SIEMENS

OSCOP P

Fault Locator

Manual

E50417-H1076-C354-A2

Note:

Please observe the safety information and warnings described in the preface.

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Preface

This manual is intended for qualified personnel who want to determine the fault location and the fault type in a high-voltage system using OSCOP P.

Network parameterization requires detailed knowledge of its elements.

Fault location is a special function of OSCOP P. More information on OSCOP P can be found in *OSCOP P 6.60, Manual /1/*.

Validity of this Manual

The manual is applicable to OSCOP P from the version 6.60 on.
The location of faults on double-circuit lines is carried out by means of Hotfix 2.

Standards

OSCOP P and the manual were developed in accordance with the guidelines of 9001:2000.

Contact person

For any general, sales or licensing information regarding measuring and recording technology, please contact your local Siemens representative.

Hotline

For technical questions on parameterization and analysis software OSCOP P, as well as on SIMEAS R / P / Q / T and OSCILLOSTORE P5xx devices, please contact our hotline in Nuremberg:

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Internet

For more current information on **Power Quality**, please refer to:

www.simeas.com

Information for Your Safety

This manual does not represent a complete listing of all the safety measures required to operate the equipment (module, device) since specific operating conditions may make further measures necessary. However, it contains information which you have to observe in order to ensure your personal safety and in order to avoid property damage. The information is highlighted by a warning triangle and, depending on the degree of danger, is shown as follows:

Danger

indicates that death, severe personal injury or substantial property damage **will** result if proper precautions are not taken.

Warning

indicates that death, severe personal injury or substantial property damage **can** result if proper precautions are not taken.

Caution

indicates that minor bodily injury or material damage may result if appropriate precautions are not taken.

Caution

indicates that material damage may result if appropriate precautions are not taken.

Note

indicates important information about the product, its handling or the respective part of the manual to which particular attention should be drawn.

Qualified personnel

Commissioning and operation of equipment (module, device) described in this manual may only be carried out by qualified personnel. Qualified personnel in the sense of the safety instructions in this manual are persons who are entitled to commission, enable, earth and identify devices, systems and circuits in accordance with the standards of safety technology.

Use as prescribed

The equipment (device, module) may only be used for the applications described in the catalogue and the technical specifications and only in combination with third party equipment recommended or approved by Siemens.

The successful and safe operation of this device is dependent on proper handling, storage, installation, operation, and maintenance.

Hazardous voltages occur in parts of this electrical equipment during operation. Severe personal injury or property damage can result if the device is not handled properly.

- The device is to be earthed to the protective-earth terminal before any other connections are made.
- Hazardous voltages can occur in all the circuit parts connected to the power supply.
- Hazardous voltages may occur in the equipment even after the power supply voltage has been removed (capacitors may still be charged).
- Equipment with current transformer circuits may not be operated openly.
- The limit values specified in the manual or in the operating instructions must not be exceeded; this must also be observed during testing and commissioning.

Contents

General

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Contents

1.1 Overview

OSCOP P Modules

OSCOP P is a modularly structured program. The program modules are:

- **Parameterize PC**
  This module allows you to create devices, to define device connections to data concentrators and PCs or to specify access rights, balance units and central interfaces.
- **Parameterize Devices**
  This module allows you to specify, for example, device functions, individual device configuration, channel assignments or trigger functions, to define time synchronisation and print functions, to parameterize external device interfaces or form group alarms.
- **Transfer**
  This module allows you to activate the transmission of device data either manually on demand, or cyclically in automatic mode.
- **Evaluate**
  This module allows you to graphically process measured values, indications and fault records and to present them on your colour monitor in the form of curves and tables. Furthermore, OSCOP P calculates other variables for detailed analysis of signal curves. In addition, you can output all data to a printer or plotter.
- **Power System Description**
  This module allows you to describe your power system. This description is required for the fault location calculation. The fault location calculation is performed by the fault locator.

This document gives as much information on the OSCOP P modules as it is needed to perform a fault location. More information on the OSCOP P modules can be found in the *OSCOP P 6.60, Manual /1/*.

Measuring devices

OSCOP P is able to determine a fault location using the fault records from the following devices:

- Digital fault recorder SIMEAS R
- OSCILLOSTORE P500, P510, P520, P530
- OSCILLOSTORE P531 (8 and 12 bit resolution)
- Protection device with an IEC60870-5-103 interface
- Comtrade files from measuring devices

Fault location

The analysis (e. g., fault location) of fault records from measuring devices can be performed using:

- **Evaluation PCs** to which your measuring devices are connected directly or via data concentrators.
- Data concentrators **DAKONs** to which your measuring devices are connected directly.
- **Server PCs** to which your measuring devices are connected directly or via data concentrators.
- **Client PCs** which do not have any direct access to the data of measuring devices or data concentrators. They are connected to server PCs via the network and evaluate data stored in the database of the server PC.

Fault locator

The fault locator is a software function which provides an ASCII file as a result.

The performance characteristics of the fault locator are:

- Fault location can be performed either automatically or manually.
- Calculation of a fault location on a parameterized line segment.
- Calculation of fault location on single-circuit lines (see Chapter 5.1). In this case, it is possible to calculate the fault location from one or both line ends.
- Calculation of fault location on double-circuit lines (see Chapter 5.2).
- Calculation of a fault location for solidly earthed systems.
- A fault location can be calculated for the following fault types: phase-earth, phase-phase, phase-phase-earth, phase-phase-phase and phase-phase-phase-earth.
- Calculation can be done for 50 Hz and 60 Hz system frequency.
- The type of the currently detected line fault is determined automatically. Immediately after the fault location has been determined, an analysis algorithm is used to automatically detect and output the automatic reclosure, as well as the state at the end of the line.

Note

Faults behind the line end are detected, however, the fault location cannot be calculated.

Phase-earth voltages and phase currents can be measured using the fault recorder.
This is also possible if fault records are obtained from a protection device or provided as a COMTRADE file.

The prefault time length should be at least 150 ms for all scanning rates.

1.2 Power System Description (PSD)

Power System Description (PSD)

In order to be able to perform a fault location with OSCOP P, it is necessary to execute the following steps:

- ❑ represent your power system as a topological structure and as a network model using the PSC configurator,
- ❑ specify the device circuiting using PSD,
- ❑ activate the fault location in the **Transfer** OSCOP P module.

The fault locator provides an ASCII file as a result. This file contains detailed information about the fault analysis.

Note

In the case of OSCOP P modules **PSD**, **Parameterize PC**, **Transfer** and **Parameterize devices,** only one can be opened at a time. Parallel operation is possible with the module **Evaluate** only.

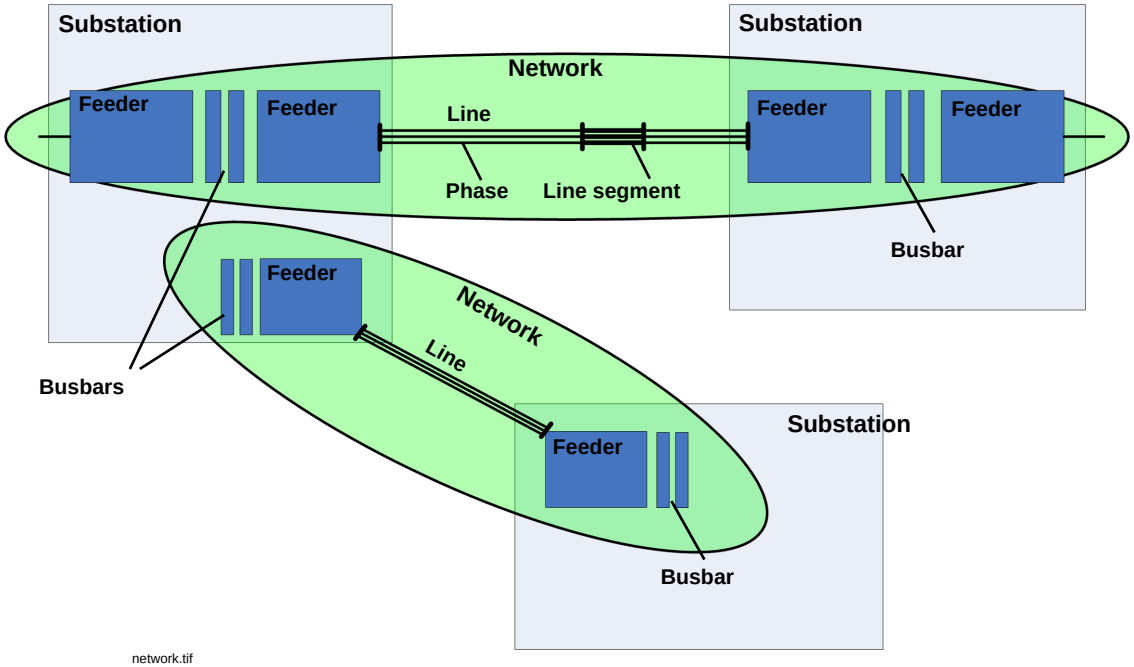
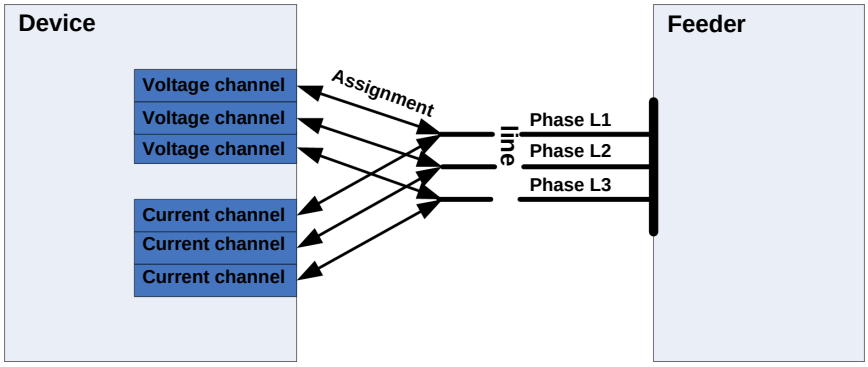


Figure 1-1 Network model

Figure 1-1shows a power system with three substations and two lines.

A feeder is located at each line end. A line consists of at least one line segment.
To perform a fault location, at least one line end must be assigned to a feeder. A feeder may only be assigned to one line.



assignment.tif

Figure 1-2 Circuiting of the measuring device

Figure 1-2 shows the circuiting of a device. A voltage and a current channel is assigned to each line phase.

Elements of a network

The following table lists and describes the elements of a network model.

Table 1-1 Elements of a network

Element	Description
Network	Summation of elements (busbar, feeder ...) that are electrically connected to each other. All elements of a network have the same nominal voltage and nominal frequency. Some network properties influence the calculation. Two feeders connected by a line must belong to the same network to which this line is assigned.
Busbar	The busbar is an element both of a substation and a network. Their assignment must be defined. A busbar includes feeders. All feeders of a busbar belong to the same network. The voltage measured in all feeders of a busbar is identical.
Feeder	The ends of a line are marked by feeders. Voltage and current are measured at the feeder.
Substation	The substation is used to subdivide a network. It does not have any effect on the calculation. It comprises several feeders which are geographically close to each other.
Line	Connection between two feeders. This assumes that both feeders belong to the same network. The feeders must belong to different busbars which in turn are usually assigned to different substations.
Line segment	Part of a line. A line must consist of at least one line segment. The length of a line is the sum of the lengths of all line segments.
Phase	Each line has three phases in a PSD model.
Device	Measuring unit which measures voltages and currents.
DAU	The Data Acquisition Unit (DAU) is a device component (e. g., of the SIMEAS R). It comprises several channels.
Analog channel	The analog channel is used to measure the current or voltage of a feeder phase. It is the smallest unit of a device.
Circuit	The logical connection of an analog channel with a feeder phase.

1.2.1 Views in PSD

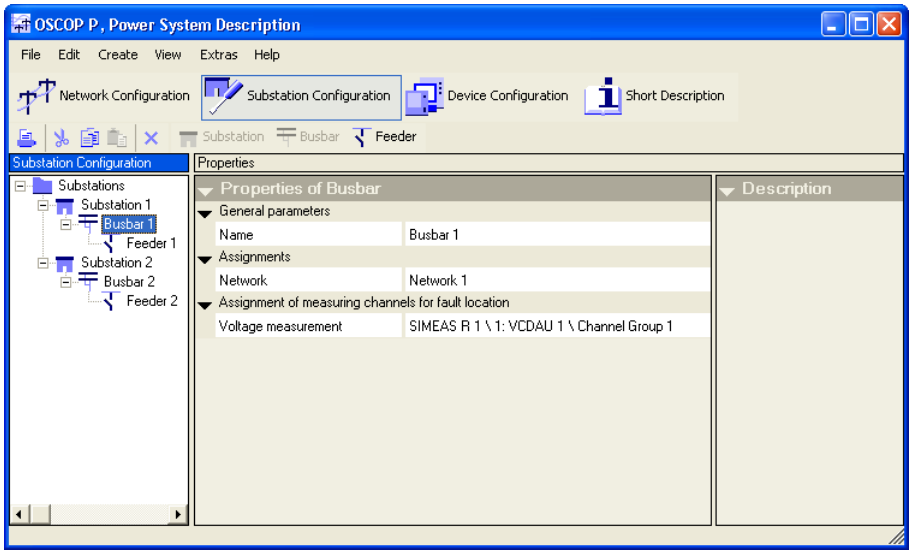
PSD allows you to display your power system/network in three different views. The three views are:

- Substation Configuration
- Network Configuration
- Device Configuration

The **Short Description** view gives you information on how to work with PSD in short form.

You configure and parameterize your power system mainly in the **Substation Configuration** view.
The configuration is completed in the **Network Configuration** view.

Substation Configuration



psd_window.tif

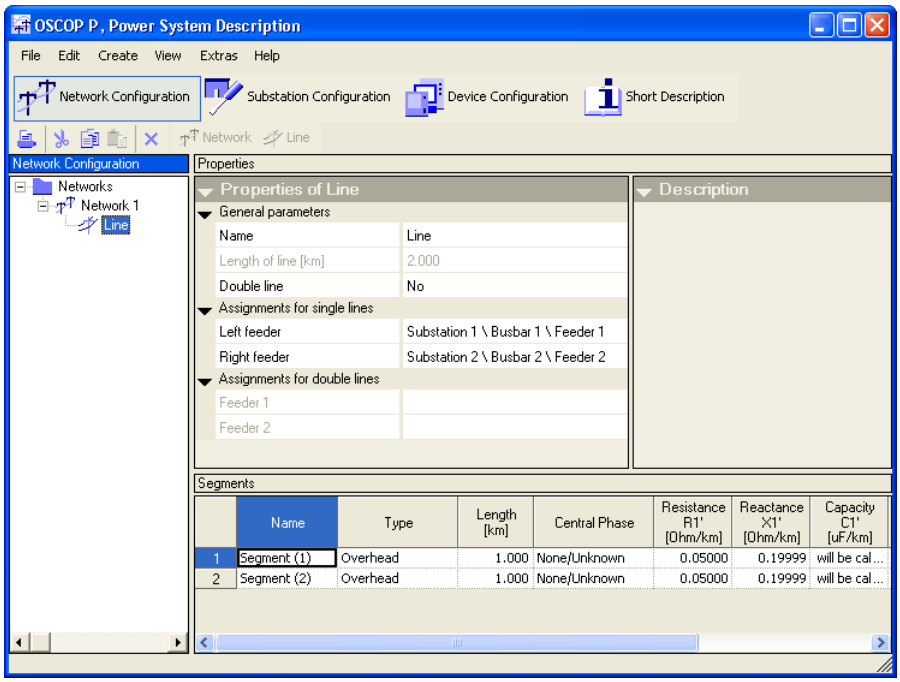
Figure 1-3 PSD, substation configuration view

The **Substation Configuration** view displays the topological structure (as a topological tree) of the power system in the **left pane**. You can navigate as well as create, rename and delete elements in this view.

The topological structure comprises the substations with their busbars and feeders.

The **right pane** represents the dialog area. The dialog area displays parameters of the selected element. The parameters can be edited.

Network Configuration



energy_system.tif

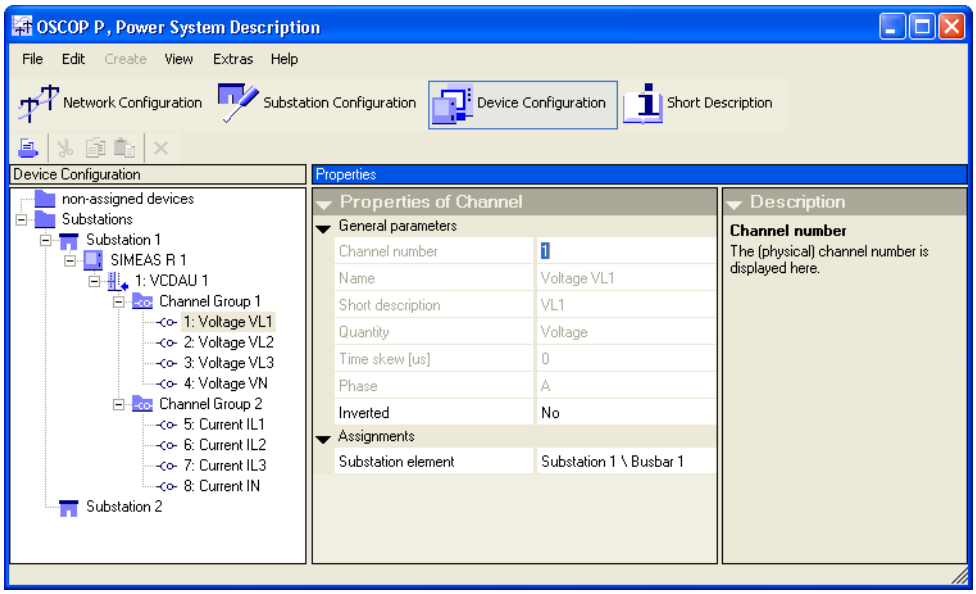
Figure 1-4 PSD, network configuration view

The **left pane** of the view **Network configuration** displays the network structure of the power system. You can navigate as well as create, re-name and delete elements in this view.

The network structure comprises the networks and the corresponding lines with their segments.

The **right pane** represents the dialog area. The dialog area displays parameters of the selected element. The parameters can be edited. You can add and parameterize line segments for the line element.

Device Configuration



configuration.tif

Figure 1-5 PSD, device configuration view

The **Device Configuration** view displays the existing devices with their modules and channels in the **left pane**. You can navigate in this view.

The **right pane** represents the dialog area. The dialog area displays parameters of the selected element.

Note

Parameters which cannot be changed can be edited in the **Parameterize PC** and **Parameterize devices** OSCOP P modules.

1.2.2 Displaying information

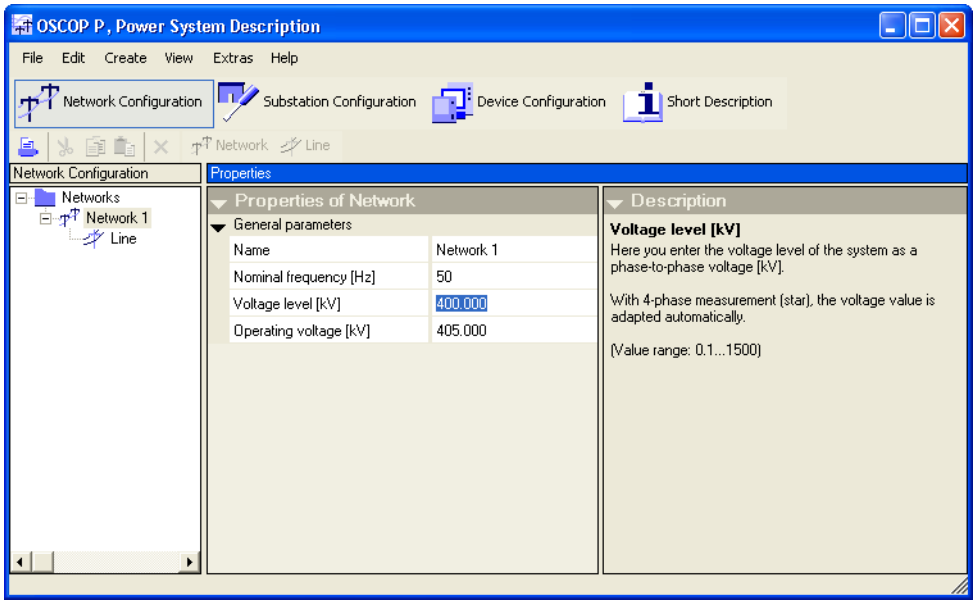
If parameter lists are displayed in the right pane, information and input help on these parameters are shown.

How to view information texts on the individual parameters:

- Click on a parameter name or a parameter value in the **Properties** pane.

Description

Information on the selected parameter is shown now under **Description** (to the right of the parameter list). Setting options and interactions with other parameters are displayed.



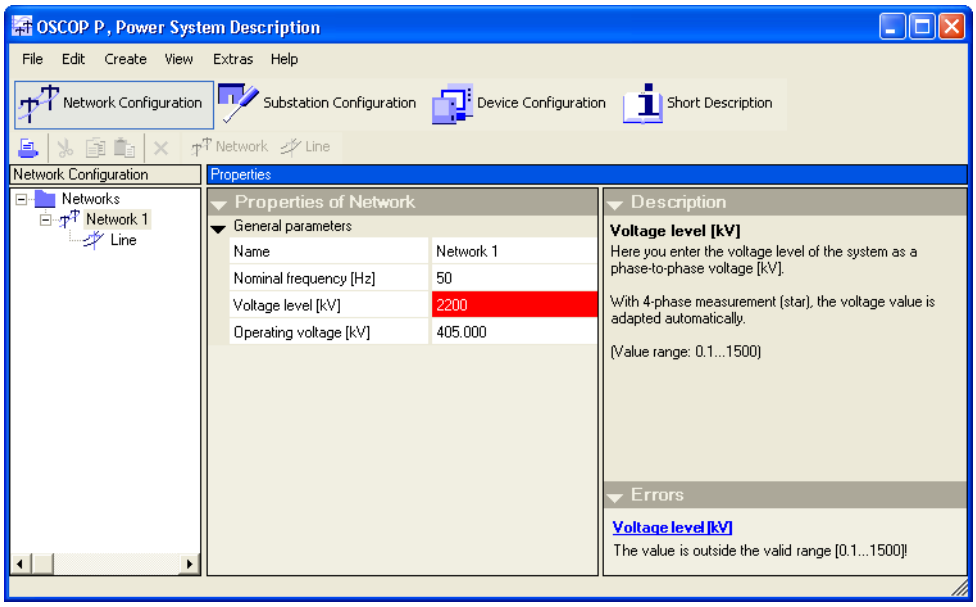
descript01.tif

Figure 1-6 Parameter description

Error messages

If you have entered invalid values in an input field, an error message will be displayed in the respective window at the bottom right. This message indicates, for example, the permissible value range.

- Clicking on the blue legend brings you to the faulty parameter which you can change directly.



descript02.tif

Figure 1-7 Error messages

1.2.3 Language setting

You can set the language of the user interface in the OSCOP P module **Parameterize PC**. This setting applies to all program modules.

How to set the language:

- Exit the **Power System Description** program module.
- Start the **Parameterize PC** program module.
- Select the menu item **Global** → **Language**.
- Select the desired language.
- Click **OK** to close the dialog box.
- Restart the **Power System Description** program module.
  The new setting takes effect after restarting the program module.

1.2.4 Setting the system of units

The system of units (metric or inch system) is set in the **Parameterize PC** OSCOP P module. It applies to all program modules.

The system of units you choose to work in is used for the fault location calculation.

How to set the system of units:

- Exit the **Power System Description** program module.
- Start the **Parameterize PC** program module.
- Select the menu item **Global** → **Country settings**.
- Select the system of units **Metric units** or **US units** (inch system) in the **Metric sizes** field.
- Click **OK** to close the dialog box.
- Restart the **Power System Description** program module.
  The new setting takes effect after restarting the program module.

1.2.5 Documenting a project

The print function allows you to document your project. You can print your data on paper or save it in an HTML file.

How to proceed:

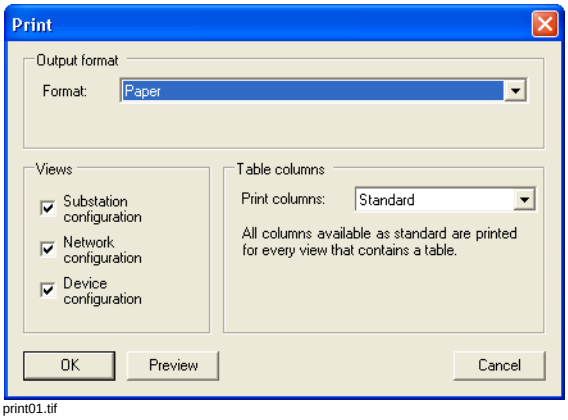
The print function consists of three steps:

- ❑ Printer setup
- ❑ Print preview
- ❑ Print

Print setup

The print setup is carried out as follows:

- Select **File > Print**. The dialog box Print opens.



print01.tif

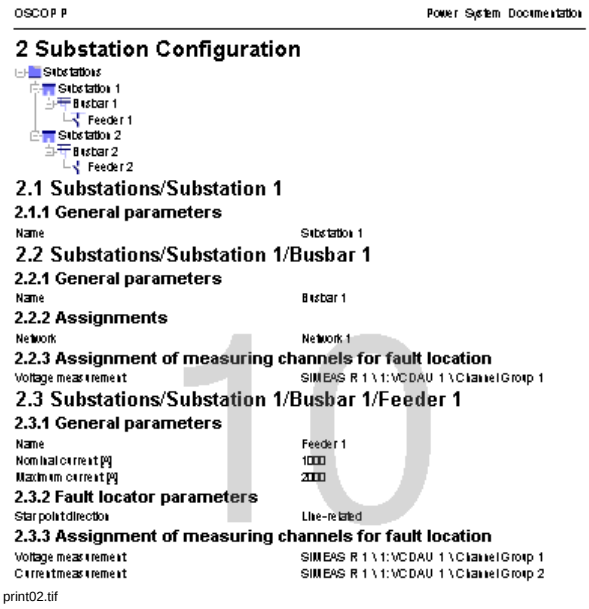
Figure 1-8 Print setup

- Select one or several configurations you want to print under **Views**.
- Select one of the options under **Table columns**.

Print preview

The print preview is displayed as follows:

- Click the button **Preview** in the dialog box **Print**.
  The print preview is created and displayed.


OSCOP P Power System Documentation

2 Substation Configuration

Substations
Substation 1
Busbar 1
Feeder 1
Substation 2
Busbar 2
Feeder 2

2.1 Substations/Substation 1

2.1.1 General parameters

Name	Substation 1

2.2 Substations/Substation 1/Busbar 1

2.2.1 General parameters

Name	Busbar 1

2.2.2 Assignments

Network	Network 1

2.2.3 Assignment of measuring channels for fault location

Voltage measurement	SIMEAS R 1 \ 1: VCDAU 1 \ Channel Group 1

2.3 Substations/Substation 1/Busbar 1/Feeder 1

2.3.1 General parameters

Name	Feeder 1
Nominal current [A]	1000
Maximum current [A]	2000

2.3.2 Fault locator parameters

Star point direction	Line-related

2.3.3 Assignment of measuring channels for fault location

Voltage measurement	SIMEAS R 1 \ 1: VCDAU 1 \ Channel Group 1
Current measurement	SIMEAS R 1 \ 1: VCDAU 1 \ Channel Group 2

print02.tif

Figure 1-9 Print preview, substation configuration

Printing

- While in preview mode, click the **print icon** to print the displayed objects.

In the **Preview** mode, you can also save the contents in a file, set up a page, scroll, enlarge or reduce the display and set the page view.

Short Description

2

Contents

This short description gives you information on the following topics:

- Modelling a Power Distribution System with PSD
- Upgrading from an Older OSCOP P Version

2.1 Modelling a Power Distribution System with PSD

Procedure for creating a new project

The Power System Description (PSD) offers you three views of your data:

- In the **Network configuration** view, you create networks ("Voltage levels") and lines.
- In the **Substation configuration** view, you can parameterize substations and substation elements (busbars and feeders).
- In the **Device configuration** view, you can assign devices and measuring channels to your substation elements.

First of all, create your networks in the **Network configuration** view and make the appropriate settings.

Then change to the **Substation configuration** view to create your substations there. First enter the busbars within a substation. You must immediately assign a network (and thus a voltage level) to each busbar.

Then create the corresponding **Feeders** in the level below the busbars. Every feeder represents a measuring point in this model.

The feeders are required:

- for fault location.
  Feeders mark the end points (measuring points) of a line.
- for PowerQuality evaluations
  A feeder represents a SIMEAS Q or the corresponding channels of a SIMEAS R.

A complete feeder parameterization includes the assignment of measuring channels for current and voltage measurement. Configuration is possible, however, only if the respective devices are provided in PSD (see **Parameterization the devices**).

To be able to perform a fault location, you must parameterize the lines. This is done in the **Network configuration** view.

Once you have created a line below a network object, the line parameters can be entered. In doing so, you can choose between a single-ended or a two-ended fault location. In the case of a single-ended fault location, an optional parallel line compensation for double-circuit lines can be carried out (to do so, select the option **Yes** under the **Double-circuit line**).

A line can comprise of several sections with different impedances, for example, cable and overhead line. This is why PSD enables you to subdivide your line into several **Segments** with different characteristics.

Parameterizing the line sections

Various characteristic data of a line segment are required for fault location. Basically, it is a matter of impedance of the positive-sequence system, the earth impedance as well as the coupling impedance, as the case may be (if **Double-circuit line** has been set). There are several options for entering the impedances:

- Entry of the positive sequence system using
  - R1 and X1, or
  - X1 and angle ("Phi").
- Entry of the earth impedance matching using
  - R0 and X0,
  - the ratios RE/RL and XE/XL (RL = R1, XL = X1),
  - the complex matching factor kL, or
  - the complex impedance ratio Z0/Z1.

The input format can be selected via the menu **Extras** → **Options**. To enter the coupling impedance, there is only one option with the ratios RM/RL and XM/XL. For the definitions of the individual values please refer to *Appendix: Equation Symbols and Equations*.

All impedances and matching factors are quantities per unit length (e.g., Ohm/km). Impedances referred to the primary side are required. You can choose between kilometres and miles as the unit of length. This setting can be made in the OSCOP P module **Parameterize PC** under the menu item **Global** → **Country settings** → **Metric or US units**. The setting applies to all OSCOP P modules.

If you change the input format or switch between kilometres and miles, values that have already been entered will be converted automatically.

You can enter the capacities in all input formats. The capacity values are calculated appropriately from the remaining impedances. We recommend the default setting (at least for overhead lines). If you want to enter the capacities explicitly, click on the corresponding value and overwrite the displayed text **will be calculated** with the value.

The equations for automatically calculating the capacities can be found in *Appendix: Equation Symbols and Equations*.

In addition to the line impedances, you can set several further parameters. The total length of the line is calculated from the lengths of the individual sections and is displayed in the general parameter table.

You can use the context menu to add further sections. To do so, click on the section number in the first column with your right mouse button. You can either create a new section with the preset values under **Add segment** or use an existing section as a template with **Copy** and **Paste**. The order of the sections can also be changed subsequently via the context menu.

Parameterizing the devices

At the moment, there is no option to create or parameterize the devices directly in the PSD configurator. For this purpose, you have to use the other OSCOP P modules (**Parameterize PC** for creating devices and **Parameterize Devices** for configuring devices).

Only the device parameters that are required for parameterizing the fault location are displayed in the PSD model. Basically, these are assignments of devices and measuring channels to other substation elements.

2.1.1 Notes on How to Configure Assignments

Measuring channel assignment for fault location

- You must define channels both for voltage and current measurement for every feeder.
- Here you can assign the following devices/device components to the feeder:
  - Channel group of a SIMEAS R
  - DAU of an OSCILLOSTORE
- The assignments made here are applicable only for fault location. However, you can assign several devices to the feeder, e.g., an additional SIMEAS Q for measuring PowerQuality data. These additional assignments are configured in the **Device configuration** view.
- You can also measure and assign the voltage for all feeders centrally at the busbar.
- General restrictions:
  - The voltage and current channels for fault location must always be assigned to the same device.
  - Channels that have already been assigned to another feeder can no longer be assigned (if necessary, delete the old assignment first).

Assignment between line and feeder

- The lines must be assigned in the **Network configuration** view.
  Regarding the assignment, it must be differentiated between the two-ended fault location and the single-ended fault location with parallel line compensation.

Two-ended fault location

- You can assign a feeder to each of the two line ends. The feeders are here referred to as **Left feeder** and **Right feeder**. Please note for line orientation that the section on top of the section table has been assigned to the **left** feeder.
- You can also assign only one line end to a feeder if necessary. In this case, fault location is performed from one side only. However, the results of single-ended fault location are far less accurate than that of two-ended fault location.
- General restrictions:
  - Both feeders that you assign to one line must be in different substations.
  - Both feeders must have been assigned to the same network that the line has also been assigned to. (A feeder is assigned to a network indirectly via the busbar.)

Single-ended fault location with parallel line compensation

- To assign the feeders of the double-circuit line, use the fields marked **Feeder 1** and **Feeder 2**.
- In order to carry out the compensation, both feeders must be assigned.
- If a single-ended fault location without compensation shall be carried out, select the option **No** in **Double-circuit line** and then assign the **Left feeder** only.
- Both feeders of the double-circuit line must be installed at the same substation and they must be part of the same network.

Assigning a substation element (feeder or busbar) to a device or a device component

- In the **Device configuration** view, you can very flexibly assign devices and device components to your substation elements.
- The following devices can be assigned as an entity:
  - SIMEAS Q
  - Protection devices
  - COMTRADE archive
- You can assign the following device components:
  - DAU (only with OSCILLOSTORE)
  - Channel group (only with SIMEAS R and SIMEAS R-PMU)
  - Channel
- Several devices or device components can be assigned to a substation element, e.g., one for fault location and another for PowerQuality evaluation.
- If you do not want to assign a complete channel group to a feeder but want to assign the channels individually, you can use the **Device configuration** view.

2.2 Upgrading from an Older OSCOP P Version

When installing OSCOP P, all the data from your old OSCOP P database is transferred. The database including all configuration settings is converted automatically to the new format.

The fault locator configuration ("V2 diagnostics") of an old OSCOP P version is compatible to the PSD configurator.

The following configuration elements are transferred automatically from an old project:

- Device configuration
  The device parameters including the channel information are transferred one-to-one to the new project.
- Network configuration
  Networks in this form did not exist in OSCOP P so far, only indirectly as voltage levels. A network object is created for each individual voltage level in PSD. The name results from the voltage value, e.g., **110_kV**.
- Line configuration
  The lines and line parameters, especially the impedance values, are transferred automatically.
- Substation configuration
  Substations are transferred automatically.
- Feeder configuration
  The feeders are directly transferred from the old data; in contrast to previous OSCOP P versions, the feeders are not assigned directly to a substation but always via a busbar. The busbars required for this arrangement, that did not exist in the old project, are created automatically. The names are generated according to the pattern **Busbar1**, **Busbar2** etc.

After you have transferred an old project, check the configuration data that has been entered automatically and complete it insofar as this is necessary.

- Line sections
  Check whether the sections have been transferred correctly and in the correct order. Check all impedance values exactly and compare the values with your plant charts. The accuracy of the fault location calculation greatly depends on the correctness of the parameterized line impedances.
- Feeders
  Check the substation configuration and add missing parameters.
- Networks
  In the old configuration, networks did not yet exist as independent objects. When old data is transferred, the network objects are generated from the information on the voltage levels. If necessary, adapt the network structure to your specific network model.
- Assignments
  The assignments between the various device and substation components are transferred as far as possible. Check and complete all assignments.

Configuring a Power System

3

Contents

3.1 General

The OSCOP P module **Power System Description (PSD)** is used to configure and parameterize your power system. A correct parameterization is the prerequisite for precisely determining the fault location and the fault type.

The analysis is performed for faults in the high-voltage system (overhead lines, isolated lines) only. You can parameterize several line segments per line. When determining the fault location, the fault locator considers all parameterized line segments. The fault location is designed for solidly earthed systems.

The type of the currently detected line fault is determined automatically.

The fault location can be done either manually or automatically. For more information on how to set it, please refer to Chapter 4.

How to parameterize a fault location

This chapter explains the fault location by way of an example. A SIMEAS R is used as a device that provides fault records in this example.

Proceed as follows to perform the fault location:

- ❑ Configure the SIMEAS R (see Chapter 3.2).
- ❑ Configure and parameterize your power system (see Chapter 3.3).
- ❑ Parameterize the fault location (see Chapter 4).
- ❑ Perform the fault location manually (see Chapter 4).

More application examples for additional assistance can be found in Chapter 5.

Example

A simple example is used to describe the procedure in this chapter. The sample project contains all possible elements of a power system. In case of a real system, the number and combination of these elements can be different.

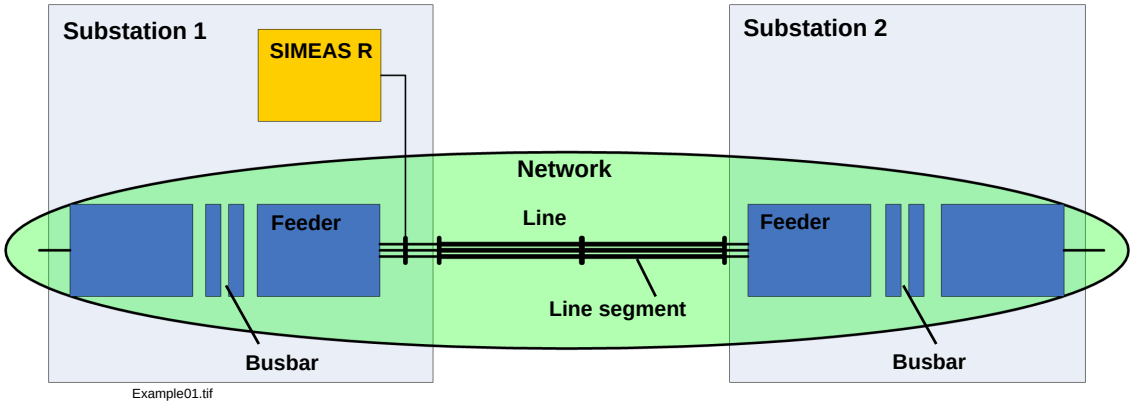


Figure 3-1 Example of a power system/network

The sample project contains

- two substations each with
- one busbar and
- one feeder as well as
- a high voltage line consisting of
- two line segments.
- A SIMEAS R is used as a device.

3.2 Creating and parameterizing a device

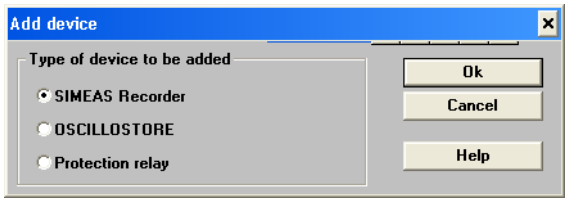
You must first create and parameterize a data source in OSCOP P, which is a SIMEAS R in this example.

This chapter describes how to create and parameterize a device only to the extent required for this example. A detailed description can be found in *OSCOP P 6.60, Manual /1/*

Add SIMEAS R

Proceed as follows to add a device:

- Start the OSCOP P module **Parameterize PC**.
- Select **Configure** → **Devices**.
  The **Configure device** dialog box is opened.
- Click **Add**. The **Add device** dialog box is opened.

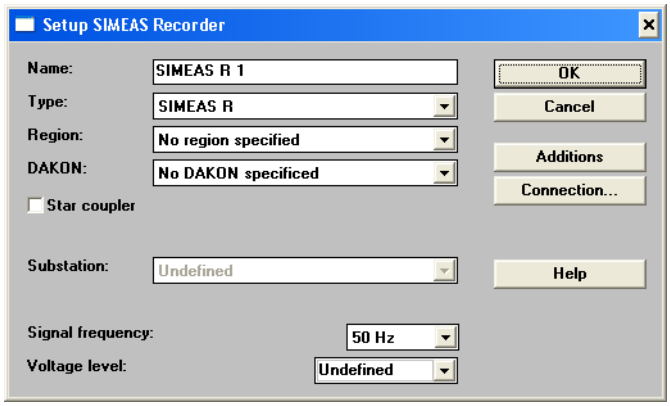


param02.tif

Figure 3-2 Dialog box "Add device"

- Activate **SIMEAS Recorder** and confirm with **OK**.

The **Set up SIMEAS Recorder** dialog box is opened.



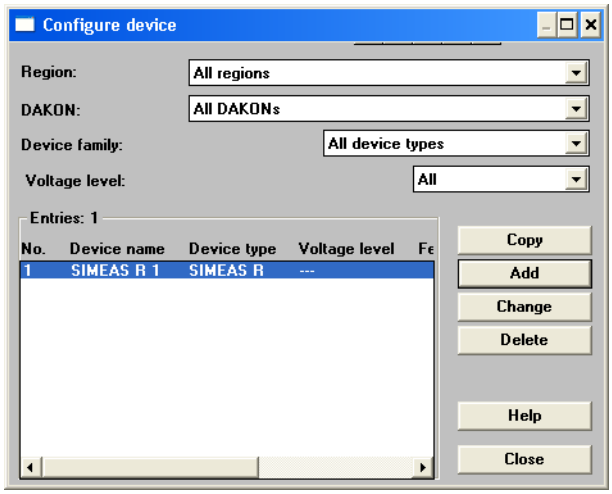
param03.tif

Figure 3-3 Dialog box "Set up SIMEAS Recorder"

- Enter a **Name** for the device.
- Select the **SIMEAS R** type.
- Set the **Signal frequency**.

The **Voltage level** is parameterized in the PSD configurator at a later point in time.

- Confirm your entries with **OK**.
  This returns you to the **Configure device** dialog box.



param04.tif

Figure 3-4 Dialog box "Configure device"

The SIMEAS R has been added.

- Close the dialog box by clicking Close.
- Exit the OSCOP P module **Parameterize PC**.

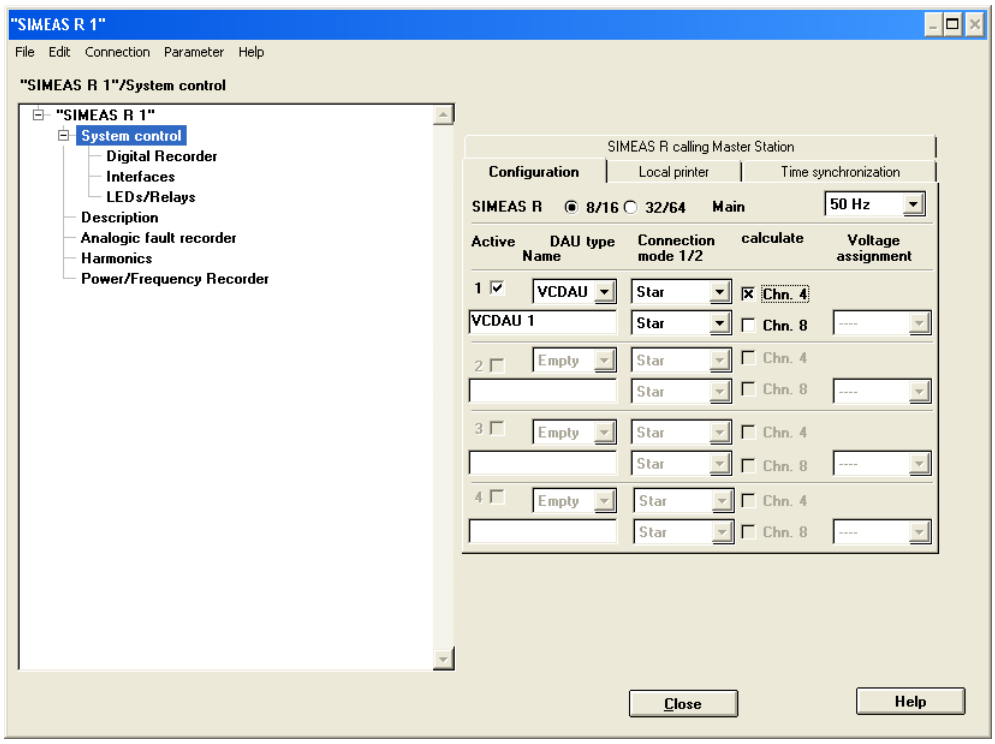
Parameterizing SIMEAS R

In practice, you would load the device settings from the device. For reasons of simplicity, the parameterization is performed directly in this example.

Proceed as follows to parameterize SIMEAS R:

- Start the OSCOP P module **Parameterize devices**.
- Select the **Device** → **Parameterize** menu item.
  The **Select device** dialog box is opened.
- Select the **SIMEAS R** created before and click **OK**.
- Select **No** in the next dialog box in order not to load parameters from the device.

This opens the dialog box where you can parameterize the SIMEAS R.



param05.tif

Figure 3-5 Dialog box "Parameterize SIMEAS R"

SIMEAS R must measure at least 3 voltage and 3 current channels as it is possible with, e. g., a VCDAU.

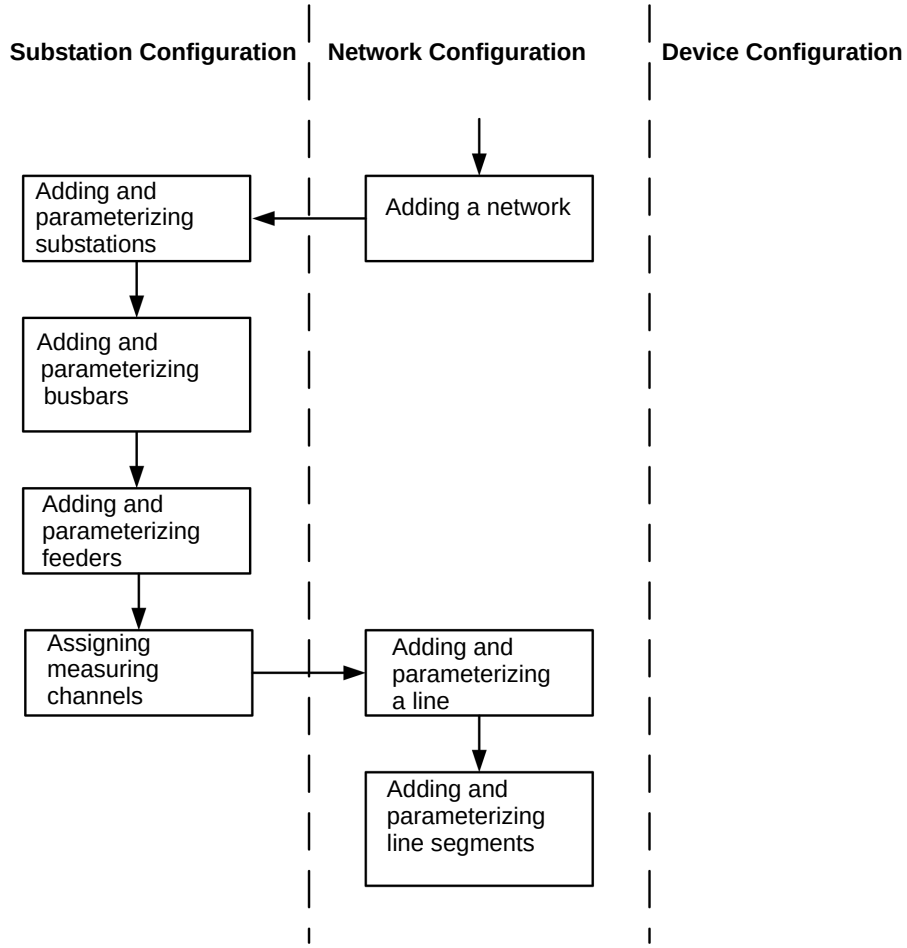
- Select the **System control** level in the left pane.
- Activate one **VCDAU** module in the **Configuration** tab.
- Proceed with other settings. For more information, please refer to *SIMEAS R, Digital Fault and Power Quality Recorder, Manual /4/*.

3.3 Configuring and parameterizing a power system

Overview

You configure and parameterize your power system mainly in the **Substation Configuration** view.
The configuration is completed in the **Network Configuration** view.

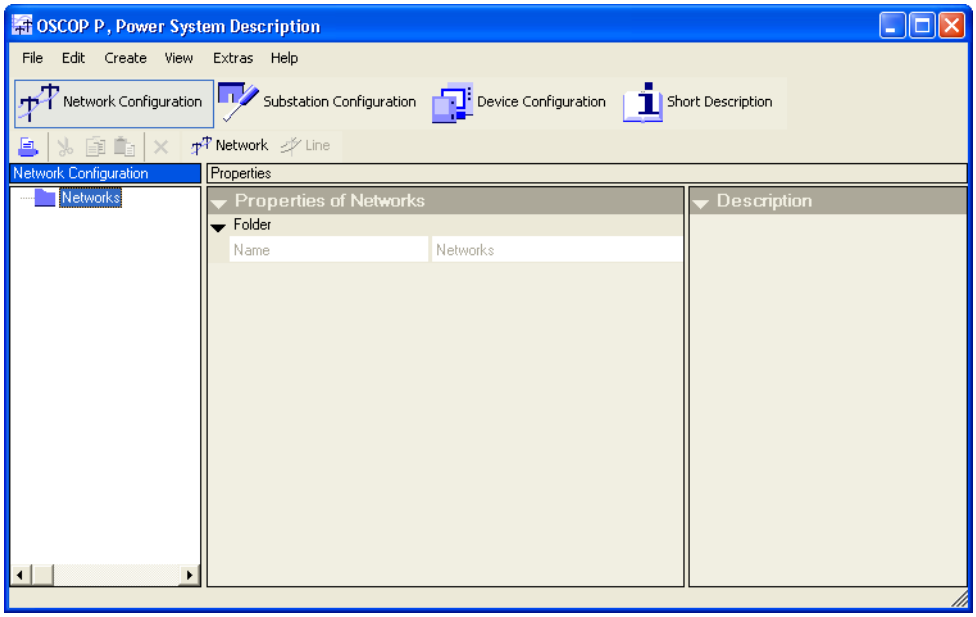
The figure below shows how to configure the substation using PSD.



proceeding.tif

Adding and parameterizing a network

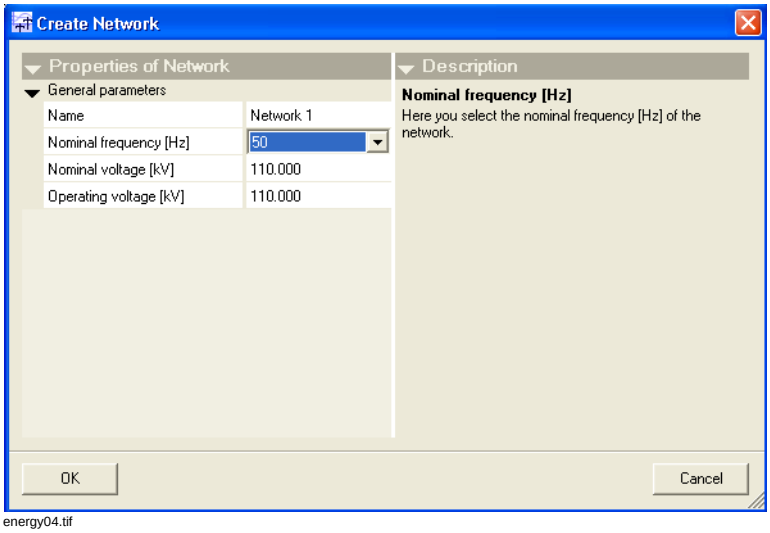
- Start the OSCOP P module **Power System Description** (PSD).
- Select the **Network Configuration** view.



energy01.tif

Figure 3-6 Power System Description, Network Configuration

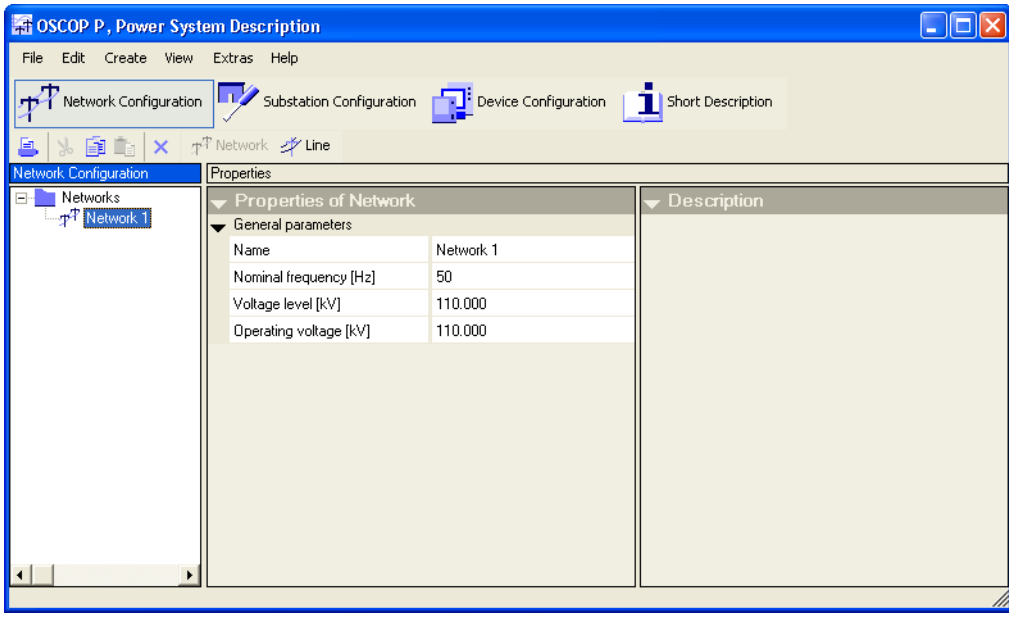
- Select **Networks** in the left pane.
- Select the **Create** → **Network** menu item.
  The **Create Network** dialog box is opened.
- Enter a **Name** for the network.
- Specify the **Nominal frequency**, **Nominal voltage** and **Operating voltage**.



energy04.tif

Figure 3-7 Power System Description, parameterizing a network

- Click **OK** to close the dialog box.
  The added network is displayed.



energy02.tif

Figure 3-8 Parameterizing a network

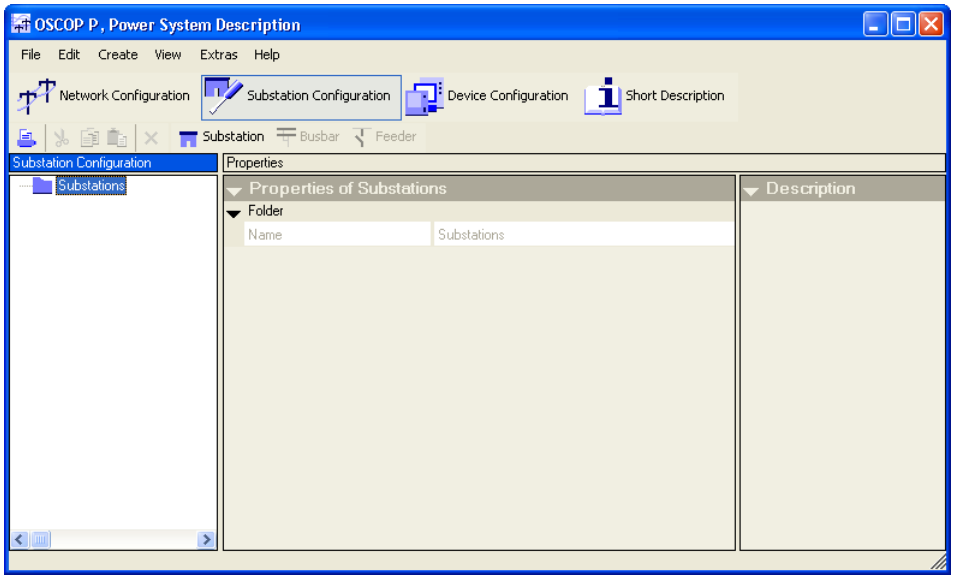
You can also change the parameters in the right pane subsequently.

View "Substation Configuration"

In the view **Substation configuration,** add substations, busbars and feeders as elements.

Adding substations

- Select the **Substation Configuration** view.



topo01.tif

Figure 3-9 Power System Description, Substation Configuration

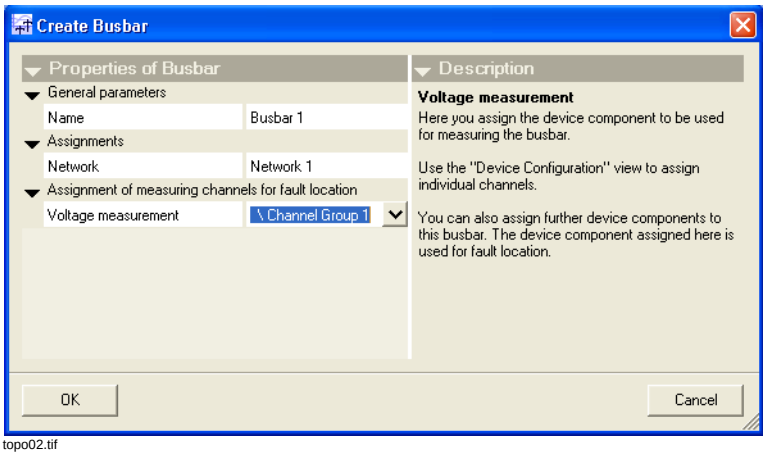
- Select the menu item **Create** → **Substation**.
  The dialog box **Create substation** is displayed.
- Enter the name of the **substation** (e. g. Substation 1).
- Close the dialog box with **OK**.
  The new substation is created and displayed under **Substation configuration**.
- Add a second substation (e. g., Substation 2).

Adding and parameterizing busbars

Note

Each busbar must be assigned to a network. If the network does not yet exist, you must create it in the network configuration view before adding the busbar.

- Select a substation (e. g., Substation 1) you have added.
- Select the **Create** → **Busbar** menu item.
  The **Create Busbar** dialog box is opened.



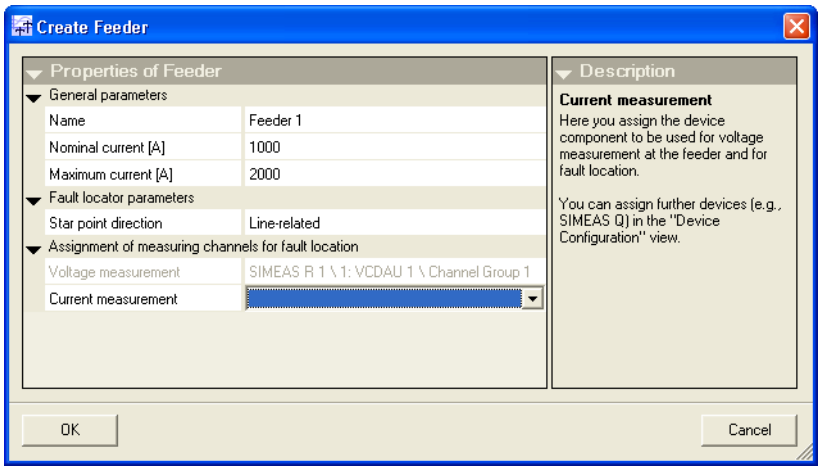
topo02.tif

Figure 3-10 Power System Description, parameterizing a busbar

- Enter a **Name** (e. g., Busbar 1) for the busbar.
- Select the network you have added before under **Assignments**.
- Select the device component for voltage measurement under **Assignment of measuring channels for fault location**.
- Confirm by clicking **OK**. The busbar is added.
- Add a busbar for the second substation (e. g., Busbar 2) and also assign it to the network.

Adding and parameterizing feeders

- Select the busbar (e. g., Busbar 1) that you have added.
- Select the **Create** → **Feeder** menu item.
  The **Create Feeder** dialog box is opened.

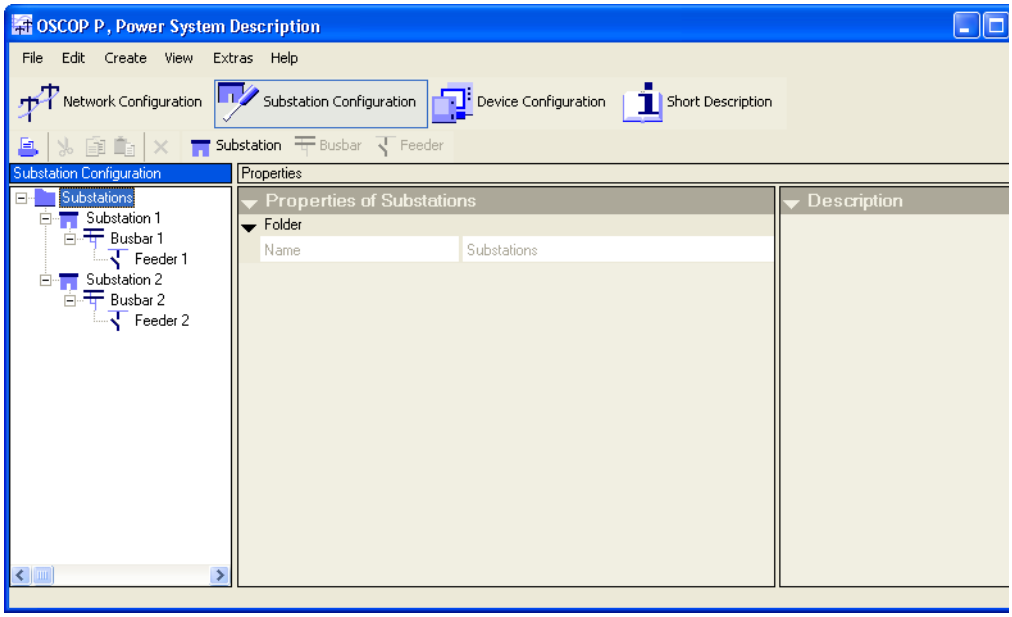


topo03.tif

Figure 3-11 Power System Description, parameterizing a feeder

- Enter a **Name** (e. g., Feeder 1) for the feeder.
- Enter further parameters under **General parameters**.
- In the right pane, click inside the **Current measurement** input box under **Assignment of measuring channels for fault location**. A selection box is opened.
- Assign a channel group (e.g. Channel group 2) to the current measurement as well.
- Add a feeder for the second substation (e. g., Feeder 2).

You can also view the assignment of measuring channels in the **Device Configuration** view.



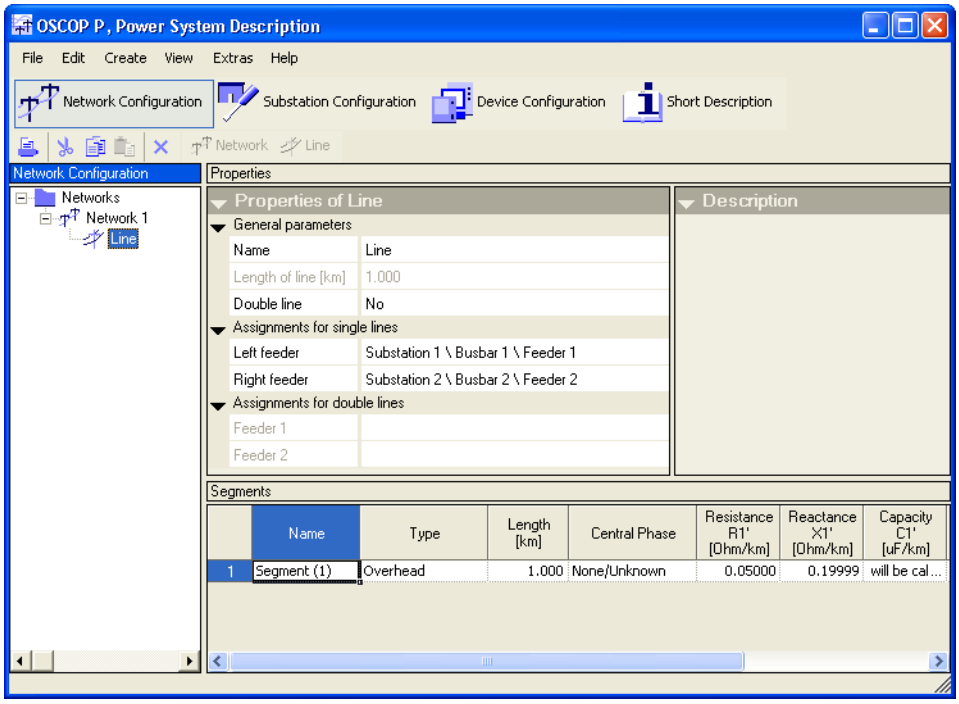
topo04.tif

Figure 3-12 Power System Description, Substation Configuration

In the left pane under **Substation configuration,** the configured power system is now displayed.

Adding and parameterizing a line

- Select the **Network Configuration** view.
- Select the added network under **Network configuration**.
- Select the menu item **Create → Line**.
  The dialog box **Create line** is opened.
- Confirm by clicking **OK**.
  The new line is created and displayed under **Network configuration**.

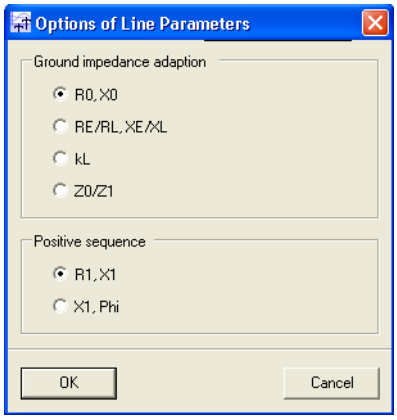


energy03.tif

Figure 3-13 Power System Description, parameterizing a line

- Select the left (e. g., Feeder 1) and the right feeder (e. g., Feeder 2) under **Assignments**.

- Use **Extras** → **Options** to open the dialog box.
  Data entry format for line parameters.



energy06.tif

Figure 3-14 Power System Description, data entry format for line parameters

Note

The selection of **R1, X1** for the positive sequence and of **R0, X0** for earth impedance compensation results in the highest accuracy of the fault location calculation.

- Select the data entry format that matches the existing data.
  You can change the data entry format any time. The entries already made are then converted to the new format.

Adding and parameterizing a line segment

- Select the line you have added in the left pane.
- Parameterize the created **Segment (1)** under **Segments** (see table below).

Note

The segment in the **first** line of the list is the segment at the left feeder. The segment in the **last** line is the segment at the right feeder.

You can enter the capacities manually or have them calculated automatically.

The capacity is calculated from the reactance (See Chapter A).

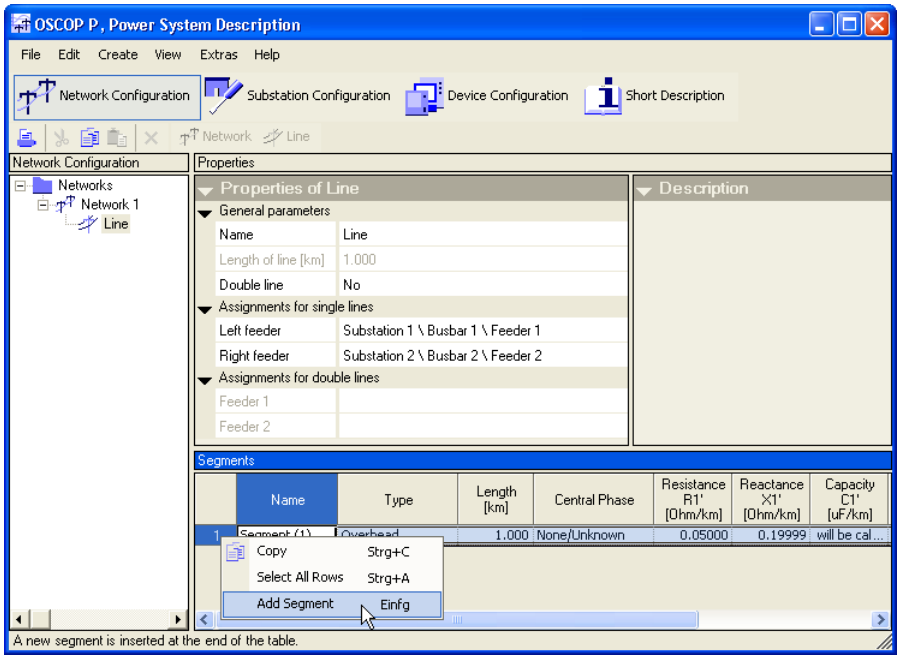
- Right-click inside the input box and select **will be calculated** for the capacity value to be calculated automatically.

All the possible parameters are listed in the table. Depending on the selected input format (see Fig. 3-14), the relevant parameters are subject to configuration.

Field	Definition
Name	Name of the line segment.
Type	Type of the segment. You can enter **Overhead line**, **Three-phase cable** or **Single-phase cable** here.
Length	Length of the line segment in km or miles (depending on the setting in the Parameterize PC module)
Central phase	Phase in the middle of the phase arrangement In case of twisted lines, **None/ Unknown** must be set here.
Resistance R_1'	Ohmic resistance (positive sequence) in Ω/km or in Ω/mile
Reactance X_1'	Reactance (positive sequence) in Ω/km or in Ω/mile
Capacity C_1'	Capacity (positive sequence) in μF/km or in μF/mile C_1' equals the service capacity C_B'.
Resistance R_0'	Ohmic resistance (zero sequence) in Ω/km or in Ω/mile
Reactance X_0'	Reactance (zero sequence) in Ω/km or in Ω/mile
Capacity C_0'	Capacity (zero sequence) in μF/km or in μF/mile
Angle Phi	Angle between R_1 and X_1 (positive sequence) in degrees
R_E/R_L	Ratio of resistances R_E = resistance (earth), R_L= resistance (line)
X_E/X_L	Ratio of reactances X_E = reactance (earth), X_L= reactance (line)
k_L absolute value	Absolute value of the ratio of impedances, Z_E/Z_1 (Z_E = absolute value of earth impedance, Z_1= absolute value of positive sequence impedance) k_L corresponds to the k_0 parameter
k_L angle	Angle between the impedances $\underline{Z}_E$ and $\underline{Z}_1$ in degrees k_L corresponds to the k_0 parameter
Z_0/Z_1 absolute value	Absolute value of the ratio of impedances, Z_0/Z_1 (Z_0 = absolute value of zero sequence impedance, Z_1= absolute value of positive sequence impedance)
Z_0/Z_1 angle	Angle between the impedances $\underline{Z}_0$ and $\underline{Z}_1$ in degrees
RM/RL	Parallel line coupling RM = resistance (coupling impedance), RL = resistance (line)
XM/XL	Parallel line coupling XM = reactance (coupling impedance), XL = reactance (line)

The lengths (also applies to absolute values) can be entered either in **km** or **miles** (see Chapter 1.2.4).

For more information on these terms and equations, please refer to Chapter A



energy05.tif

Figure 3-15 Power System Description, adding a segment

- Add the second segment (e.g. Segment (2)) and parameterize it.

The configuration of your power system is complete now. Information on how to perform the fault location can be found in Chapter 4.

Performing a Fault Location

4

Contents

4.1 Performing a fault location

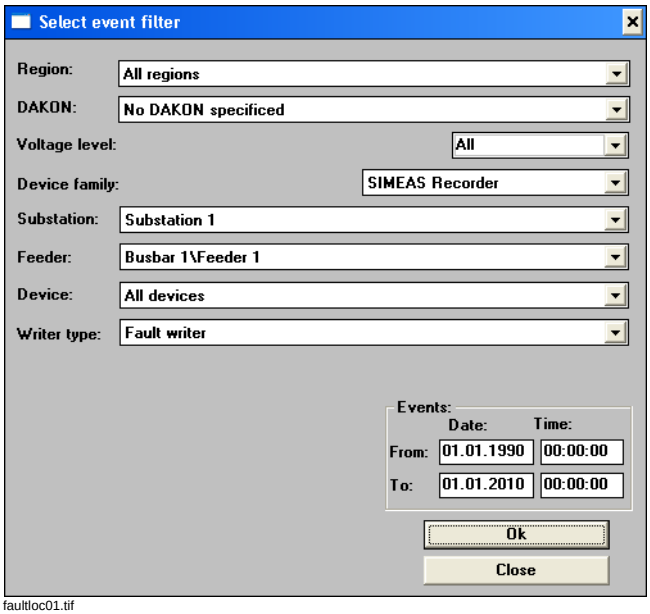
A fault location can be performed either manually or automatically.

Manual fault location

To be able to perform the fault location manually, you must first exit the automatic mode (if activated).

The fault location can be performed after a fault event (fault record) has been transferred. You must select the fault event for the fault location as described below.
Open the OSCOP P module **Transfer**.

- Select the **File** → **Edit events** menu item. The **Select event filter** dialog box is opened.

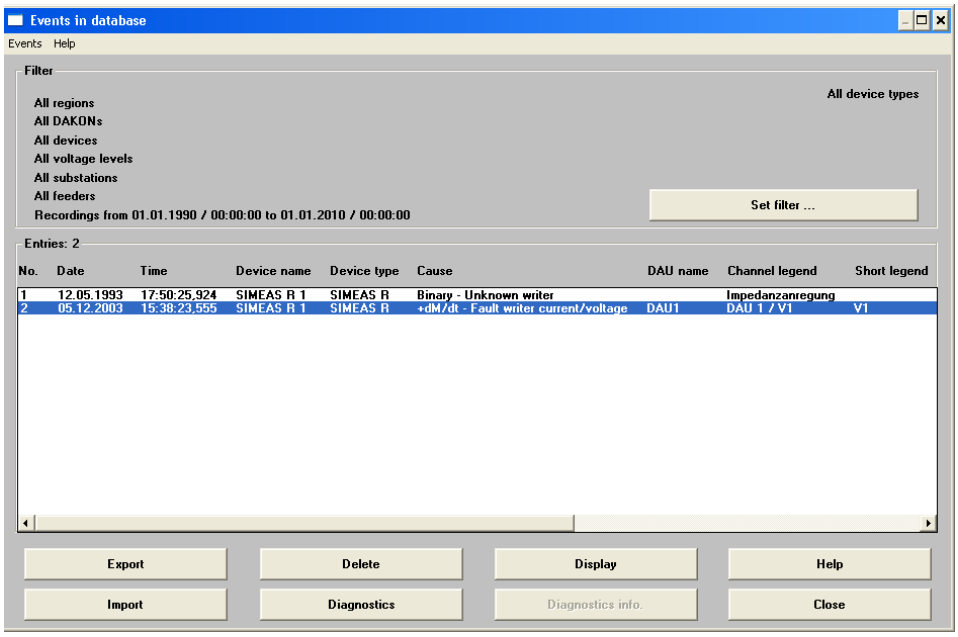


faultloc01.tif

Figure 4-1 Parameterizing event filters

- Select the filter criteria from the drop-down lists.
- Confirm by clicking **OK**.

The events selected via the event filter are displayed in the **Events in database** dialog box.

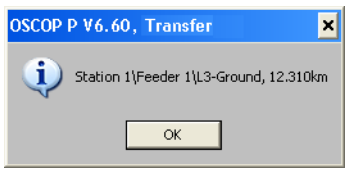


faultloc02.tif

Figure 4-2 Event display

- Select the event you want to analyse in the **Events in database** dialog box.
- Click the **Diagnosis** button. This starts the fault location (diagnosis).

All events related to this fault are used for fault location. There may be one, two or more events. The criteria are as follows: the fault event must be related to the same line and the same time interval (within 60 seconds).



faultloc03.tif

Figure 4-3 Result, short information

After the fault location has been completed, a short message is displayed. It contains the most important information on the result: substation/ feeder, cause and distance.

- Close the message with **OK**.

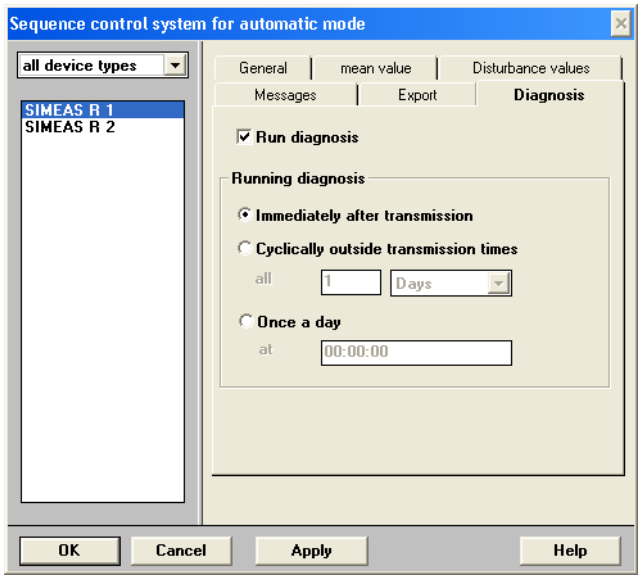
The detailed result of the fault location can be viewed and printed out (see Chapter 4.2).

Automatic fault location

The fault location can be performed automatically if OSCOP P is in the **Automatic mode**. The fault location result can be viewed in the **Events in database** window (Transfer OSCOP P module).

How to activate automatic fault location:

- Select the **Settings** → **Automatic mode** → **Sequence control system** menu item in the OSCOP P module **Transfer**.
- Select the **Diagnosis** tab.
- Select one or several devices.
- Activate the **Run diagnosis** option.



faultloc00.tif

Figure 4-4 Parameterizing the automatic fault location

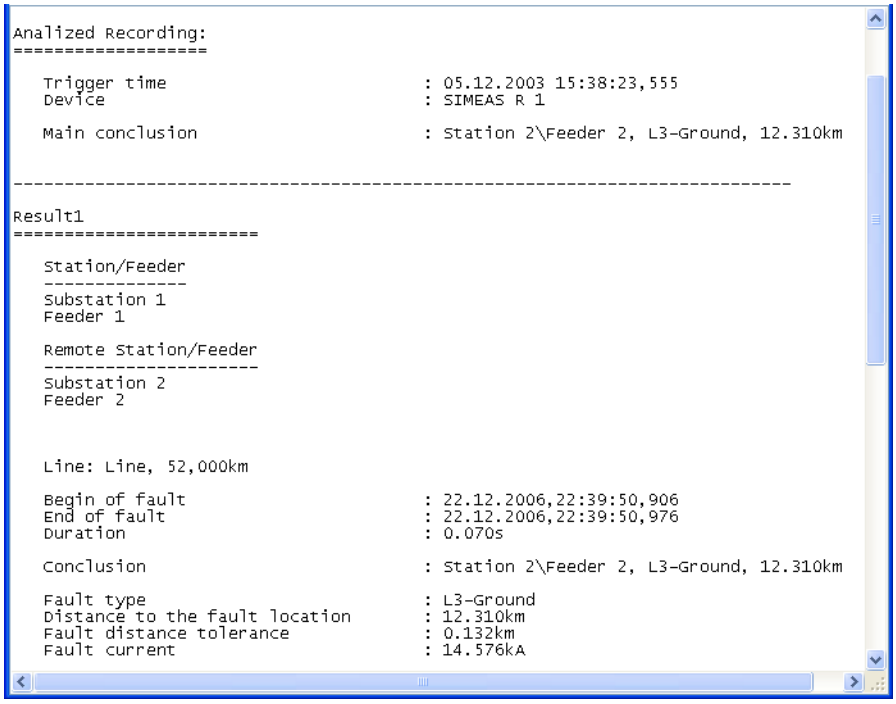
- Select the desired time interval of the diagnosis under **Running diagnosis**. These settings can only be made if the **Run diagnosis** option is selected.
- Confirm by clicking **OK**.

More information on the automatic mode can be found in the document *OSCOP P 6.60, Manual /1/*.

4.2 Viewing the calculation result

Proceed as follows to view the detailed result of the fault location:

- Select the event for which the fault location has been performed in the **Events in database** dialog box.
- Click the **Diagnostics info.** button. The result of the fault location is displayed.



```
Analized Recording:
===================

   Trigger time                          : 05.12.2003 15:38:23,555
   Device                                : SIMEAS R 1

   Main conclusion                       : Station 2\Feeder 2, L3-Ground, 12.310km


------------------------------------------------------------------------------

Result1
=======================

   Station/Feeder
   --------------
   Substation 1
   Feeder 1

   Remote Station/Feeder
   ---------------------
   Substation 2
   Feeder 2


   Line: Line, 52,000km

   Begin of fault                        : 22.12.2006,22:39:50,906
   End of fault                          : 22.12.2006,22:39:50,976
   Duration                              : 0.070s

   Conclusion                            : Station 2\Feeder 2, L3-Ground, 12.310km

   Fault type                            : L3-Ground
   Distance to the fault location        : 12.310km
   Fault distance tolerance              : 0.132km
   Fault current                         : 14.576kA
```

faultloc04.tif

Figure 4-5 Extract from the result file

The result file contains all the data related to the fault.

The result of the fault location can be viewed, edited and printed out.

Fault Location - Examples

5

Contents

This chapter explains the fault location by way of an example. The fault records required for the example in Chapter 5.1 can be found on the installation CD.

5.1 Two-ended fault location on a single-circuit line

The fault records available on the installation CD (directory\OSCOP\Example) are in the COMTRADE format. You can perform, for example, a two-ended fault location using these files. To do so, copy the fault records to the hard disk of your evaluation PC and carry out the steps described below.

The configuration and parameterization must be carried out exactly as described. Otherwise, fault location will give incorrect results.

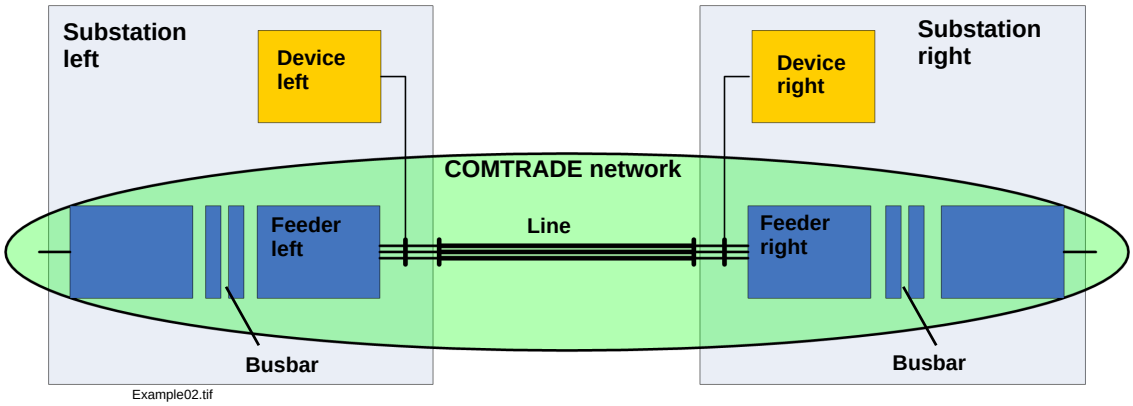


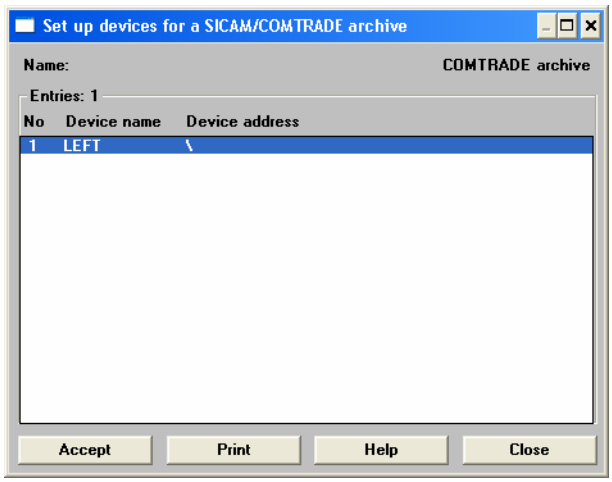
Figure 5-1 Example of a power system/network

The sample project includes

- ❑ two substations each with
- ❑ one busbar and
- ❑ one feeder as well as
- ❑ a high voltage line consisting of
- ❑ a line segment and
- ❑ two devices.

Parameterize PC

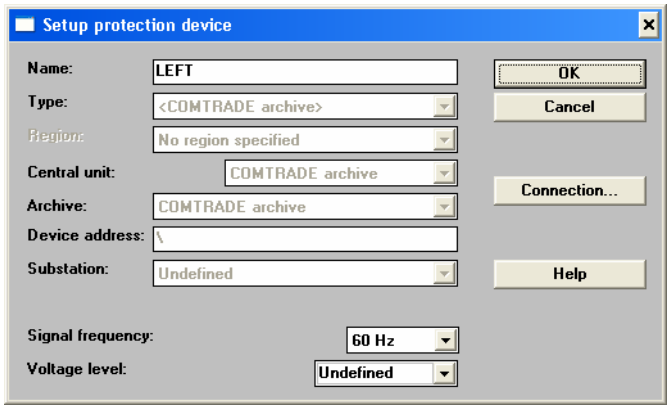
- Start the OSCOP P module **Parameterize PC**.
- Select the **Configuration** → **DAKONs** menu item.
  The **Configure DAKON/LSA** dialog box opens.
- Select the **COMTRADE Archive** type from the drop-down list of the **Type** field.
- Click **Add**. The **Set DAKON/LSA parameters** dialog box opens.
- Click **Select**.
- Select the directory in which the COMTRADE archive is located and click **OK**.
- Click the **Device list** button in the **Set DAKON/LSA parameters** dialog box. The **Set up devices for a SICAM/COMTRADE archive** dialog box opens.



example51.tif

Figure 5-2 Set up devices for a SICAM/COMTRADE archive

- Select **Left** and click **Accept**.
  This opens the dialog box Setup protection device.



example52.tif

Figure 5-3 Setting a signal frequency

- Set the **Signal frequency** to **60 Hz**.

All other parameters may remain unchanged. The **Substation** and the **Voltage level** is parameterized in PSD at a later point in time.

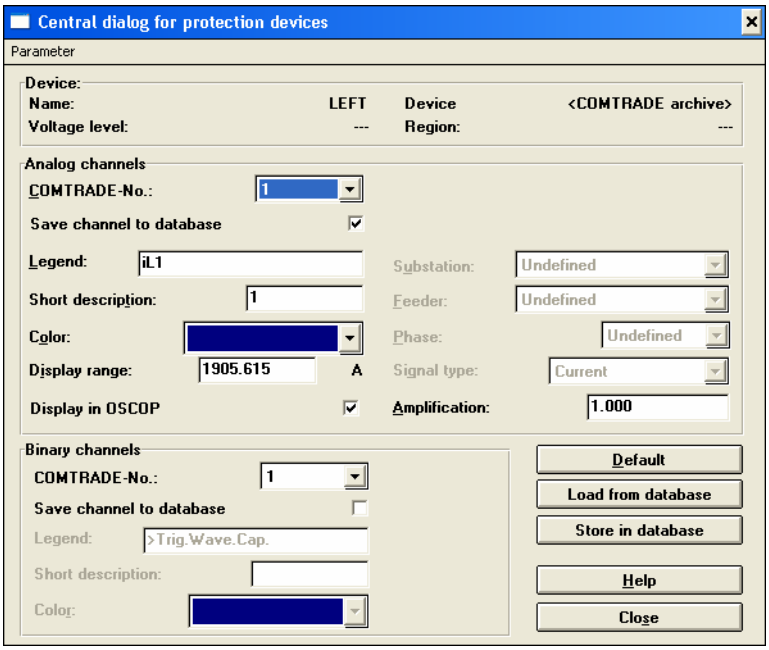
- Click **OK** to close the dialog box.
- Proceed in the same way for **Right**.

Thus, the parameterization in the OSCOP P module **Parameterize PC** is finished.

- Close all dialog boxes with **OK**/**Close** and exit **Parameterize PC**.

Device parameterization

- Start the OSCOP P module **Parameterize devices**.
- Select the **Device** → **Parameterize** menu item.
  The **Select device** dialog box opens.
- Select the device **Left** and click **OK**.
  The **Central dialog box for protection devices** dialog box opens.



example53.tif

Figure 5-4 Assignment of analog channels

Create the analog channels 1 to 8 in this dialog box.

- Select the channel number from the drop-down list of the **COMTRADE-No.** box.
- Activate **Save channel to database**.

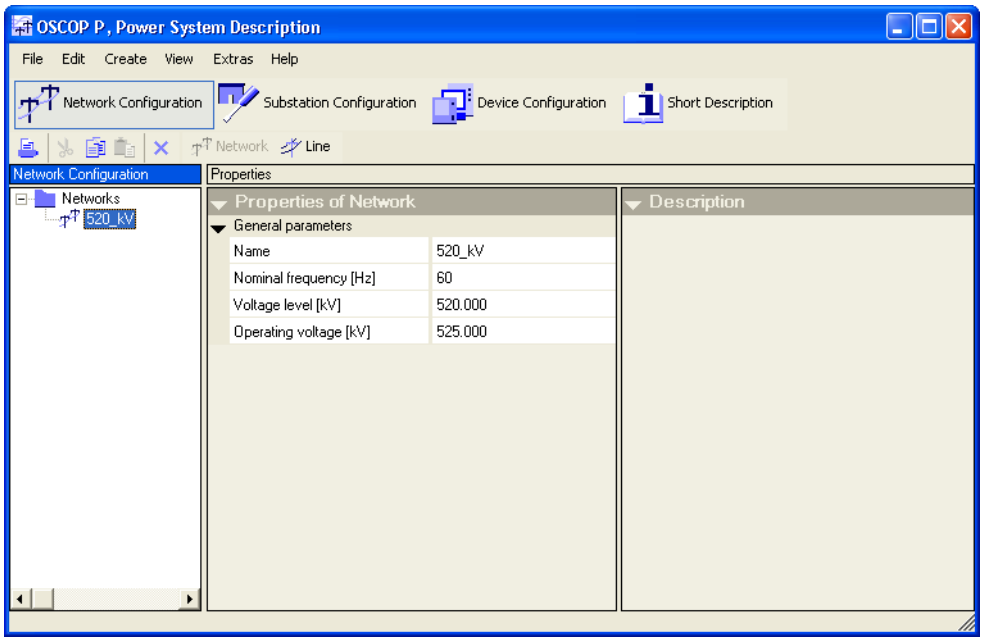
The assignment of **Comtrade-No.** to **Phase** is performed automatically and cannot be changed here. The assignment can be changed in the OSCOP P module **PSD**.

No further settings need to be changed in this dialog box.

- Save the settings in the database and close the dialog box.
- Make the same settings for the device **Right**.
- Exit **Parameterize devices**.

Creating a network

- Start the OSCOP P module **Power System Description** (PSD).
- Select the **Network Configuration** view.
- Create a network with the name **520_kV**, nominal frequency of **60 Hz**, voltage level of **520 kV** and operating voltage of **525 kV**.

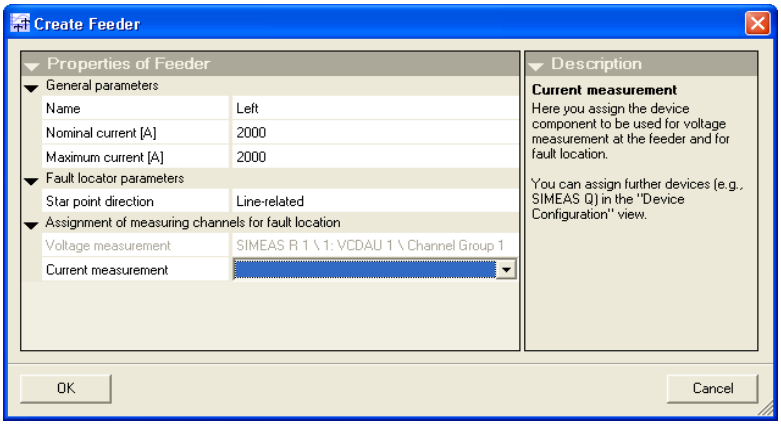


example54.tif

Figure 5-5 Creating a network

Configuring a substation

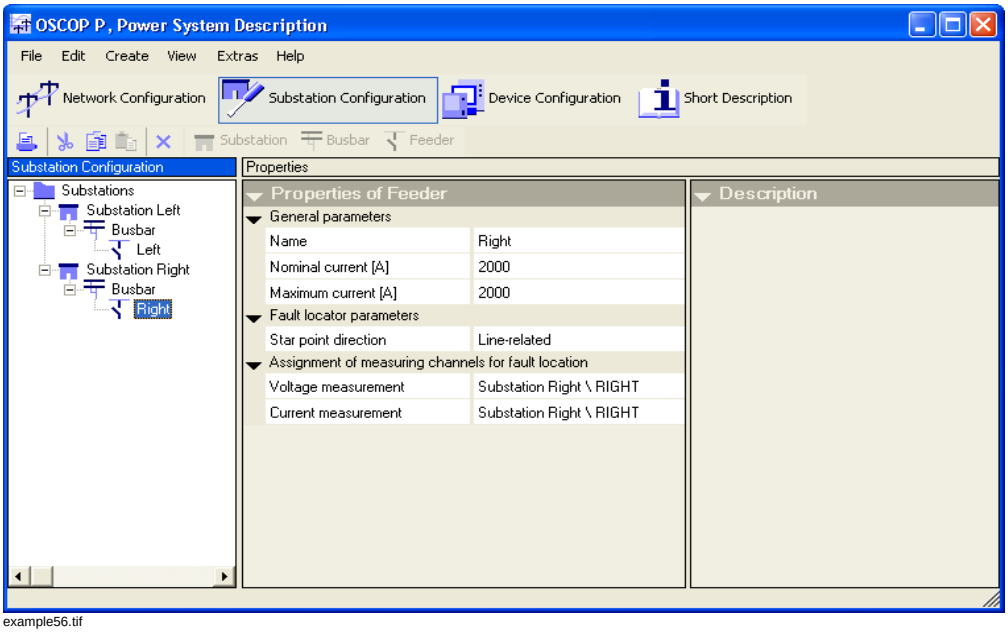
- Select the **Substation Configuration** view.
- Create a substation with the name **Substation Left**.
- Create a busbar with the name **Busbar**.
- Assign the busbar to the **520_kV** network.
- Create a feeder with the name **Left**, nominal current of **2000 A** and a maximum load current of **2000 A**.



example55.tif

Figure 5-6 Creating a feeder

- Select the device **LEFT** under **Assignment of measuring channels for fault location** to measure voltage.
  The current measurement is assigned to the same device automatically.
- Create the second substation with the name **Substation Right**.
- Create a busbar with the name **Busbar** and the **520_kV** assignment for this substation as well.
- Create a feeder with the name **Right**, nominal current of **2000 A** and a maximum load current of **2000 A**.
- Select the device **RIGHT** under **Assignment of measuring channels for fault location** to measure voltage.
  The current measurement is assigned to the same device automatically.



example56.tif

Figure 5-7 Substation Configuration

Channel parameterization

Now, the channels must be assigned.

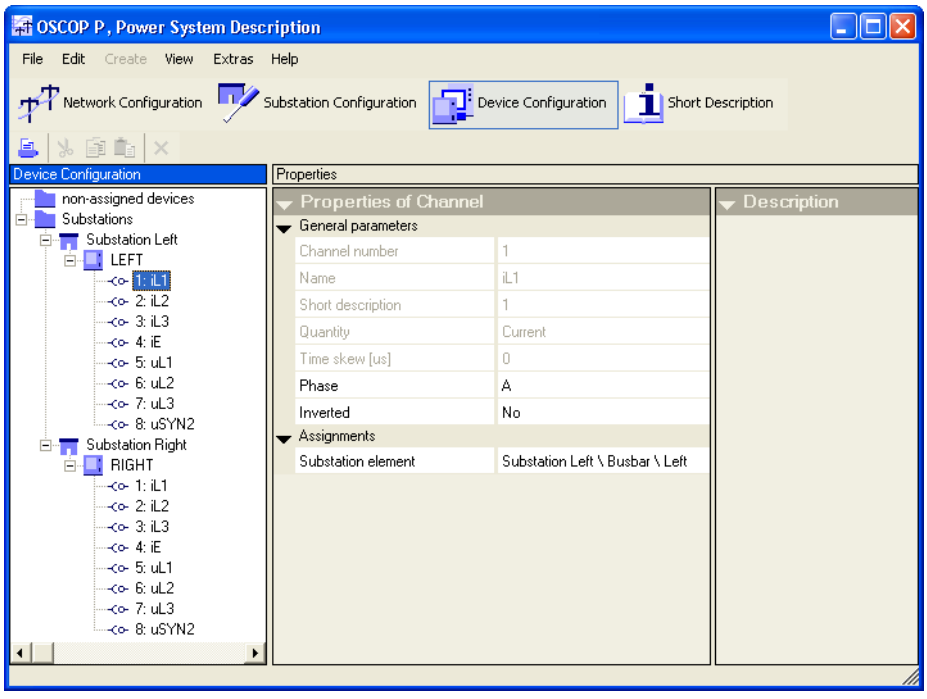
- Select the view **Device Configuration**.

The devices created in the OSCOP P module **Parameterize PC** are displayed.

- Select a channel under **Device configuration**.
  The properties of the channel are displayed.
- Assign the corresponding **Phase** to the channel.

This assignment must be done for all channels and for both devices (see Table).

Channel	Phase
1	A
2	B
3	C
4	N
5	A
6	B
7	C
8	Undefined



example57a.tif

Figure 5-8 Channel assignment

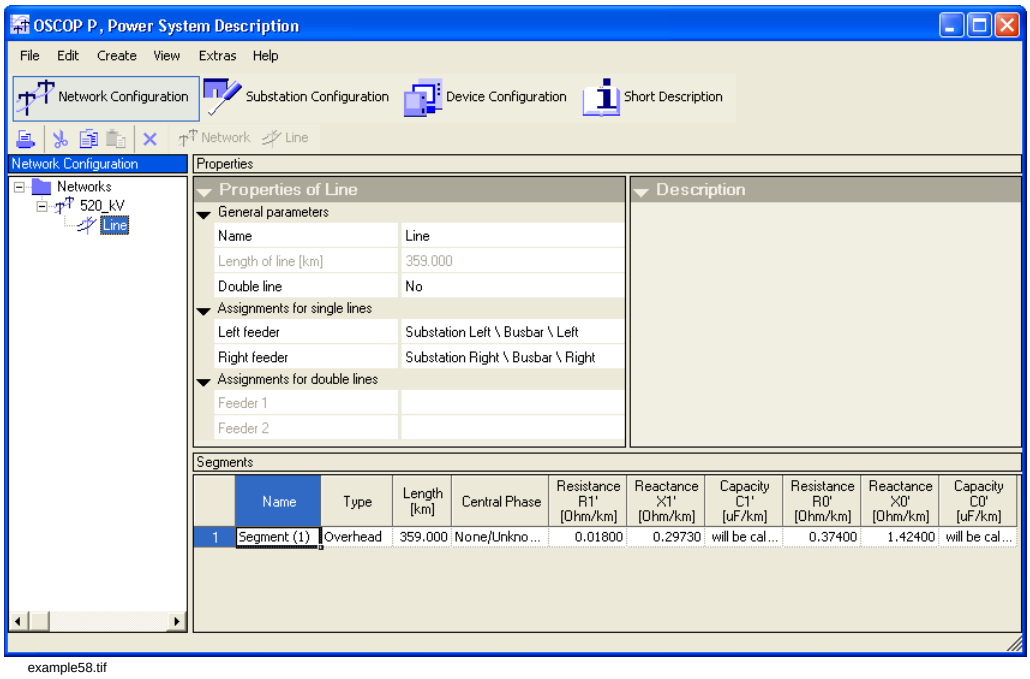
Creating and assigning a line

- Select the **Network Configuration** view.
- Create a line with the name **Line** and parameterize the line segment as follows:

Parameters	Setting
Type	Overhead line
Length	359 km
Central phase	None/Unknown
Resistance R1’	0.018 Ω/km
Reactance X1’	0.2973 Ω/km
Capacity C1’	will be calculated
Resistance R0’	0.374 Ω/km
Reactance X0’	1.424 Ω/km
Capacity C0’	will be calculated

Note

The line parameters used in the example are theoretically determined values. In practice, it may happen that the exact values are unknown. This especially applies to the earth impedance (R0’, X0’).
The less accurate the values, the less accurate the result of the fault location.



example58.tif

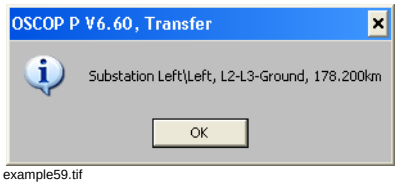
Figure 5-9 Network configuration with the parameterized line

- Assign the feeder under **Assignments**.

The configuration and parameterization of the power system is complete now. The fault location can be performed.

Performing a fault location

- Start the OSCOP P module **Transfer**.
- Select the **Transfer** → **Manual mode** menu item.
  The **Select device** dialog box opens.
- Select the device **Left** and click **OK**.
  This opens the **Transfer from Left** dialog box.
- Select the entry and click **Accept**.
  The records are accepted.
- Close the dialog box.
- Accept the records of the device **Right** in the same way.
- Select the **File** → **Edit events** menu item.
  The **Select event filter** dialog box opens.
- Do not alter any settings and click **OK**.
  The **Events in database** dialog box opens. The two events are displayed.
- Select the event for the device **Left** and click **Diagnosis**.
  The fault location is performed and the result output.



example59.tif

Figure 5-10 Result message of the fault location

The calculated fault location is approx. in the middle of the overhead line, **178.2 km** away from the **Substation Left**.

Viewing the fault location result

- After the fault location has been performed, click in the **Events in database** dialog box on **Diagnostics info** to view the detailed results.

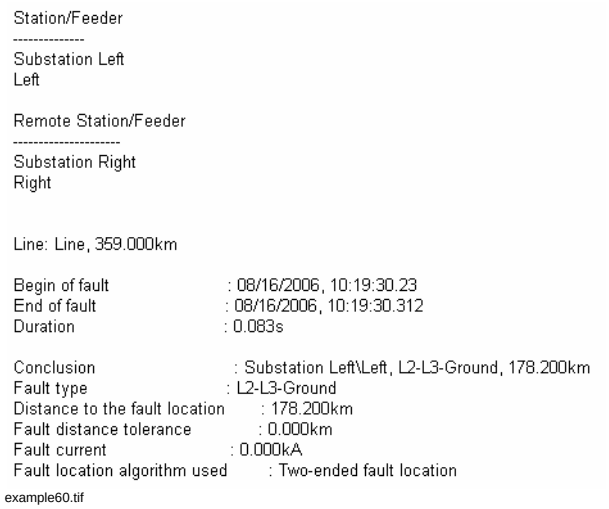


Figure 5-11 Extract from the diagnostics information

5.2 Fault location on a double-circuit line

In case of ground faults, the fault location provides a far more accurate result if the second line is considered for a double-circuit line.
In order to carry out parallel line compensation for a double-circuit line, additional values for the coupling must be provided (R_M/R_L, X_M/X_L). These values describe the influence of the parallel lines on each other.

On a double-circuit line, a single-sided fault location only is possible.

A double-circuit line can consist of several segments. The segmentation makes sense if the properties undergo significant changes along the line. This may be the case due to, e.g. a different soil type or a different tower system.

To calculate the fault location on a double-circuit line, the following prerequisites must be fulfilled:

- ❑ Both lines must be continuously carried by one tower system.
- ❑ Fault records of both lines are recorded by one device (SIMEAS R). The recording by means of two separate devices is possible under particular conditions (see below).
- ❑ All properties of the parallel lines (e.g. voltage level, impedance) must be identical.

The following must be considered while recording the fault event by means of two separate devices:

- ❑ Two SIMEAS R devices must be used.
- ❑ Simultaneous triggering (network triggers) of both devices must be ensured.
- ❑ Both devices must be time-synchronized.

Note

If a fault record is available from one device only, a fault location is also carried out. This is done, however, without parallel line compensation.

This example gives a picture of fault location on a double-circuit line. The necessary adjustment and configuration in the OSCOP P modules **Parameterize PC**, **Parameterize Devices** and **Transfer** are not described here. For the device SIMEAS R, two modules VCDAU must be parameterized. For further details please refer to the document *OSCOP P 6.60, Manual /1/*.

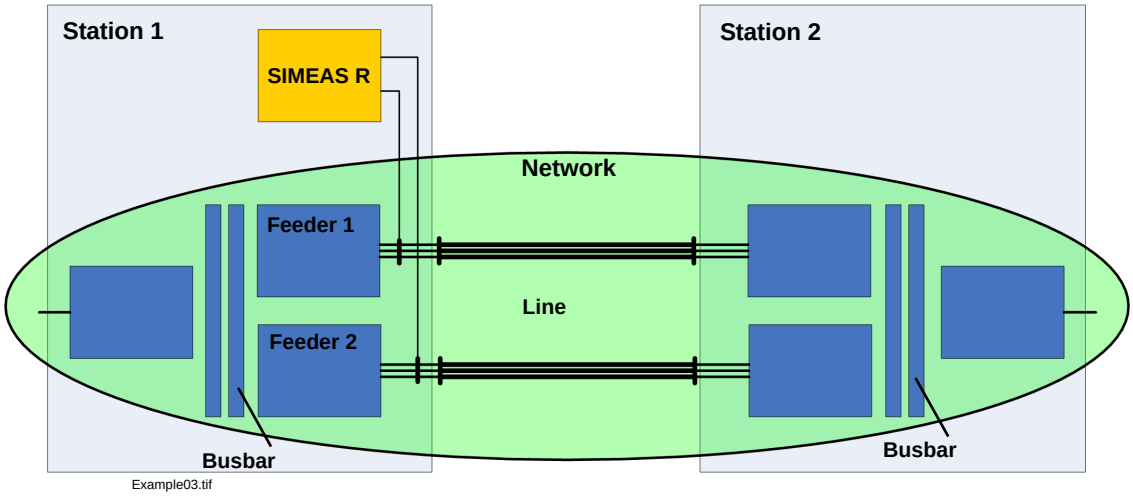


Figure 5-12 Example of a energy system/network with double-circuit

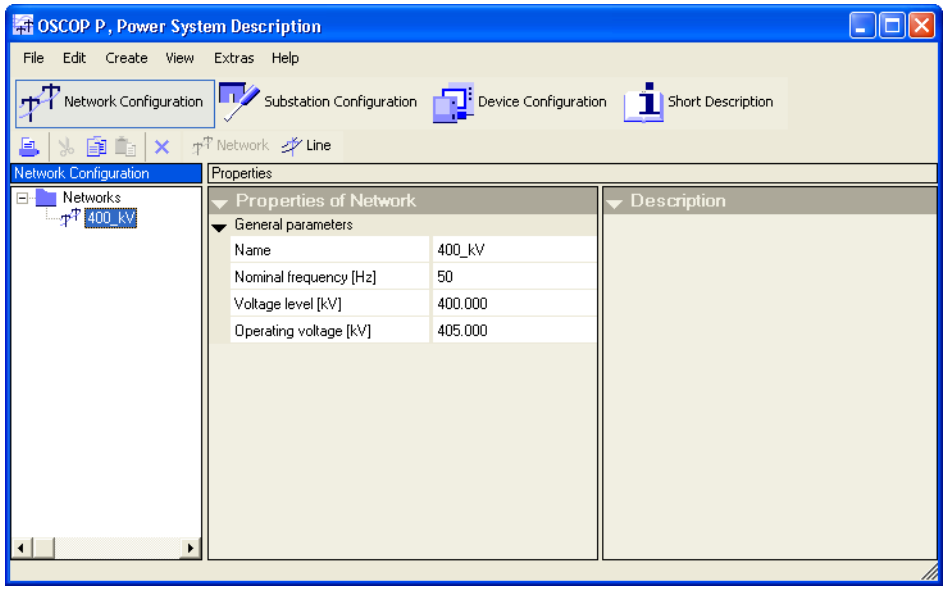
The demo project contains the following core components:

- a substation with
- a busbar and
- two feeders as well as
- a high-voltage line
- a SIMEAS R device

The line is of the double-circuit type. It consists of two parallel lines with identical properties. The line consists of one line segment only.

Creating a network

- Start the OSCOP P module **Power System Description** (PSD).
- Select the view **Network configuration**.
- Create a network and name it, e.g. **400_kV**.
- Parameterize **Nominal frequency**, **Voltage level** and **Operating voltage**.

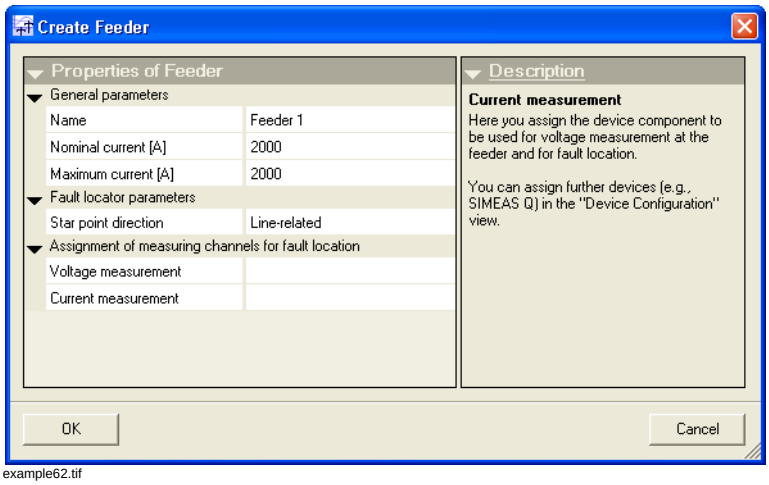


example61.tif

Figure 5-13 Creating a network

Configuration of a substation

- Select the view **Substation configuration**.
- Create a substation with the name **Substation 1**.
- Create a busbar with the name **Busbar**.
- Assign the busbar to the network.
- Create a feeder with the name **Feeder 1**.
- Parameterize **Nominal current** and **Maximum current**.

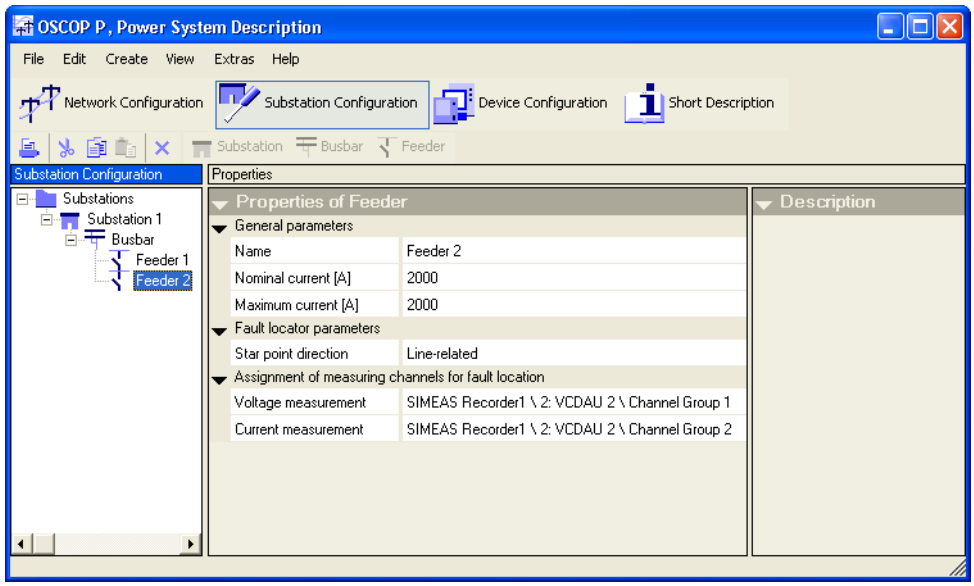


example62.tif

Figure 5-14 Creating a feeder

- Select the devices **VCDAU 1** under **Assignment of measuring channels for fault location** to measure voltage.
- To measure current, select the devices **VCDAU 1** as well.
- Confirm by clicking **OK**. The feeder is added.

- Create the second feeder with the name **Feeder 2** and parameterize it.
- Assign the devices **VCDAU 2** to this feeder.

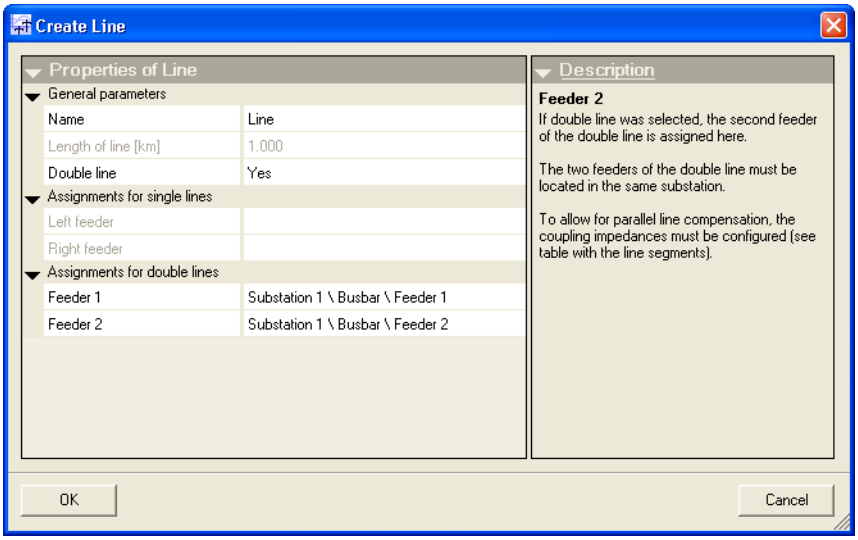


example63.tif

Figure 5-15 Substation configuration

Creating and assigning a line

- Select the view **Network configuration**.
- Select the inserted network under **Network configuration**.
- Select the menu item **Create → Line**.
- The dialog box **Create line** opens.
- Name the line **Line**.
- Parameterize the line as **Double-circuit line**.
- Assign the feeders to the line under **Assignments for the double-circuit lines**.



example63a.tif

Figure 5-16 Creating a line

- Confirm by clicking **OK**.
  The new line is created and displayed under **Network configuration**.

Entering and parameterization of the line segment

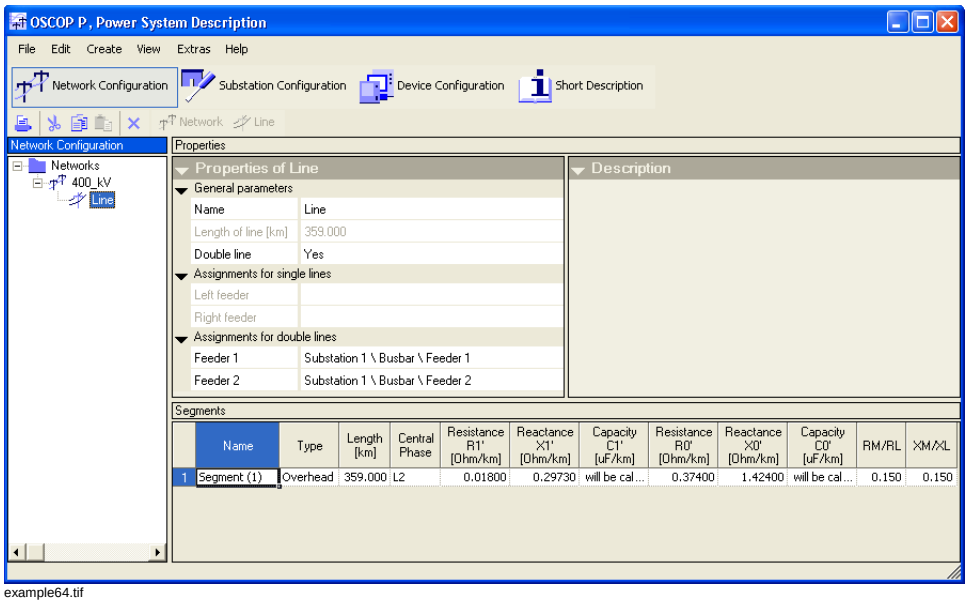
- Select the added line in the left pane.
- Parameterize the created **Segment (1)** under **Segments** (see table below).

Note

The segment in the **first** line of the list is the segment at the feeders. The segment in the **last** line is the segment at the end of the line.

The values given in the following table constitute realistic examples.

Parameter	Adjustment
Type	Overhead Line
Length	359 km
Centrale phase	L2
Resistance R1’	0.018 Ω/km
Reactance X1’	0.2973 Ω/km
Capacity C1’	will be calculated
Resistance R0’	0.374 Ω/km
Reactance X0’	1.424 Ω/km
Capacity C0’	will be calculated
RM/RL	0.15
XM/XL	0.15



example64.tif

Bild 5-17 Network configuration with a parameterized line

The configuration and parameterization of the power system has been completed.

Perform fault location

The fault location can be carried out analogously to example 1.

When using one device, one event per fault only is displayed in the dialog box **Events in database** of the module **Transfer**. Select this event and start the diagnosis.

The fault location is carried out.

When using two devices (one device for each feeder), two events per fault are displayed in the dialog box **Events in database** of the module **Transfer**. Select the event and start the diagnosis. The fault record of the second device is automatically included into the calculation of the fault location.

Appendix: Equation Symbols and Equations A

This chapter lists equation symbols and equations which are important for fault location calculation.

Contents

A.1 Equation symbols

R_0'	Ohmic resistance (zero sequence) in Ω/km
X_0'	Reactance (zero sequence) in Ω/km
C_0'	Capacity (zero sequence) in F/km
L_0'	Inductance (zero sequence) in H/km
R_1'	Ohmic resistance (positive sequence) in Ω/km
X_1'	Reactance (positive sequence) in Ω/km
C_1'	Capacity (positive sequence) in F/km
L_1'	Inductance (positive sequence) in H/km
Z_C	Characteristic impedance of the cable in Ω
R_E	Earth resistance in Ω
R_L	Resistance of the line in Ω
X_E	Earth reactance in Ω
X_L	Reactance of the line in Ω
$\underline{Z}_0$	Zero sequence impedance
$\underline{Z}_1$	Positive sequence impedance
$\underline{Z}_E$	Earth impedance
R_M	Resistance of the parallel line coupling in Ω
X_M	Reactance of the parallel line coupling in Ω

A.2 Equations

Equations for conversion of resistance/impedance values

$R_E / R_L = (R_0 / R_1 - 1) / 3$ Ratio of resistances

$X_E / X_L = (X_0 / X_1 - 1) / 3$ Ratio of reactances

$\underline{k}_L = \underline{Z}_E / \underline{Z}_1 = (\underline{Z}_0 / \underline{Z}_1 - 1) / 3$ Ratio of impedances

Capacity calculation C_1 and C_0

- Type = overhead line
  $C_1' = 1 / (L_1' * v^2)$ with v = 295,000 km/s
- Type = cable
  $C_1' = L_1' / Z_C^2 \approx L_1' / (50\ \Omega)^2$
- Type = overhead line
  $C_0' = 1 / (L_0' * v^2)$ with v = 220,000 km/s
- Type = 1-pole cable
  $C_0' = 0.6 * C_1'$
- Type = 3-pole cable
  $C_0' = C_1'$

Calculation of inductances L_1 and L_0

$L_1' = X_1' / 2\pi f$

$L_0' = X_0' / 2\pi f$

C_i', L_i' and X_i' are each to be considered as a quantity per unit length (F/km, H/km, Ω/km) in these equations.

Literature

/1/ OSCOP P 6.60, Manual
E50417-H1076-C170

/2/ SICARO PQ, Software for Analysis of Power System Quality, Application Description
E50417-H1076-C119

/3/ SIMEAS Q, Power Quality Recorder, Application Description
E50417-H1076-C072

/4/ SIMEAS R, Digital Fault and Power Quality Recorder, Manual
E50417-B1076-C209

/5/ SIPROTEC DIGSI 4, Start Up
E50417-G1176-C152

/6/ SIPROTEC 4, System Description
E50417-H1176-C151

/7/ Installation of DAKON XP, Application Description
E50417-X1074-C330

/8/ SIMEAS R-PMU, Manual
E50417-H1076-C360

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