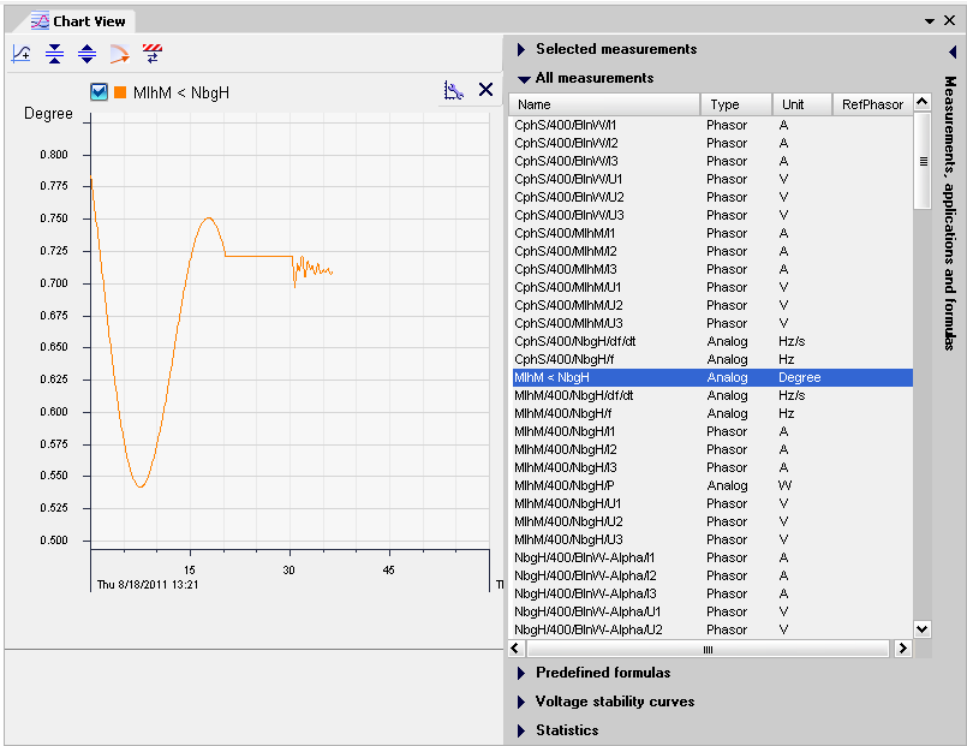


Figure 2-13 Listing of All Measuring Points

2.6.4 Predefined Formulas

The list **Predefined formulas** contains all predefined formulas in SIGUARD PDP. These formulas can be dragged into a Chart View in order to integrate corresponding measuring points into the formula as a parameter and calculate a curve from this. This curve is then shown in the Chart View. Assign a unique name to the calculated curve.

NOTE

Depending on the selected curve, only certain measured values can be used as input quantities. With some formulas, you can use constant values.

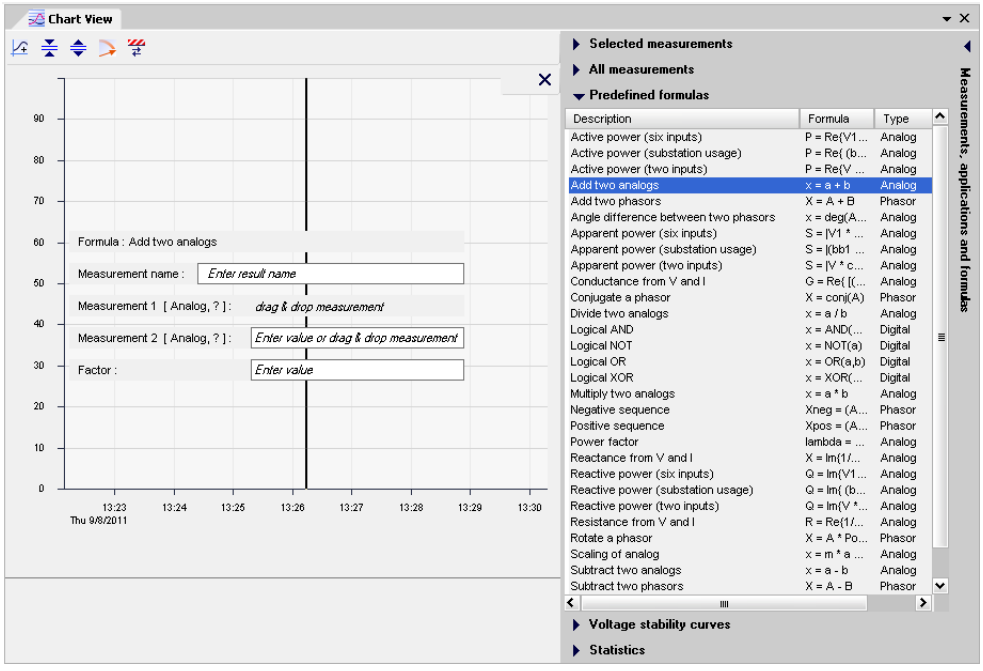


Figure 2-14 Listing of All Predefined Formulas

2.6.5 Voltage stability curves

The list **Voltage stability curves** contains all measuring points in the power system with which voltage stability curves can be calculated using the application VSC.

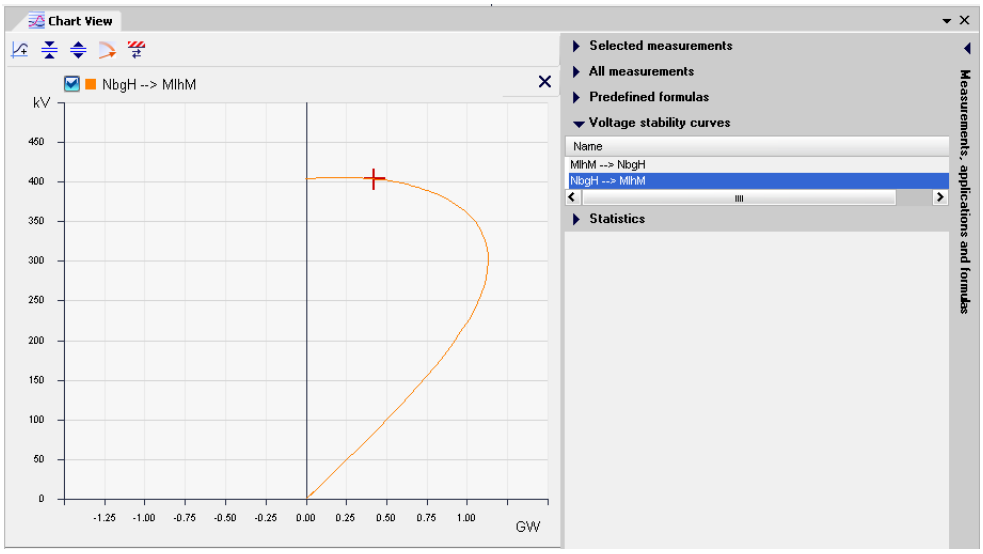


Figure 2-15 Listing of All Measuring Points for Calculation of the VSCs

2.6.6 Statistics

6 statistical values which can be displayed as diagrams are gathered for each PMU:

- **Count of received errors**

  Number of errors received per parameterizable counting period.

- **Count of received frames**

  Number of telegrams that are transmitted from the PMU to the SIGUARD PDP Server per counting period (for example, 600).

- **Count of telegram errors**

  Number of the PMU status flags contained in each telegram.

- **Count of timestamp errors**

  Number of errors with deviation from the regularity of timestamps per repetition rate.

- **Count of timestamp window error**

  Number of errors with deviation of timestamps per time slot (tolerance). The deviation can lie in the past or in the future.

- **Latency**

  Measurement of maximum latency. The latency is the time difference between the sending of the measured values from the PMU to the arrival at the SIGUARD PDP Server.

NOTE

Take note that the absolute latency is analyzable only if the PDP Server is time-synchronized. If the server is not time-synchronized, you can only observe the difference between latencies of different PMUs.

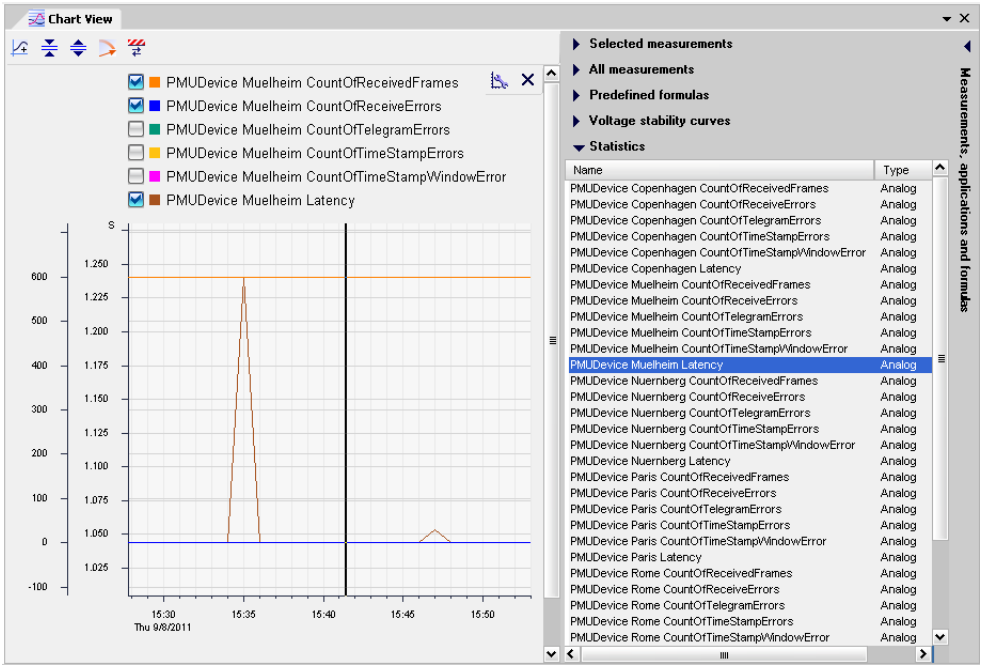


Figure 2-16 Listing of Statistical Measured Values

2.7 Alarm List and Event List

2.7.1 Overview

SIGUARD PDP UI messages can be shown in the form of lists:

- **Alarm list**

  The Alarm list contains only appearing messages.

- **Event list**

  The event list contains all messages (appearing and disappearing messages).

The alarm list and the event list are opened in the lower right window section within SIGUARD PDP UI. The window can be separated and enlarged or inserted into another position in the SIGUARD program window (see *2.8 Arranging Program Interface*).

The alarm list or event list contains alarms or events that occurred in the time range that is set by the left and right limitation of the PSS curve.

NOTE

The message **Out of Service** indicates that the mean value is less than 10 % of the calculated rated value. The message does not mean that the PMU is out of service.

2.7.2 Alarm List

Open a window for an alarm list in SIGUARD PDP by clicking the button  .

Alarm List

Time	Date	Name	Event element	Incidence	Message
18:59:56.453	2010-09-21		Island Detection	ISD error	No Frequency Value Data Available
18:59:46.406	2010-09-21	Rome	PMU Device	PMU device communication failure	create connection
18:59:46.406	2010-09-21	Paris	PMU Device	PMU device communication failure	create connection
18:59:46.406	2010-09-21	Muelheim	PMU Device	PMU device communication failure	create connection
18:59:46.406	2010-09-21	Munich	PMU Device	PMU device communication failure	create connection
18:59:46.406	2010-09-21	Vienna	PMU Device	PMU device communication failure	create connection
18:59:46.406	2010-09-21	Nuernberg	PMU Device	PMU device communication failure	create connection
15:10:49.468	2010-09-21	Paris	PMU Device	PMU device communication failure	create connection
15:10:49.468	2010-09-21	Vienna	PMU Device	PMU device communication failure	create connection
15:10:49.468	2010-09-21	Nuernberg	PMU Device	PMU device communication failure	create connection
15:10:49.468	2010-09-21	Rome	PMU Device	PMU device communication failure	create connection
15:10:49.468	2010-09-21	Muelheim	PMU Device	PMU device communication failure	create connection
15:10:48.937	2010-09-21		No Element	License Error	Missing license for enhanced PDC / ISD
16:45:54.000	2010-09-20	MlhM/400/NbgH/f	Channel	Limit Low 2 violated	value 49.87 Hz
16:45:53.900	2010-09-20	VieR/400/BlnW/U2	Channel	Limit Low 1 violated	value 379981 V
16:45:53.880	2010-09-20	Rome/400/PalL/I3	Channel	Limit High 1 violated	value 1200.4 A
16:45:53.880	2010-09-20	Rome/400/MadS2/I3	Channel	Limit High 1 violated	value 1200.4 A
16:45:53.880	2010-09-20	Rome/400/VieR2/I3	Channel	Limit High 1 violated	value 1200.4 A
16:45:53.880	2010-09-20	Rome/400/MadS1/I3	Channel	Limit High 1 violated	value 1200.4 A

Figure 2-17 Alarm list

The alarm list is comparable to an EXCEL table. It contains the following columns:

Table 2-5 Parameters of the Alarm list

Element	Explanation
Time	Point in time at which the warning indication was tripped in hours:minutes:sec 1/1000 (time stamp). The warning indications can be sorted according to time rising or falling, by clicking the heading **Time** with the left mouse button. The column is always shown.
Date	Date of tripping the warning indication in the format: Year-Month-Day (for example, 2010-09-21)
Name	Name of the physical PMU or the measuring channel that triggered the warning indication.
Event element	Element that triggered the warning indication (for example, PMU device, Channel, Island Detection, or Power Swing Recognition)
Incidence	Description of the event (for example, **Limit Low 1 violated** (limiting value shortfall) or **PMU device communication failure** or **License Error**)
Message	Additional information (for example, size of the measured value: **Value 379981 V**, since the lower limiting value 1 of 380 000 V was undercut).

For notes on editing the Alarm list, see *2.7.4 Editing of Messages*.

2.7.3 Event List

Open a window for an event list in SIGUARD PDP UI by clicking the button  .

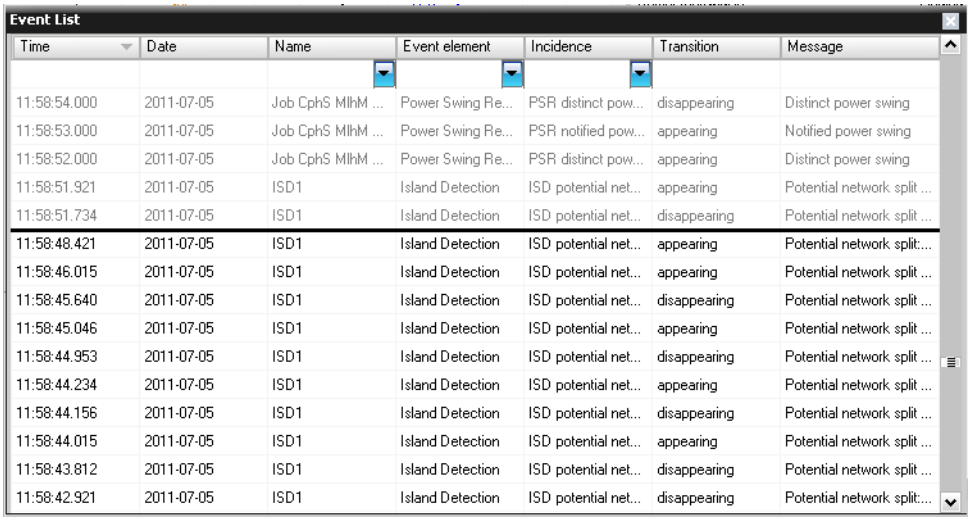


Figure 2-18 Event list

A horizontal line marks the current point in time (offline operation). Events which lie in the future (from the point of view of the current time cursor) are colored gray.

The time cursor (horizontal line) can be moved. Select the corresponding row and call up the context menu **Move > locator**.

The event list is comparable with an EXCEL table. It contains the following columns:

Table 2-6 Parameters of the Event list

Element	Explanation
Time	Point in time at which the event indication was tripped in hours:minutes:sec 1/1000 (time stamp). The event messages can be sorted according to time rising or falling. The column is always shown.
Date	Date of tripping the event indication in the format: Year-Month-Day (for example, 2010-09-21)
Name	Name of the physical PMU or the measuring channel that triggered the event indication.
Event element	Element that triggered the event indication (for example, PMU device, Channel, Island Detection, or Power Swing Recognition)
Incidence	Description of the event (for example, **Limit Low 1 violated** (limiting value shortfall) or **PMU device communication failure** or **License Error**)
Transition	Display whether an appearing or disappearing event indication is upcoming.
Message	Additional information (for example, size of the measured value: **Value 379981 V**, since the lower limiting value 1 of 380 000 V was undercut).

For notes on editing the event list, see *2.7.4 Editing of Messages*.

2.7.4 Editing of Messages

For a better overview of the alarm list and the event list, the table can be edited.

Editing Columns

- **Hiding columns**

  All columns with the exception of the column **Time** can be hidden. Open the context menu in the header. Only marked headers are displayed (shown).
- **Column sequence**

  You can move individual columns by dragging the header horizontally to another place in the table, thereby changing the column sequence.
- **Change column widths**

  All columns can be changed widthwise by dragging the column edge.

Sorting According to Column Contents

The alarm list and the event list can only be sorted according to time (rising or falling). For this, click the header of the column **Time**.

Filtering According to Column Contents

In the column **Name**, **Event element** (Element that triggered the alarm) and **Incidence** (event) are available in the selection lists according to whose parameters the lists can be filtered.

Copying the Contents of Lists

Select a line and press **<CTRL-A>**, in order to select all lines, and **<CTRL-C>**, in order to copy lines into the clipboard. Open the corresponding application (for example, Microsoft Word Pad) and press **<CTRL-V>**, in order to copy the contents of the clipboard into the file.

2.8 Arranging Program Interface

You can arrange the **Program Interface** of SIGUARD PDP according to your needs. You can display all window sections in one window or distribute it across several windows.

The window sections **Menu**, **Toolbar**, and **PSS Curve** make up the main window, and they can be opened only once.

The window sections **Chart View**, **Event list**, **Alarm list**, and **PSRs** can be opened several times. The window section**SIGUARD PDP UI - Map** can be opened only once.

All Window Sections in One Window

In the initial start of SIGUARD PDP UI, the PSS curve is displayed in the main window. Further components can be opened with a click on the symbols on the top left. The components, for example, the map and lists, are also inserted into the main window.

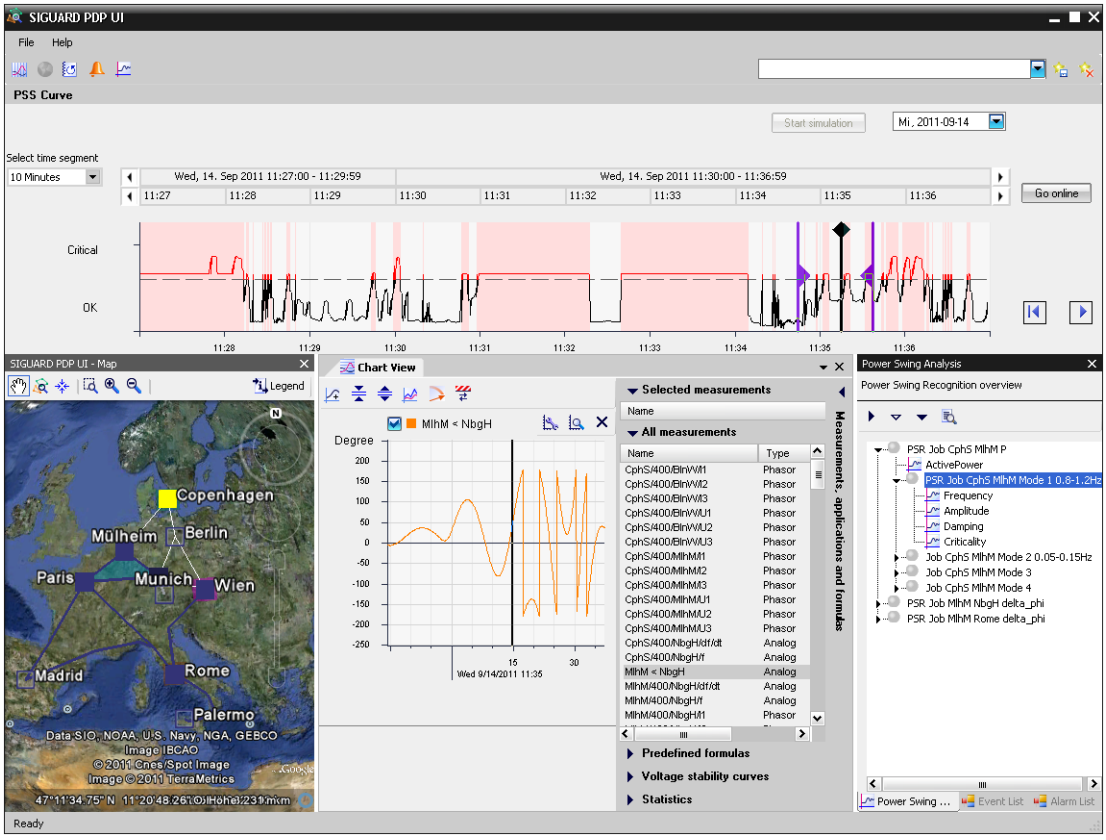


Figure 2-19 All Window Sections in One Window

Window Sections on Several Monitors

When using **2 Monitors** you can distribute the window sections between these, for example, in 2 windows. But you can also display window sections on additional monitors.

You can distribute window sections between 2 windows as follows:

✧ Select a window section, for example, the map, with the mouse and drag it out from the main window to the second monitor.

- ✧ Drag additional window sections into the window on the second monitor.
- ✧ Arrange the window sections in both windows according to your needs.

The desired display is shown in the 2 windows. You can place the 2 windows in 2 monitors.

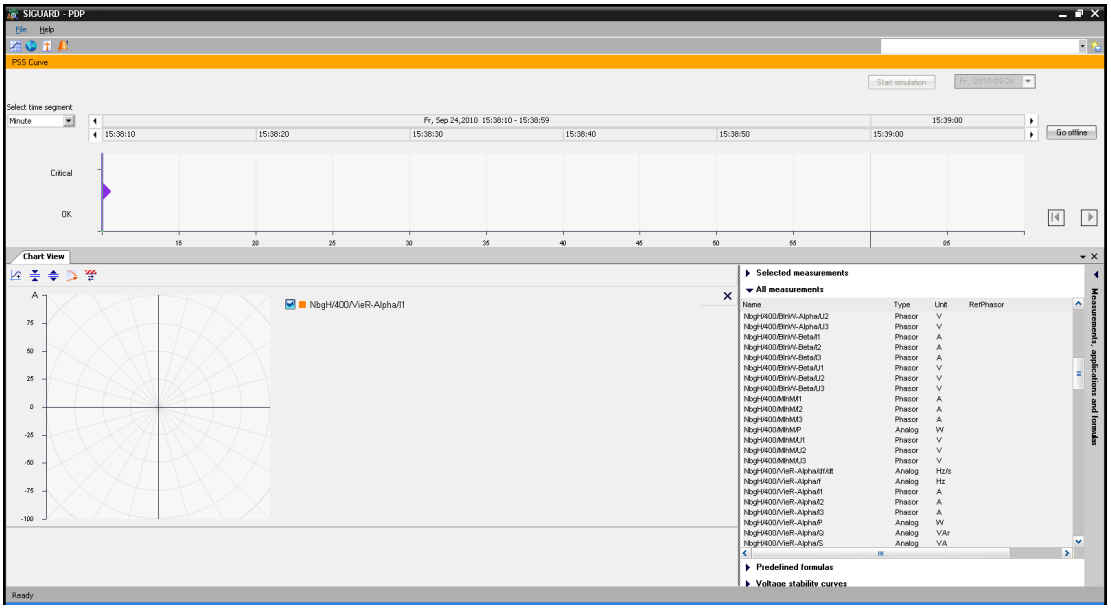


Figure 2-20 Main Window with Chart View

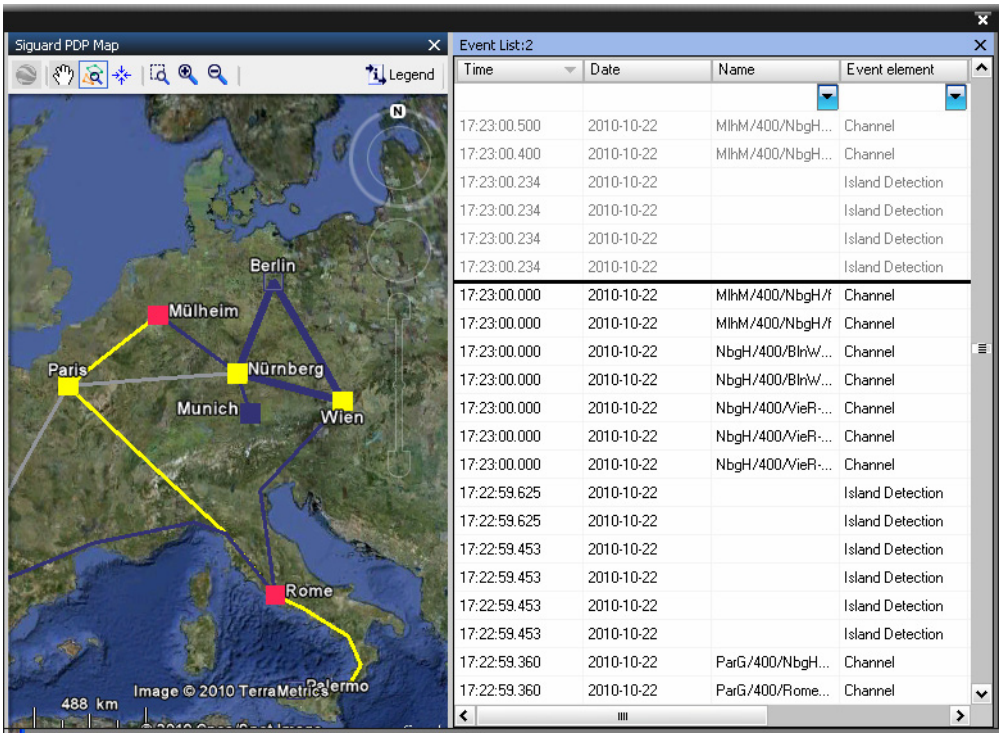


Figure 2-21 Second Window with Map and Event List

Save User Interface

When closing, SIGUARD PDP UI saves the current display of the program interface as a favorite with the designation **StartUpFavorite**. When reopening, the program interface of SIGUARD PDP is shown in the saved display.

You can also save additional displays as **Favorites**.

You can save a display as a favorite as follows:

✧ Click in the toolbar on the icon **Save Favorite**.

The **Save Favorite** dialog is opened.

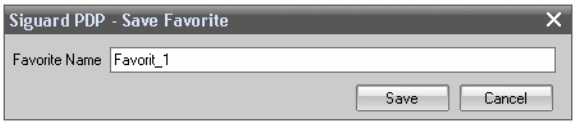


Figure 2-22 Enter Name for Favorites

✧ Give the favorite a name and close the dialog with **Save**.

The favorite is saved under the name entered.

NOTE

The following are not saved in the favorite:
- The list of measuring points under **Selected measurements**.
- The calculated values generated and displayed by a predefined formula (under **Predefined formulas**).

Call up Saved User Interface

You call up a saved user interface as follows:

✧ Select the desired user interface under **Favorite name**.

The saved user interface is displayed.

Deleting a Saved User Interface

To delete a saved user interface, proceed as follows:

✧ Select the desired user interface under **Favorite name**.

The saved user interface is displayed.

NOTE

A deleted user interface cannot be restored after deletion.

✧ In the toolbar, click the icon **Delete Favorite**.

2.9 Limit Editor

In the **Limit Editor**, you define the limiting values/thresholds that are to play a role in the evaluation. All configured measuring points are listed.

The limiting values/thresholds can be defined in the tool **SIGUARD PDP Engineer**, see *4.4 Phasor Measurement Unit (PMU)*.

Starting Limit Editor

Start the **Limit Editor** as follows:

✧ In the window section **Chart View**, click the top left button  .

You can enter limiting values for all measuring points and subsequently change them (see *2.5 Chart View*).

3 minimum and 3 maximum values are possible for each measuring point. Enable the limiting values to ensure that they are effective. Measuring points for which no limiting values are effective are not considered when calculating the system status (Power System Status).

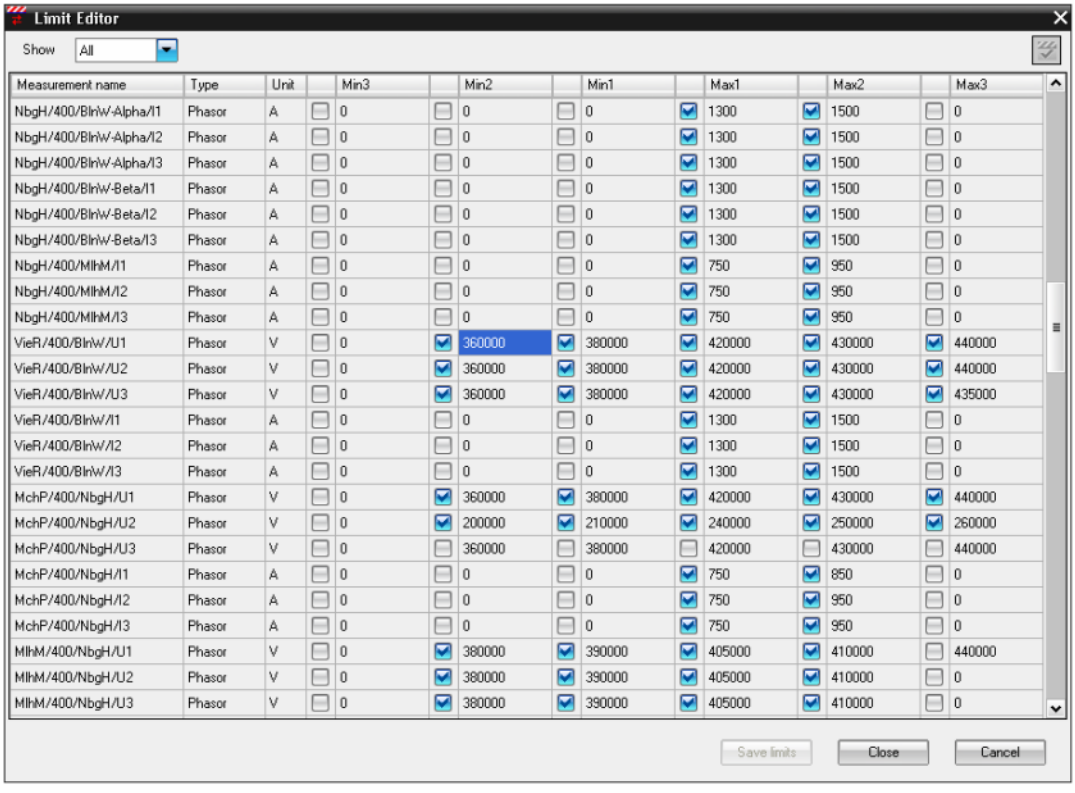


Figure 2-23 Limit Editor, Definition of the Limiting Values

Entering Limiting Values

✧ Set the parameters for the limiting values.

6 columns are available for entering the limiting values:

- **Min1, Min2, Min3**

  In these columns, enter the lower limiting values/threshold. **Min3** is the lower/most critical value. **Min1** is the upper/least critical value.

- **Max1, Max2, Max3**

  In these columns, enter the upper limiting values/thresholds. **Max1** is the lower/least critical value. **Max3** is the upper/most critical value.

Copying Limiting Values and Activations

Copy limiting values and activations as follows:

✧ While keeping the left mouse button pressed, select the limiting values and activations by dragging with the mouse.

✧ Right-click in the selection and select **Copy** from the context menu.

✧ Right-click the cell, which corresponds to the upper left corner of the area to be inserted, and select **Paste** from the context menu.

Effect of limiting values:

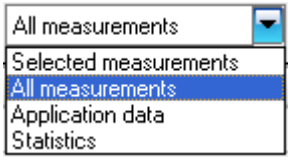
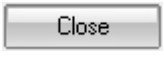
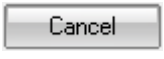
- The limiting values affect the coloring in the geographical overview display in Google Earth. The color of the stations indicates whether the voltages have violated limiting values. The color of the lines indicates whether the currents have violated limiting values.
- The limiting values are drawn into the line and vector diagrams.
- The limiting values influence the status of the curve in the **PSS Curve** window section.

Setting options/displays

✧ Make settings in the **Limit Editor** with the help of the buttons and selection lists.

The following table explains the setting options and displays of the **Limit Editor**.

Table 2-7 Limit Editor Window Section

Element	Explanation
	Use this element to select which measuring points are to be listed: • Selected measurements The measuring points preselected in the map are listed. • All measurements All measuring points are listed. • Application data for example, data from power swing recognition (PSR) • Statistics Measured values from the PMUs
	Click this element to activate changed limiting values in the overall system. The **Limit Editor** is closed.
	Enter the limiting value and enable it by checking it. Subsequently, activate the changes.
	Click this element to activate changed limiting values in the overall system. The **Limit Editor** is closed.
	Click this element to save the changes locally and to exit the **Limit Editor**. The changes are only effective on the local computer.
	Click this element to discard the changes and to exit the **Limit Editor**.

2.10 Reporting

In order to document an event, diagrams can be stored in the clipboard and inserted from there, for example, into Microsoft Word.

Copying a Diagram into the Clipboard

You can copy a diagram into the clipboard as follows:

- ✧ Right-click the diagram in the **Chart View** window section.
- ✧ Select **Copy to Clipboard ...** from the context menu.

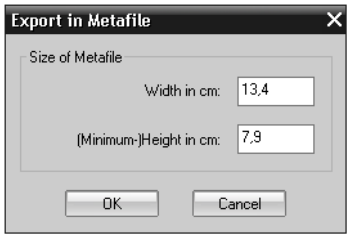


Figure 2-24 Export to metafile

- ✧ Enter the image size and click **OK** to confirm.

Export Values

You can export the measured values of the time range selected with the sliders from the SIGUARD Archive into a **CSV file**. Then edit this CSV file further with a spreadsheet program.

You export measured values into a CSV file as follows:

- ✧ Switch to offline mode.
- ✧ In the window section **PSS Curve**, set the desired time range with the sliders.
- ✧ Select the menu item **File > Save to CSV...**.
- ✧ Enter the file name in the dialog **Save Csv**.
- ✧ Click **Save**.

The measured values are exported into a CSV file. The path and the directory were defined during the installation of SIGUARD PDP.

NOTE

Note that it may not be possible to process the file with common spreadsheet programs if it contains more than 255 columns and more than 65,536 lines. For each phasor, you need 3 columns; for each analog value, you need 2 columns, plus an additional column for the time stamp. 65,536 lines amount to 1 h 39 min at 10 values per second or 21 min at 50 values per second.

You can determine the quality of the measured values from the CSV file, see the following example.

TimeStamp	MlhM/400/NbgH/df/dt	MlhM/400/NbgH/df/dt.qual	MlhM/400/NbgH/f	MlhM/400/NbgH/f.qual	MlhM/400/NbgH/I1.val	MlhM/400/NbgH/I1.deg	MlhM/400/NbgH/I1.qual	MlhM/400/NbgH/I2.val
Wed Mar 25 11:54:40:900 2009	-0.002033		49.999756		876	-24.165001	H1V	874
Wed Mar 25 11:54:41:000 2009	-0.002219		49.999798		890	-24.365999	H1V	890
Wed Mar 25 11:54:41:100 2009	-0.001661		49.999779		906	-24.479	H1V	905
Wed Mar 25 11:54:41:200 2009	-0.001533	DAI	49.999832	DAI	917	-24.656002	DAI	917
Wed Mar 25 11:54:41:300 2009	-0.001403	DAI	49.999847	DAI	930	-24.820999	DAI	929
Wed Mar 25 11:54:41:400 2009	-0.000914	DAI	49.999859	DAI	940	-24.98	DAI	937
Wed Mar 25 11:54:41:500 2009	-0.000575	DAI	49.999908	DAI	945	-25.242001	DAI	943
Wed Mar 25 11:54:41:600 2009	-0.000183	DAI	49.999943	DAI	951	-25.341002	DAI	947
Wed Mar 25 11:54:41:700 2009	-0.000025	DAI	49.999981	DAI	950	-25.565001	DAI	949
Wed Mar 25 11:54:41:800 2009	0.000533	DAI	49.999996	DAI	949	-25.689001	DAI	946
Wed Mar 25 11:54:41:900 2009	0.000517	DAI	50.000053	DAI	945	-25.886	DAI	942
Wed Mar 25 11:54:42:000 2009	0.001019	DAI	50.000053	DAI	937	-25.926001	DAI	935
Wed Mar 25 11:54:42:100 2009	0.000994	DAI	50.000103	DAI	929	-26.150002	DAI	926
Wed Mar 25 11:54:42:200 2009	0.001164	DAI	50.000099	DAI	917	-26.210001	DAI	916
Wed Mar 25 11:54:42:300 2009	0.001242	DAI	50.000118	DAI	906	-26.438002	DAI	905
Wed Mar 25 11:54:42:400 2009	0.001203	DAI	50.000126	DAI	893	-26.596001	DAI	891
Wed Mar 25 11:54:42:500 2009	0.001178	DAI	50.000122	DAI	880	-26.712999	DAI	878
...	...	...	...	...	...	...	...	...
Wed Mar 25 11:54:43:700 2009	-0.001817	ERR	49.999817	ERR	844	-29.075003	ERR|H1V	843
Wed Mar 25 11:54:43:800 2009	-0.001839	ERR	49.999817	ERR	856	-29.294003	ERR|H1V	854
...	...	...	...	...	...	...	...	...
Wed Mar 25 11:54:46:100 2009	0.000225	NSY	50.000046	NSY	848	-32.864998	NSY|H1V	846
Wed Mar 25 11:54:46:200 2009	0.000097	NSY	50.000023	NSY	839	-33.021	NSY|H1V	838
...	...	...	...	...	...	...	...	...

Figure 2-25 Extract from a CSV Export File

Table 2-8 Significance of the Quality Code in an Exported CSV File

Abbreviation	Meaning	Source of the quality code
COE	PMU communication error	SIGUARD PDP Server
CTO	Collector time-out	SIGUARD PDP Server
SC1	Time synchronization 1	PMU
SC2	Time synchronization 2	PMU
COC	Configuration change	PMU
TGR	Transfer trigger	PMU
CLF	Time error	PMU
NSY	PMU not synchronized	PMU
ERR	PMU error	PMU
DAI	PMU data invalid	PMU
DAM	PMU data missing	PMU
OOS	Out of service	SIGUARD PDP Server
L3V	Limit violation Minimum 3	SIGUARD PDP Server
L2V	Limit violation Minimum 2	SIGUARD PDP Server
L1V	Limit violation Minimum 1	SIGUARD PDP Server
H1V	Limit violation Maximum 1	SIGUARD PDP Server
H2V	Limit violation Maximum 2	SIGUARD PDP Server
H3V	Limit violation Maximum 3	SIGUARD PDP Server
DNF	Data not found in archive	SIGUARD PDP Server

2.11 Applications

2.11.1 Overview

In SIGUARD PDP UI, various applications can be executed:

- Island Detection in Networks (ISD)
- Recognition of swings in the network (PSR)
- Display of Voltage Stability Curve (VSC)

The configuration and parameter assignment of individual applications is done in SIGUARD PDP Engineer, see *4.7.1 Overview*.

2.11.2 Island State Detection (ISD)

Island detection in SIGUARD PDP uses the measured values present in every PMU **Frequency** (f) and **Frequency Changing Speed** (df/dt).

2 component applications are present:

- **Static Island Detection**

  Here, all frequency values are compared with one another. 3 different conditions are distinguished:

  - If the difference between 2 frequency values lies below one of the lower limiting values, no islanding is detected.
  - If the difference between at least 2 neighboring frequency values lies between the lower and upper limiting values, potential islanding is reported. This notification can be understood as a warning indication.
  - If the difference of at least 2 neighboring frequency values lies above an upper limiting value, then, with sufficient certainty, islanding is detected and a corresponding notification is generated. This notification can be understood as a warning indication.

- **Dynamic Island Detection**

  Here, all rates of frequency change are compared with one another. 2 conditions are distinguished here:

  - If the difference between at least 2 neighboring values of the rate of frequency change lies under the limiting value, then there is no islanding.
  - If the difference between at least 2 neighboring values of the rate of frequency change lies above a limiting value, then islanding is possibly present or is in the process of arising. This notification can be understood as a warning indication.

For the parameter assignment of the application **Island State Detection**, see *4.7.2 Island State Detection (ISD)*.

Display of Island Detection in the Event or Alarm List

All notifications generated by SIGUARD PDP ISD are to be found in the event list. When potential or certain island formations are detected, corresponding entries are written into the alarm list.

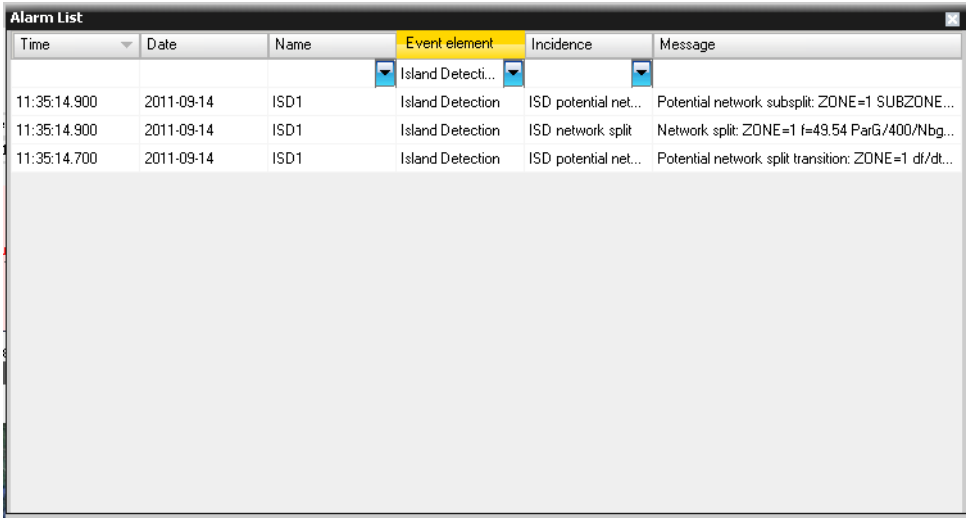


Figure 2-26 Alarm List, Filtered according to the Event Element Island Detection

In the filtered alarm list, the detected islands are displayed with the event **ISD network split** or **ISD potential network split**. An **ISD network split** in the **Message** column of which Zone 1, Zone 2 and Zone 3 are entered is a definite event for island detection. This means that 3 islands were detected.

NOTE

The displayed values in the respective ISD event for frequency und frequency increase are averages of the PMU values over a time constant given in the SIGUARD configuration file. Consequently, they deviate from the respective PMU values on the measuring time point given in the ISD event. Moreover, if several PMUs or frequency measuring points lie in a zone, then a further averaging of its average values occurs.

Display of Island Detection on the Map

Various colored areas corresponding to the number of recognized islands are displayed on the map. If only one substation is contained in the island, then the area around the substation is displayed as a square. If there are several substations, then the area is displayed as a polygon with the substations as corners.

The colored display correlates with the colors of the Chart Views (1st island = orange, 2nd island = blue, 3rd island = green, etc.).

You can find further information on parameterization in chapter *4.7.2 Island State Detection (ISD)*.

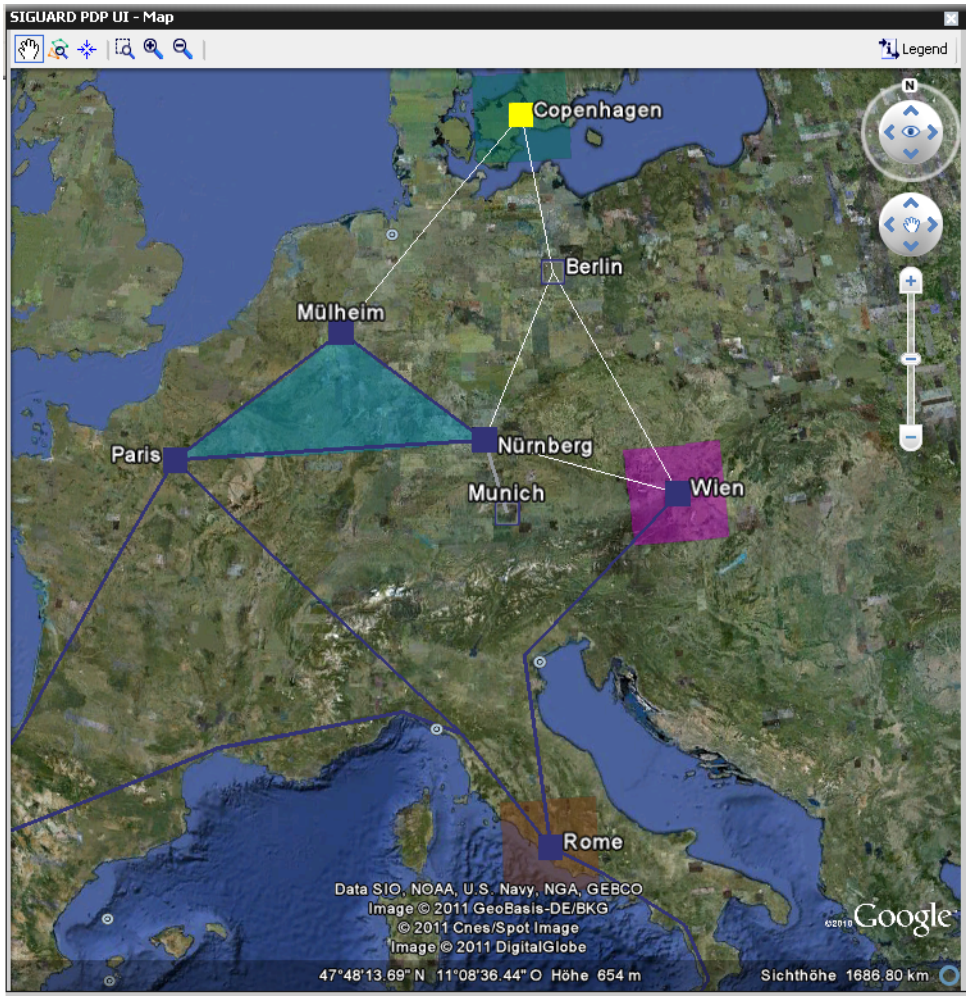


Figure 2-27 Map with Detected Islands

2.11.3 Power Swing Recognition

A detected active-power swing is displayed in various window sections at the user interface (UI):

Display of the Power Swing Recognition on the Map

If a power swing measured in terms of angle difference is present, the locations of the 2 PMUs involved are circled and the connection line is inserted between them (see connection Mülheim – Nürnberg in the following figure). If a power swing measured in terms of active power is present, then the PMU where the measurement was made is present is marked with a circle (see Copenhagen in the following figure). The color of the icon matches the color in the previous figure.

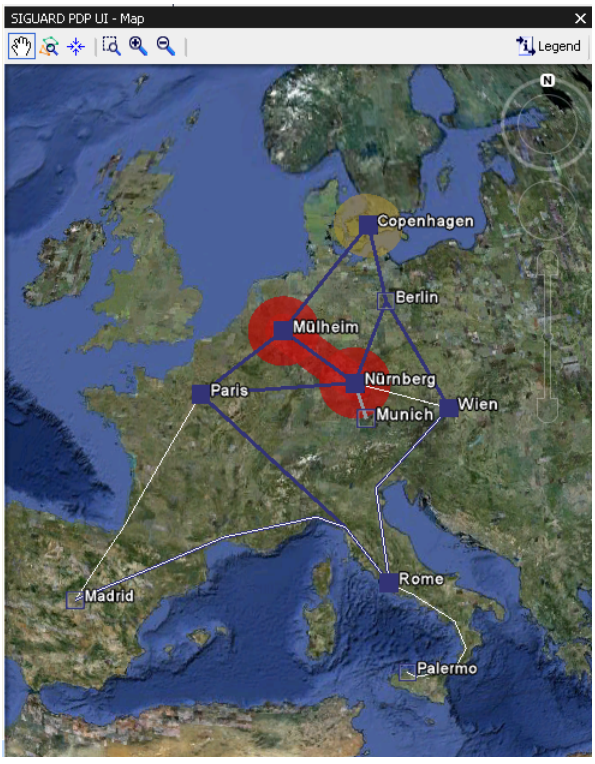


Figure 2-28 Power swings on the map

Display of Power Swing Recognition in Power Swing Analysis

All notifications generated by SIGUARD PDP PSR can be found in the event list. Corresponding entries are written in the alarm list in the case of recognized power swings.

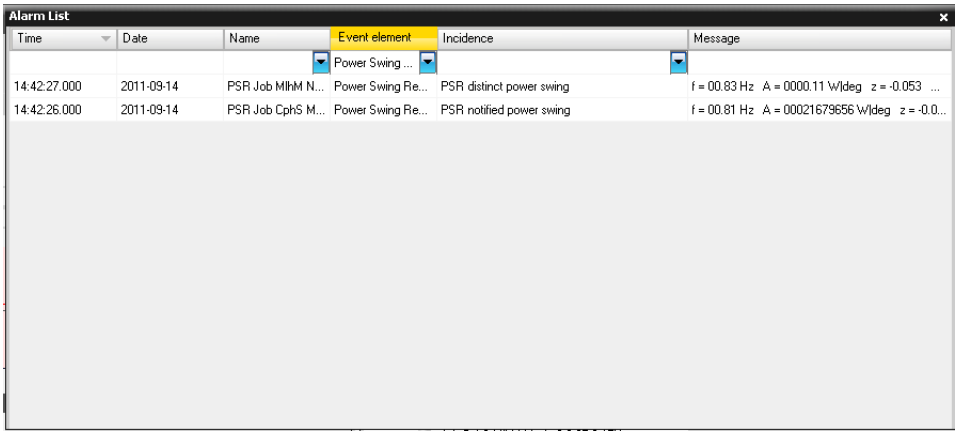


Figure 2-29 Alarm list filtered according to the Event element Power swing recognition

In the filtered alarm list, the recognized power swings are displayed with the corresponding event.

All jobs configured with SIGUARD Engineer and their corresponding modes are listed in the window section- **Power swing analysis**. Picked up modes are displayed with icons identified by colors. The colors of the icons correspond to the color in *Figure 1-10*.

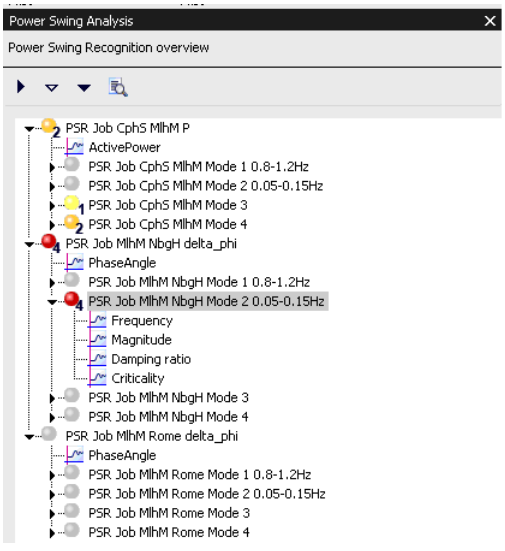


Figure 2-30 Interface components for Power swing analysis

Table 2-9 Interface components for Power swing analysis

Element	Explanation
Power Swing Recognition overview	Click the element and drag it into a Chart View in order to generate a **PSR Overview**.
	Click this element in order to close the entire PSR tree structure.
	Click this element in order to open the first hierarchy of the PSR tree structure.
	Click this element in order to open the entire PSR tree structure.
	Click this element in order to display the name of the measuring points in the PSR tree structure or switch to display of the parameter names again.
	Gray marking No power swing was recognized.
	Yellow marking (1) **PSR notified power swing** A recognized power swing was reported.
	Bright orange marking (2) **PSR distinct power swing** A distinct power swing was recognized and reported.
	Dark orange marking (3) **PSR critical power swing** A critical power swing was recognized and reported.
	Red marking (4) **PSR undamped critical power swing** An undamped critical power swing was recognized and reported.

Display of Power Swing Recognition in Power Swing Recognition Overview

Using drag and drop from the Power swing analysis, this diagram can be displayed in the **Chart View** window section. The diagram shows all recognized power swings for the current time point in the frequency damping diagram.

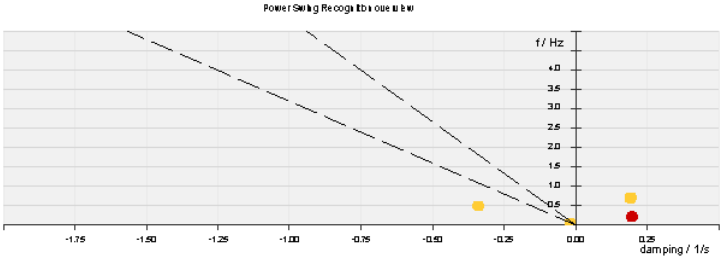


Figure 2-31 Recognized Power swings diagram overview (frequency over damping)

Display of the Input Curves in the Chart View

The input curves (active power or phase angle) and the quantities determined therefrom for a recognized mode (frequency, magnitude damping ratio and DOE) in the **Power Swing Analysis** window section can be displayed in the **Chart View** window section.

NOTE
Take note of the following:
- A separate license is required for the application PSR. If you have not purchased a PSR license, then this application cannot be run.
- In order to avoid an overload of the server, control the computing time needs of PSR.exe, before you define other PSR jobs. You can observe the computing time needs in percent on the **Processes** tab of the Windows Task Manager. The application should not consume more than 50 % of the calculation module (approx. 12.5 % for a four-ore processor).
- A patent is pending for the algorithms of the PSR.

You can find further information on parameterization of the PSR in chapter *4.7.3 Power Swing Recognition PSRs*.

2.11.4 Voltage Stability Curve (VSC)

SIGUARD PDP offers the option to calculate and output a voltage stability curve (P-V curve) in the SIGUARD PDP UI.

2 different modes are supported:

- Measurement of the voltage stability curve of a line with a PMU at the beginning and end, respectively (voltage and current measurement)
- Measurement of the voltage stability curve of a line with a PMU at the beginning of the line (voltage and current measurement) and the associated 2-port parameters.

If the line is equipped with only one PMU, the 2-port parameters of the line (Resistance R [Ω], Reactance X [Ω], Conductance G [µS], and Susceptance B [µS]), are used for the calculation of voltage and current at the end of the line, see following illustration.

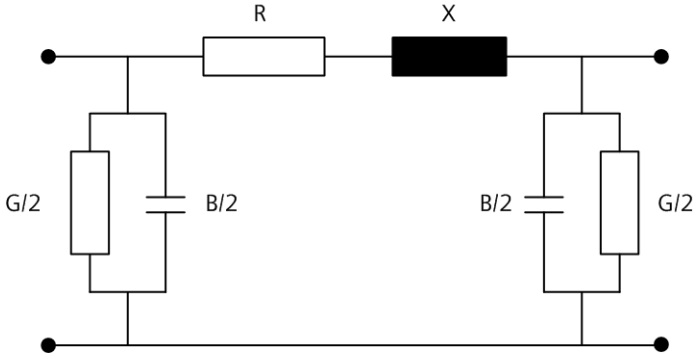


Figure 2-32 2-Port Equivalent Circuit of the Transmission Line

(1) R = Resistance
(2) X = Reactance
(3) G = Conductance
(4) B = Susceptance

The current load admittance is calculated with the measured or calculated voltages and currents in the endpoint node of the line. The corresponding line load is represented as an operating point on the curve (red cross) (see following illustration). The voltage stability curve itself arises through variation of the complex load admittance in the endpoint node of the line from zero to infinity. The recalculation of the curve is performed with each update of the SIGUARD PDP UI.

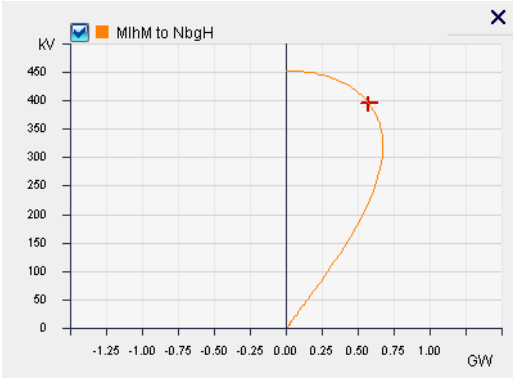


Figure 2-33 Example of a Voltage Stability Curve

All parameterized voltage stability curves (VSCs) are listed in the lower right window section in SIGUARD PDP UI under **Applications - Voltage stability curves**. By dragging a voltage stability curve, for example, **MlhM -> NbgH**, with the mouse into the window section **Chart View** beneath the timing diagram, the voltage stability curve is displayed (see *3.3 Displaying Curves*).

A red cross marks the current operating point. In the figure above, the critical point is nearly reached. With minimally higher power, the stability criteria are violated and a network disconnection can result.

NOTE

If controllable reactive power sources are present in the endpoint node of the line or in its vicinity, the curve shape of the voltage stability curve is not constant, rather it varies with the degree of the reactive power fed in. Therefore no quantitative statement can be gained from the diagram as to how much additional transferable power can be transported via the line. Nonetheless, a qualitative evaluation of the voltage stability curve is helpful, as it allows the user the option of evaluating the distance to maximum power.

For the parameter assignment of the voltage stability curves, see *4.7.4 Voltage Stability Curve (VSC)*.

■

3 Working with SIGUARD PDP UI

3.1 Sample Event

A simple example is given to illustrate the handling of SIGUARD PDP.

In this example, a time range is selected from the archive that is displayed as critical in the **PSS Curve** window section. The essential curves for this time range are to be displayed and analyzed. The analysis is performed in **offline mode**. The goal of the analysis is to find out why the PSS curve keeps going into the red range.

Procedure

The suggested procedure is to illustrate the individual steps for examining and assessing an event.

Proceed as follows:

- Select the time range in which the event to be examined is found.
- Display the essential curves to the event.
- Export the time range into the permanent archive.
- Import the time range from the permanent archive.
- Create and print a report.

3.2 Selecting the Time Range

The analysis of a time interval can only be performed in **offline mode**. In offline mode, the information from the devices is still stored in the archive and can later be viewed and analyzed.

In the window section **PSS Curve**, select the time range you want to display and analyze.

You can see the temporal progression of the selected range in the window section **SIGUARD PDP UI - Map**.

Switch on Offline Mode

✧ Click the **Go offline** button to set **Offline mode**.

The following figure shows the status curve with several critical ranges. These are displayed in red.

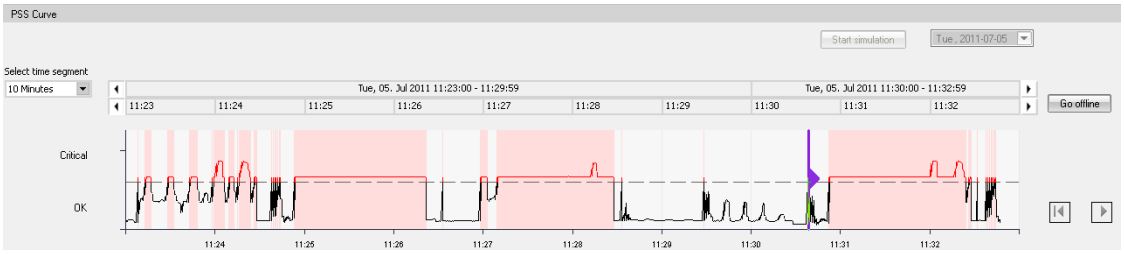


Figure 3-1 Power System Status, Curve with Critical Ranges

Selecting the Time Range

✧ Set the length of the visible time range with the list box. 

✧ Scroll with the arrows to the desired location in the archive.

✧ Move the sliders on the time line to the desired points using the mouse.

The time range between the sliders is represented in the diagrams.

The selected time range is displayed in the **From** and **To** boxes.

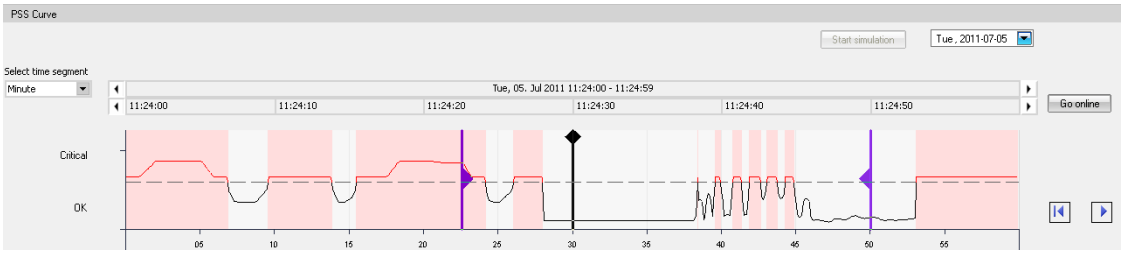


Figure 3-2 Power System Status, Selecting the Time Range

Starting the Sequence

✧ Click the button  in order to position the cursor at the left edge of the selected time range.

✧ Click the button  in order to run the time range.

On the map (**SIGUARD PDP UI - Map** window section), you can see the projected sample project. It consists of 4 substations/measuring points and associated high-voltage lines. The coloring of the objects changes, depending on the state at different instants.

The default object coloring is **blue**. An exceedance of the first limiting values is displayed in **yellow**, a violation of the second limiting value is displayed in **red.**

In the figure, the line between the measuring points **Mülheim** and **Paris** is clearly critical. The cause is to be found below.

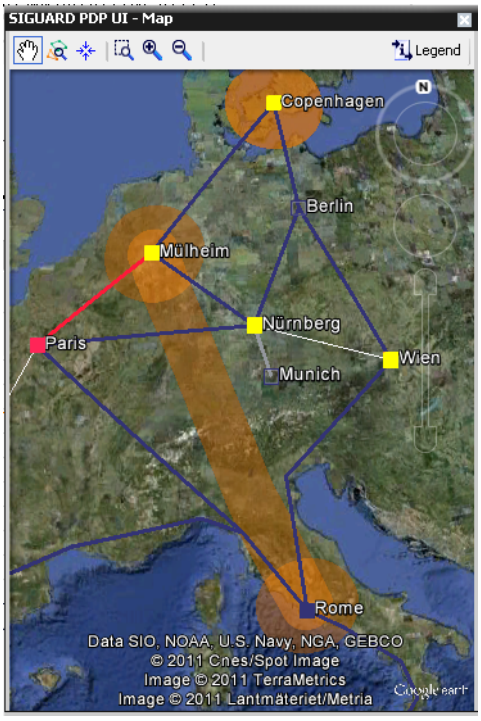


Figure 3-3 SIGUARD PDP UI - Map, Following the Progression

Stop Sequence

✧ Click the  button to stop the sequence.

Selecting a Specific Instant

✧ In the selected time range, click on a point to display the state at this instant.

On the map, you see the objects colored depending on the state at this instant.

3.3 Displaying Curves

Map with Objects

In the **SIGUARD PDP UI - Map** window section, you see a map with the power-supply system inserted. The power-supply system consists of objects, for example, generators and lines. You can display **tooltips** for the individual objects. Furthermore, a **legend** is available.

Display Tooltips

You can call tooltips for the individual objects on the map. Measured values are displayed for the respective objects.

- ✧ Click the  button to display tooltips.
- ✧ Place the cursor over an object to display the tooltip.

The available information on the object is displayed.

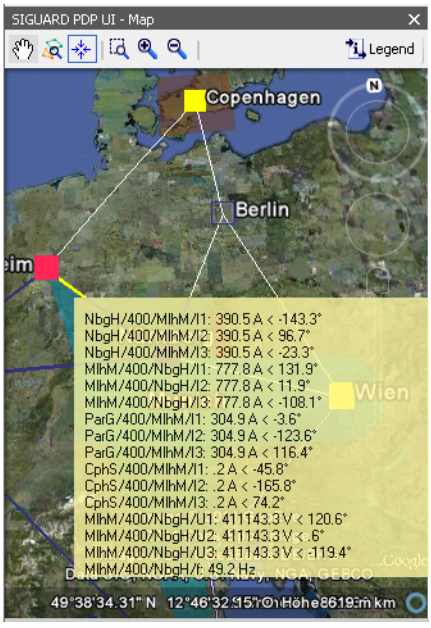


Figure 3-4 SIGUARD PDP UI - Map, display tooltip

Showing the Legend

The objects of the map and their coloring are described in a legend.

✧ Click the **Legend** button to display it.

The legend is shown.

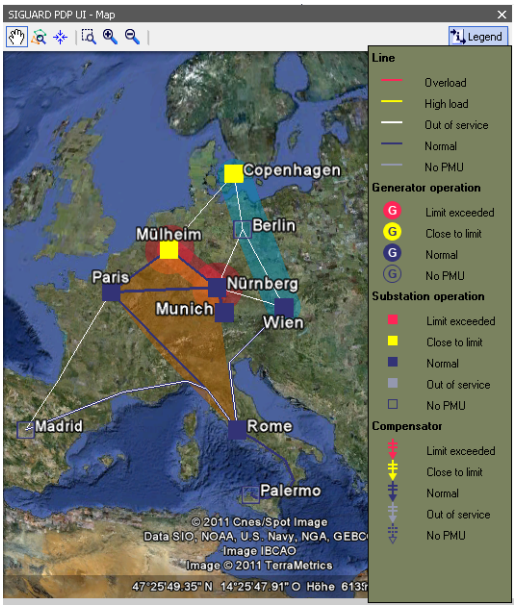


Figure 3-5 SIGUARD PDP UI - Map, display legend

For further information on the objects in the map, see *2.4 Map*

Selecting Objects

On the map, select the objects for which you want to display curves.

✧ Click the  button.

✧ In the **SIGUARD PDP UI - Maps** window section, select an area around the objects for which you want to perform an analysis.

The selection is shown.

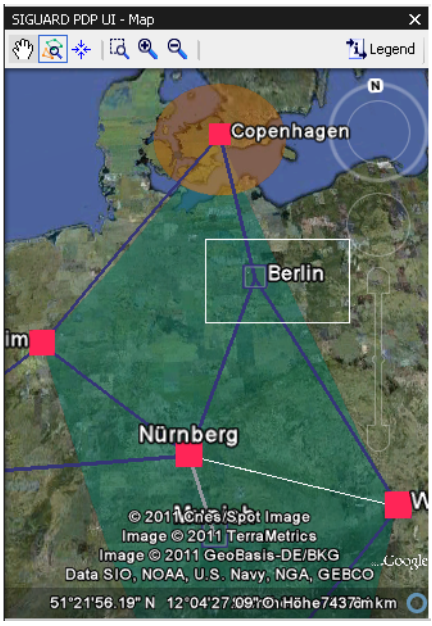


Figure 3-6 SIGUARD PDP UI - Map, select objects

✧ In the right side of the window, click the arrow above **Measurements, Applications, Formulas**.

The list of measured values is displayed.

The measured values available for the selected objects are listed in **Selecting Measurements**. In the next step, you can display curves for these measured values.

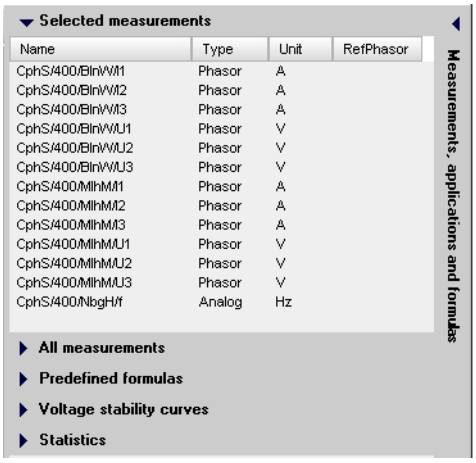


Figure 3-7 Measurements, Listed Measured Values

Zoom in on the Map Section

You can enlarge the display of a map section. Details of the power-supply system are visible in the enlarged display. For example, multiple lines become visible that have previously only been represented as one single line.

The details are only displayed if they have been previously parameterized.

✧ Click the  button to zoom in on the map section.

The map is displayed in an enlarged form.

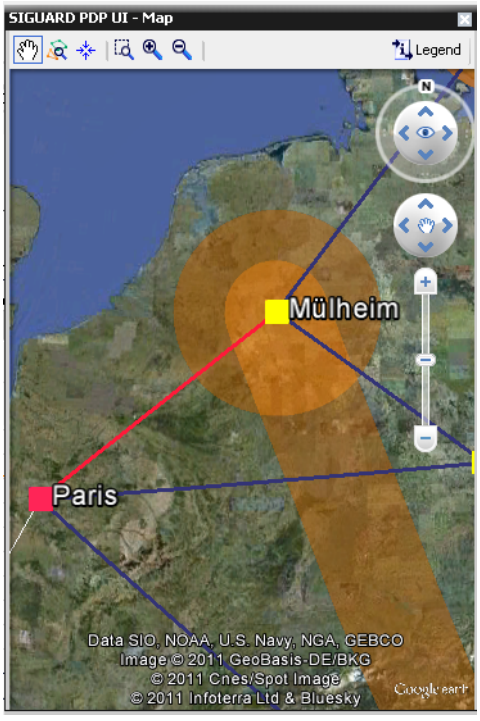


Figure 3-8 SIGUARD PDP UI - Map, enlarged map section

✧ Click the  button to undo the enlargement.

Displaying Curves

You can now represent the available measured values as curves in diagrams.

To analyze the event, create the following charts:

- A timing diagram with currents
- A vector diagram with voltages
- A diagram with a voltage stability curve

✧ In the **Chart View** window section, click the  button to generate a blank line diagram.

✧ Drag and drop 2 measured currents with the mouse pointer, for example, **NbgH/I1** and **MlhM/I1**, to the generated diagram.

You can select several measured values in the list and simultaneously drag them into a diagram.

These measured values are current phasors of the measuring points Nuremberg and Mülheim. The timing diagram represents the time characteristic of the absolute current values, but not their phase.

As a time range, the time range selected in **PSS Curve** is displayed in the window section.

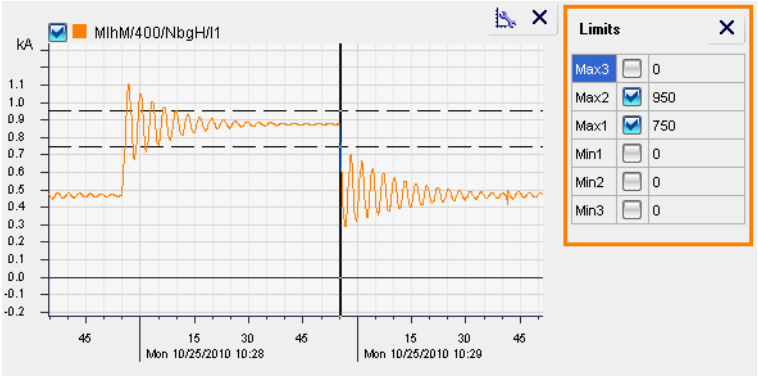


Figure 3-9 Timing Diagram, Currents

The figure shows considerable changes of the amperage and damped oscillations. The amperage changes are caused by connecting and disconnecting a heavy load. The oscillations indicate a power swing.

Create a diagram with voltage phasors for further examination.

In the **Chart View** window section, you can scroll down to insert and display further diagrams.

✧ Drag and drop a voltage phasor, for example, NbgH/U1, to the **Chart View** window section below the timing diagram.

A vector diagram with a voltage vector is displayed.

✧ In addition, drag and drop a voltage phasor, for example, **MlhM/I1**, to the vector diagram.

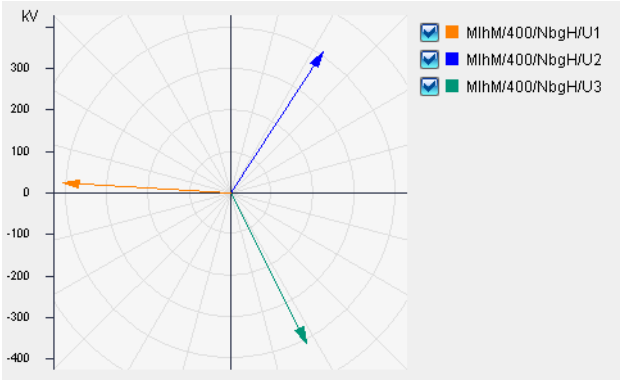


Figure 3-10 Vector Diagram, Voltages

The vector diagram shows the characteristics of the phase angles of the voltages, that is whether there is a phase displacement and how large this difference is. Furthermore, it can be seen whether the phase between the voltages increases or decreases or remains the same. This enables you to derive, for example, whether 2 generators oscillate against each other.

A voltage stability curve can provide additional information.

The voltage stability curves are listed in **Applications**.

✧ Drag and drop a voltage stability curve, for example, **MlhM -> NbgH**, to the **Chart View** window section below the timing diagram.

A diagram with the voltage stability curve is displayed.

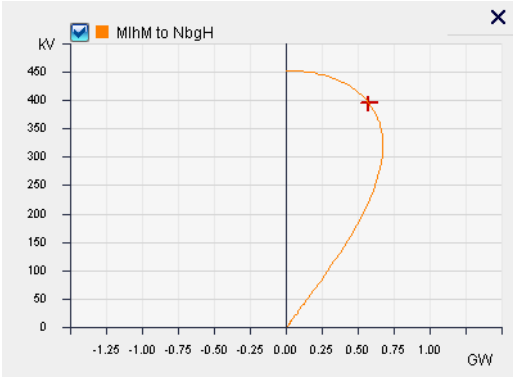


Figure 3-11 Diagram with Voltage Stability Curve

The voltage stability curve displays the voltage over the power at a specific instant. In the figure, the critical point has almost been reached. If the power was slightly higher, stability criteria would be violated and a disconnection could occur.

Displaying measured values in the diagram

The measured values can only be displayed in the offline mode.

✧ Move the mouse pointer over the diagram.

✧ In the context menu, select **Show measure line > <Measured value>**.

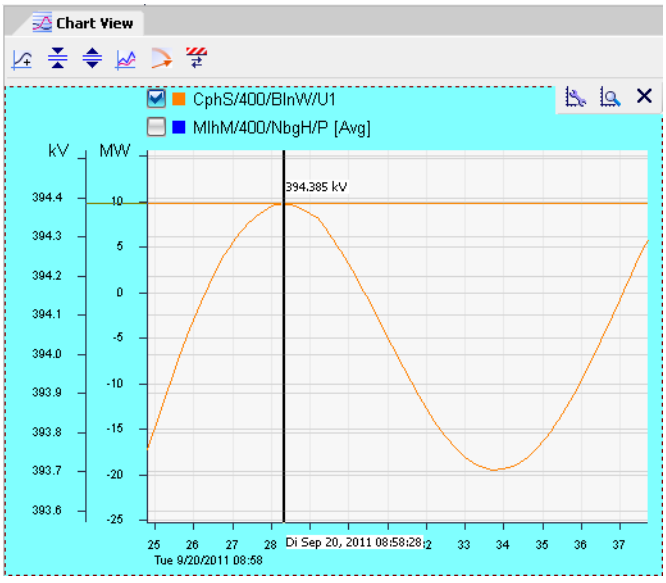


Figure 3-12 Showing a measuring line (horizontal line)

A horizontal line is shown in the color of the diagram. The current measured value is displayed at its intersection with the diagram. In the time line, the date and time of day are shown for the cursor position.

✧ In the context menu, select **Show second cursor**.

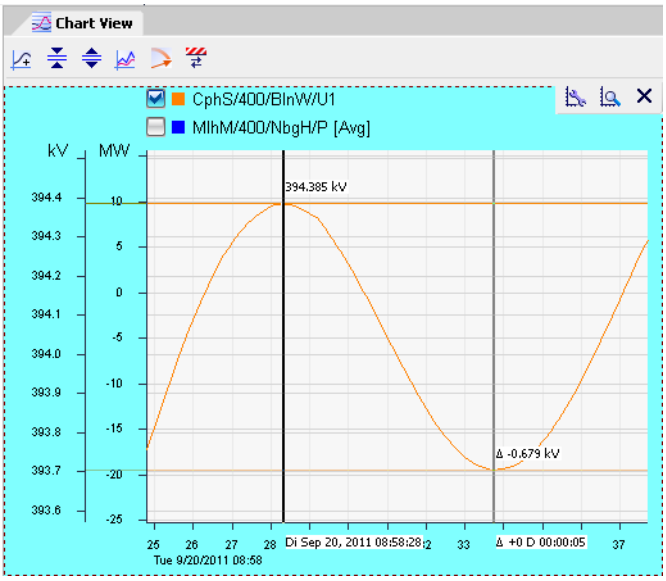


Figure 3-13 Showing a second cursor (vertical line)

A second cursor (gray vertical line) and an additional horizontal measuring line are shown. At the intersection with the diagram, the difference from the first measured value is displayed. In the time line, the time difference from the first measured value is displayed at the position of the second cursor.

Displaying average values of a diagram

The average value can be generated only for line diagrams.

✧ Display a curve, for example:

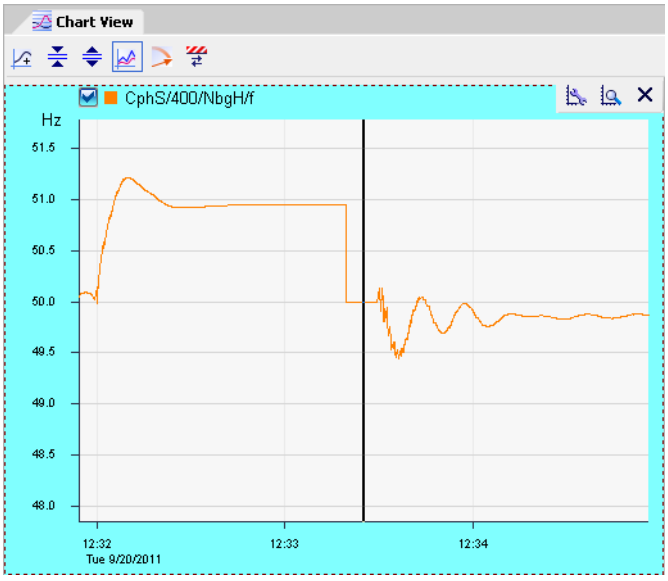


Figure 3-14 Diagram without smoothing average generation

✧ In the context menu, select **Show average value**.

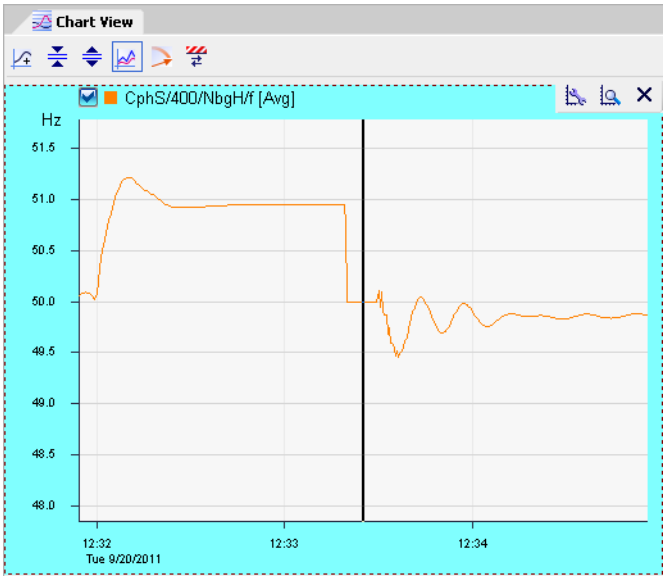


Figure 3-15 Diagram with smoothing average generation

The line diagram is displayed smoothed. The name of the measuring point is followed by **[Avg]** (average).

Hiding the Map

✧ Click the **X** in the upper right of the window **SIGUARD PDP UI - Map** to hide the map. The display of the **Chart View** window section is enlarged.

You can also pull the component **Chart View** out of the main window and position and zoom in anywhere on the desktop.

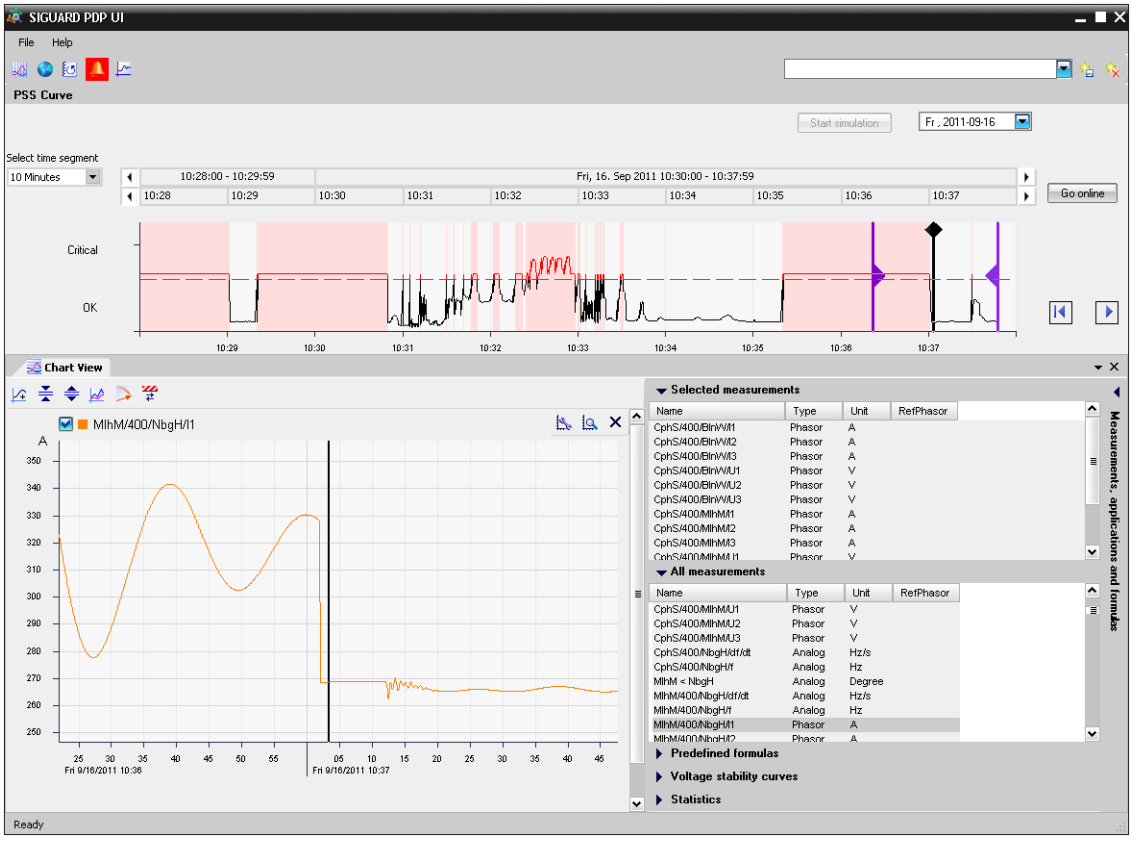


Figure 3-16 Chart View, Hidden Map

Changing Limiting Values

The limiting values can be shown and edited to the right of the diagram.

- ✧ Above the diagram, double-click a measured value to display its limiting values.
- ✧ Change a limiting value.

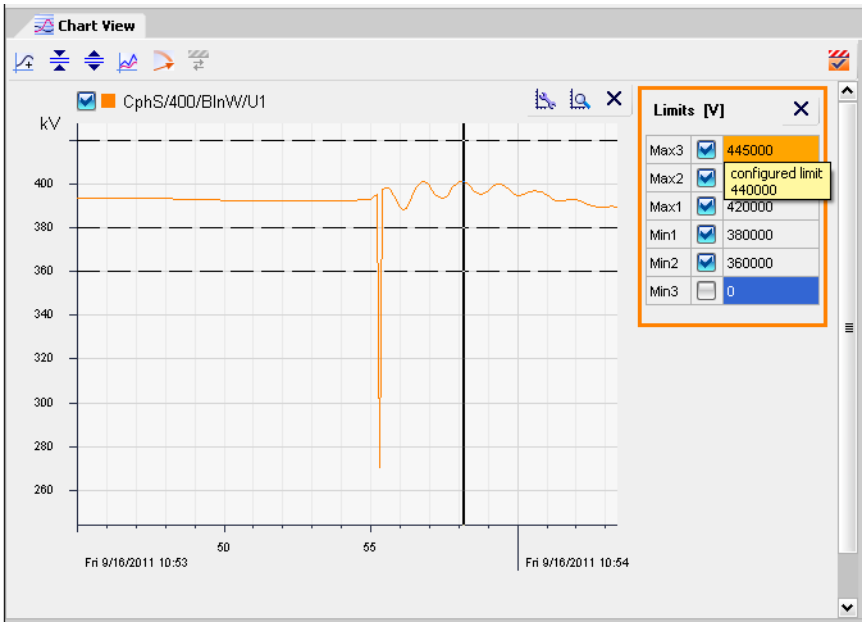


Figure 3-17 Changed/configured limiting value

The old limiting values are displayed as a tooltip. After changing a limiting value, the background of the limiting value is displayed in orange.

- ✧ Click the  button to save and activate the changed limiting value.

The background of the limiting value becomes blue.

Opening the Limit Editor

✧ Open the **Limit Editor** by clicking the  button.

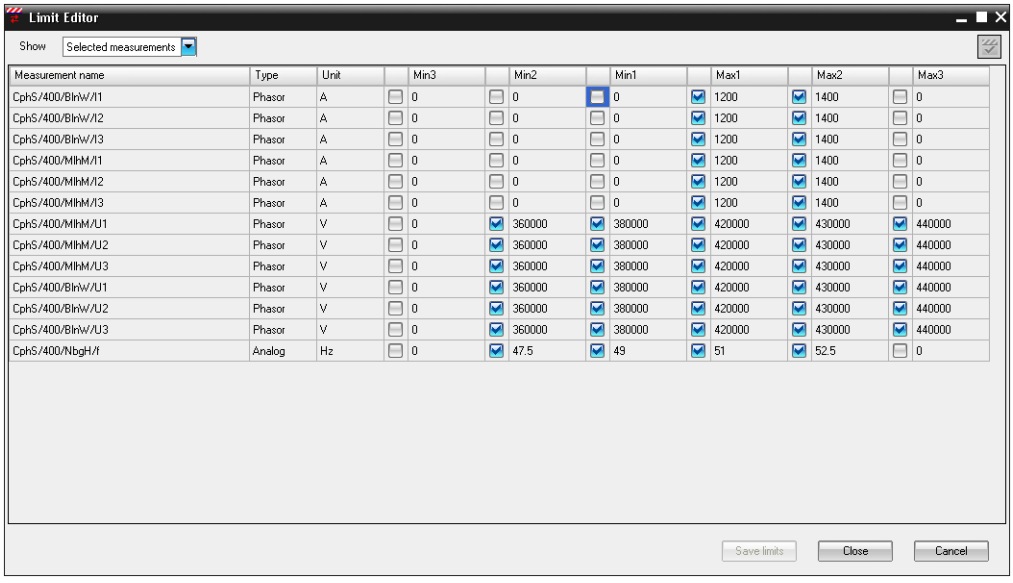


Figure 3-18 Limit Editor

It lists all measured values with the associated limiting values. You can change and enable/disable the limiting values.

✧ Enter new limiting values.

✧ Activate the changed limits with a check.

✧ Activate the changed limiting values by selecting **Save Limits**.

The Editor is exited.

Using Predefined Formulas

A number of predefined formulas are available in **Formulas**. These formulas can be applied to measured values.

Use predefined formulas as follows:

✧ Drag and drop the desired formula, for example, ActivePower, in the **Chart View** window section.

A dialog is displayed in which you have to enter the parameters necessary for the new curve.

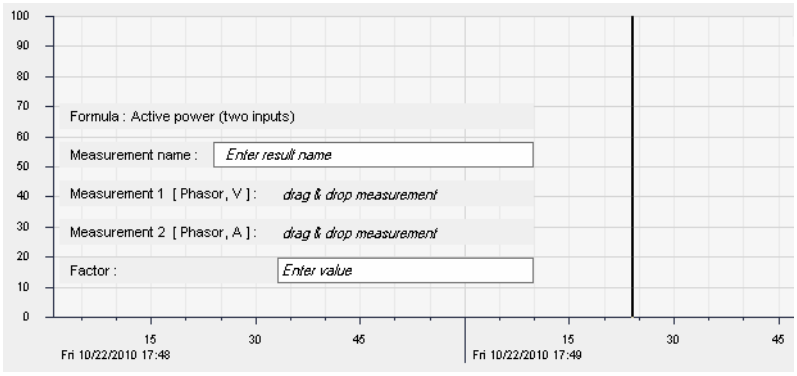


Figure 3-19 Inserting a Predefined Formula

✧ In **Measurement name**, enter any name for the new curve.

✧ Drag and drop measuring points (voltage phasor and associated current phasor) from the **Measurements** window section to the **Measurement 1** and **Measurement 2** text boxes.

✧ In **Factor**, enter a decimal value.

The curve is multiplied with this value. Typically this Value is 1. When calculating power this factor can deviate since it depends on the measurement (phase-to-phase voltage or phase-to-ground voltage).

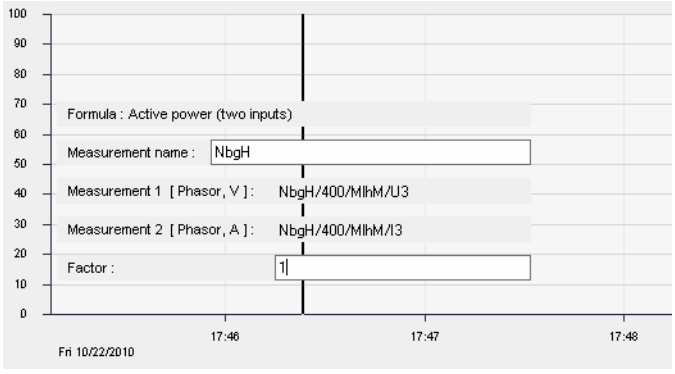


Figure 3-20 Entering Parameters for Formula

✧ After entering the last parameter press the key **Enter** on the keyboard.

The diagram with the calculated curve is displayed.

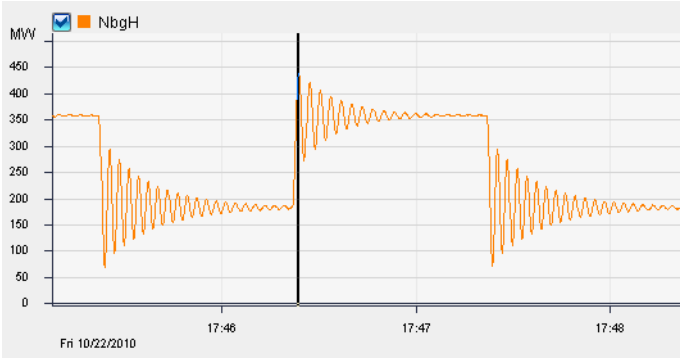


Figure 3-21 Diagram with Calculated Curve

3.4 Export and Import of Time Ranges

3.4.1 Exporting of Time Ranges

In SIGUARD PDP UI, measured data are continuously saved in a ring archive. If the ring archive is full, earlier measured data are overwritten and are lost. To prevent this, time ranges and the measured values contained in them are saved in a permanent archive. These data can also be loaded again and are available for evaluation purposes.

Additionally, time ranges and the measured values contained in them can be saved in CSV format (comma-separated value). This format can, for example, be opened in a spreadsheet and further processed.

Importing is not possible here. However, a CSV export from a permanent archive can be performed.

Proceed as follows:

Permanent Saving as Time Ranges

✧ Select the menu **File > Save time range...**.

The **Save time range** dialog is displayed.

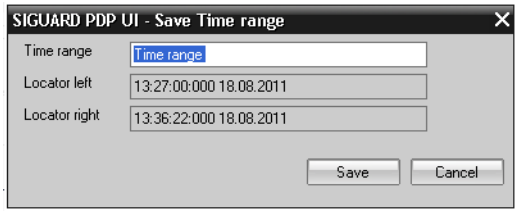


Figure 3-22 Save time range dialog

The beginning point in time **Locator left** and the final point in time **Locator right** are automatically displayed in the dialog and cannot be changed.

Changing the time range is possible only in the **PSS Curve** window section.

✧ In the **Time range** entry field, enter the name of the time range (for example, TimeSlice_01) that you want to save.

✧ Click the button **Save**, to save the time range.

The time range is possibly stored as several files and directories.

NOTE

Saving can last several minutes even though the window has already been closed. The amount of time required for saving depends on the amount of the data that must be written in the permanent archive, and on the length of the time range you have selected.

Saving Time Ranges in CSV Format

✧ Select the menu **File > Save to Csv...**.

The **Save Csv** dialog is displayed.

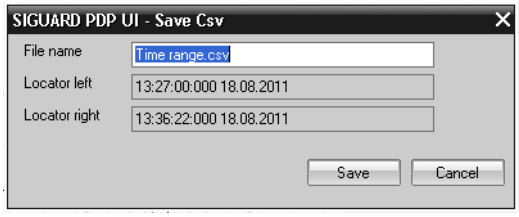


Figure 3-23 Dialog Save Csv

The beginning point in time **Locator left** and the final point in time **Locator right** are automatically displayed in the dialog and cannot be changed.

Changing the time range is possible only in the **PSS Curve** window section.

✧ Enter the file name in the entry field **File name**.

✧ Click the button **Save**, to save the time range in CSV format.

The export directory is on the server and was defined during the installation. From a UI, you can also find the directory under the path **\\<servername>\SIGUARD_Export** in order to copy or further process the export files.

NOTE

Saving can last several minutes even though the window has already been closed. The amount of time required for saving depends on the amount of the data that must be written in the permanent archive, and on the length of the time range you have selected.

3.4.2 Importing Time Ranges

Time ranges can be selected again and are available for evaluation again. They are no longer loaded into the ring archive.

Loading Time Ranges

✧ Select the menu **File > Load time range...**.

The **Load time range** dialog is displayed.

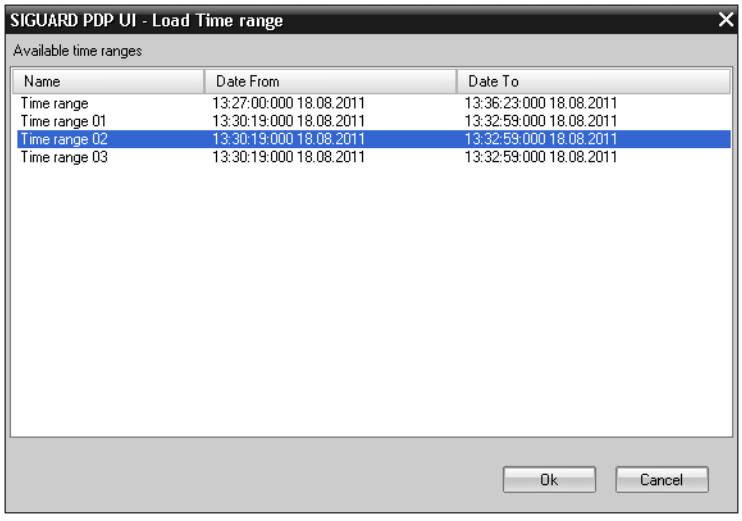


Figure 3-24 Load time range dialog

All available time ranges are displayed with name, start, and end time in a list format. The size of the window can be changed.

NOTE

The time range is not displayed in the list, until the export from the ring archive into the permanent archive has finished completely.

✧ Select the time range that you would like to view/evaluate.

✧ Confirm your selection by clicking the **OK** button.

The loaded time range with the corresponding measured values is displayed in the **PSS Curve** window section.

You can leave this display from the permanent archive by selecting new data from the permanent archive or by displaying current values in online Mode.

3.4.3 Deleting Time Ranges

Time ranges and the measured values contained in them, which were saved in the permanent archive can be deleted selectively.

Deleting a Time Range

✧ Select the menu **File > Delete time range...**.

The **Delete time range** dialog is displayed.

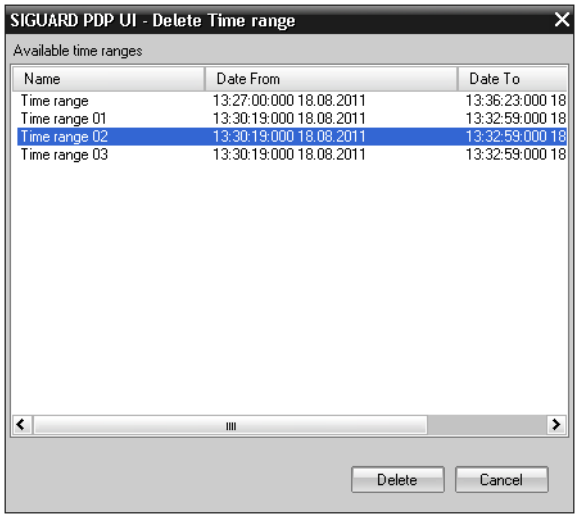


Figure 3-25 Delete time range dialog

All available time ranges are displayed with name, start, and end time in a list format. The size of the window can be changed.

✧ Select the time range that you would like to delete.

NOTE

Time ranges can only be deleted individually.

Deleted time ranges cannot be restored.

✧ Confirm your selection by clicking the **Delete** button.

The time range with the corresponding measured values is deleted and the dialog is closed.

3.5 Conclusion from the Analysis

The analysis of the sample event leads to the following result:

- The **PSS Curve** is in the red range due to exceeded current limiting values, see *Figure 3-1*.
- The cause for the exceedance is the periodic connection of a high load.
- The periodic connection of a high load causes power oscillations that are well damped, see *Figure 3-21*.
- The current limiting value is briefly exceeded, see *Figure 3-9*.
- So that undesired protection trips do not arise, the protection settings of the line must be checked.

3.6 Creating and Printing Reports

Using the **Copy to Clipboard** function, you can create, save, and print reports. To do this, insert the diagrams, for example, into Microsoft Word and comment on them.

- ✧ Right-click the diagram in the **Chart View** window section.
- ✧ Select **Copy to Clipboard ...** from the context menu.

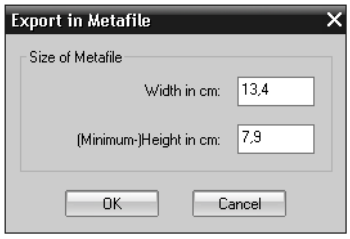


Figure 3-26 Settings for the metafile

- ✧ In the next dialog, enter the image size and confirm with **OK**.
- ✧ Open a blank document or a self-prepared report template using the text editor.
- ✧ Use **<CTRL> + <V>** to insert the clipboard contents into the document.
- ✧ Open the event list or the alarm list.
- ✧ Select the relevant messages (click them individually or select them with Ctrl-A) and copy the messages with Ctrl+C into the clipboard.
- ✧ Insert the events or alarms into the document with Ctrl+V.
- ✧ Add your own text as comments. For this, use the default settings of the text editor.
- ✧ Save the document and print it.

■

4 SIGUARD PDP Engineer

4.1 Overview

Application of SIGUARD PDP Engineer

SIGUARD PDP Engineer is the parameterizing and settings tool for SIGUARD PDP. You can set up and change the function of SIGUARD PDP with it. The following tabs are available for editing:

- **PMU**

  Add, duplicate, change, or delete physical and logical PMUs.

  Adding or changing measuring points for existing or new PMUs.

- **Calculation**

  Add, duplicate, change, or delete calculated values.

  Assign parameters of calculated values with factor and formula that uses the input measured values from the measured and calculated values.

- **Graphics**

  Add, duplicate, or delete elements for graphical representation of power-supply systems.

  Use of Google Earth functions.

- **Application**

  Adding, duplicating, deleting, and parameterization of various applications:

  - Voltage Stability Curve (VSC)
  - Island State Detection (ISD) in networks
  - Swing recognition in networks (Power Swing Recognition PSR)

- **Communication**

  Adding, duplication, deletion, and parameterization of communication via various interfaces:

  - C37.118

    Creation of PDC server and logical PMUs and configuration of the measuring channels

  - ICCP

    Parameterization of the communication settings, assignment and parameterization of measuring points and assignment of event objects.

  - OPC

    Parameterization of the OPC servers and assignment and parameterization of the measuring points.

Installation

The tool **SIGUARD PDP Engineer** is available on DVD and is installed on the target computer together with SIGUARD PDP UI (see *Administrator Manual, System installation*).

Program Window

The main window of **SIGUARD PDP Engineer** is composed of the following window sections:

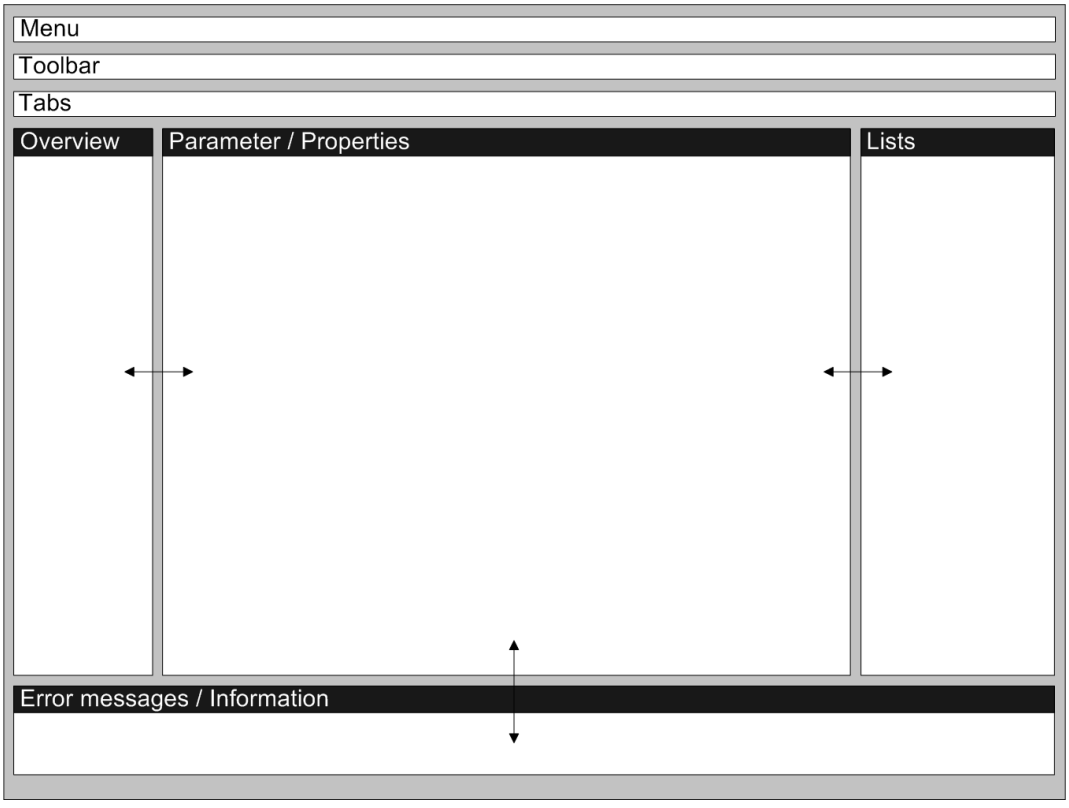


Figure 4-1 Schematic Representation of the Program Window of SIGUARD PDP Engineer

NOTE

You can change the individual windows sections in the direction of the arrow by dragging the boundary line.

- **Menu**

  Via the menu you call up general functions (see *4.2 Menu*).
- **Toolbar**

  Via the toolbar you call up functions, which can be used within a project (see *4.3 Toolbar*).
- **Tabs**

  Via the tabs you select various configuration and parameterizing options.

  Depending on the selected tab, corresponding window sections and functions are available to you (see *4.4 Phasor Measurement Unit (PMU)* to *4.8.4 OPC*).
- **Overview**

  In the left window section, the tree structure of the existing elements for the selected tab are shown.
- **Parameters/Properties**

  In the middle window section, the parameters and/or properties of the selected element are shown.

- **Lists**

  In the right window section, lists are shown depending on the selected tab (for example, measured and calculated values or element types).

- **Error messages after Validation**

  In the lower window section, **Project validation - Errors** error messages are shown based on the validation, for example:

  - Info (tab name): Description
  - Error (tab name): Error description

  For further information, see *4.9 Shared Functions*.

- **Current error messages**

  For every element that is marked with a warning symbol,  a quick info (tooltip) can be shown. Point to the element with the cursor. The quick info contains the element type and a description of the error that has appeared.

  For further information, see *4.9 Shared Functions*.

4.2 Menu

Each menu consists of the following parts:

Menu Group Project

Within the menu group **Project**, you can call up the following functions:

- **Project > New...**

  Creates a new project.
- **Project > Open...**

  Open an existing project.

  You can open only one project at a time. If you want to open another project or want to create a new one, you must close the Engineer.
- **Project > Save**

  Save changes to an existing project.
- **Project > Validate**

  Tests a project for validation and shows information or any errors in the window section **Project validation Errors**.
- **Project > Print...**

  Prints all data of a project on your printer (also in PDF format).
- **Project > Activate**

  Activates a project that has been edited, check for validation, and saved object for the runtime process.
- **Project > Exit**

  Close the open project.

  If the project has not been saved yet, a security question is asked whether it should be saved prior to closing.

Menu Group Edit

Within the menu group **Edit**, you can call up the following functions, which are also implemented in the toolbar:

- **Edit > Undo**

  Reverses an executed function.
- **Edit > Redo**

  Restores a reversed function.

NOTE

You can reverse up to 500 changes.

Menu Group Help

Within the menu group **Help**, you can call up the following functions:

- **Help > Engineer...**

  Calls up the help function of SIGUARD PDP UI and SIGUARD PDP Engineer
- **Help > About...**

  Gives information about the program version of SIGUARD PDP Engineer

4.3 Toolbar

Buttons

Executes the following functions via the buttons on the toolbar:

Table 4-1 Toolbar of SIGUARD PDP Engineer

Element	Explanation
	Click the button **New**, in order to create a new project.
	Click the button **Open**, in order to open an existing project.
	Click the button **Save**, in order to save changes to an existing project.
	Click the button **Validate**, in order to check the opened project for validation.
	Click the button **Undo**, in order to reverse an executed function.
	Click the button **Redo**, in order to restore a reversed function.
	Click the button **Print** in order to print all data from a project.
	Click the button **Activate**, in order to activate a project that has been edited, tested for validation, and saved for the runtime process.

4.4 Phasor Measurement Unit (PMU)

The following prerequisites must be fulfilled to parametrize a PMU:

- An existing project or a new project must be open.
- The tab **PMU** must be selected.

Tab PMU Is Selected

When you have selected the tab **PMU**, the layout for adding and editing physical and logical PMUs is shown.

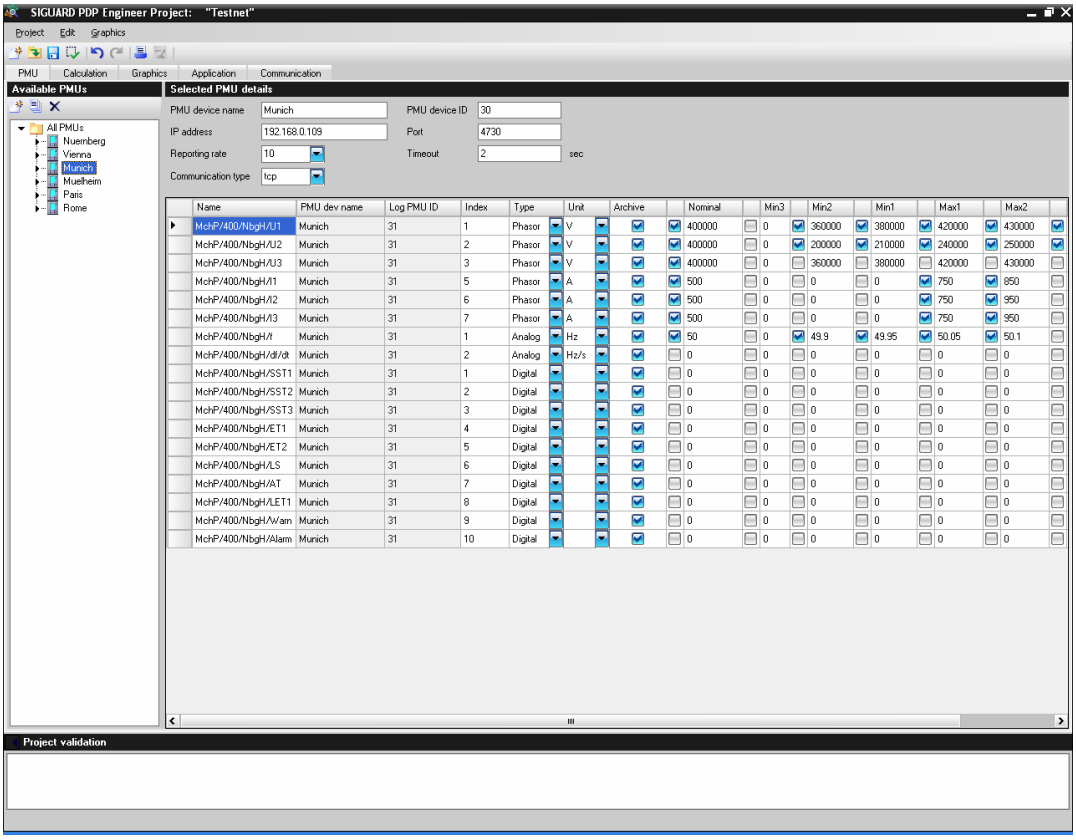


Figure 4-2 Selected Tab PMU

- **Available PMUs**

  In the left window section, the overview of all available PMUs in the directory **All PMUs** is shown.
- **Selected PMU details**

  In the middle window section, the parameter data of the selected PMU is shown. If no PMU is created or selected this window section is colored gray.

  In the upper part the parameters of the selected PMU are shown, and in the lower part the measuring points created for this PMU are shown in a table.

Functions

The following functions can be performed when the tab **PMU** is selected:

Table 4-2 Functions for PMUs

Element	Explanation
	Click the button **New**, in order to create a new, physical PMU in the marked directory **All PMUs** or a logical PMU within a marked physical PMU.
	Click the button **Duplicate**, in order to duplicate either a marked, physical PMU with the same name and subordinated logical PMUs or a marked logical PMU.
	Click the button **Delete**, in order to delete either a marked logical PMU or a marked physical PMU with all subordinated, logical PMUs.

Parameters of a Physical PMU

When you have selected a physical PMU in the window section **Available PMUs**, the following right window section is displayed.

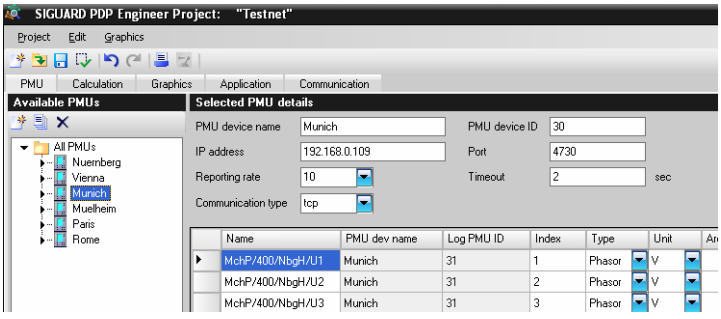


Figure 4-3 Parameters of a Physical PMU

In the following table, the setting options of the properties/parameters of a physical PMU are explained.

Table 4-3 Parameters of a Physical PMU

Element	Explanation
PMU device name	The name of the physical PMU can be selected freely, for example: *Munich* **Note** Ensure that all names in the overall system are unique, so that messages in the event and alarm list can be assigned uniquely. The uniqueness is checked in the framework of the validation.
PMU device ID	ID of the connected, physical PMU The data must be inherited from the configuration of the physical PMU. for example: *30*
IP address	IP address of the connected, physical PMU The data must be inherited from the configuration of the physical PMU, for example: *192.168.0.109*
Port	Port to which the physical PMU is connected. The data must be inherited from the configuration of the physical PMU, for example: *4712*

Element	Explanation
Reporting rate	Number of telegrams (frames) per second that are transferred from the physical PMU. The data must be inherited from the configuration of the physical PMU. You can set the value via a list box from 10 frames/second up to 60 frames/second. If the value does not agree with the configuration of the physical PMU, an error message appears and no transfer takes place.
Timeout	Time in secs how long a delayed telegram from the PMU was waited for.
Communication type	You can select the type of communication **tcp** or **udp** via a list box.
UDP port	Display only in case of selected type of communication **udp**, for example: *4713*

Further information can be found in the bibliography under /1/.

NOTE

In case of missing or erroneous entry, the entry field is highlighted in red.

Parameters of a Logical PMU

When you have selected a logical PMU in the window section **Available PMUs**, the following right window section is displayed.

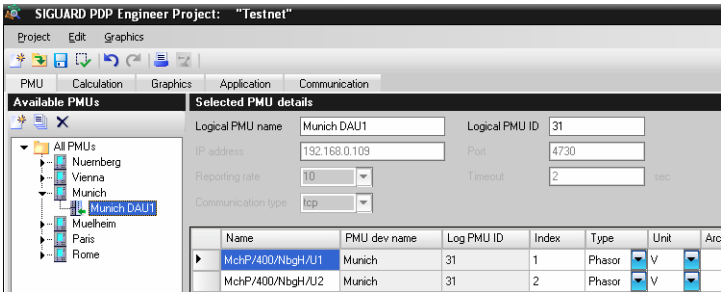


Figure 4-4 Parameters of a Logical PMU

In the following table, the setting options of the properties/parameters of a logical PMU are explained.

Table 4-4 Parameters of a Logical PMU

Element	Explanation
Logical PMU name	The name of the logical PMU can be selected freely, for example: *Munich DAU1* **Note** Ensure that all names in the overall system are unique, so that messages in the event and alarm list can be assigned uniquely. The uniqueness is checked in the framework of the validation.
Logical PMU ID	ID of the connected, logical PMU. The data must be inherited from the configuration of the physical PMU, for example: *31*

NOTE

The remaining parameter fields are not active (colored gray).

Editing Measuring Points

- **Add measuring points**

  In order to add a measuring point, click in the last line of the column **Name**. Enter a name for the new measuring point. An additional blank line is inserted, by which a further measuring point can be defined.

  The name **PMU device** of the physical PMU and the **Logical PMU ID** are automatically entered. The parameters **Index**, **Type**, and **Unit** make an entry according to the configuration of the physical PMU. Add further parameters.

- **Copying/inserting measuring points**

  To copy measuring points, select one or several measuring points (lines) in the table and select the context menu **Copy**.

  To insert copied measuring points, select the line at which it should be inserted and select the context menu **Paste**. As many lines, including the marked line, are always overwritten, as lines are inserted.

- **Column sequence**

  You can move individual columns by dragging the heading to another place in the table, and thereby change the column sequence.

- **Delete measuring points**

  To delete measuring points, select one or several measuring points (lines) in the table and press **<Del>**.

NOTE

Ensure that you create precisely those measuring points that the PMUs to be connected actually use in later operation. A comparison with the parameter data of the PMUs is recommended.

Parameters of a Measuring Point

For every logical PMU the created measuring points are displayed in window section under the PMU parameters in the form of a table. They can be edited only with a selected logical PMU.

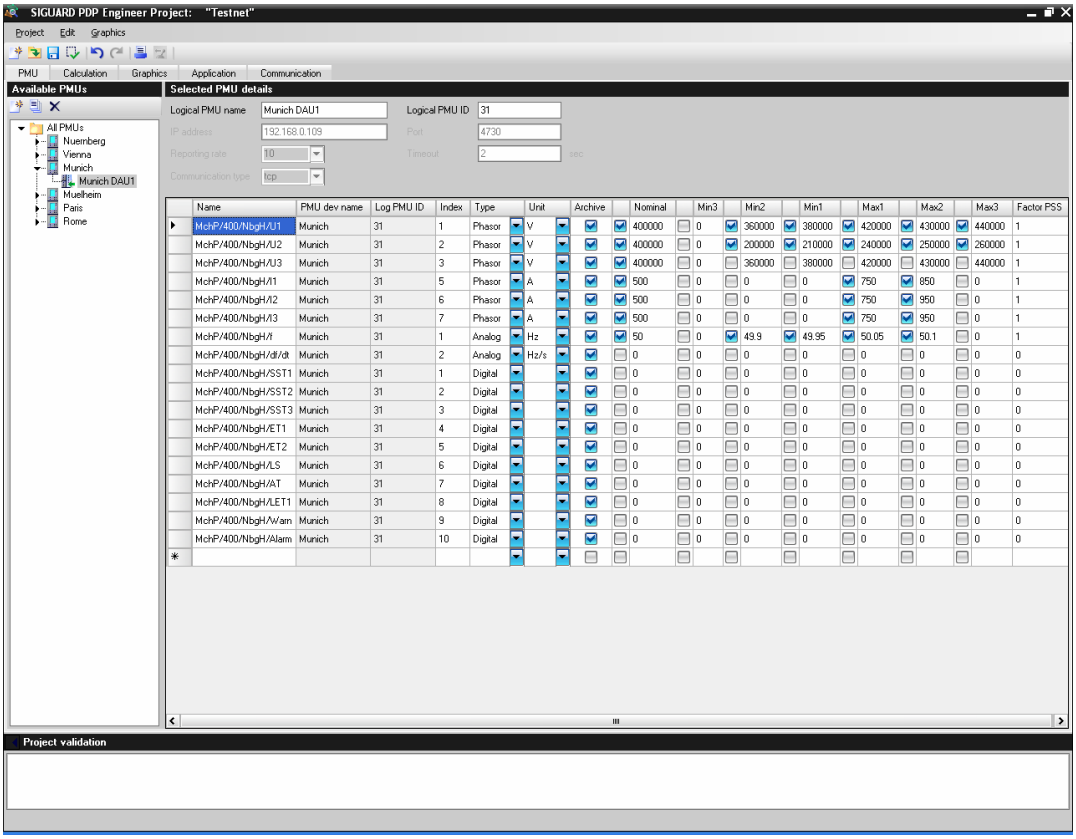


Figure 4-5 Parameters of the Measuring Points

In the following table, the setting options of the properties/parameters of the measuring points are explained.

Table 4-5 Parameters of the Measuring Points

Element	Explanation
Name	The name of a measuring point can be selected freely, for example: *MchP/400/NbgH/U1*
PMU device name	Name of the physical PMU The data are automatically inherited, for example: *Munich*
Log PMU ID	ID of the logical PMU The data are automatically inherited, for example: *31*
Index	The index is a pointer to the protocol transferred from the PMU, in order to identify the corresponding measurement. The data must be inherited from the configuration of the physical PMU, for example: *7*
Type	The measurement type can be entered via a list box. Available types are: *Phasor*, *Analog*, or *Digital*.

Element	Explanation
Unit	The unit of the measured value that is measured at this measuring point can be entered according to measurement type via a list box, for example: *A* for current, *V* for voltage, *W* for active power, *VA* for apparent power, *VAr* for reactive power, *Degree* for the phase angle, *Hz* for frequency, or *Hz/s* for the frequency changing speed.
Archive	If the check box is marked, the measured values at this measuring point are saved in the archive.
Nominal	Entry of the rated value of the value to be measured, for example: *400000* If the check box is selected, the rated value is included in the measurement.
Min1 ... Min3	Definition of up to 3 lower limiting values regarding the rated value, for example: *380000*, *360000* and *340000*.
Max1 ... Max3	Definition of up to 3 upper limiting values regarding the rated value, for example: *420000*, *430000* and *440000*. If the respective check box is marked, the corresponding limiting value is included in the measurement.
Factor PSS	The PSS factor states the influence of the measurement on the PSS curve. The higher the PSS factor selected, the greater the influence on the PSS curve. Standard = *1*

Saving a Project

The data of a project should be saved after every change or reconfiguration. You can even save a project when the validation is still not successful.

NOTE

After saving a project, newly created measuring points are entered into the list **Available measurements**; deleted measuring points are also deleted from this list.

For further information on saving a project, see *4.9 Shared Functions*.

Validation

Current errors can be displayed in tooltips during entry. A complete validation takes place via the menu **Project > Validate** or via the icon  . If error messages are displayed, re-edit the configuration. If the validation is free of errors, the project can be activated for the runtime process.

For further information on validating a project, see *4.9 Shared Functions*.

Activation of a Project

After successful validation, an opened and saved project can be made available to the runtime process. This takes place via the menu **Project > Activate** or via the icon  .

For further information on activating a project, see *4.9 Shared Functions*.

4.5 Calculated Measurements

The following requirements must be satisfied for creating and editing calculated values:

- A project must be created or an existing project must be opened.
- The tab **Calculation** must be selected.

The Calculation Tab Is Selected

When you have selected the tab **Calculation**, the layout for adding and editing calculated values is displayed.

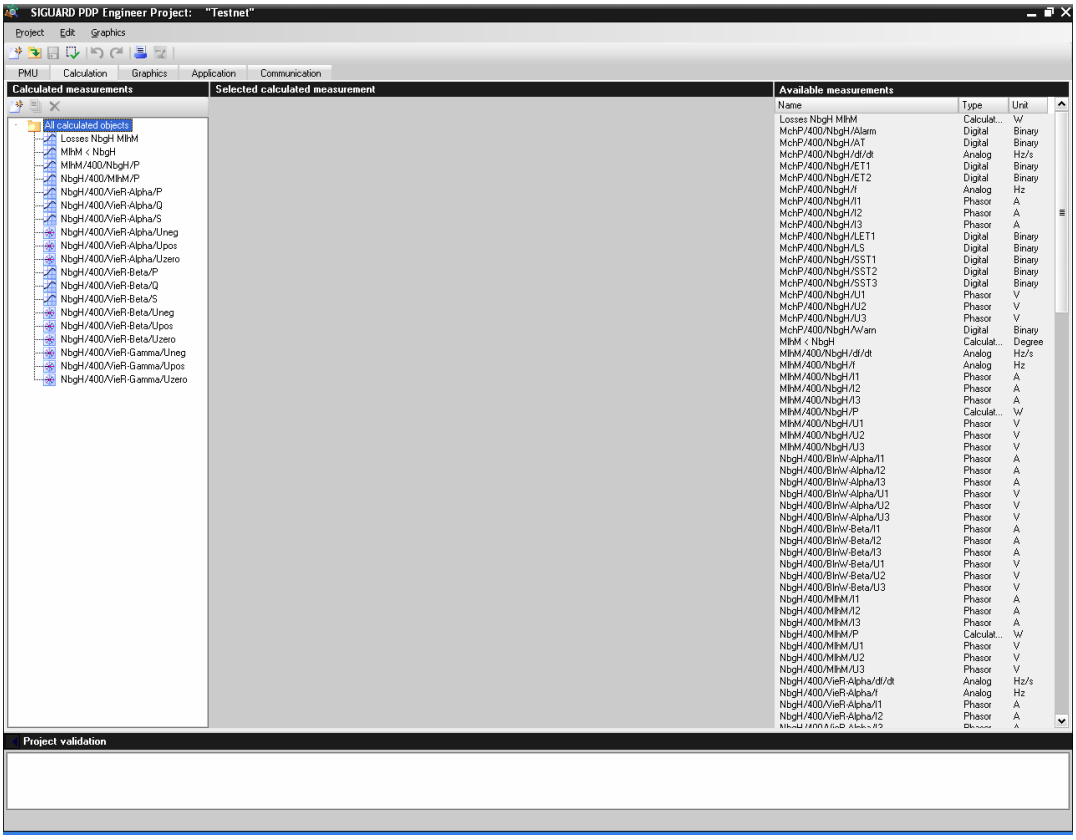


Figure 4-6 Selected Tab Calculation

- **Calculated measurements**

  In the left window section, the overview of all existing calculated values are shown in the directory **All calculated objects**.
- **Selected calculated measurements**

  In the middle window section, the parameter data (**Name**, **Factor**, and **Formula**) of a selected calculated value is displayed.
- **Available measurements**

  In the right window section, all available values **Available measurements** are displayed with name, type, and unit, which are used for the input measurand of the formula.

Functions

The following functions can be executed via buttons in the tree view when the tab **Calculation** and marked element are selected.

Table 4-6 Functions for Calculated Values

Element	Explanation
	Click the button **Create a new calculation**, in order to create a new, calculated value in the marked directory **All calculated objects**.
	Click the button **Duplicate a selected calculation**, in order to duplicate a marked, calculated value for further editing.
	Click the button **Delete the selected calculation** or press the key **Delete**, in order to delete a marked, calculated value.

Parameters of a Calculated Value

When you have selected a calculated value in the window section **Calculated measurements**, the following middle window section is displayed.

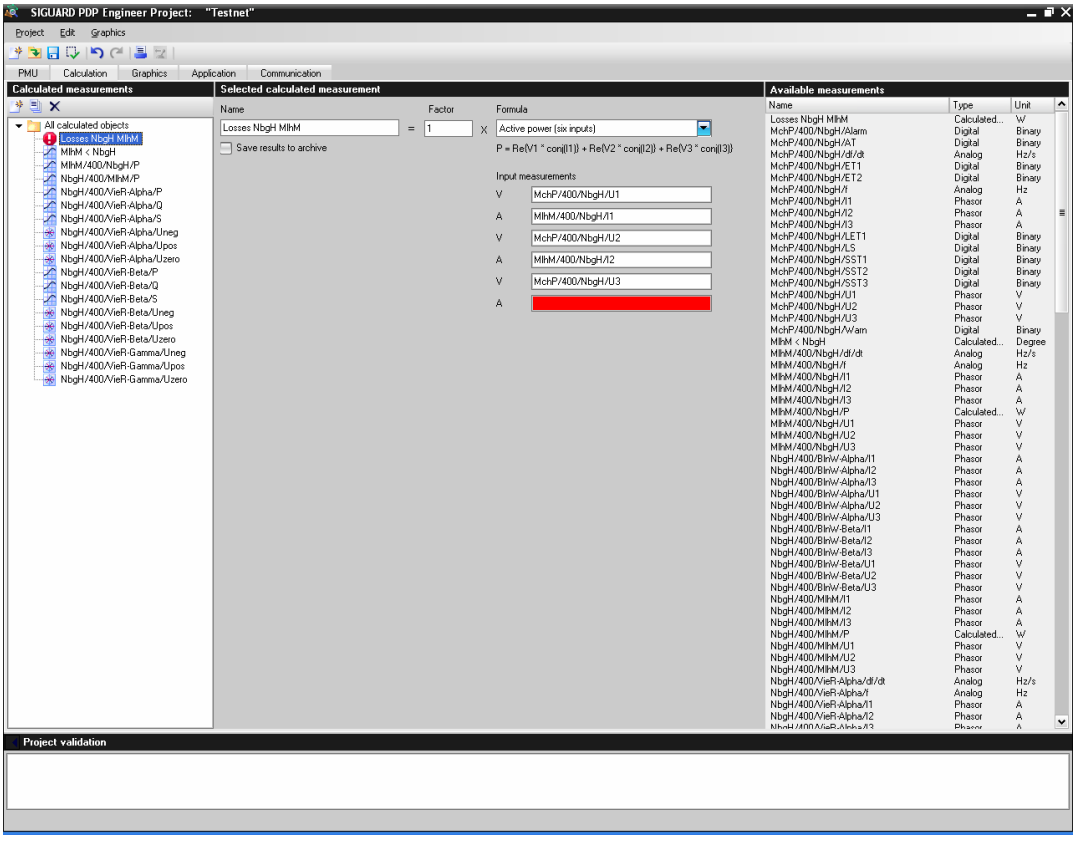


Figure 4-7 Parameters of a Calculated Value

A calculated value consists of the **Name**, which is made up of the **Factor** and the **Formula**.

In the following table, the setting options of the properties/parameters of the calculated values are explained.

Table 4-7 Parameters of a Calculated Value

Element	Explanation
Name	In this field, the name of the calculated value is entered, changed, or displayed in the case of an existing value. The name can be selected freely. If no entry takes place a name is automatically assigned.
Factor	Multipliers for calculated values Only numerical entries with a period in the place of the comma are valid.
Formula	You can select various formula functions. For this, corresponding input measurand **Input measurements** are necessary, which can be defined via measured and calculated values.
Save results to archive	If the check box is marked, its value is saved in the archive. Saving is not necessarily required, since the value can also be recreated based on the input measurand. However, you must expect a longer retrieval time, since greater amounts of data must be retrieved from the archive.
Input measurements	Input measurand for the calculation that is assumed from the measured and calculated values **Available measurements**. For certain formulas, it is also possible to enter constants.

NOTE

Empty entry fields are highlighted in red. Enter a value.

Defining Calculated Values

If a newly created calculated value is not yet defined, for example, if no formula is stored, the list box is **undefined**.

Define a formula with the corresponding input measurands. The type of the calculated value is determined from the first input measurand (phasor, analog, or digital), and furnished with the corresponding unit in the overview, if the formula allows variable input measurands. Other formulas require input measurands of a precisely defined type.

Defining Formulas

The following formula functions are available.

Table 4-8 Overview of the Formulas for a Calculated Value

Element	Formula	Explanation
Active power (6 inputs)	P = Re{V1*conj(I1)} + Re{V2*conj(I2)} + Re{V3*conj(I3)}	Calculation of the active power with 6 input measurands
Active power (substation usage)	P = Re{(bb1*V1 + bb2*V2 + bb3*V3) *conj(I)}	Calculation of the active power, based on the busbar voltages (V1 to V3) and the current in the bay (i) while considering the position of the busbar disconnector (bb1 to bb3)
Active power (2 inputs)	P = Re{V*conj(I)}	Calculation of the active power with 2 input measurands
Add 2 analogs	x = a + b	Addition of 2 analog values
Add 2 phasors	X = A + B	Addition of 2 phasors (2 voltages or 2 currents, respectively)
Angle difference between 2 phasors	x = deg(A) - deg(B)	Calculation of the phase angle between 2 phasors

Element	Formula	Explanation
Apparent power (6 inputs)	S = IV1*conj(I1)I + IV2*conj(I2)I + IV3*conj(I3)I	Calculation of apparent power with 6 input measurands
Apparent power (substation usage)	S = I(bb1*V1 + bb2*V2 + bb3*V3) *conj(I)I	Calculation of the apparent power, based on the busbar voltages (V1 to V3) and the current in the bay (i) while considering the position of the busbar disconnector (bb1 to bb3)
Apparent power (2 inputs)	S = IV*conj(I)I	Calculation of apparent power with 2 input measurands
Conductance from V and I	G = Re{[(V1*I1 - V2*I2) + (V1*I2 - V2*I1)] / (V2**2 - V1**2)}	Conductance G of a line through measurement of the voltage and current at the beginning and the end
Conjugate a phasor	X = conj(A)	Conjugation of a phasor (voltage or current)
Divide 2 analogs	x = a/b	Division of 2 analog values (numbers)
Logical AND	x = AND(a,b)	Logical AND relation of 2 digital inputs
Logical NOT	x = NOT(a)	Logical inversion of a digital input
Logical OR	x = OR(a,b)	Logical OR operation of 2 digital inputs
Logical XOR	x = XOR(a,b)	Logical XOR operation of 2 digital inputs
Multiply 2 analogs	X = a*b	Multiplication of 2 analog values (numbers)
Negative sequence	Xneg = (A + a**2*B + a*C)/3	Calculation of system components negative-sequence system
Positive sequence	Xpos = (A + a*B + a**2*C)/3	Calculation of system components positive-sequence system
Power factor	lambda = P/S = Re{V*conj(I)} / IV*conj(I)I	Calculation of the power factor from active power and apparent power and the input measurands voltage and current
Reactance from V and I	X = Im{1/Yq} = Im{V1**2 - V2**2) / (V1*I2 - V2*I1)}	Reactance X of a line through voltage and current measurement at the beginning and the end
Reactive power (6 inputs)	Q = Im{V1*conj(I1)} + Im{V2*conj(I2)} + Im{V3*conj(I3)}	Calculation of reactive power with 6 input measurands
Reactive power (substation usage)	Q = Im{(bb1*V1 + bb2*V2 + bb3*V3) *conj(I)}	Calculation of the apparent power, based on the busbar voltages (V1 to V3) and the current in the bay (i) while considering the position of the busbar disconnector (bb1 to bb3)
Reactive power (2 inputs)	Q = Im{V*conj(I)}	Calculation of reactive power with 2 input measurands
Resistance from V and I	R = Re{1/Yq} = Re{(V1**2 - V2**2) / (V1*I2 - V2*I1)}	Resistance R of a line through measurement of the voltage and current at the beginning and the end
Rotate a phasor	X = A * Power(e,x)	Rotation of a phasor
Scaling of analog	x = m * a + c	Scaling of an analog value a with the help of a gradient m and a constant summand c

Element	Formula	Explanation
Subtract 2 analogs	x = a - b	Subtraction of 2 analog values (numbers)
Subtract 2 phasors	X = A - B	Subtraction of 2 phasors (2 voltages or 2 currents, respectively)
Susceptance from V and I	B = Im{[(V1*I1 - V2*I2) + (V1*I2 - V2*I1)] / [V2**2 - V1**2)}	Susceptance B of a line through measurement of the voltage and current at the beginning and the end
Zero sequence	Xzero = (A + B + C)/3	Calculation of system components zero-sequence system

Allocate Input Quantities

Depending on the formula, a corresponding number of entry fields for the input measurands **Input measurements** are represented. Before each field, the type/unit of the measured or calculated value **Available measurements** is displayed, which must be routed to this field.

Example:

If, for example, a phasor is supposed to be multiplied by an analog value, then a phasor must be routed as the first input measurand. Only an analog value can be routed to the second input measurand. Other routings are not valid and cannot be executed.

Assuming Formulas

In case of duplicated calculated values, there are 2 possibilities for defining formulas and corresponding input measurands:

- Selection of a formula via the list box and reallocation of the input measurands from the measured and calculated values **Available measurements**
- Select the contents of the list box by double-clicking. This activates the group function and the selection of the formula can be performed via the keys **<Arrow up>** or **<Arrow down>**, where already existing input measurands are maintained and do not need to be rerouted.

NOTE

The old input measurands are only assumed if the list box is opened up and a function is selected with the same input types.

Saving a Project

The data of a project should be saved after every change or reconfiguration. You can even save a project when the validation is still not successful.

For further information on saving a project, see *4.9 Shared Functions*.

Validation

Current errors can be displayed in tooltips during entry. A complete validation takes place via the menu **Project > Validate** or via the icon  . If error messages are displayed, re-edit the configuration. If the validation is free of errors, the project can be activated for the runtime process.

For further information on validating a project, see *4.9 Shared Functions*.

Activation of a Project

After successful validation, an opened and saved project can be made available to the runtime process. This takes place via the menu **Project > Activate** or via the icon  .

For further information on activating a project, see *4.9 Shared Functions*.

4.6 Graphical Representation of Power-Supply Systems (Graphics)

4.6.1 Overview

The following requirements must be met in order to create and edit graphical displays of networks:

- A project must be created or an existing project must be opened.
- The tab **Graphics** must be selected.

The Graphics Tab Is Selected

If the tab **Graphics** was selected, the layout for creating network graphics is displayed.

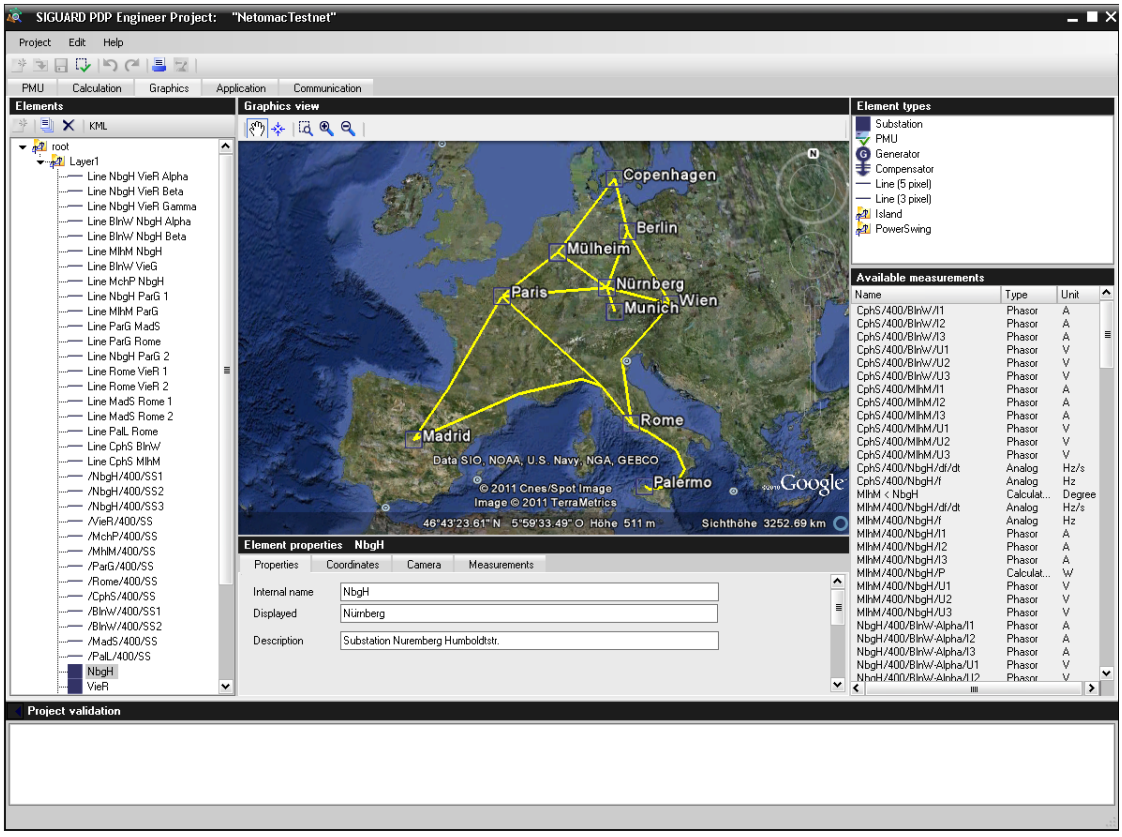


Figure 4-8 Selected Tab Graphics

- **Elements**

  In the left window section, the overview of all elements already existing in the directory **root** are shown (for example, **Layer1** for the complete graphic or parts of a graphic and subelements for stations, lines, and others). The overview represents an organization of the graphical elements for a network.

- **Graphics view**

  In the upper part of the middle window section, Google Earth is opened as a background. A network can be overlaid graphically over the map from the element types.

- **Element properties**

  In the lower part of the middle window section, the properties of the marked element are displayed.

  The properties are divided into:

  - General properties, tab **Properties**
  - Properties of the coordinates, tab **Coordinates**
  - Setting for the camera, tab **Camera**
  - List of routed measurements, tab **Measurements**

- **Element types**

  A library of graphical elements is shown in the upper part of the right window section. These elements are available for drawing a graphical network structure in the window section **Graphics view**.

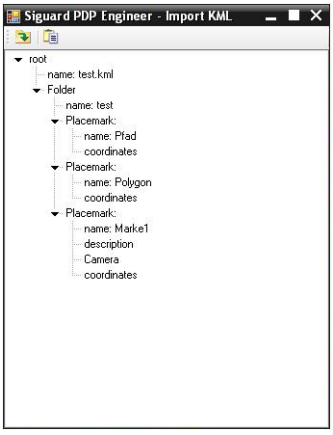
- **Available measurements**

  In the lower part of the right window section, all available measurements **Available measurements** are shown with name, type, and unit, which are drawn on for the configuration of the element properties and produce a color according to the quality of the measured value.

Functions for Elements

The following functions can be executed for editing the elements via buttons.

Table 4-9 Functions for Elements

Element	Explanation
	Click the button **New**, in order to create a new graphic **New layer** in the directory **root** or an element in the marked graphics folder.
	Click the button **Duplicate**, in order to duplicate an existing graphic or an existing graphic element. The graphic or the graphic element is inserted at the end of the respective group.
	Click the button **Delete**, in order to delete a graphic or graphic element.
	Click the button **KML**, in order to import coordinates for a graphic element in KML format. 

Functions for Graphical Editing

The representation of a network on the map is comparable to a structure with 2 levels that lie on top of one another:

- Google Earth level

  Representation of the map with the corresponding Google Earth functions

- User level

  Representation of a network with the parameters that are defined in SIGUARD PDP Engineer in the tab **Graphics**.

The following functions can be performed for graphical processing of the elements in the window section **Graphics view** via buttons.

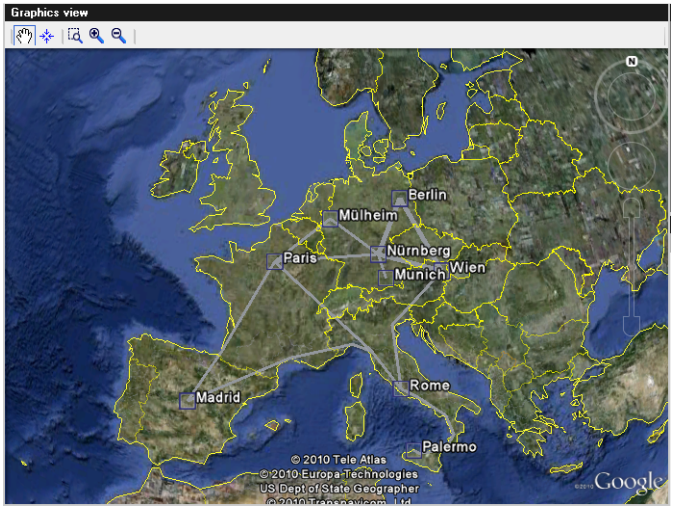


Figure 4-9 Interface for the Editing of Graphic Elements

Table 4-10 Functions for Graphic Elements

Element	Explanation
 Google Earth level	Click the button **Navigate in map**, to navigate within the map and use the functions of Google Earth.
 User level	Click the button **Drag mode**, in order to define, or change the position of an element. • **Positioning Element** - Click the button **Drag mode**. - Select a layer in the tree structure under which the new element should be created. - Select an element in the window **Element types**. - Use drag and drop to pull the element to the desired position in **Graphics view**. The newly positioned element appears in the tree structure. For this, the properties under **Properties** can now be defined. • **Changing Element Position** - Click the button **Drag mode**. - Select the element in the tree structure. - Use drag and drop to pull the selected element to the new position in **Graphics view**. The graphical icon changes its position.
 User level	Click the button **Zoom to area**, in order to select a rectangle, the contents of which are enlarged to the size of the window section.
 Google Earth level	Click the button **Zoom in**, in order to gradually enlarge the map.
 Google Earth level	Click the button **Zoom out**, in order to gradually scale down the map.

4.6.2 Properties of the Elements

The parameter assignment of the properties of an element is distributed to the following tabs.

Properties

On the tab **Properties**, the following parameters are available.

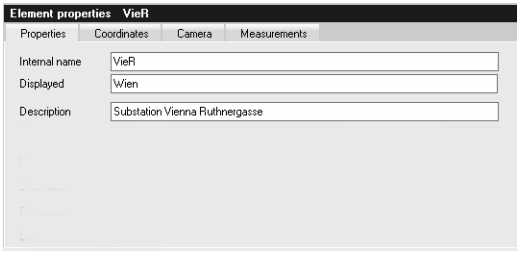


Figure 4-10 Parameter Properties

Table 4-11 Parameters of the Tab Properties

Element	Explanation
Internal Name	Name of the element that is displayed in the overview (technical name)
Displayed	Name of the element that is displayed in the map (for example, Berlin)
Description	Description of the element

Coordinates

On the tab **Coordinates**, the following functions are available.

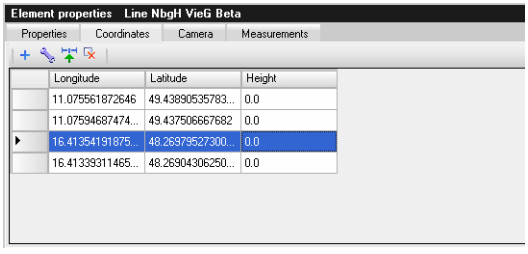


Figure 4-11 Parameter Coordinates

Table 4-12 Functions of the Tab Coordinates

Element	Explanation
	Click the button **Add Coordinate** and into the map, in order to add a new coordinate for this element. The new coordinate is inserted under the marked line. The parameters of a coordinate are shown in a table. Editing is not possible here. • **Longitude** Parameter for the geographical length in degrees (length in degrees). • **Latitude** Parameter for the geographical width in degrees (width in degrees). • **Height** Parameter for elevation over NN.
	Click the button **Change Coordinate**, in order to change the position of an element. • Select the element in the tree structure, the position of which is to be changed. • Click the button **Change Coordinate**. The cursor appears as + - icon in **Graphics view** • Position the cursor on the new position and double-click the left mouse button. The new coordinates are assumed in the table.
	Click the button **Fly to coordinate**, in order to transfer a saved camera position to a new element and in order to fly to individual coordinates with the saved camera position. • Double-click the element in the tree structure, the camera position of which (angle of view and elevation) is to be assumed. The selected camera position is displayed in **Graphics view**. • Click the element in the tree structure for which the camera position (angle of view and elevation) is to be assumed. The previous coordinates are displayed. • Click the button **Fly to coordinate**. The camera position (field of vision and elevation) is transferred to the new element and displayed in **Graphics view**. The individual coordinates (for example, of a line) can now be selected and the corresponding camera position displayed: • Select the coordinates and click the button **Fly to coordinate**. • Double-click a coordinate (line). The camera position (field of vision and elevation) of the selected coordinates is displayed in **Graphics view**. During the start of the line, the camera elevation can be adapted via the Google function. The next operation of the button **Fly to Coordinate** will remember this.
	Click the button **Remove Coordinate**, in order to delete a marked coordinate for this element.

Camera

The camera position is the way of viewing an element in Google Earth. The setting occurs via a double-click on the element and scrolling in horizontal or vertical direction.

On the tab **Camera**, the following functions for the configuration of the camera position of an element are available.

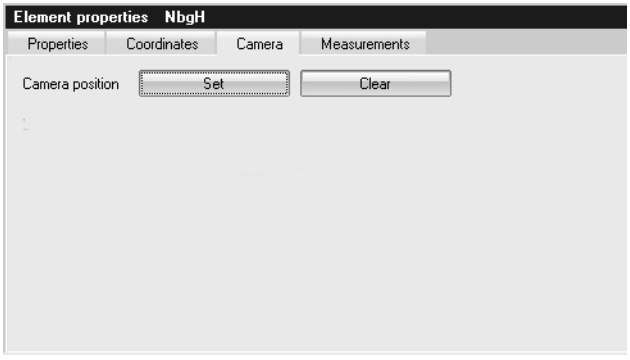


Figure 4-12 Settings for the Camera Position

Table 4-13 Functions of the Tab Camera

Element	Explanation
Set	Click the button **Set**, in order to save the set camera position for an element. To display this camera position in **Graphics view** again, double-click the element in the tree structure.
Clear	Click the button **Clear**, in order to delete the set camera position for an element.

Measurements

On the tab **Measurements**, the measuring points are displayed which were defined for this element. In this way, a linkage of the graphic element to the measuring channels is created.

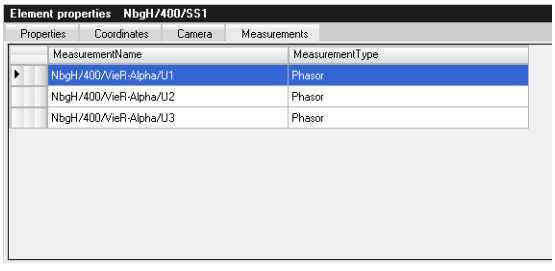


Figure 4-13 Parameter Measurements

Table 4-14 Functions of the Tab Measurements

Element	Explanation
MeasurementName	Allocation of measuring points The measuring points are assumed from **Available measurements** into the column **MeasurementName** and thus are defined for this graphic element. The quality of the measured values is responsible for the coloring of the elements in SIGUARD PDP UI. The measuring points cannot be edited here.
MeasurementType	Type of measuring point (for example, phasor, analog, or digital measured value and, calculated analog or digital measured value).

In order to delete measuring points, select a measuring point (line) and click the corresponding button  .

4.6.3 Element Types

In the upper right window section, **Element types** of the tab **Graphics** various types of elements are available to you for the creation of a graphical network structure.

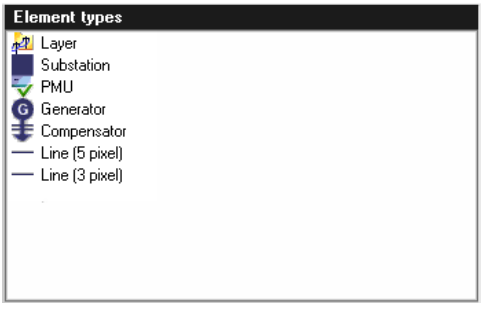


Figure 4-14 Overview of the Element Types

Table 4-15 Functions of the Tab Measurements

Element	Explanation
Layer	Folder for graphic elements
Substation	Element for a Station
PMU	Element for a Phasor Measuring Unit (PMU)
Generator	Element for a current generator
Compensator	Element for a Static Var Compensator SVC
Line (5 pixel)	Element for a thick line (collective representation of parallel systems)
Line (3 pixel)	Element for a thin line (individual line)

Saving a Project

The data of a project should be saved after every change or reconfiguration. You can even save a project when the validation is still not successful.

For further information on saving a project, see *4.9 Shared Functions*.

Validation

Current errors can be displayed in tooltips during entry. A complete validation takes place via the menu **Project > Validate** or via the icon  . If error messages are displayed, re-edit the configuration. If the validation is free of errors, the project can be activated for the runtime process.

For further information on validating a project, see *4.9 Shared Functions*.

Activation of a Project

After successful validation, an opened and saved project can be made available to the runtime process. This takes place via the menu **Project > Activate** or via the icon  .

For further information on activating a project, see *4.9 Shared Functions*.

4.7 Applications

4.7.1 Overview

For configuring and assigning parameters of applications, the following requirements must be met:

- An existing project or a new project must be open.
- The tab **Application** must be selected.

The Application Tab Is Selected

When you have selected the tab **Application**, the layout for adding and editing applications is displayed.

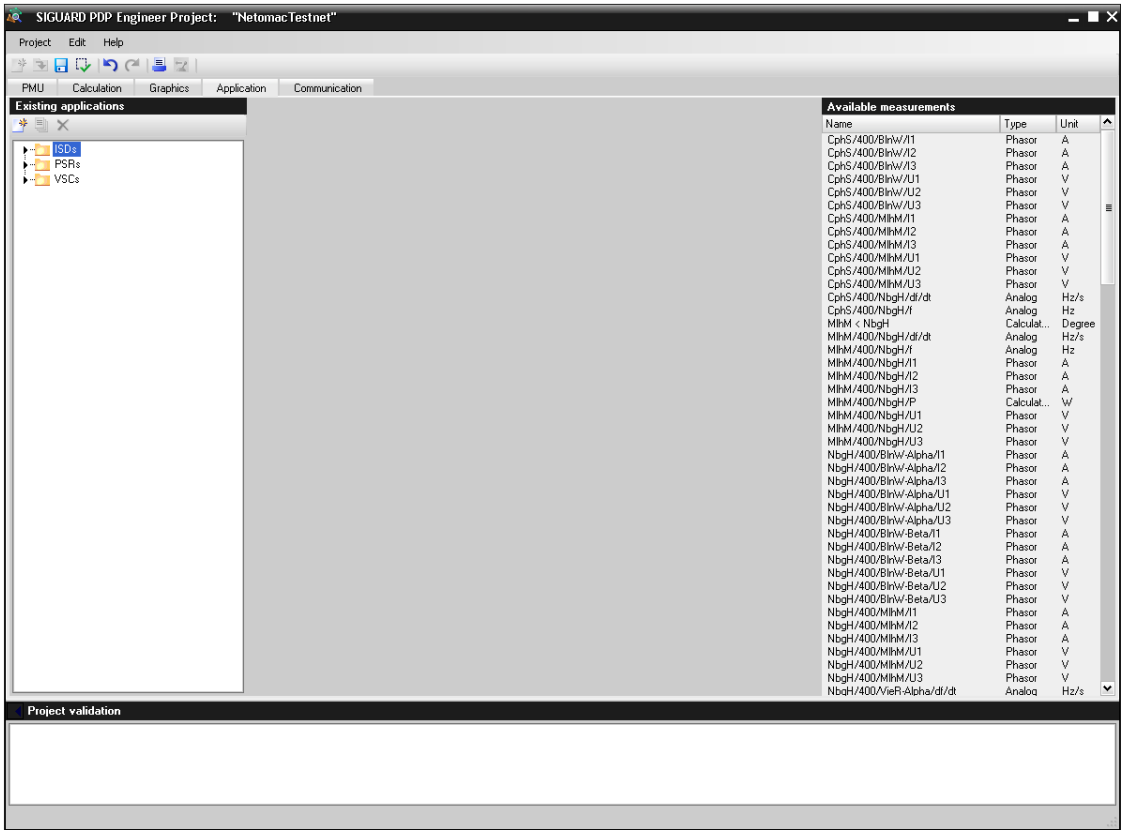


Figure 4-15 Selected Tab Application

- **Existing Applications**

  In the left window section, all available communication interfaces are displayed as folders:

  - Island detections (ISDs)
  - Power swing recognitions (PSRs)
  - Voltage stability curves (VSCs)

- **Selected Application**

  In the middle window section, the parameter data of the selected application is shown.

- **Available measurements**

  In the right window section, all available values **Available measurements** are displayed with name, type, and unit, which are used for the input measurands of the configuration of the applications.

4.7.2 Island State Detection (ISD)

To configure island detection, the folder **ISDs** is selected and a name for the folder **ISDs** is defined:

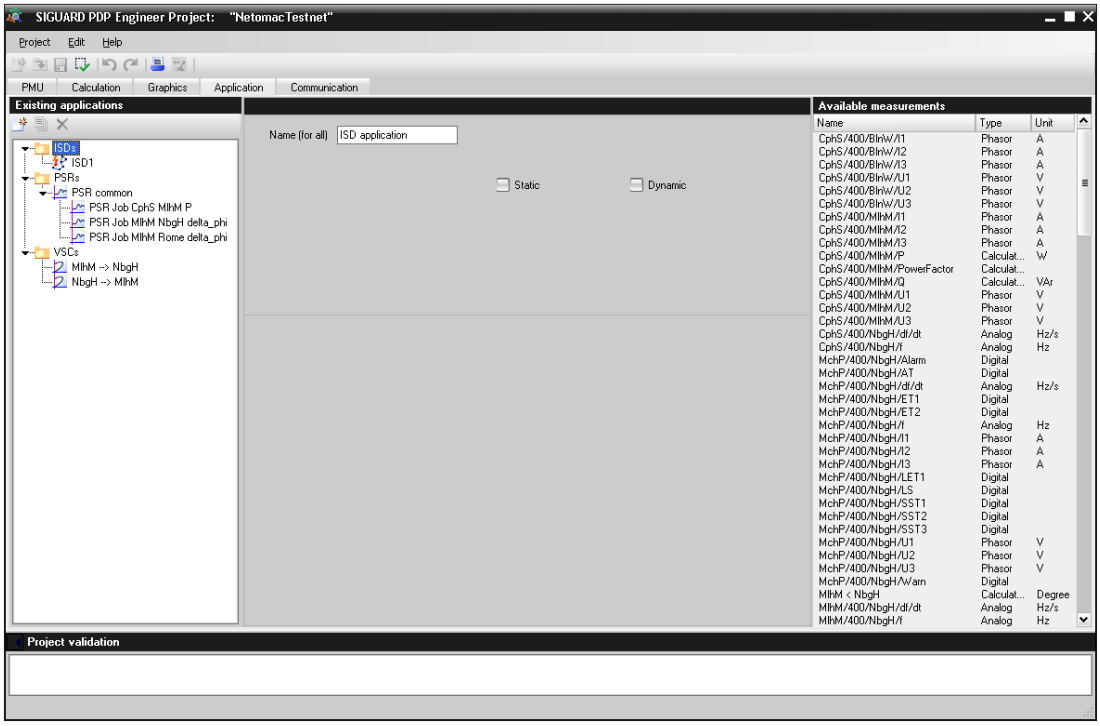


Figure 4-16 Name for ISDs folder is assigned

Next, the folder **ISDs** is opened and island detection is selected.

NOTE

You need a corresponding SIGUARD PDP license for the ISD to function. The existence of this license is not queried in the SIGUARD PDP Engineer.

Functions

For a selected folder **ISDs** or selected island detection, the following functions can be performed via buttons.

Table 4-16 Toolbar of the ISDs application

Element	Explanation
	Click the button **New island detection** in order to create a configuration scheme for a new application **Island detection** in the **ISDs** folder.
	Click the button **Duplicate island detection** to duplicate a configuration of an existing application **Island detection** for further processing.
	Click the button **Delete island detection** in order to delete an application **Power swing recognition**.

Parameters of an Application ISDs

If the folder **ISDs** is opened and an island detection is selected, the following middle window section **Application - Island detection** is displayed:

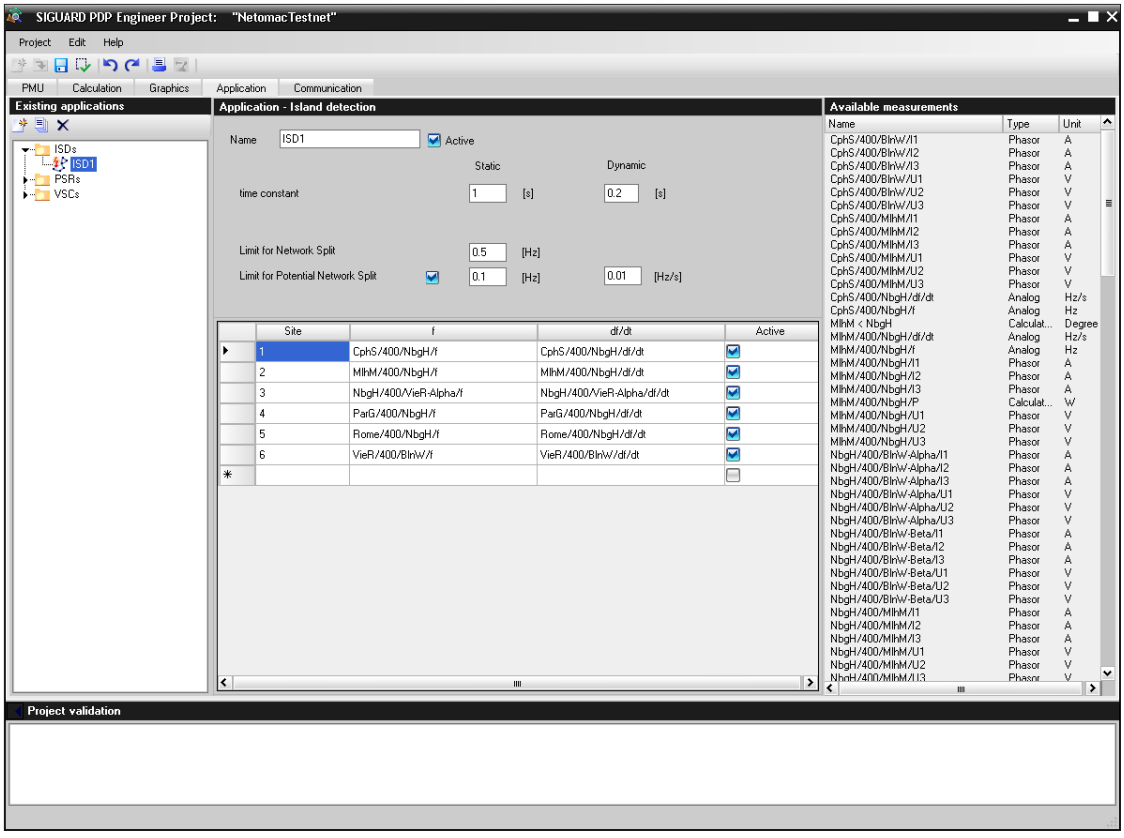


Figure 4-17 Parameters of the Application ISDs

In the following table, the setting options of the properties/parameters of the application **ISDs** are explained.

Table 4-17 Parameters of the Application ISDs

Element	Explanation
Name	In this field the name of the application **Island detection** is entered, changed, or displayed for an existing application.
Active	If the check box is marked, the application is switched to **active**.
Time constant	Time constant for static (Default = 1) and dynamic island detection (Default = 0.2) in seconds
Limit for Network Split	Upper limiting value in Hz for **static island detection** If the frequency difference between at least 2 neighboring frequencies is larger than the upper limiting value (Standard = 0.05 Hz), an island is detected.
Limit for Potential Network Split (static island detection)	Upper limiting value in Hz for **static island detection** If the frequency difference between at least 2 neighboring frequencies is smaller than the lower limiting value (Standard = 0.01 Hz), no island is detected. If the frequency difference between at least 2 neighboring frequencies lies between the lower and upper limiting values, there is a possible network split. If the check box is marked, a message is triggered in the case of an exceedance of the limiting value.
Limit for Potential Network Split (dynamic island detection)	Upper limiting value in Hz for **dynamic island detection** If the difference between at least 2 neighboring values for the rate of frequency change is larger than the limiting value (Standard = 0.001 Hz/s), there is a possible network split (island detection).

Configuration of Sites

A site is the aggregation of measuring points of a PMU.

It consists of the measuring points for a frequency (f) and a frequency changing speed (df/dt). In order to be able to compare frequency changing speeds, at least 2 sites per application **Island detection** must therefore be created and switched to **active**.

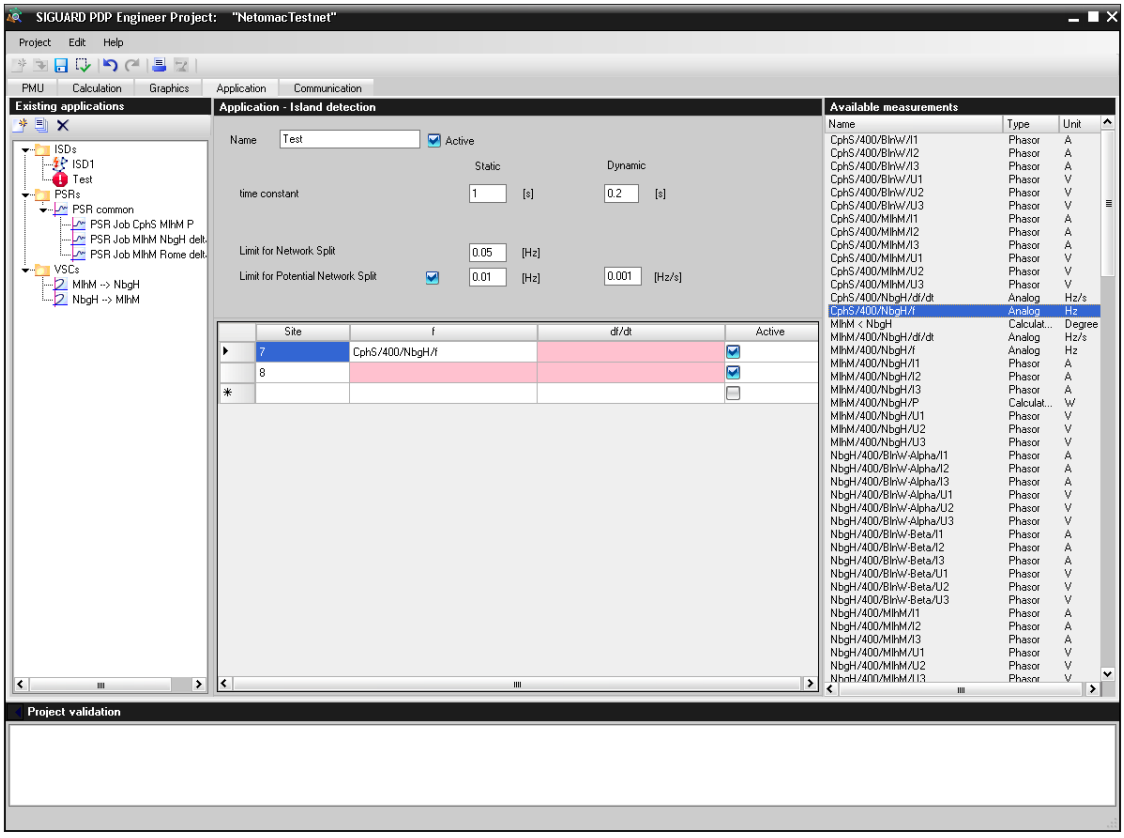


Figure 4-18 Configuration of Sites for Island Detection

NOTE

Empty entry fields are highlighted in red. The measuring points must be inserted here via drag and drop.

In the following table, the setting options of the properties/parameters of the **Sites** are explained.

Table 4-18 Parameters of the Sites

Element	Explanation
Site	Numbering occurs automatically.
f	Sort the list **Available measurements** according to type. Insert a measuring point for the frequency (f) from **Available measurements**. It is checked whether a measuring point for the frequency is also inserted. The measuring point can come from different PMUs.

Element	Explanation
df/dt	Sort the list **Available measurements** according to type. Insert a measuring point for the rate of frequency change (df/dt) from **Available measurements**. It is checked whether a measuring point for the frequency changing speed is also inserted. The measuring point can come from different PMUs.
Active	If the check box is marked, the provision for the corresponding measuring point for the evaluation of island detection occurs.

4.7.3 Power Swing Recognition PSRs

To configure power swing recognition, the folder **PSRs** is selected and a name for the folder **PSRs** is assigned:

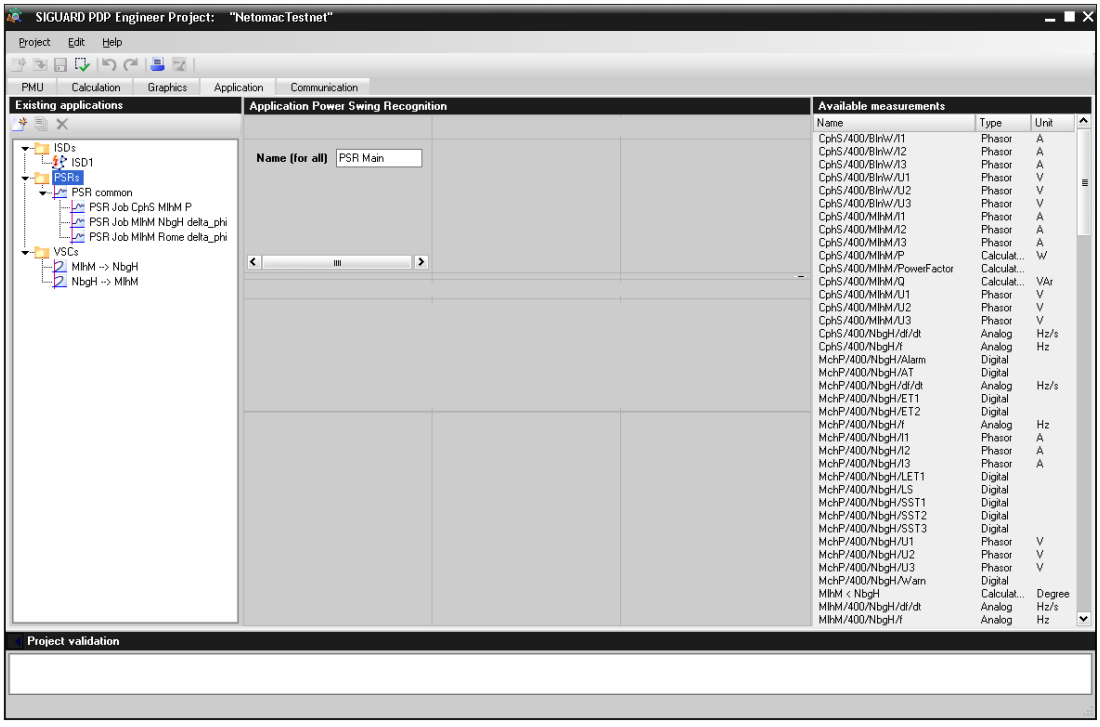


Figure 4-19 Name for PSRs folder is assigned

Next, the folder **PSRs** is opened and a swing recognition is selected.

NOTE

You need a corresponding SIGUARD PDP license for the PSR to function. The existence of this license is not queried in the SIGUARD PDP Engineer.

Functions

For a selected folder **PSRs** or selected power swing recognition, the following functions can be performed via buttons.

Table 4-19 Toolbar of the PSRs application

Element	Explanation
	Click the button **New power swing recognition** to create a configuration scheme for a new application **Island detection** in the **PSRs** folder and a subordinate job.
	Click the button **Duplicate power swing recognition** to duplicate a configuration of an existing application **Power swing recognition** for further processing.
	Click the button **Delete Power Swing Recognition** to delete a configuration for an application **Island detection**.

Parameters of application PSRs

If the folder **PSRs** is opened and you have opened a new power swing recognition, the following middle window section **Application Power Swing Recognition** is displayed:

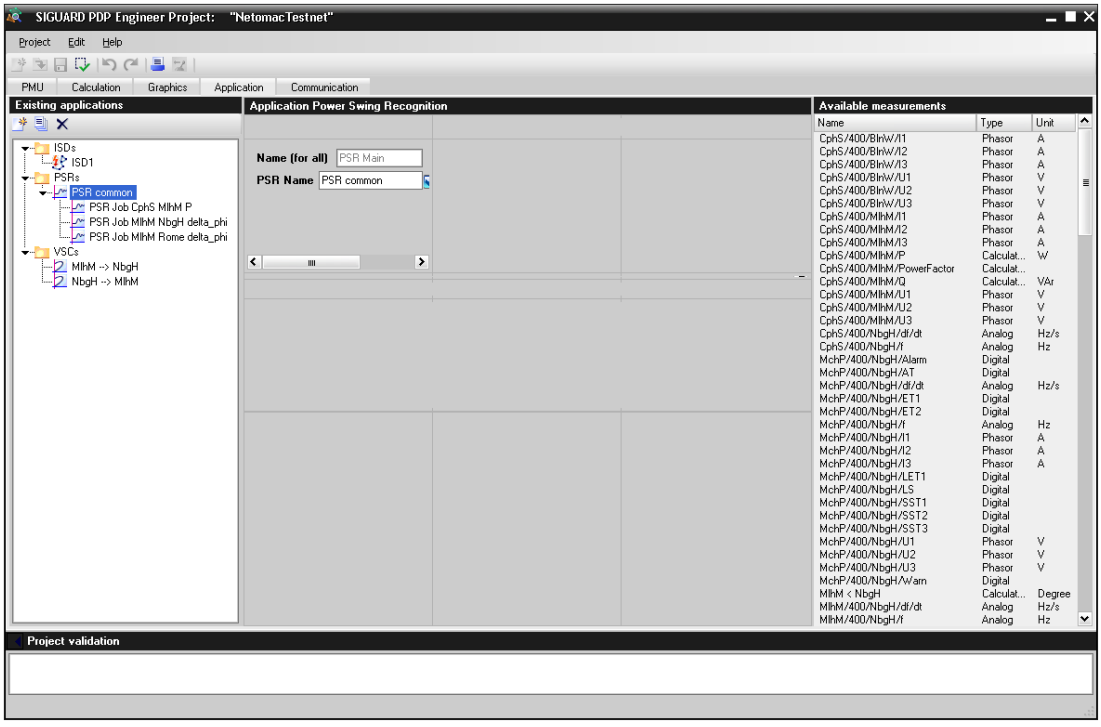


Figure 4-20 Parameters of the PSRs application

The setting options for the properties/parameters of the application **PSRs** are explained in the following table.

Table 4-20 Parameters of the PSRs application

Element	Explanation
PSR Name	In this field, the name of the application **Power swing recognition** is entered, changed, or displayed for an existing application.
Active	If the check box is selected, the application is switched to **active**.
ISD	If the check box is selected, the results of the application ISD (Island State Detection) are used by suppressing calculation of jobs whose input variables lie in 2 different islands.

Parameters of a PSR job

If you have selected **PSR job**, the following middle window section **Application power swing recognition** is displayed:

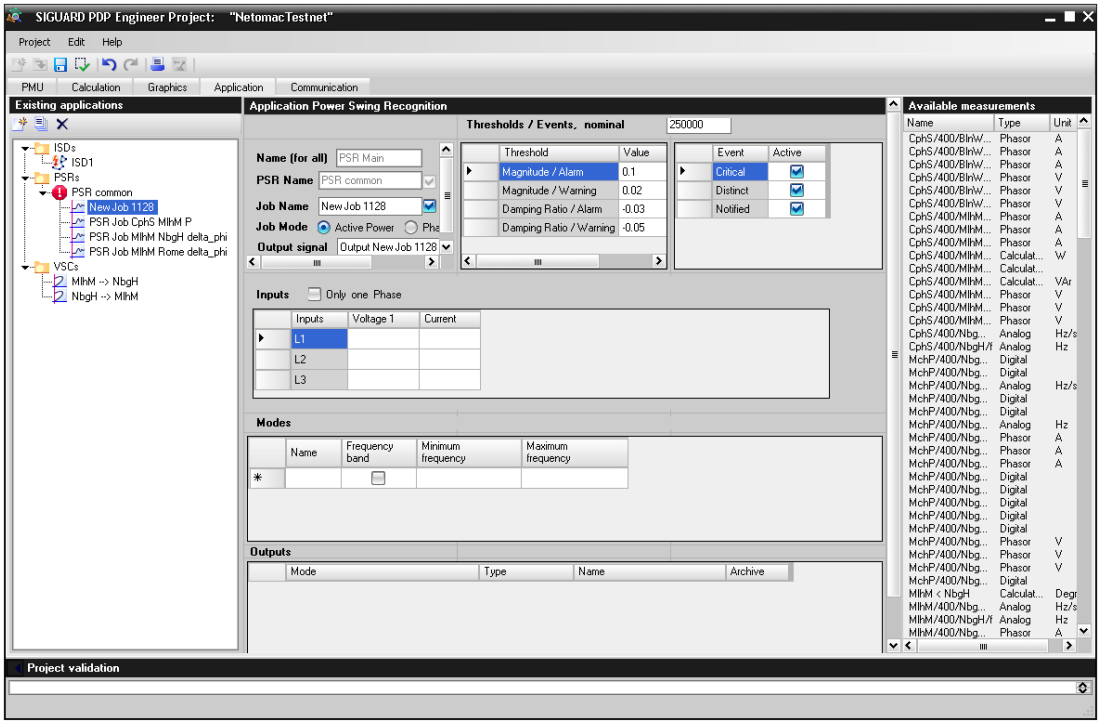


Figure 4-21 Parameters of the PSR job

The setting options for the properties/parameters of a **PSR job** are explained in the following table.

Table 4-21 Parameters of a PSR job

Element	Explanation
Job Name	In this field, the name of the **PSR job** is entered, changed, or displayed for an existing PSR job.
Active	If the check box is selected, the PSR job is switched to **active**.
ISD	If the check box is selected, the processing of this job is set, if the ISD has recognized that the input values lie in different islands. Only effective with jobs in Job mode **Phase angle**.

Element	Explanation
Job mode	PSR recognizes 2 different Job modes: • **Active Power**. Voltage and current are linked to one another at a PMU location. The active power calculated from that is analyzed for power swings. • **Phase angle**. The voltages are linked together at 2 different locations. The voltage angle difference calculated from this is analyzed for power swings.
Thresholds/Events, nominal	This rated value is used as reference for the relative threshold values stated below for the warning or the alarm based on the magnitude. Also see *Figure 1-10* in chapter *1.5 SIGUARD PDP Power Swing Recognition (PSR)*.
Threshold - Magnitude/Alarm	If this relative value for the magnitude is exceeded, then this power swing is placed in the 1st row of the DOE table. Reference value is the rated value, see above. Also see *Figure 1-10* in chapter *1.5 SIGUARD PDP Power Swing Recognition (PSR)*.
Threshold - Magnitude/Warning	If this relative value for the magnitude is exceeded, then this power swing is placed in the 2nd row of the DOE table. Reference value is the rated value, see above. Also see *Figure 1-10* in chapter *1.5 SIGUARD PDP Power Swing Recognition (PSR)*.
Threshold - Damping Ratio/Alarm	If this value for the damping factor is exceeded, then this power swing is placed in the 3rd column of the DOE table. Note that this value must be negative. Also see *Figure 1-10* in chapter *1.5 SIGUARD PDP Power Swing Recognition (PSR)*.
Threshold - Damping Ratio/Warning	If this value for the damping factor is exceeded, then this power swing is placed in the 2nd column of the DOE table. Note that this value must be negative. Also see *Figure 1-10* in chapter *1.5 SIGUARD PDP Power Swing Recognition (PSR)*.

Input Parameters

After the general parameters for the **PSR job** were set, the **Inputs** (measured values for voltage and current) must be defined in the middle window section **Application power swing recognition** for each phase.

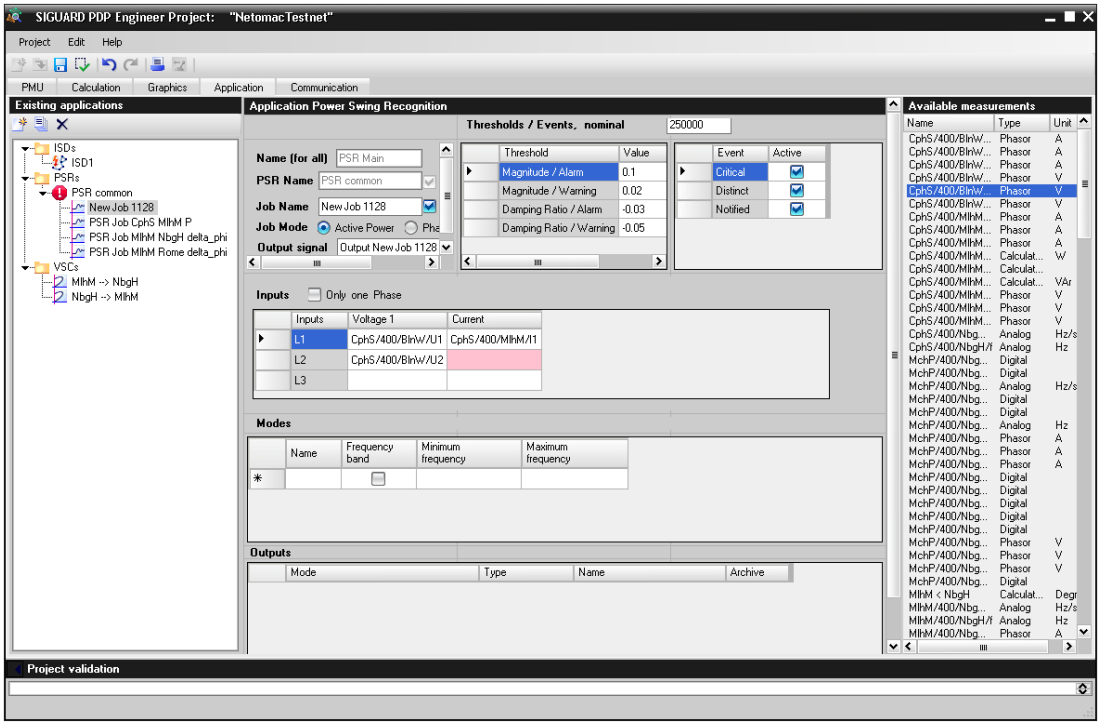


Figure 4-22 Input parameters for the phases

The setting options for the properties/parameters of the **Inputs** are explained in the following table.

Table 4-22 Parameters of the input variables

Element	Explanation
Inputs L1 - L3	The following measuring points from the **Available measurements** list must be defined for each phase: • One measuring point **Voltage 1** and one measuring point **Current** for the job mode **Active Power** • One measuring point **Voltage 1** and **Voltage 2** for the job mode **Phase Angle** These values are pulled into the table via drag and drop from the **Available measurements**. Fields that must contain values are marked red.
Only one phase	If the check box is selected, the phases 2 and 3 are hidden. Only one phase is active.

Determine Modes for the Job

After the definition of the input variables, the **Modes** [1] must be defined in the middle window section **Application Power Swing Recognition** .

For this, a mode name is defined. The appropriate outputs are created automatically.

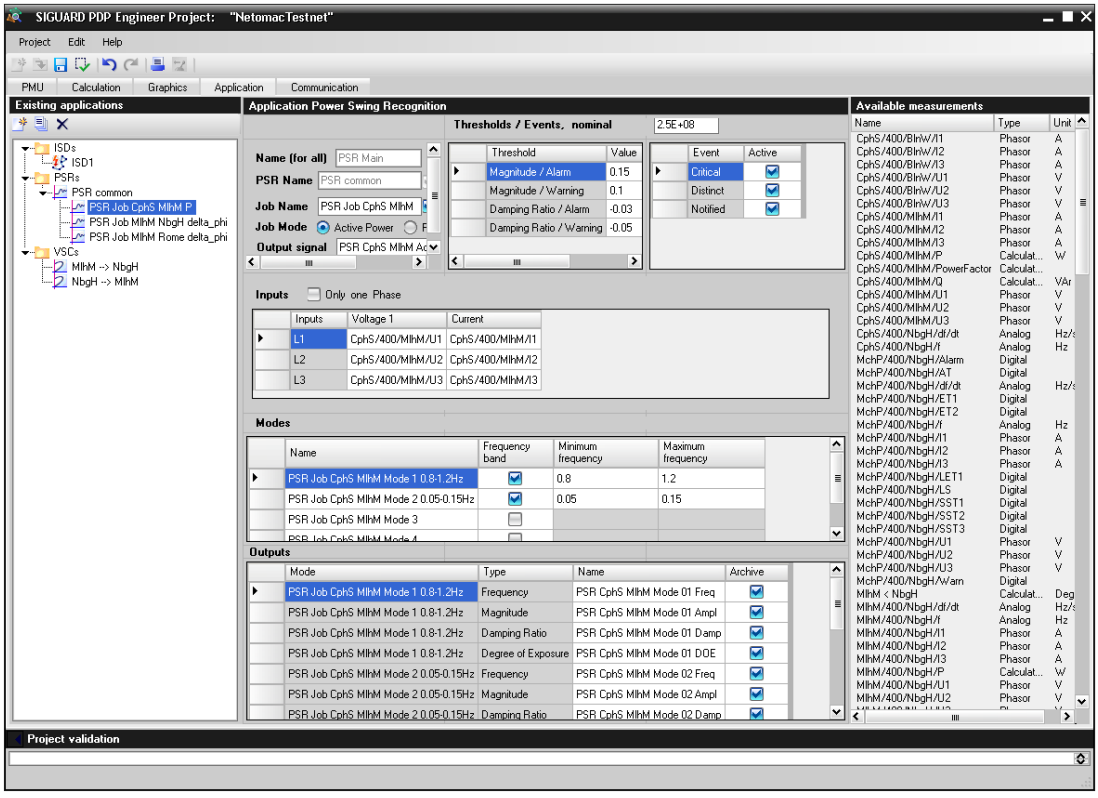


Figure 4-23 Definition of the mode name/outputs

The setting options for the properties/parameters of the application **Modes** are explained in the following table.

Table 4-23 Parameters of the input variables

Element	Explanation
Name	If a name is entered for the mode, for example, **Mode4**, the corresponding **Outputs** are created for this (entries for the types: • Frequency • Magnitude • Damping ratio • Degree of Exposure
Frequency band	If the check box is selected, the fields for **Maximum frequency** and **Minimum frequency** are released for the maximum and minimum frequencies.

1. Available power swings can also be composed of partial power swings with different frequencies. These partial power swings are also designated a power swing mode.

Element	Explanation
Minimum frequency	Minimum frequency Power swings with a natural frequency larger than this minimum frequency and smaller than the maximum frequency Maxf are preferentially assigned to this mode.
Maximum frequency	Maximum frequency Power swings with a natural frequency larger than the minimum frequency Minf and smaller than this maximum frequency are preferentially assigned to this mode.

Selecting Modes

In order to maintain the overview with several modes, the entire row can be selected for a mode, for example, **Mode2**. In this case, only the outputs for Mode2 are displayed.

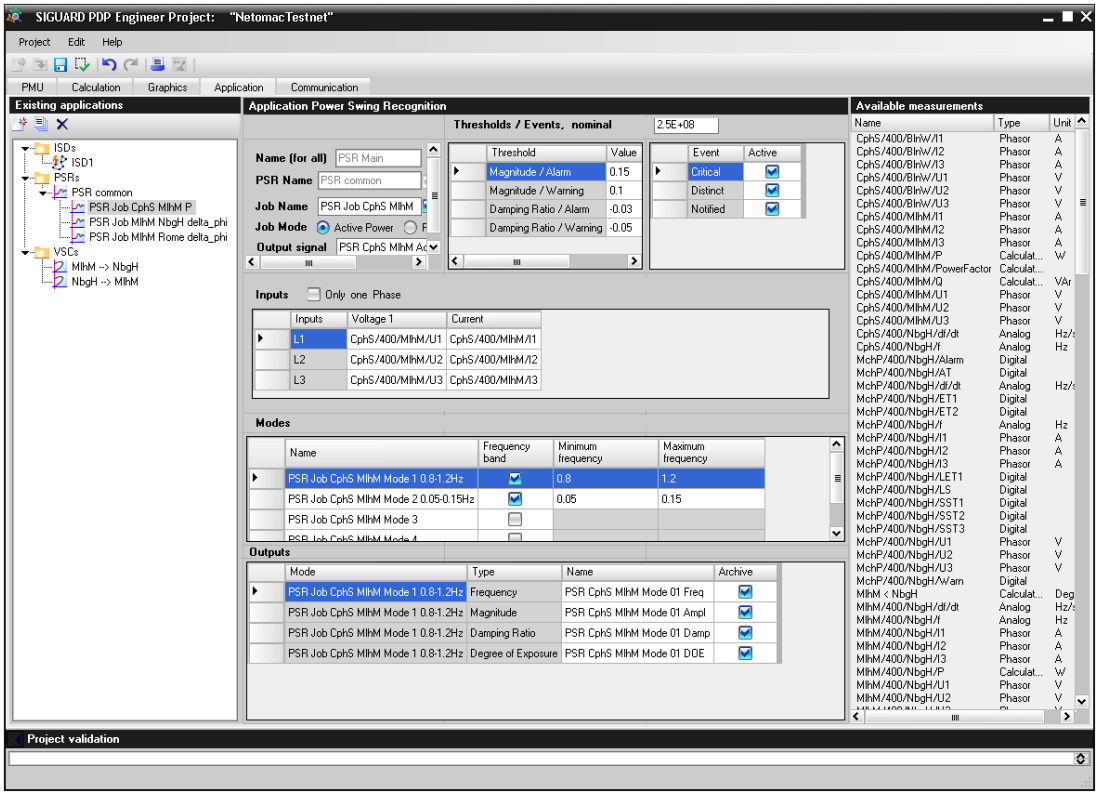


Figure 4-24 Selected mode/outputs

Table 4-24 Parameters of the output quantities

Element	Explanation
Mode	If a name is selected for the mode, for example, **Mode4**, the corresponding **Outputs** are displayed with the name of the mode.
Type	Type of output quantities (for example, frequency, magnitude, damping)
Name	Name of the output quantity
Archive	Selection, so that the output quantities are saved in the archive.

You can find further information on saving, activating, and validating the project in chapter *4.9 Shared Functions*.

4.7.4 Voltage Stability Curve (VSC)

To configure the display of a voltage stability curve, the folder **VSCs** is selected and a name for the folder **ICCP** is defined:

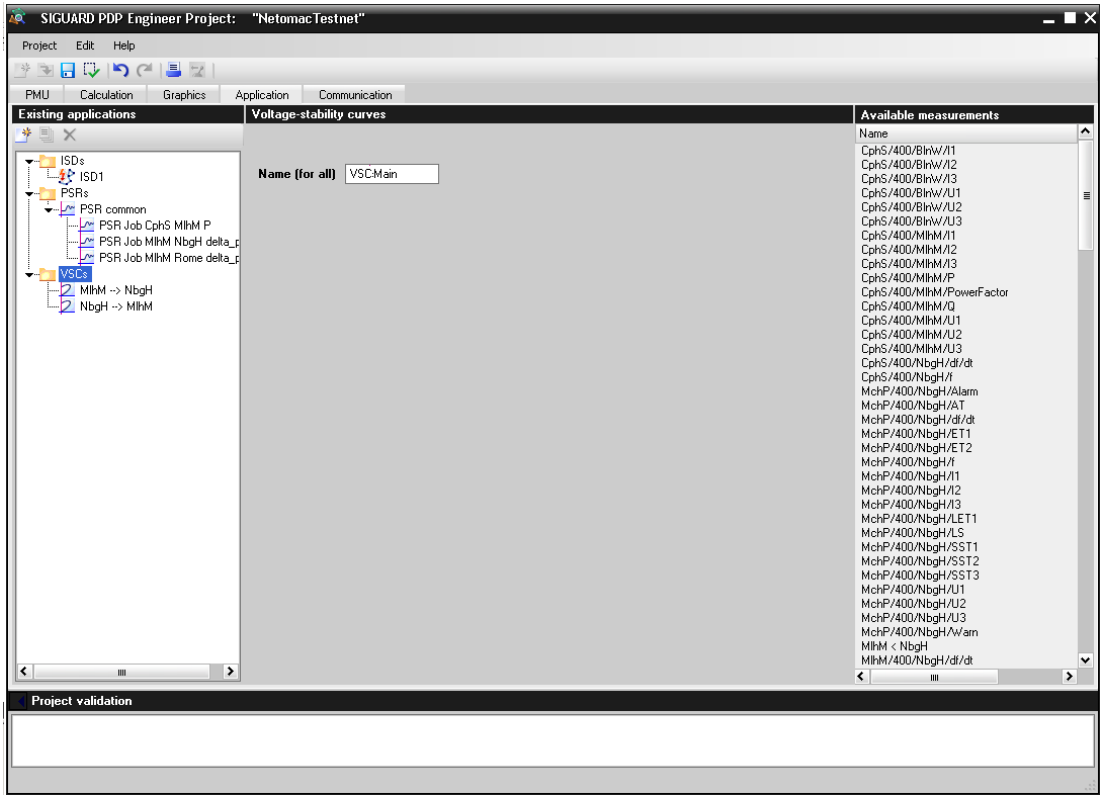


Figure 4-25 Name for VSCs folder is assigned

Next, the folder **VSCs** is opened and a curve is selected.

Functions

For a selected folder **VSCs** or a selected voltage stability curve, the following functions can be performed via buttons.

Table 4-25 Toolbar of the VSCs application

Element	Explanation
	Click the button **New voltage stability curve** in order to create a configuration scheme for a new voltage stability curve in the **VSCs** folder.
	Click the button **Duplicate voltage stability curve** to duplicate a configuration of an existing voltage stability curve for further processing.
	Click the button **Delete voltage stability curve** to delete a configuration of an existing voltage stability curve.

Parameters of an Application VSCs

The following configurations for the display of a voltage stability curve are possible:

- Configuration with input measurands and line parameter (1 PMU)
- Configuration with input measurands and output measurands (2 PMU)

If you open the folder **VSCs** in the window section **Existing applications**, a voltage stability curve is selected and the check box **1 PMU** has been selected, the following middle window section **Voltage stability curves** is displayed:

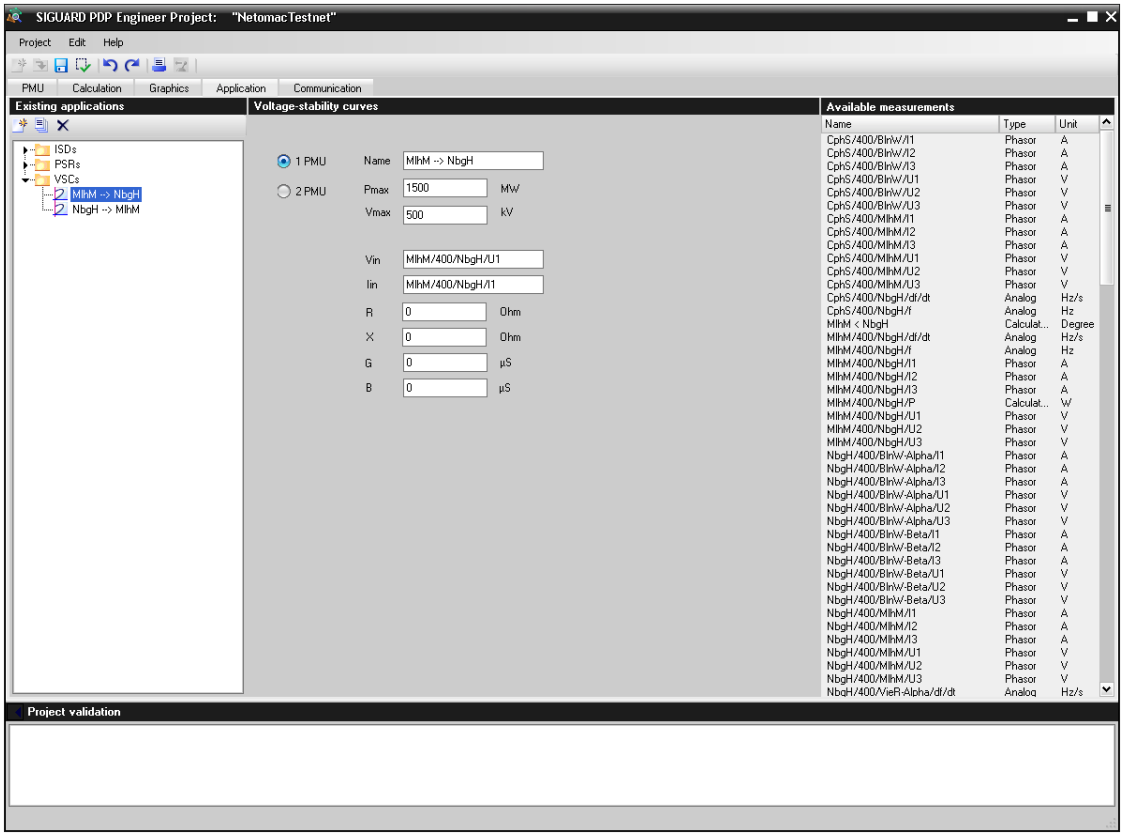


Figure 4-26 Parameters of the Application VSCs with Input Measurands (1 PMU) and Line Parameter

NOTE

Empty entry fields are highlighted in red. Enter a value.

In the following table, the setting options of the properties/parameters of the application **VSCs** are explained with input measurands.

Table 4-26 Parameters of the Application VSCs

Element	Explanation
1 PMU	This check box is selected when the voltage stability curve is supposed to be calculated with an input measurand and the line parameters.
Name	In this field the name of the voltage stability curve is entered, changed, or displayed for an existing voltage stability curve.

Element	Explanation
P_{max}	Entry of the maximum active power for the observed line in megawatts (MW).
V_{max}	Entry of the maximum voltage for the observed line in kilovolts (kV).
V_{in}	Measurand of the voltage at the input of the line from **Available measurements**
I_{in}	Measurand of the current at the input of the line from **Available measurements**
R	Resistance of the line in ohms
X	Reactance of the line in ohms
G	Conductance of the line in micro-siemens
B	Susceptance of the line in micro-siemens

When you have selected the application **VSCs** in the window section **Existing Applications** and marked the check box **2 PMU**, the following middle window section is displayed.

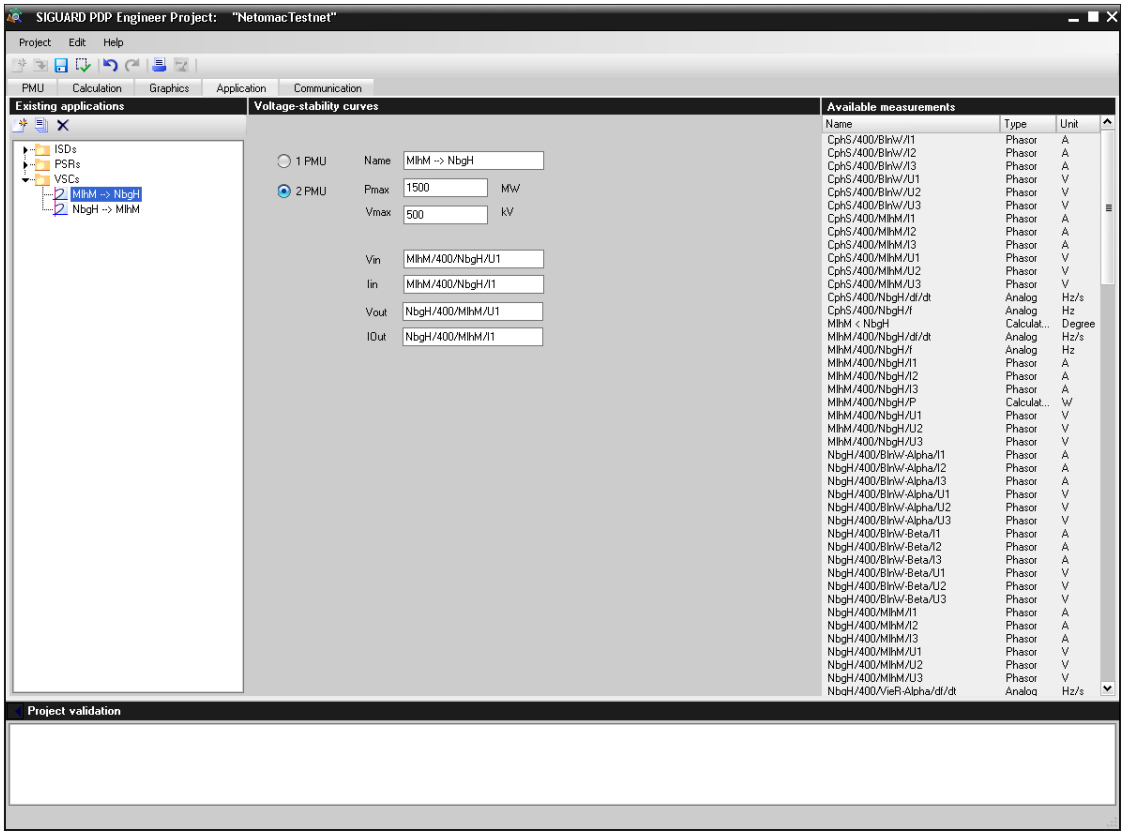


Figure 4-27 Parameters of the Application VSCs with Input and Output Measurands (2 PMU)

NOTE

Empty entry fields are highlighted in red. An entry is required.

In the following table, the setting options of the properties/parameters of the application **VSCs** are explained with input and output measurands.

Table 4-27 Parameters of the Application VSCs

Element	Explanation
2 PMU	This check box is selected when the voltage stability curve is supposed to be calculated with an input and output measurand.
Name	In this field the name of the voltage stability curve is entered, changed, or displayed for an existing voltage stability curve.
P_{max}	Entry of the maximum active power for the observed line in megawatts (MW).
V_{max}	Entry of the maximum voltage for the observed line in kilovolts (kV).
V_{in}	Measurand of the voltage at the input of the line from **Available measurements**
I_{in}	Measurand of the current at the input of the line from **Available measurements**
V_{out}	Measurand of the voltage at the output of the line from **Available measurements**
I_{out}	Measurand of the current at the output of the line from **Available measurements**

4.8 Communication

4.8.1 Overview

To configure and set the communication interface parameters, the following requirements must be met:

- An existing project or a new project must be open.
- The tab **Communication** must be selected.

The Communication Tab Is Selected

When you have selected the tab **Communication**, the layout for adding and editing communication interfaces is displayed.

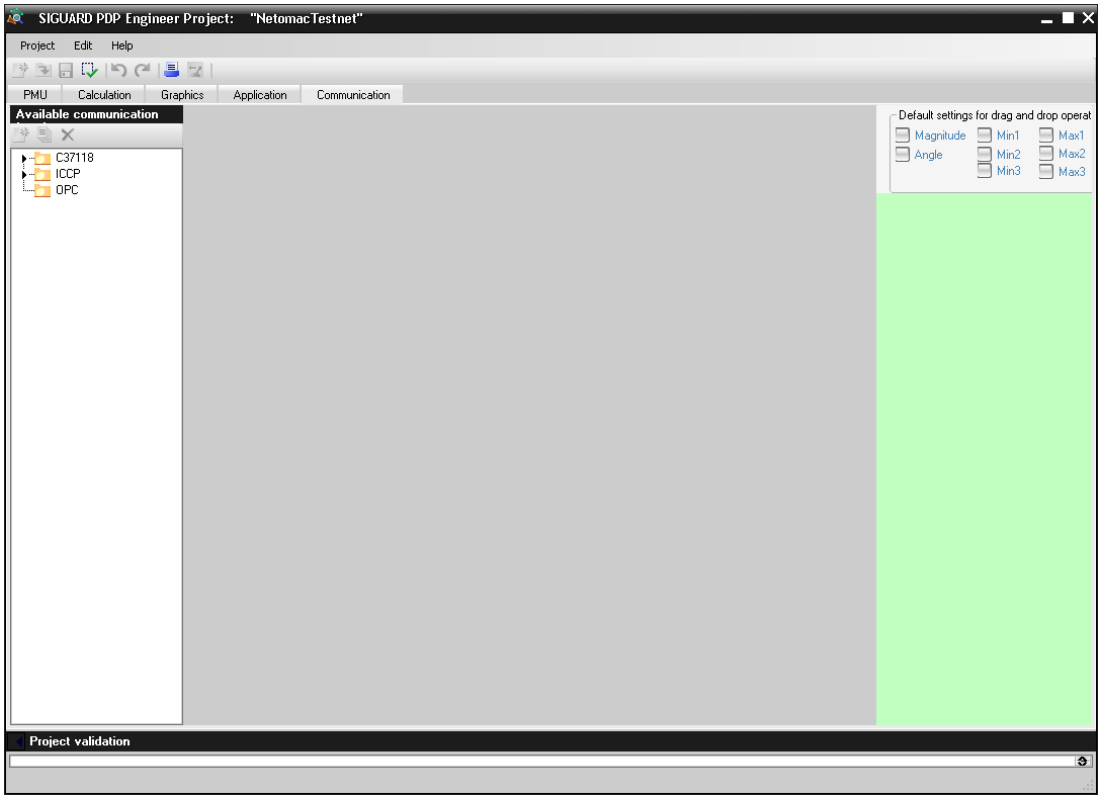


Figure 4-28 Selected Tab Communicated

- **Available communication interfaces**

  In the left window section, all available communication interfaces are displayed as folders:

  - C37.118
  - ICCP
  - OPC

- **Selected Application**

  In the middle window section, the parameter data for the selected communication interfaces are shown.
- **Available measurements**

  In the right window section, all available values **Available measurements** are displayed with name, type, and unit, which are used for the input measurands within the configuration of the applications.

4.8.2 Protocol C37.118

The function of the PDC server is the following:

SIGUARD PDC sends data in the IEEE C37.118 protocol to other PDCs. In this way, the data from SIGUARD PDP can also be used by other PDCs.

To configure the communication interfaces, the folder **C37118** is selected, and a name for the folder **C37118** is assigned.

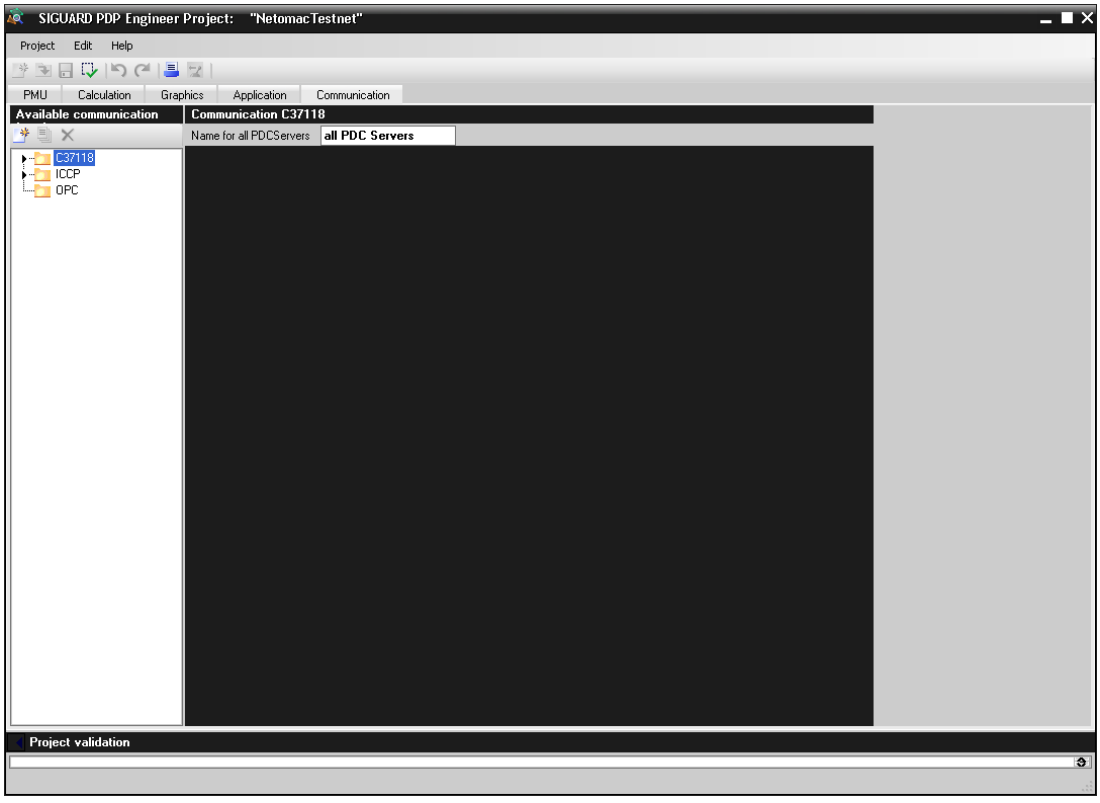


Figure 4-29 Name for folder C37118

Next, the **C37118** folder is opened and an interface is selected.

Functions

The following functions can be performed when the folder **C37118** is selected:

Table 4-28 Functions for PDC Servers and Logical PMUs

Element	Explanation
	Click the button **New**, in order to create a new PDC server. or in the case of a selected PDC server to set up a subordinate logical PMU.
	Click the button **Duplicate**, in order to create a duplicate with the same name and subordinate logical PMUs for the selected PDC server. or to duplicate a selected logical PMU.
	Click the button **Del**, in order to delete a selected PDC server with the subordinate logical PMUs or to delete a selected logical PMU.

Parameters of the PDC Server

When you have selected a PDC server in the window section **PDCServers and logical PMUs**, the following middle window section is displayed.

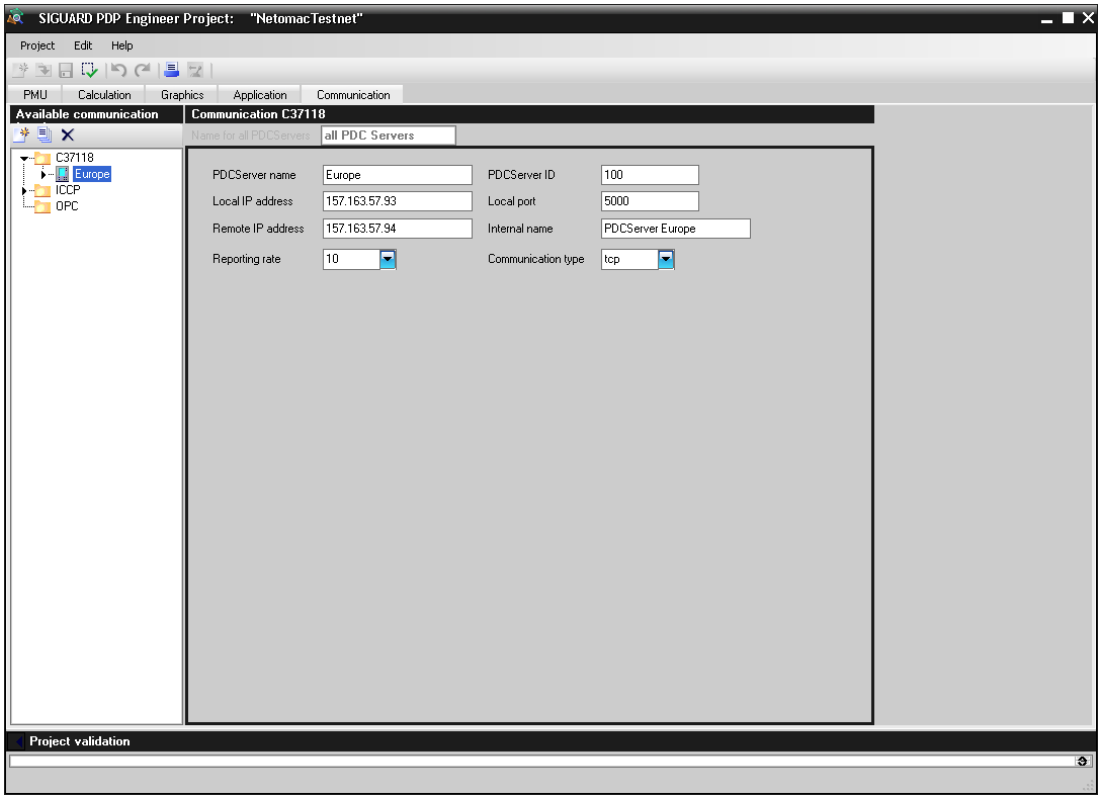


Figure 4-30 Parameters of the PDC Server

In the following table, the setting options of the properties/parameters of a PDC server are explained.

Table 4-29 Parameters of the PDC Server

Element	Explanation
PDC server name	You can freely select the name of the PDC server. This name is entered as **PDC Server Name** in the protocol IEEE C37.118 and is agreed with the communication partner. It does not need to be unique (see Internal name), for example: *SIGUARD*.
PDC server ID	ID of the connected PDC server This name is entered as **PDCID** in the protocol IEEE C37.118 and is agreed with the communication partner, for example: *111*.
Local IP address	IP address at which the PDC server can be reached from the outside. This IP address helps to define the LAN interface to be used for communication to the outside. If there is only one interface, then enter the IP address of the server, for example, *55.26.213.186*.
Local port	Port number at which the PDC server can be reached from the outside, for example: *4712*.
Remote IP address	IP address of the outside PDC servers (a client from the perspective of the SIGUARD PDC server). Only one PDC server with this IP address can establish a connection with the local SIGUARD PDC server.
Internal name	This name must be unique and may not occur in the case of other objects (for example, measured value, calculation, etc.).
Reporting rate	Number of telegrams that can be transferred per second by the PDC server. The **Reporting rate** must be agreed with the communication partner. **CAUTION** Note that not all combinations are possible. Which value in allowed depends on the **Reporting rate** of the values to be transferred. You can set the value via a list box from 10 up to 60 frames/second. If the value does not agree with the configuration of the PDC server, an error message appears and no transfer takes place.
Communication type	Via a list box the communication type **tcp** or **udp** can be selected.

NOTE

In case of missing entry, the entry field is highlighted in red. Enter a value.

Parameters of a Logical PMU

When you have selected a logical PMU in the window section **PDC servers and logical PMUs**, the following middle window section is displayed.

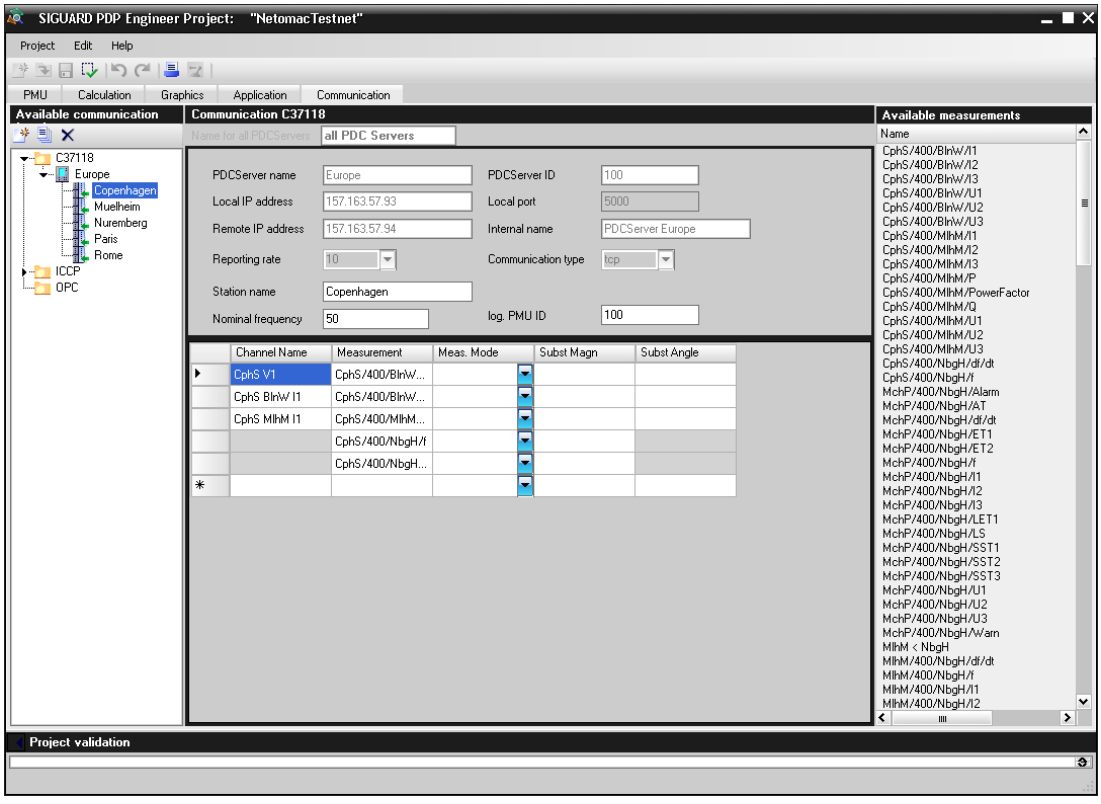


Figure 4-31 Parameters of a Logical PMU and the Measuring Channels

In the following table, the setting options of the properties/parameters of a logical PMU are explained.

Table 4-30 Parameters of a Logical PMU

Element	Explanation
Station name	You can freely select the name of a logical PMU. This name is entered as **PDC Station Name** in the protocol IEEE C37.118 and is agreed with the communication partner. It does not need to be unique (in contrast to Internal name), for example: *SIGUARD PMU1*.
Logical PMU ID	ID of the connected, logical PMU This ID is entered as **PMUID** in the protocol IEEE C37.118 and is agreed with the communication partner, for example: *112*.
Rated frequency	Rated frequency of the station, for example: *50* Hz.

NOTE

The remaining parameter fields are not active (colored gray), because they are not parameterizable here.

Editing Measuring Channels

- **Add measuring channel**

  In order to add a measuring channel, add a measuring point from **Available measurements** in the last line of the column **Measurement**. An additional blank line is inserted, by which a further measuring channel can be defined.

- **Delete measuring channel**

  To delete measuring channels, select the measuring channel (line) in the table and press the key **<Del>** or select the context menu **delete**.

- **Sorting according to column contents**

  The list of measuring channels can be sorted according to the contents of the columns. Clicking the header sorts in ascending or descending list items.

- **Column sequence**

  You can move individual columns by dragging the header to another place in the table, and thereby change the column sequence.

- **Change column widths**

  All columns can be changed widthwise by dragging the column edge.

Parameters of a Measuring Channel

For every PMU server the measuring channels set up for this is displayed in the form of a table in the middle window section under the parameters of the PMU server and the selected logical PMU.

In the following table, the setting options of the properties/parameters of the measuring channels are explained.

Table 4-31 Parameters of a Measuring Channel

Element	Explanation
Channel name	You can freely select the name of the measuring channel. Since it is entered into the protocol IEEE C37.118, the **Channel name** may not exceed a length of 16 characters, for example: *MchP/400/NbgH/U1*.
Measurement	Definition of the measuring point from **Available measurements**. The values measured here are transferred via this measuring channel.
Meas. Mode	Definition of the method of measurement for analog values except frequency and rate of frequency change The following parameters are displayed on the basis of the measuring point: • S (Single point) Measurement of the current value • R (RMS = root mean square) Measurement of the quadratic mean (RMS value) • P (peak) Measurement of the maximum value
Subst Magn	Definition of a substitute value, which is transferred in place of the original measured value. If no value is entered the original measured value is transferred.
Subst Angle	Definition of a substitute value, which is transferred in place of the original measured value. An entry is allowed only in the case of phasors. If no value is entered the original measured value in transferred.

NOTE

The table of the measuring channels must be sorted according to column **Meas. Mode**, in order to warrant a correct transfer in accordance with the protocol IEEE C37.118.

Selected lines can be moved upward or downward via the context menu.

Further details see protocol IEEE C37.118.

4.8.3 ICCP

The Inter-Control Center Communications Protocol, also designated IEC 60870-6/TASE.2, is a communication protocol for the exchange of data between network control centers. SIGUARD PDP is able to send data to one or several control centers with this communication protocol.

NOTE

SIGUARD PDP cannot receive any data via ICCP.

NOTE

You need a corresponding SIGUARD PDP license for the ICCP to function. The existence of this license is not queried in the SIGUARD PDP Engineer.

To configure communication protocols, the folder **ICCP** is selected and a name for the folder **ICCP** is assigned:

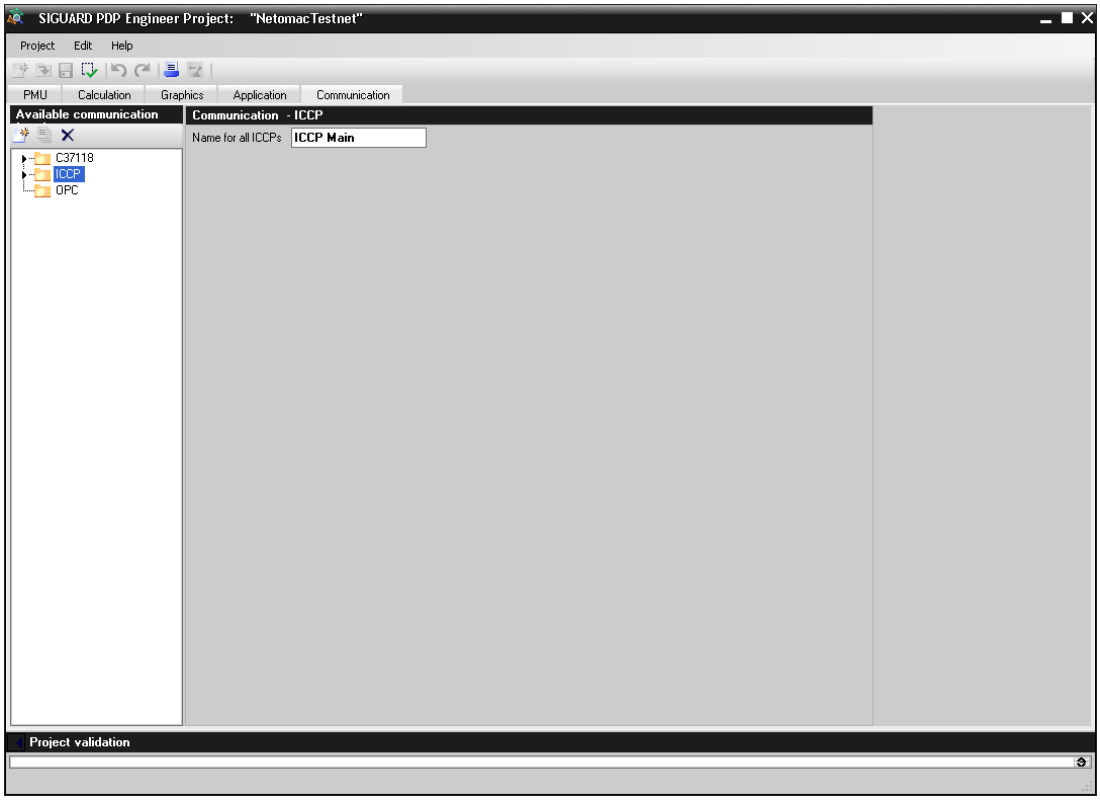


Figure 4-32 Assignment of name to the ICCP folder

Next, the **ICCP** folder is opened and a protocol is selected.

Functions

The following functions can be performed when the folder **ICCP** is selected.

Table 4-32 Functions for ICCP

Element	Explanation
	Click the button **New**, in order to create a new protocol with the appropriate subdirectories **Measurements** and **Groupindication**.
	Click the button **Duplicate**, in order to create a duplicate with a new name for the selected protocol.
	Click the button **Del** in order to delete a selected protocol with the associated subdirectories.

ICCP Communication settings

If you have selected an ICCP_Main in the window section **Available communication interfaces**, the following middle window section **Communication - ICCP** is displayed.

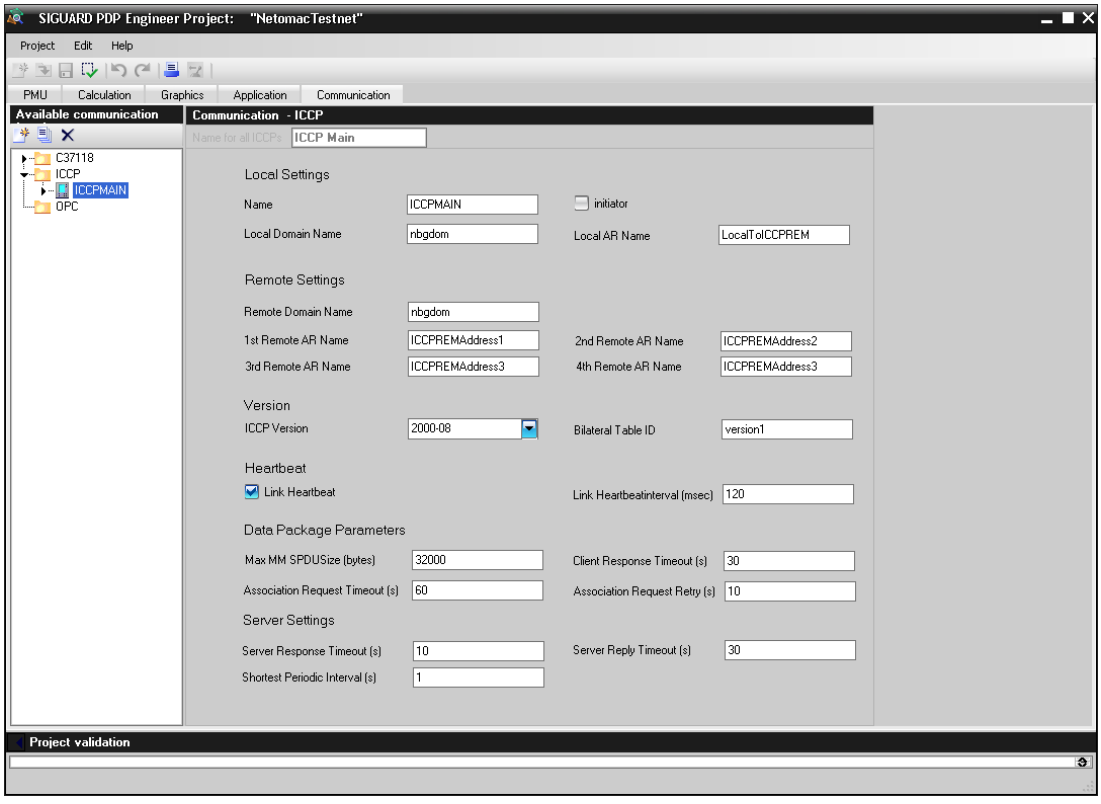


Figure 4-33 ICCP Communication settings

The setting options for the properties/ICCP communication settings are explained in the following table.

Table 4-33 ICCP Communication settings

Element	Explanation
Local Settings	
Name	Definition of the name of the ICCP interface.
initiator	If the check box is selected, then SIGUARD PDP is the initiator of the communication.
Local Domain Name	Definition of the local domain name
Local AR name	Local application reference name
Remote Settings	
Remote Domain Name	Domain name of the partner
1st Remote AR name	1st application reference name of the partner Up to 4 names (corresponding to 4 computers at the partner) are supported.
2nd Remote AR name	2nd Application reference name of the partner Up to 4 names (corresponding to 4 computers at the partner) are supported.
3rd Remote AR name	3rd Application reference name of the partner Up to 4 names (corresponding to 4 computers at the partner) are supported.

Element	Explanation
4th Remote AR name	4th Application reference name of the partner Up to 4 names (corresponding to 4 computers at the partner) are supported.
Version	
ICCP Version	The ICCP version with which this protocol is supposed to be compatible is set in this list box. The versions 1996-08 and 2000-08 are supported.
Bilateral table ID	Identification of the bilateral table In this table, the information exchanged via the protocol is listed and assigned an agreed name. Various versions of this table should show different identifications.
Heartbeat	
Link heartbeat	If the check box is selected, then test telegrams are exchanged for verification of the functionality of the communication link.
Link heartbeat interval (msec)	Interval between 2 verification telegrams
Data Package Parameters	
Max MM SPDU Size	Maximum size of the PDU for MMS reports, in bytes. The current PDU size is determined between the communicating peers and can be below the maximum size. The PDU size determined is used in order to divide large data volumes into smaller units for delivery.
Client Response Timeout (s)	When the ICCP client receives a select or operate request from a monitoring unit and sends the request to the ICCP server, this timer starts. The ICCP server must confirm the request before this time runs out.
Association Request Timeout (s)	After this time elapses, the time for a connection attempt has been exceeded. This means that, if your system initializes the connection, then it sends it a message to the peer in order to establish a connection. If no answer arrives within the time set under **Association Request Time-out**, then your system interprets it as a failed connection establishment. The system then waits for the time set under **Association Request Retry**, before it tries again to establish a connection. This is only significant if the parameter **Association Initiator** is set on **Yes**.
Association Request Retry (s)	This is the number in seconds that must elapse between connection attempts. This means that, after a failed connection attempt, the system may not start a new connection attempt until this time has elapsed. See also **Association Request Time-out**. This is significant only if the parameter **Association Initiator** is set on **Yes**.
Server Settings	
Server Response Timeout (s)	This time-out value is used only by the ICCP server. The ICCP client sends a select or operate request. The ICCP server receives this request and sends it to a supervisory control. The counter does not start until afterward. The supervisory control must confirm the request within this time. For problem-free operation with ICCP, Siemens recommends setting a value below the **Client Response Timeout** for this value.

Element	Explanation
Server Reply Timeout (s)	If a message has been sent to a server (peer), time-out does not occur until this number of seconds has passed. When this time runs out and the peer does not answer, then the communication with the remote peer is interrupted.
Shortest Periodic Interval (s)	For an ICCP-Peer, periodic data transmissions in intervals that were previously determined remotely can be necessary. This parameter is the shortest time interval, in seconds, that your system accepts. This parameter prevents an incorrectly configured Remote-ICCP-Peers from overwhelming your system with data requests. **Example:** You have set this value, for example, to 30 s. A client creates a transmission group with a periodicity of 10 s. ICCPNT recognizes that this value is too small, creates a protocol entry, and automatically adapts the periodicity of the transmission group to 30 s.

ICCP Measurements

If you have selected the subdirectory **Measurements** of an ICCP protocol, the following middle window section **Communication - ICCP** is displayed.

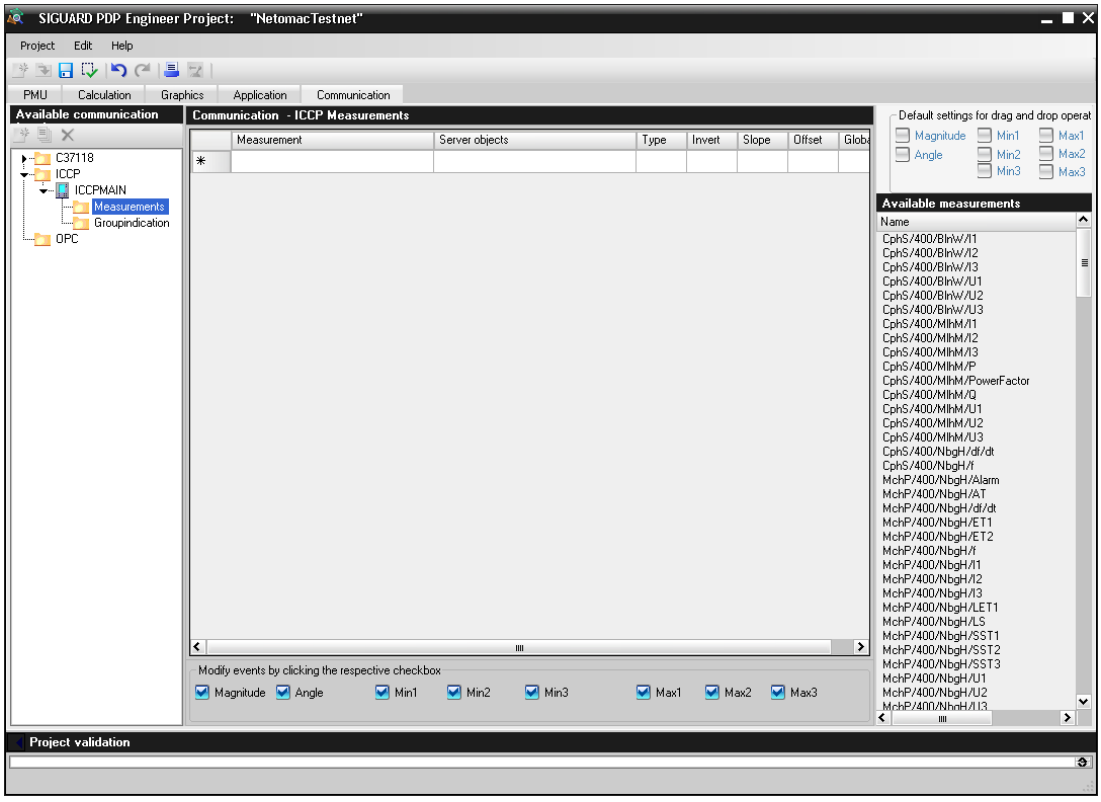


Figure 4-34 ICCP Measurements

For the definition of the measuring points, defaults must be selected so that only these specific parameters are accepted.

The window section **Default settings for drag and drop operation** contains several check boxes with which it is possible to select which information is transferred over ICCP via drag and drop.

Next, the measuring points are pulled into the middle window section via drag and drop. For every measuring point, a row is created in accordance with the defaults (parameters).

The setting options for the parameters of the measuring points are explained in the following table.

Table 4-34 ICCP Parameters for the Measuring Points

Element	Explanation
Server objects	Here, measured values from the **Available measurements** are saved via drag and drop. Note that, depending on the selection of the **Default settings for drag and drop operations**, several server objects can be created with one drag and drop operation.
invert	If the check box is selected, then digital values of 1 are transmitted as 0 and vice versa.
Slope	Values from SIGUARD PDP can be adapted in their size with a slope. For example, the voltages in SIGUARD PDP are processed generally in V. If the destination system is supposed to receive the values in kV, then enter a slope of 0.001 here.
Offset	Using the offset, values from SIGUARD PDP can be adapted to the destination system by adding the offset to the output value.
Global	If the check box is selected, the destination system can distribute this data via ICCP. If the check box is not selected, then transmission through the destination system is not allowed.

There are 2 options for modifying the events:

- Globally changing the parameters according to the selection in the lower part of the middle window section.
- Manually changing the parameters that cannot be changed globally.

For this, a row of the measuring point is selected. The default parameters are now also selected in the lower part of the window section. Remove the selection, for example, for **Max1**. The corresponding parameters for this row are deleted.

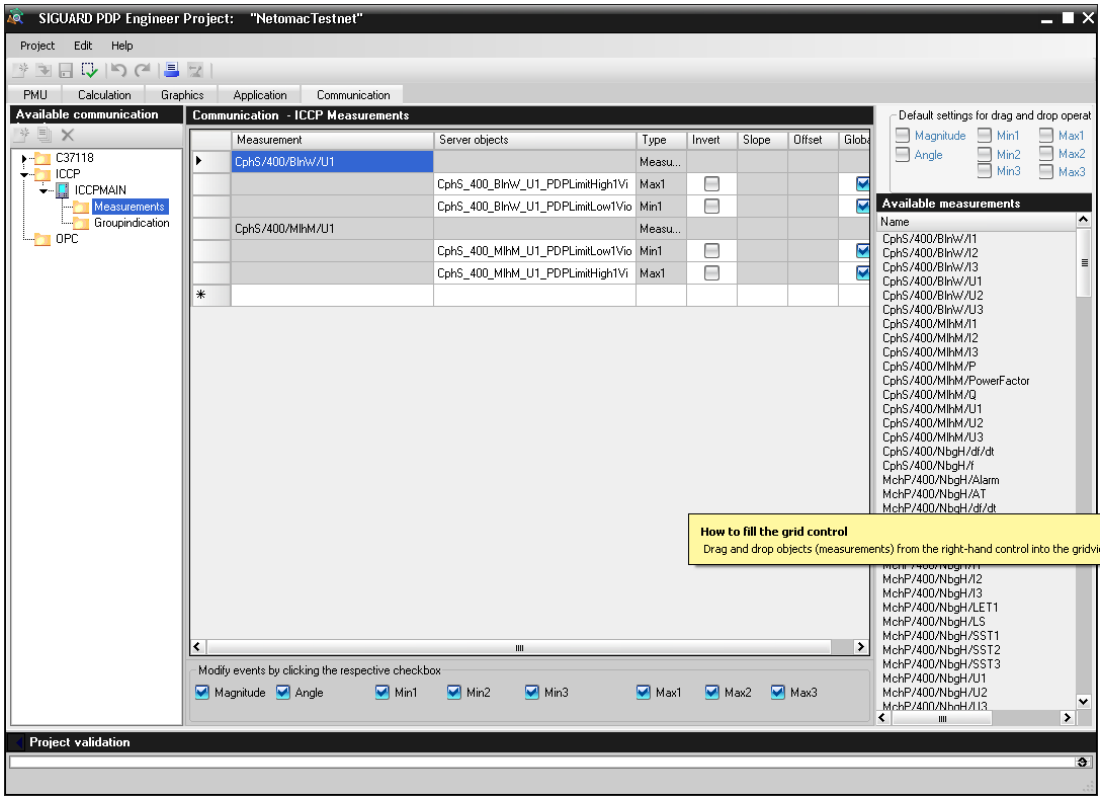


Figure 4-35 ICCP Measurements with a hidden parameter

ICCP Group Indication

With this editor, you can communicate monitoring notifications created through SIGUARD PDP, for example, a communication error to a PMU or an error in the archive, to a SCADA system and display them there. You can select individual messages or entire groups out of a large number of SIGUARD PDP messages and assign them to one or several ICCP events.

If you have selected the subdirectory **Group indication** of an ICCP protocol, the following middle window section **Communication - ICCP - ICCP measurements** is displayed.

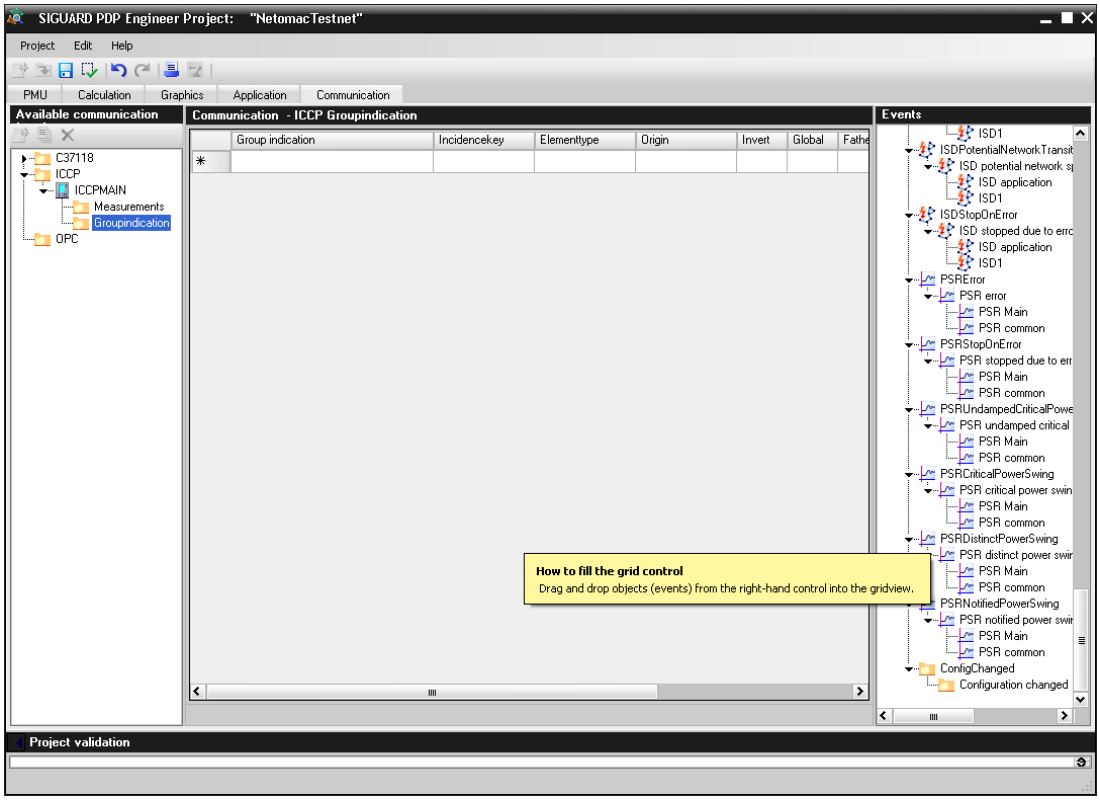


Figure 4-36 ICCP Group indication

Various events are selected that are pulled into the middle window section via drag and drop.

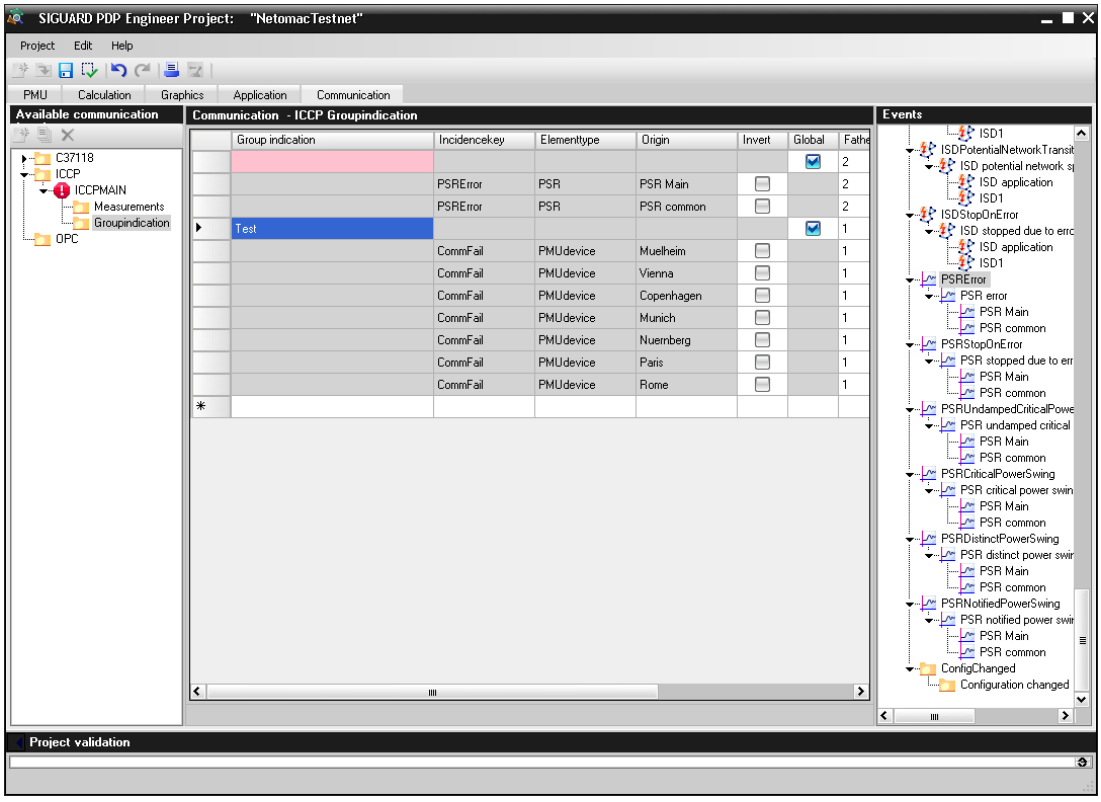


Figure 4-37 ICCP Group indication with inserted events

Individual events can be assigned to an existing group (insertion in a gray field under the object name).

Cumulative events are created after insertion as a group with a new object name (insertion in a white field in the row **Object name**).

The setting options for the parameters of the events are explained in the following table.

Table 4-35 ICCP Parameter for group indication

Element	Explanation
Object name	Name of the ICCP event object
Incidence key	The SIGUARD PDP events selected for transmission to the ICCP destination system are identified by Incidence Key and Element Type. Several SIGUARD PDP events can be linked to an ICCP event.
Element type	
ID	ID is the name of the object that is the reason for the event. You see the same name on the corresponding pages of Engineer on which you parameterize the object. If there is no object that is associated with this event, you have no ID.
invert	This check box controls whether a 0 or a 1 is transmitted with SIGUARD PDP events. If the check box is selected, then a 1 is transmitted by SIGUARD when an event occurs.
Global	If the check box is selected, the destination system can distribute this data via ICCP. If the check box is not selected, then transmission through the destination system is not allowed.

4.8.4 OPC

SIGUARD PDP includes an OPC server that allows access to the data from SIGUARD with the Data Access Profile version 3.

NOTE

You need a corresponding SIGUARD PDP license for the OPC to function. The existence of this license is not queried in the SIGUARD PDP Engineer.

To configure the measuring points for the OPC server, the folder **OPC** is selected.

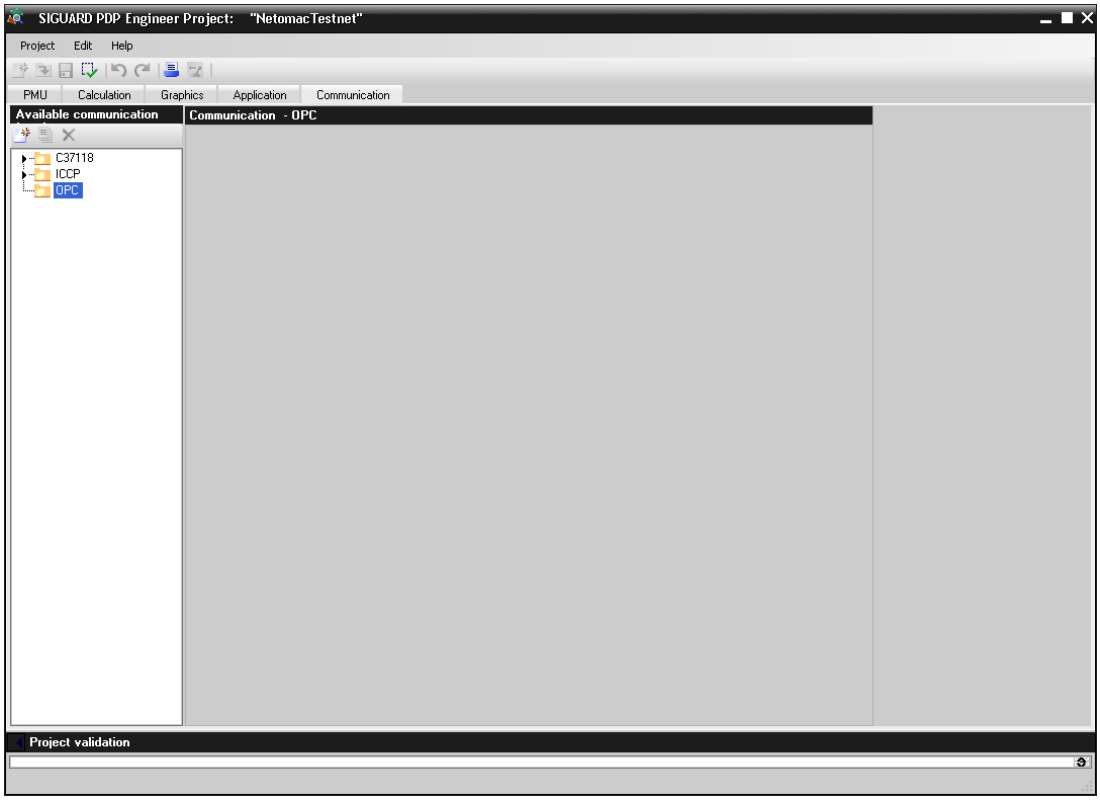


Figure 4-38

To configure the measuring points for the OPC server, the folder **OPC** is selected and a new OPC server is created.

You can find further information in the *Administrator Manual* in chapter *OCP*.

Functions

The following functions can be performed when the folder **OPC** is selected.

Table 4-36 Functions for PDC Servers and Logical PMUs

Element	Explanation
	Click the button **New**, in order to define a new OPC server and assign measuring points to the OPC server
	Click the button **Del**, in order to delete an existing OPC server.

OPC Parameters

If you have created a new OPC server, the following middle window section **Communication - OPC** is displayed.

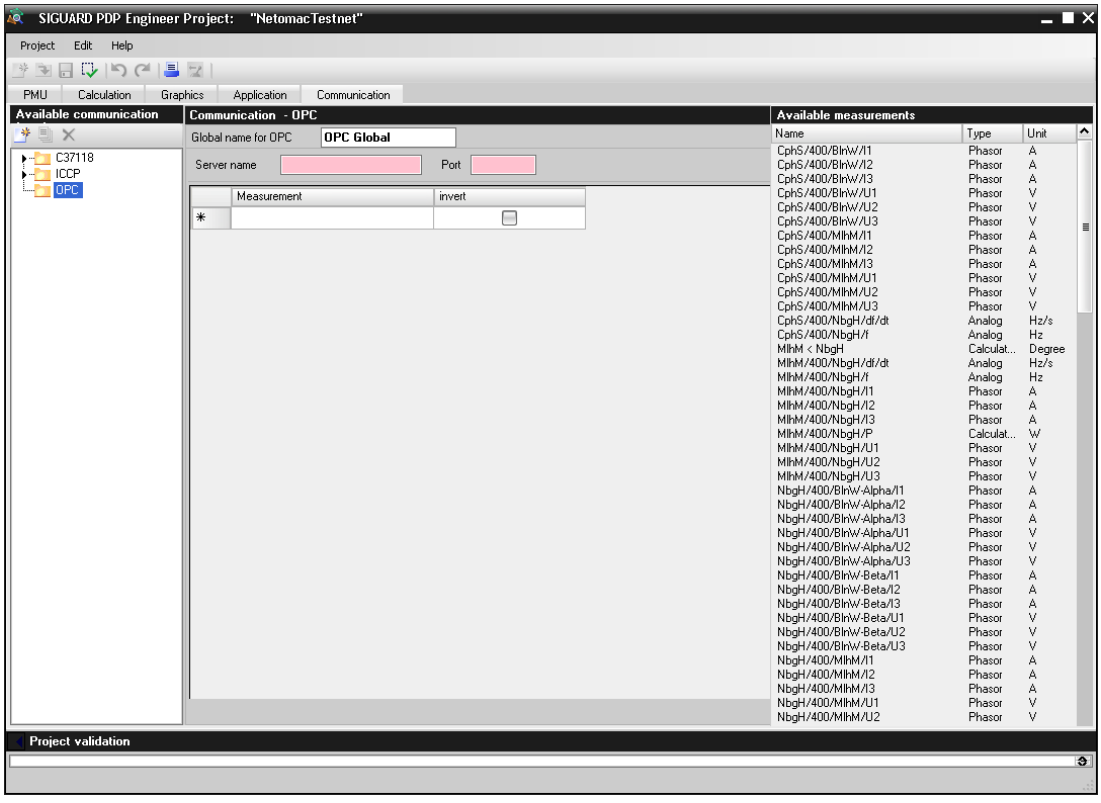


Figure 4-39 Define OPC Server

The setting options for the OPC server are explained in the following table.

Table 4-37 OPC communication settings

Element	Explanation
Server name	Definition of the name of the OPC server.
Port	Port to which the OPC server is connected.
Measurement	Using drag and drop, the measured values from the list **Available measurements** that are intended to be transmitted through the SIGUARD PDP OPC server can be inserted here.
invert	This setting is active only in the case of digital measured values. If the check box is selected, then the display of the binary signal is inverted, that is, a 1 is transmitted as 0 and vice versa.

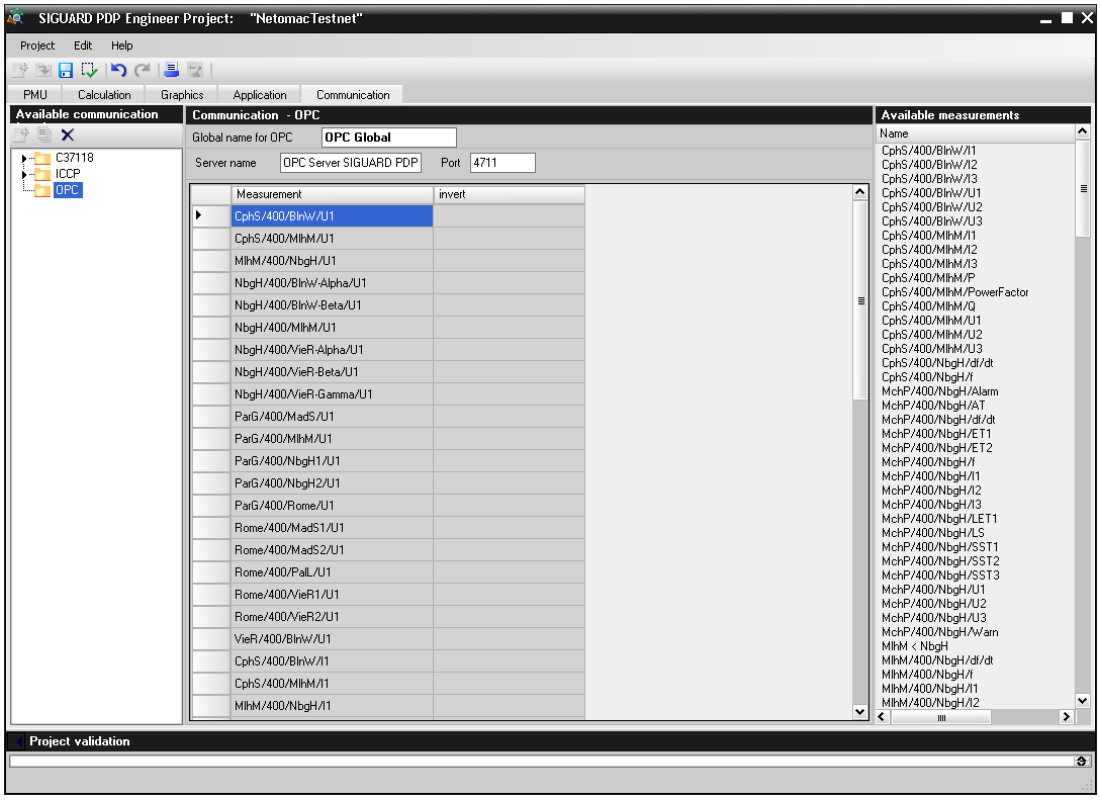


Figure 4-40 OPC server with assigned measuring points

You can find further information on saving, activating, and validating the project in chapter *4.9 Shared Functions*.

4.9 Shared Functions

For all editors in SIGUARD PDP Engineer, the following shared functions are available.

Entries

An entry field is highlighted in red if an entry is required. Entries are transferred into the configuration by:

- Operating the **<Enter>** key
- Operating the **<Tab>** key
- Moving the cursor from out of the entry field

Entries of decimal numbers are only valid if they are entered with a period (for example, 0.01).

Saving a Project

The data of a project should be saved after every change or reconfiguration (local copy of the configuration). A configuration that is not yet valid can be saved but not activated.

Validation

Current errors can be displayed in tooltips during entry. A complete validation takes place via the menu **Project > Validate** or via the corresponding icon  . If error messages are displayed, re-edit the configuration. If the validation is free of errors, the project can be activated for the runtime process.

- Current error messages

  For every element that is marked with a warning symbol,  a quick info (tooltip) can be shown. Point to the element with the cursor. The quick info contains the element type and a description of the error that has appeared.

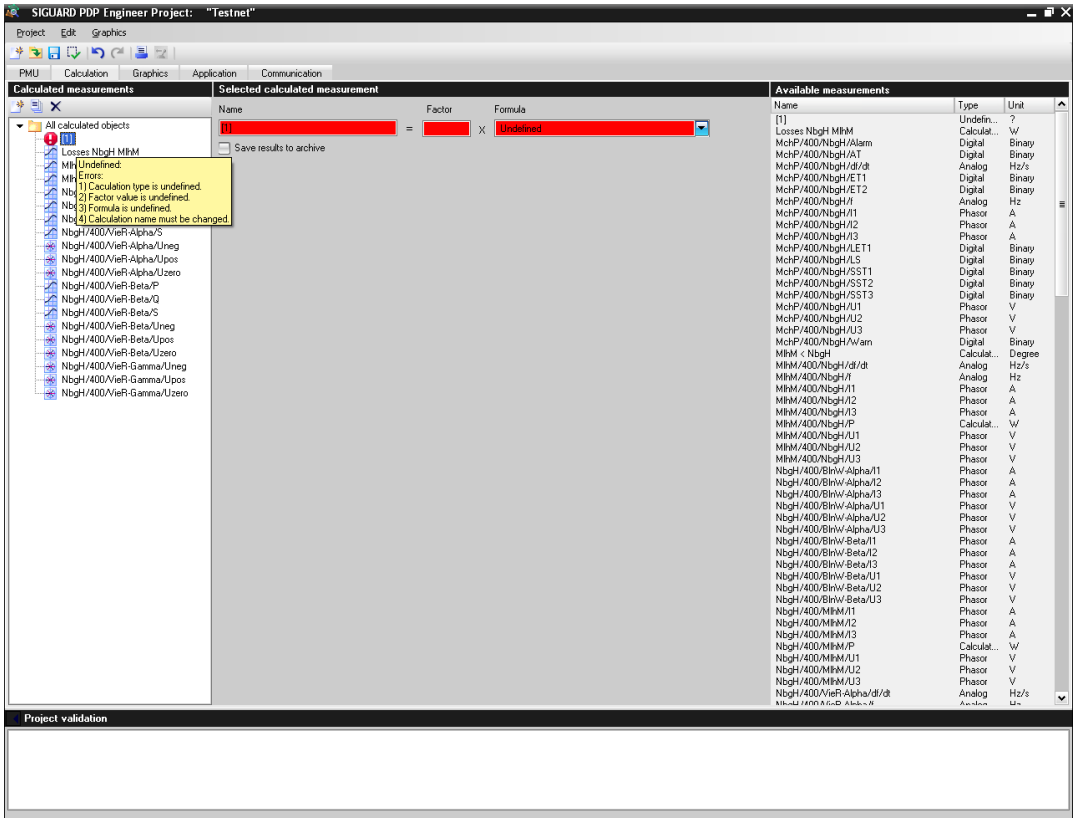


Figure 4-41 Current Errors in Tooltip

- Error messages after Validation

  In the lower window section **Project validation - Errors** error messages are shown based on the validation, for example:

  - Info (tab name): Description
  - Error (tab name): Error description

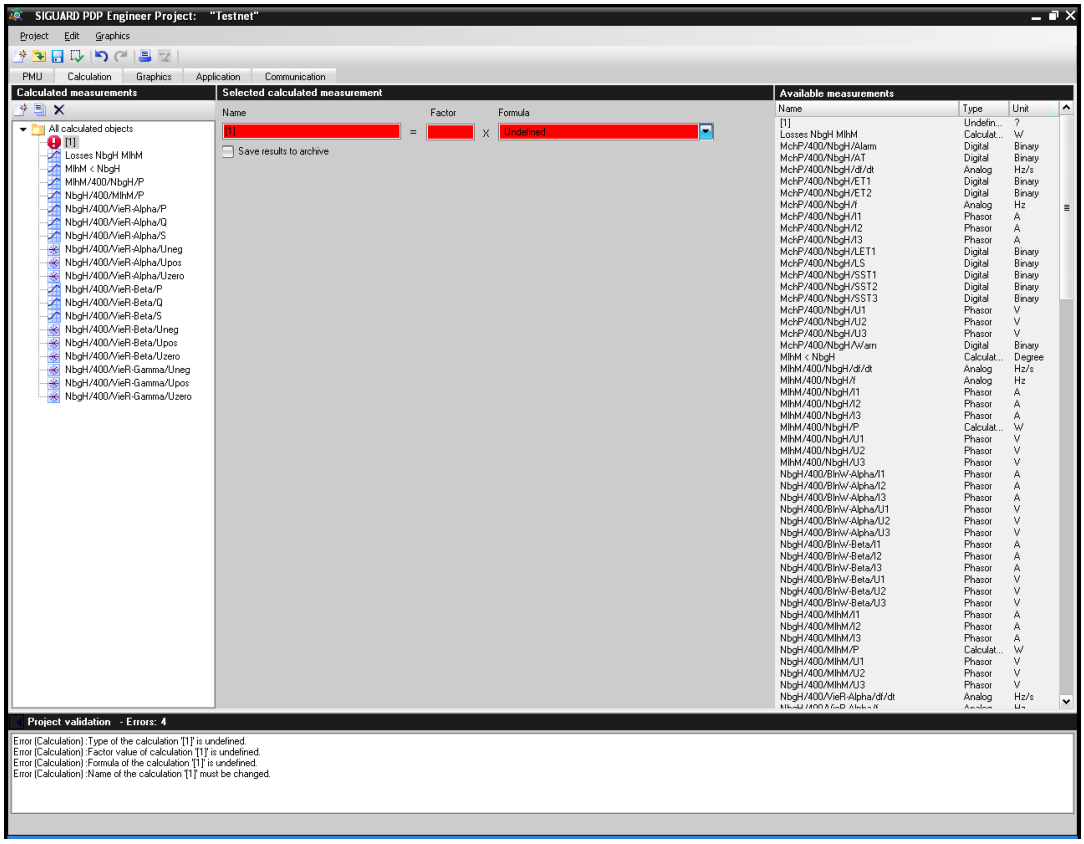


Figure 4-42 Example of an Error Message

This window section can be hidden so that only the header is visible. The number of error messages is displayed in the header. If error messages occur, a red warning symbol also appears in the header (for example, in the tree structure of **Calculated measurements**), in order to clarify which configuration triggered the error message.

After processing the error messages and a revalidation, no more messages should be displayed. The project is valid.

Activation of a Project

After successful validation, an opened and saved project can be made available to the runtime process. This takes place via the menu **Project > Activate** or via the corresponding icon . At the same time, the configuration is written to a defined position in SIGUARD PDP UI or an existing configuration with the local copy from SIGUARD PDP Engineer is overwritten. SIGUARD PDP UI must then be restarted.

■

5 Working with SIGUARD PDP Engineer

5.1 Overview

With the help of examples, the use of SIGUARD PDP Engineer shall be demonstrated to you.

The suggested procedure is to illustrate the individual steps for parameter assignment with SIGUARD PDP Engineer.

5.2 Example: Project, PMU

Proceed as follows:

- Create a new project.
- Create a new, physical PMU.
- Create a new, logical PMU.
- Define the measuring points for this logical PMU.
- Save the project.
- Perform the validation.
- Activate the project for the runtime process when the configuration is complete.

Creating a New Project

✧ Click the button  in order to create a new project.

The dialog for entering the project name appears.

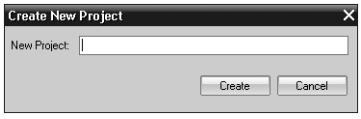


Figure 5-1 Dialog Create New Project

✧ Enter the name for the new project.

✧ Confirm the entry with the button **Create**.

Opening an Existing Project

✧ Click the button  in order to open an existing project.

The dialog for opening the project appears.

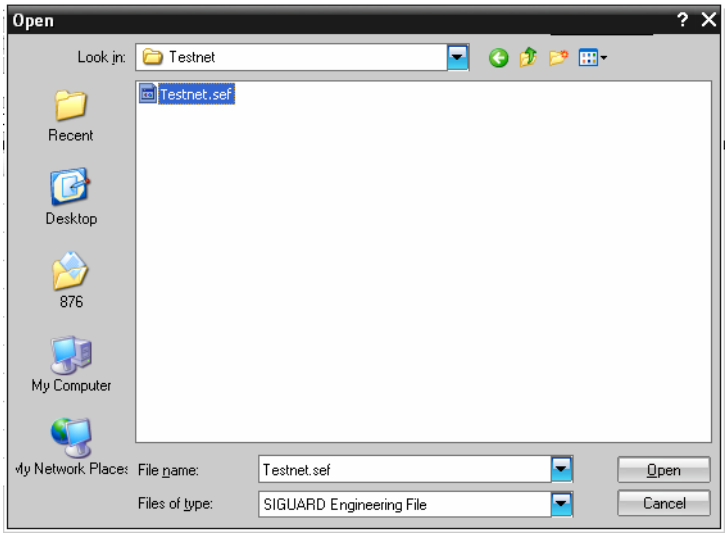


Figure 5-2 Dialog Open

- ✧ Select the directory in which the file type **SIGUARD Engineering File** is found.
- ✧ Select the SIGUARD PDP Engineer file (SEF format).
- ✧ Confirm the entry with the button **Open**.

The project data are loaded.

Creating a New, Physical PMU

- ✧ Go to the **PMU** tab.
- ✧ Select the directory **All PMUs**.
- ✧ Click the button  in the window section **Available PMUs** in order to create a new, physical PMU.

The window for entering the parameters for a physical PMU is displayed.

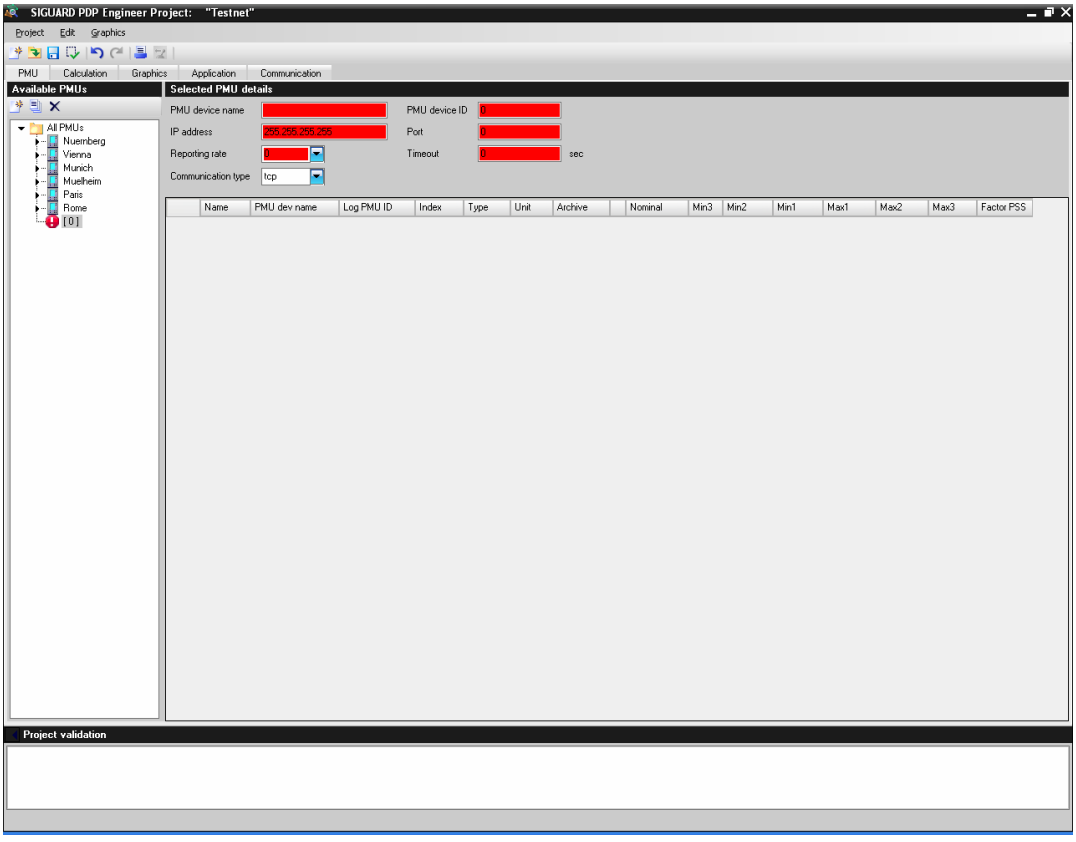


Figure 5-3 Parameters of a Physical PMU

Fill out the required entry fields marked in red.

- ✧ Enter the name in the field **PMU device name** and confirm with the **<Enter>** key.

The name will be inherited in the overview **Available PMUs**.

- ✧ Enter the **PMU device ID** (inherit from the PMU).
- ✧ Enter the **IP address** (inherit from the PMU).
- ✧ Enter the **Port** (inherit from the PMU).

Creating a New, Logical PMU

Every physical PMU must always have a logical PMU created under it. The new, physical PMU is still marked.

✧ Click the button  in the window section **Available PMUs** in order to create a new logical PMU.

The window for entering the parameters for a logical PMU is displayed.

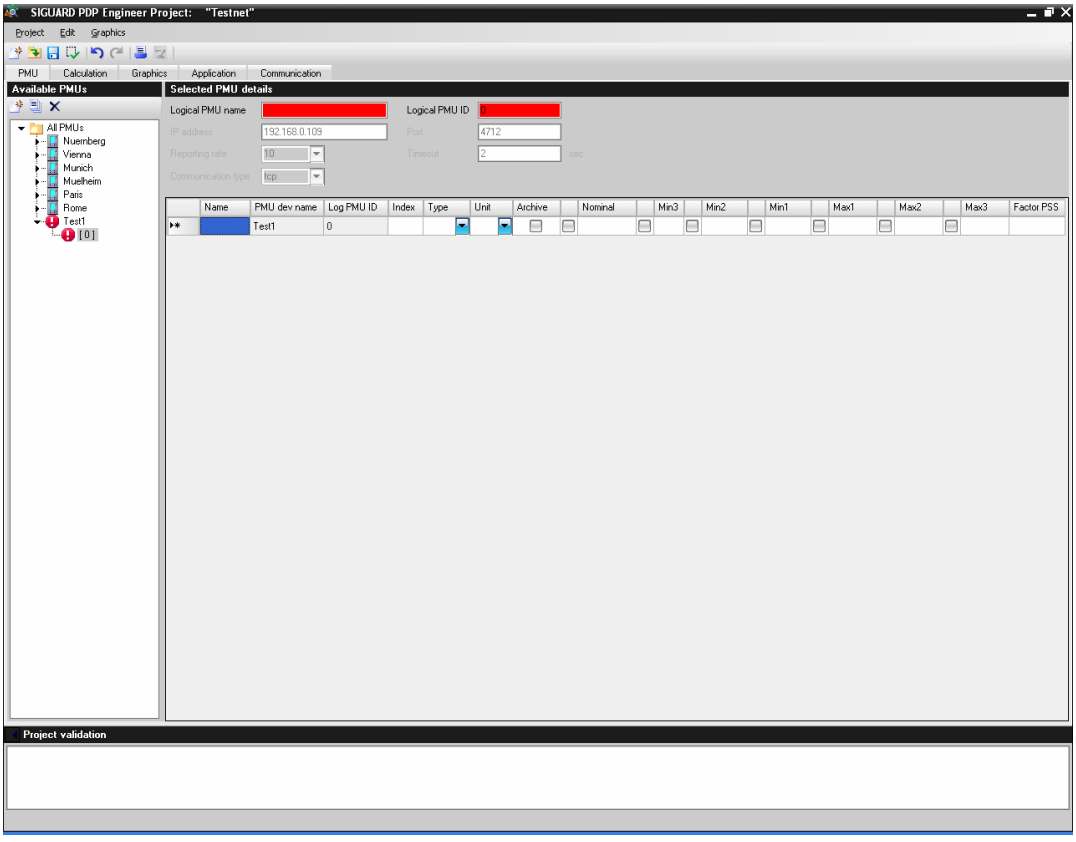


Figure 5-4 Parameters of a Logical PMU

Fill out the required entry fields marked in red.

✧ Enter the name in the field **Logical PMU name** and confirm with the **<Enter>** key.

The name will be inherited in the overview **Available PMUs**.

✧ Enter the **Logical PMU ID** (inherit from the PMU).

Defining Measuring Points

✧ Select the field **Name** in the table.

The name of the **PMU device** and the **Logical PMU ID** are inherited from the text boxes above.

✧ Enter a name for the measuring point.

A second row is inserted into the table. The line can be used for the definition of a further measuring point.

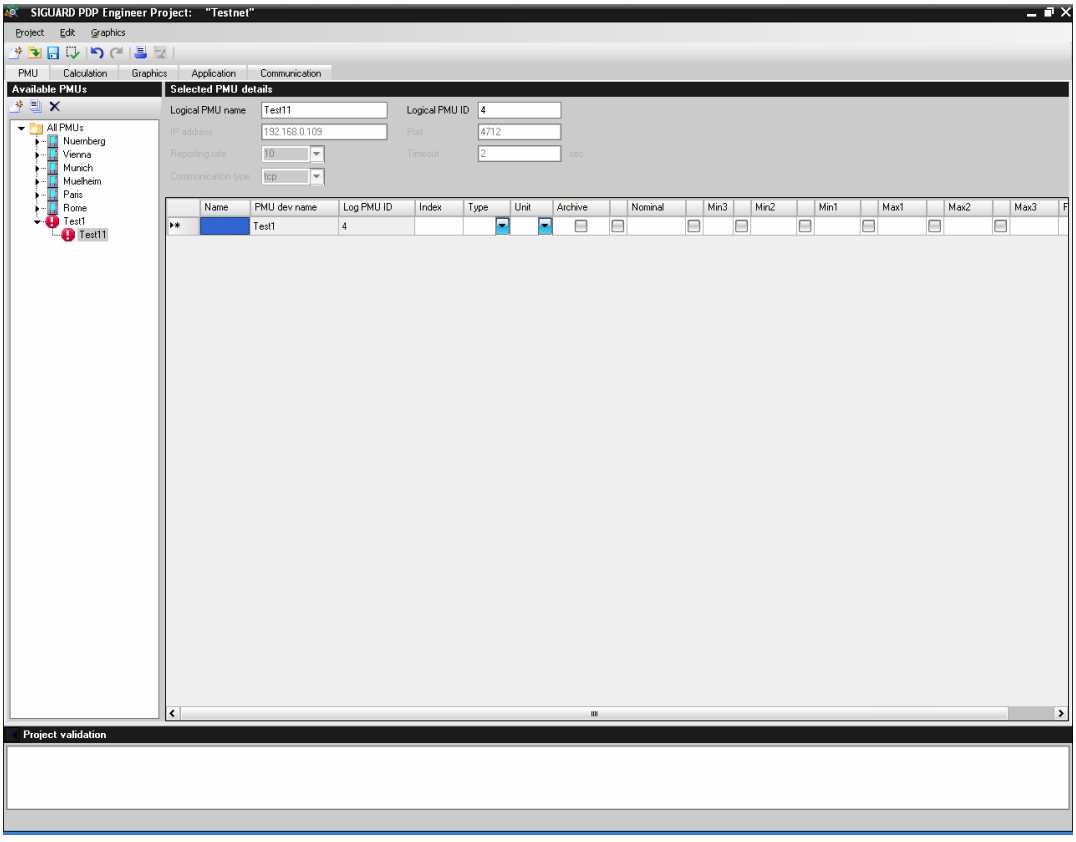


Figure 5-5 Name of the Measuring Point

✧ Enter the **Index** (inherit from the PMU).

✧ Enter the type of measuring point via the list box **Type** (inherit from the PMU).

The selected parameter is inherited.

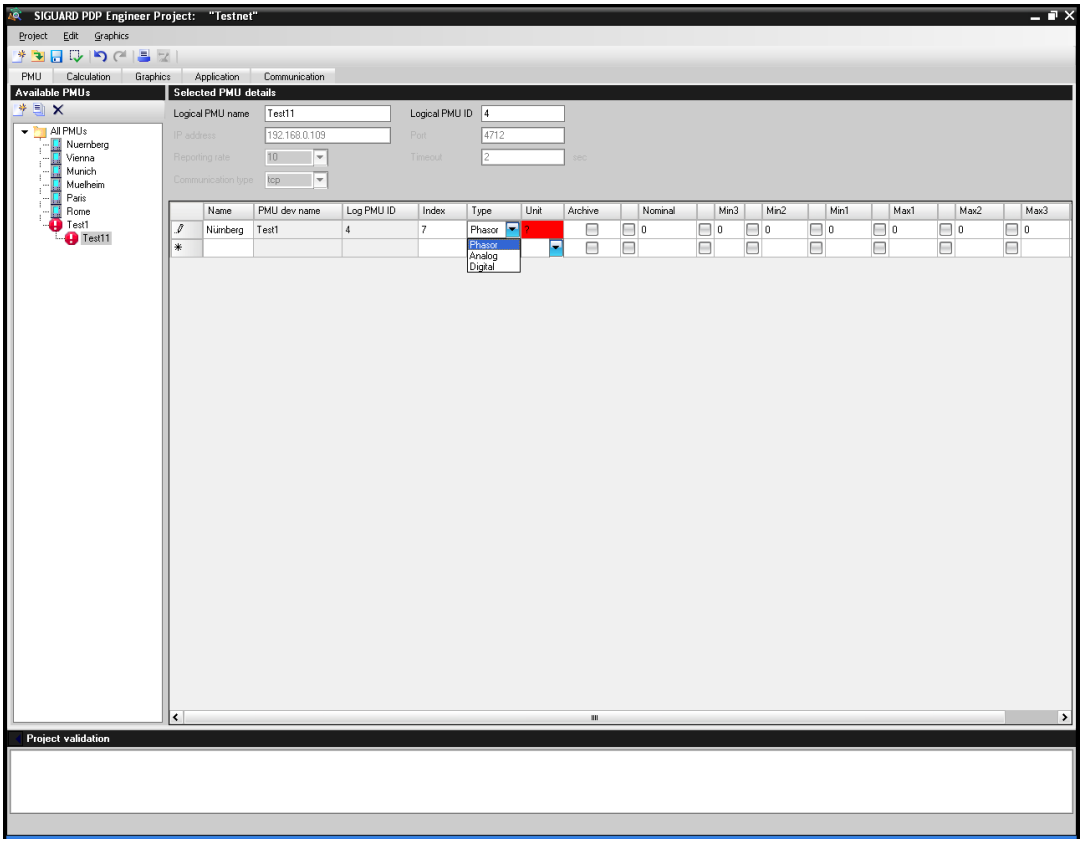


Figure 5-6 List Box Type

✧ Enter the unit of the measuring point via the list box **Unit** (inherit from the PMU).

The selected parameter in inherited.

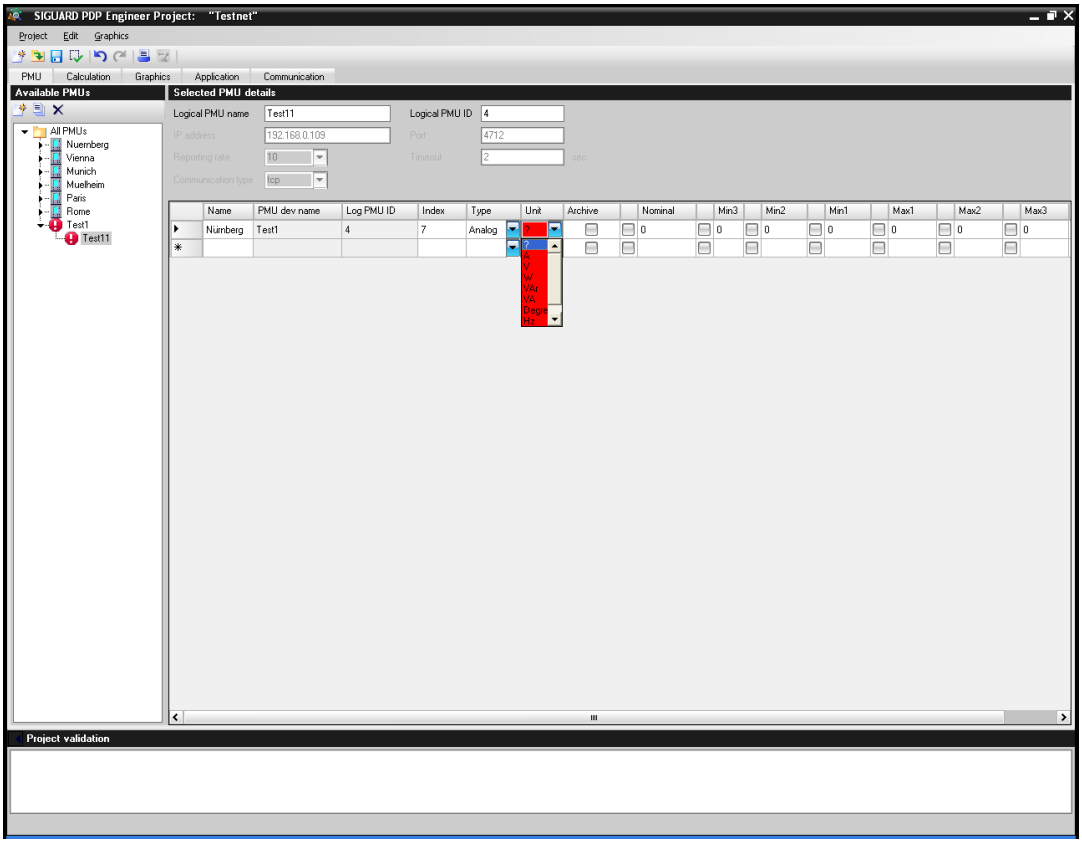


Figure 5-7 List Box Unit

- ✧ Select the corresponding check box **Archive**, if the measured values of the measuring point should be saved in the archive.
- ✧ Enter the rated value in the column **Nominal**.
- ✧ Enter the lower limiting values (**Min1** to **Min3**) and select the corresponding check box.
- ✧ Enter the upper limiting values (**Max1** to **Max3**) and select the corresponding check box.
- ✧ Enter the **Factor PSS** (Standard = 1).
- ✧ Select the check boxes for the values that should be included in the measurement.

Saving a Project

- ✧ Click the button  in order to save a project.

Perform Validation

- ✧ Click the button  in order to check the project for validation.

If errors are still present, these are shown as **Error (Project): ...**.

If the validation is faulty, it is shown as information **Info (Project): ...**.

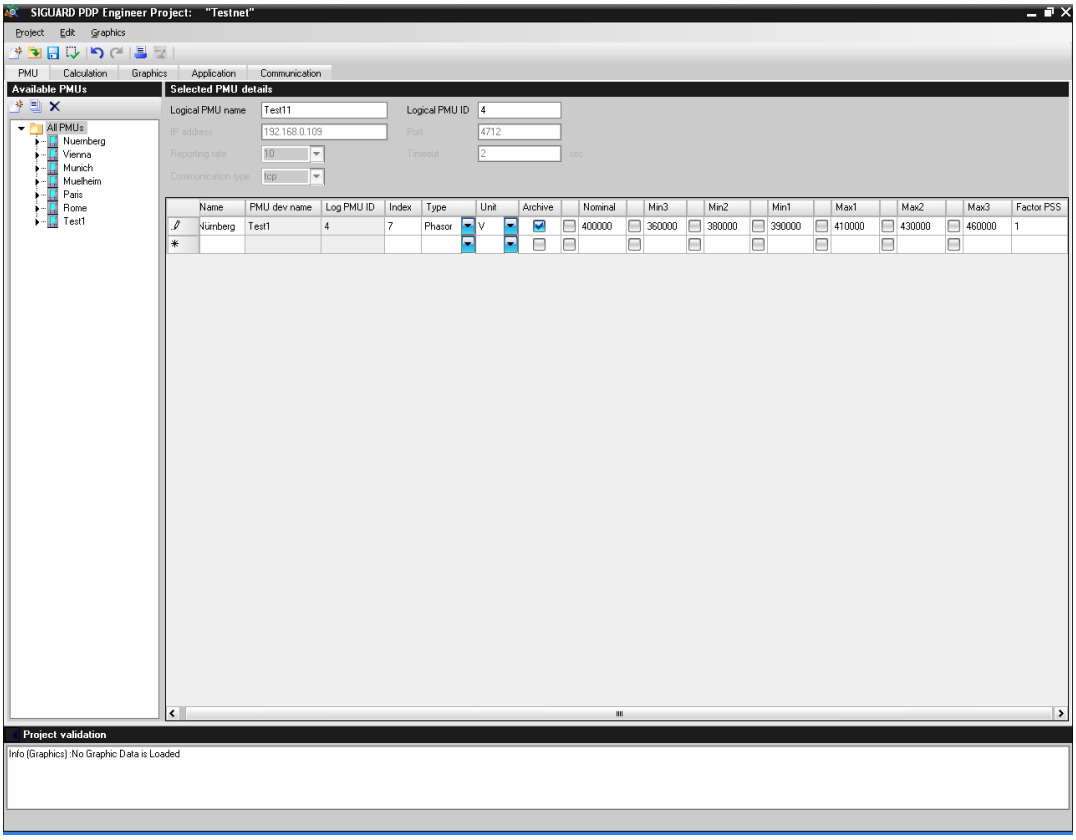


Figure 5-8 Info (Project):

Activating Project

✧ Click the button  in order to save a project for the runtime process.

NOTE

Activate the project only after the configuration is complete.

5.3 Example: Calculated Values

Proceed as follows:

- Create a new project (see *5.2 Example: Project, PMU*).
- Create a new calculated value.
- Set the parameters for this calculated value.
- Save the project.
- Perform the validation.
- Activate the project for the runtime process when the configuration is complete.

Create New, Calculated Values

✧ Select the **Calculation** tab.

✧ Select the directory **All calculated objects**.

✧ Click the button  in order to create a new calculated value.

The window for entering the parameters is displayed.

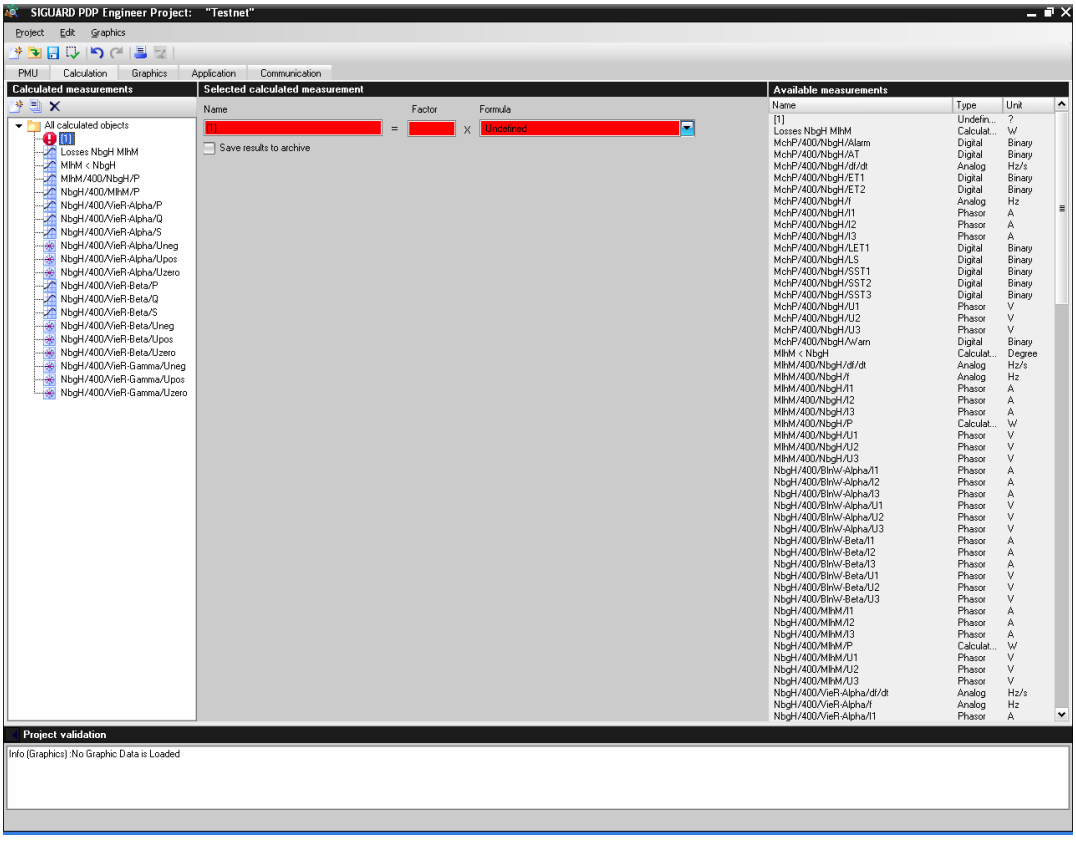


Figure 5-9 Parameters for a Calculated Value

Fill out the required entry fields marked in red.

✧ Enter the name of the new, calculated value and confirm with the **<Enter>** key.

The name will be changed in the overview accordingly.

✧ Enter the **Factor** (Standard = 1).

✧ Enter a formula via the list box **Formula** (for example, **Add two analogs**).

The selected formula is inherited.

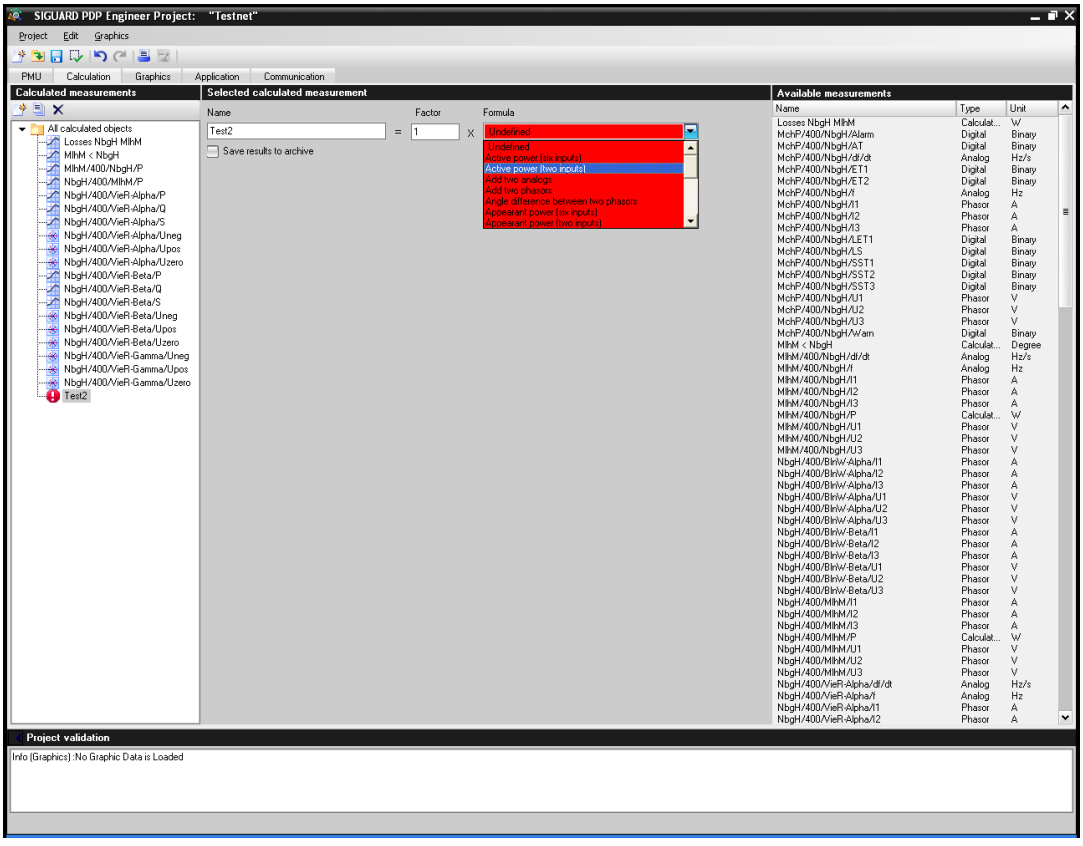


Figure 5-10 Selection of the Formula

✧ Select the check box **Save results to archive**, if the calculated measurement should be saved in the archive.

Saving a Project

✧ Click the button  in order to save a project.

Perform Validation

✧ Click the button  in order to check the project for validation.

If errors are still present, these are shown as **Error (Calculation): ...**.

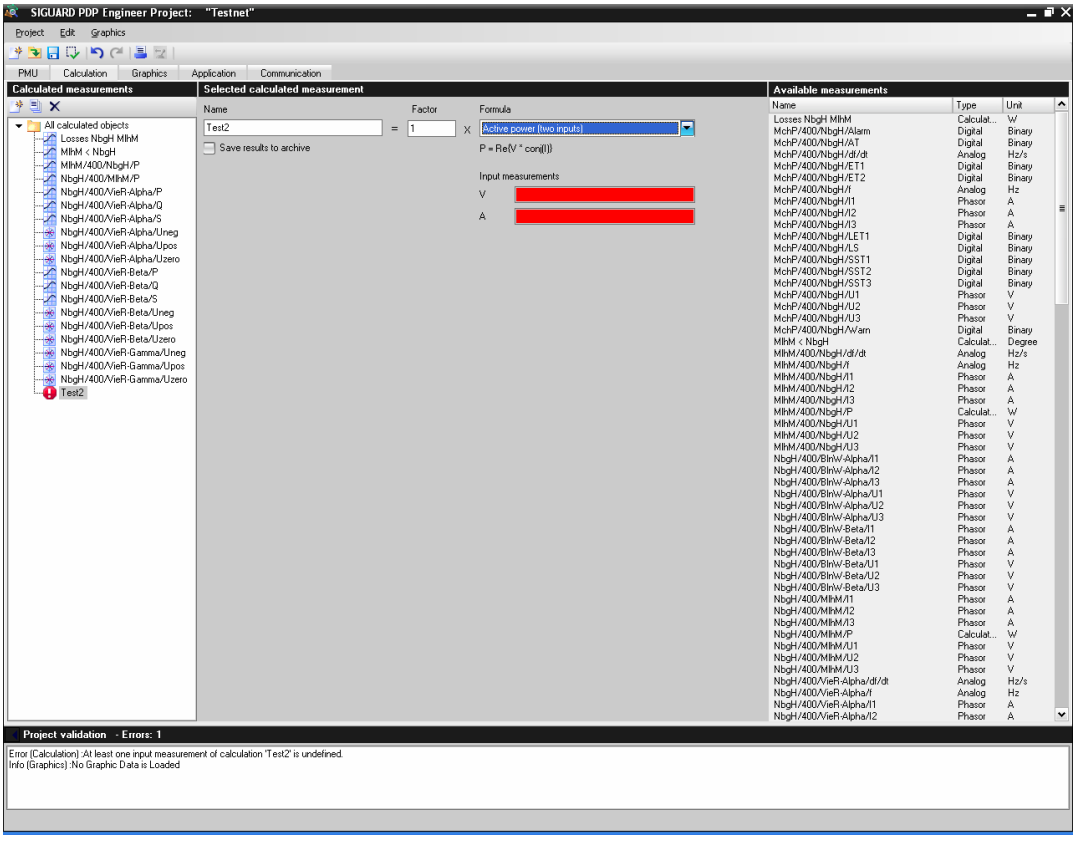


Figure 5-11 Missing Input Measurand

The missing input measurand is shown as an error (fields are highlighted in red).

✧ Drag the input measurands from **Available measurements** (Type: Analog) into the fields **Input measurements**.

The error messages are no longer shown.

Activating Project

✧ Click the button  in order to save a project for the runtime process.

NOTE

Activate the project only after the configuration is complete.

■

Literature

/1/ Siemens AG; SIMEAS R-PMU, Digital Fault Recorder, Manual; E50417-H1000-C360-A2

Glossary

Google Earth

Google Earth is software from the company Google Inc. and displays a virtual globe. It can overlay satellite and aerial images of different resolutions with geodata and show them on a digital elevation model of the earth.

In SIGUARD PDP, the map that is displayed in the window section **SIGUARD PDP UI - Map** is created based on maps from Google Earth.

SIGUARD PDP (Phasor Data Processing)

Software for monitoring the status of power distribution in extensive power-supply systems.

SIMEAS R-PMU

SIMEAS R-PMU is a device that, in addition to writers, contains an integrated **Phasor Measurement Unit (PMU)**. The PMU measures phasors and makes them available in a database. This is a highly accurate measurement of the vector quantities of voltage and current in terms of amplitude, phase angle, and time synchronization.

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