Release Information – PSS®SINCAL Platform 18.5

This document describes the most important enhancements and changes to the new program version. See the product manuals for a more detailed description.

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General Remarks

Licensing

PSS SINCAL 18.5 Platform uses the same license file as the preceding PSS SINCAL 18.0 version. In order to activate the software, it is only necessary to assign the license file to the new version using the PSS Tool utility program.

If you need a new license file or have any questions about the licensing, please contact the **PSS SINCAL Platform Support** (phone +43 699 12364435, email sincal.support.it@siemens.com).

System Requirements

The following hardware and software requirements include the minimum requirements to operate an application of the PSS SINCAL Platform 18.5.

Hardware Requirements
PC or Notebook
CPU: x64, >= 2 GHz, MultiCore
RAM: >= 8 GB
Free hard disk space: >= 20 GB
Graphics card: >= 1920 x 1200, True Color
Operating Systems Supported
Windows 8
Windows 10
Windows 11
Windows Server 2008 R2
Windows Server 2012 R2
Windows Server 2016
Windows Server 2019
Database Systems Supported
SQLite 3.x
Microsoft Access
Oracle 9i
Oracle 10g
Oracle 11g
Oracle 12c
Oracle 19c
SQL Server 2008, SQL Server Express 2008
SQL Server 2008 R2, SQL Server Express 2008 R2
SQL Server 2012, SQL Server Express 2012
SQL Server 2014, SQL Server Express 2014
SQL Server 2016, SQL Server Express 2016
SQL Server 2017
SQL Server 2019

Example Networks

PSS SINCAL

With this product version new example networks are delivered. These illustrate the basic use of the product functions and can be used to test the various calculation modules.

The following new or extended example networks are available:

Network	Description
Example Energization	Investigation of electromagnetic transients at energization of lines and cables, transformers and other grid components in power system operation.
Example TDA	Example for automated check for thermal destruction for all lines and transformers in the network.

Models

Comprehensive descriptions of the models and how they can be used in the various PSS applications are available in the "Models" manual.

New Models

The following new models are available:

Model	Description
PV_WECC.xmac	New photovoltaic system (PV) model as defined by WECC in 2021. It has a modular structure containing the parts REPC_A, REEC_D, REGC_B. It represents the main properties and controls of balanced infeed from PV systems.
GASTD.xmac	Extension of GAST model by a deadband for speed deviation and optional reference for parameters and limits to #Trate.
HYGOVD.xmac	Extension of HYGOV model by a deadband for speed deviation and optional reference for parameters and limits to #Trate.
IEESGOD.xmac	Extension of IEESGO model by a deadband for speed deviation and optional reference for parameters and limits to #Trate.

Modified Models

The following models have been updated and documented:

Model	Description
IEESGO.xmac	The model IEESGO represents a simple steam turbine introduced by Siemens PTI and contains three turbine stages.

The following models have been updated:

Model	Description
BESS_WECC.xmac	Update of using #Fflag in plant control for active power control. Update of setting Qref in electrical control for different flag settings.
ESAC1A.xmac	Modification of signs in the model of field excitation.

Removed Models

The following model has been removed:

Model	Description
IEESGO.mac	Model is replaced by IEESGO.xmac with the same behavior.

PSS®SINCAL

User Interface

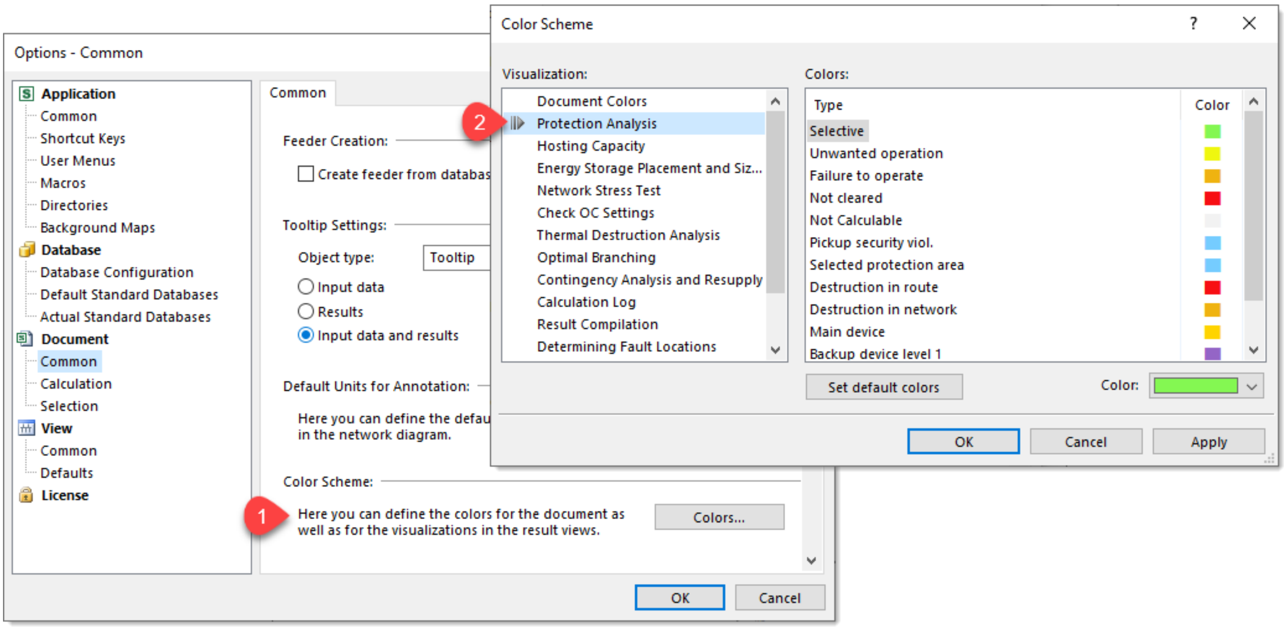
General Improvements

This section presents general improvements in the user interface.

Color Setting for Visualizations and Evaluations

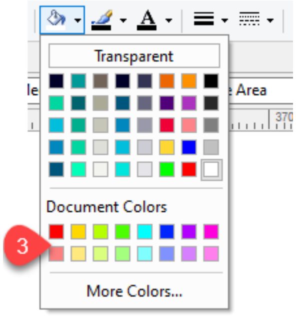
The setting of colors for visualizations and evaluations in the user interface have been revised so that they can now be fully customized by the user. This is to enable the use of colors that correspond to the corporate identity of the company and, if required, also support accessibility by, for example, being able to use a color scheme that dispenses with red and green.

In the **Options** dialog box in category **Document** the new section **Color Scheme** (#1) allows the individual adjustment of the colors. For this purpose, the dialog box **Color Scheme** (#2) is accessible, in which all available visualizations with the currently predefined colors are listed.



In the displayed figure, the colors for the visualizations of the protection devices in the protection analysis are shown. These are the colors used in the result view, but also those colors used for highlighting in the network graphic. The colors can be customized as desired by the user. The color scheme adjusted in this way is stored in the document, i.e. directly in the network model. This makes it available to all users working with the network model. Exporting and importing the color scheme with the **Workspace** enables a simple transfer of the settings to other network models.

Another new feature is available in the color selection buttons. Document colors are now displayed here in addition to the selected color palette (#3). These document colors can be customized by the user in the **Color Scheme** dialog box.



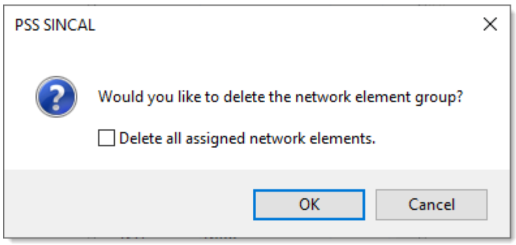
Deleting Results

The function for deleting the stored results (internal, external, signals) of the network model is available at a new location in the user interface. It can now be accessed via the **Show Input Data and Results** drop-down button in the toolbar or via the **Calculate – Results** menu.

Advanced Deletion in the Network Browser

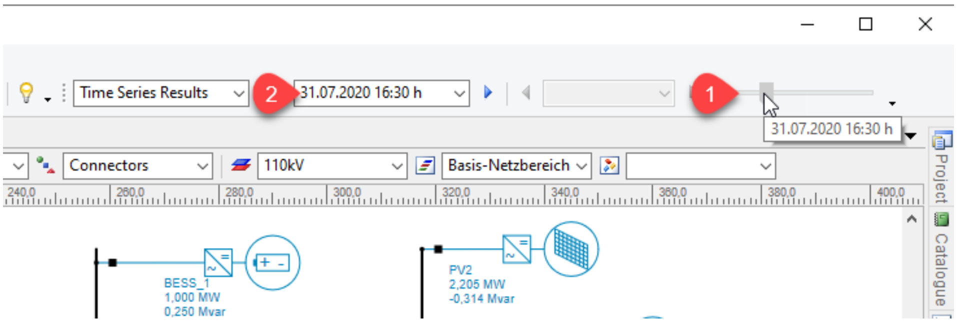
There is a new function for deleting network elements in the network browser. The aim is to make it easier to delete network elements without graphics. In the network browser it was already possible to delete single network elements and nodes via the pop-up menu. Beside that, the function **Tools – Check – Check Graphics** allowed deleting network elements without graphics. Now there is an additional functionality that allows to delete all network elements that are assigned to a network element group.

The function for deleting the network element group is called via the pop-up menu in the network browser. Then, a message box is displayed where you can select whether only the network element group with the references to the network elements should be deleted or whether all assigned network elements should be deleted as well.



Slider for Navigation in Results

The selection of results in the user interface has been extended. Now a slider (#1) is available in the **Results** toolbar to select the result to be displayed (#2).



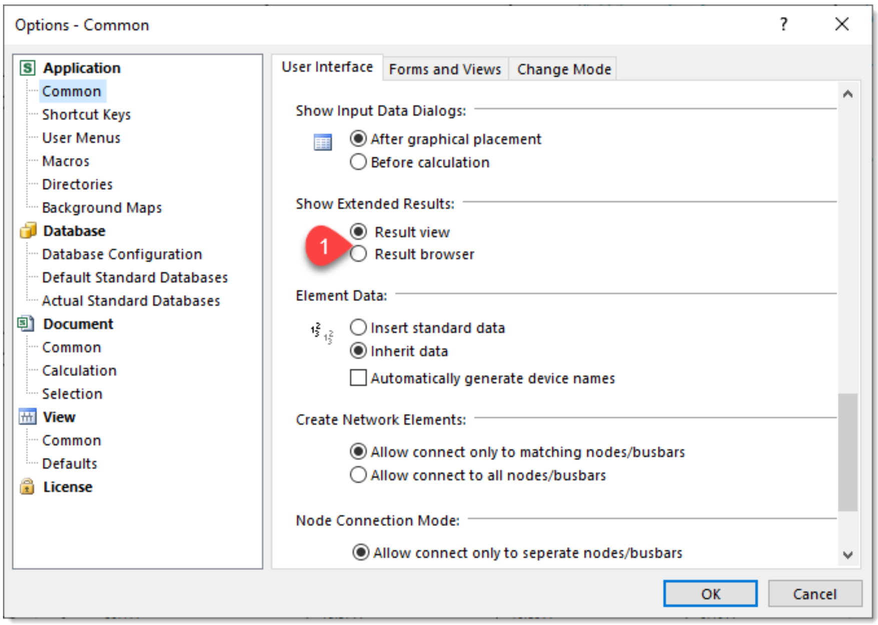
The slider has an integrated dynamic tooltip that visualizes which result is selected when it is moved.

This makes it easy to select the result you are looking for, even if there is a large number of results. When "releasing" the slider, the selected result is displayed in the graphics editor and tabular view.

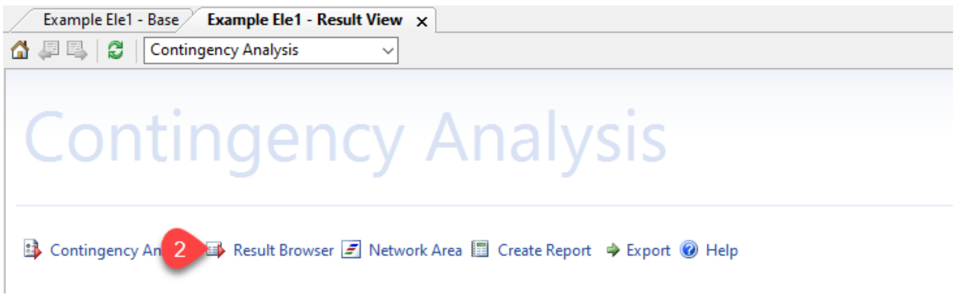
The function is available for the results of time series and operating point calculations in both electrical networks and pipe networks.

Display of Results in Result View and Result Browser

In PSS SINCAL there are some calculation modules that can visualize the results both in the result view and in the result browser. These include the contingency analysis (CA) and optimal branching (OT) modules. However, since normally it is not desired to work with both visualizations at the same time, it is now possible to configure which visualization should be opened automatically after the calculation. The configuration is done via the **Options** dialog box in the **Show Extended Results** section.



In addition, a button (#2) is available in the toolbar of the result views to open the result browser if needed.

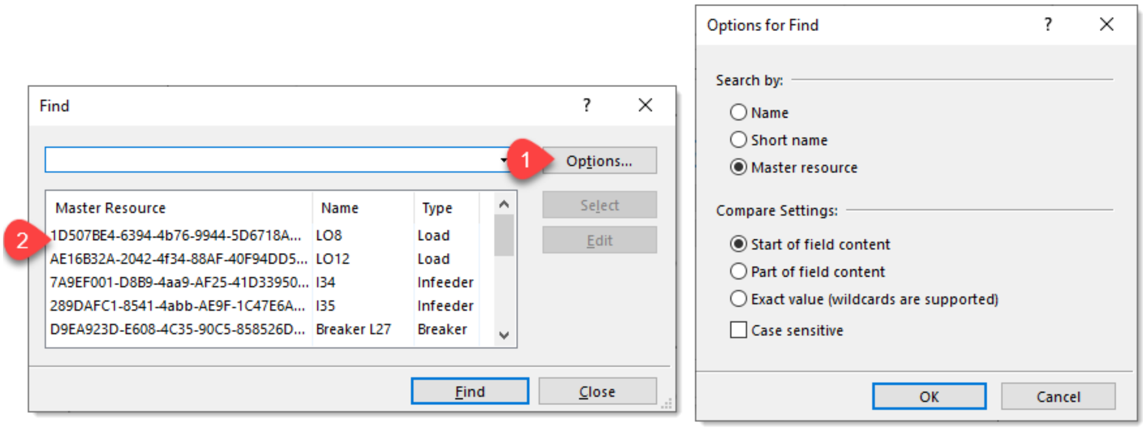


Graphics Editor

Advanced Searching in the Graphics Editor

The search function in the graphics editor has been extended by the "Master Resource" criterion. The search for elements based on the master resource (MRID) is supported for network models generated by a GIS interface, by the CIM import, or used in connection with the TSDI module. This search based on the MRID is still possible via the network browser, the search function in the graphics editor (CTRL + F) is accessible quickly if necessary.

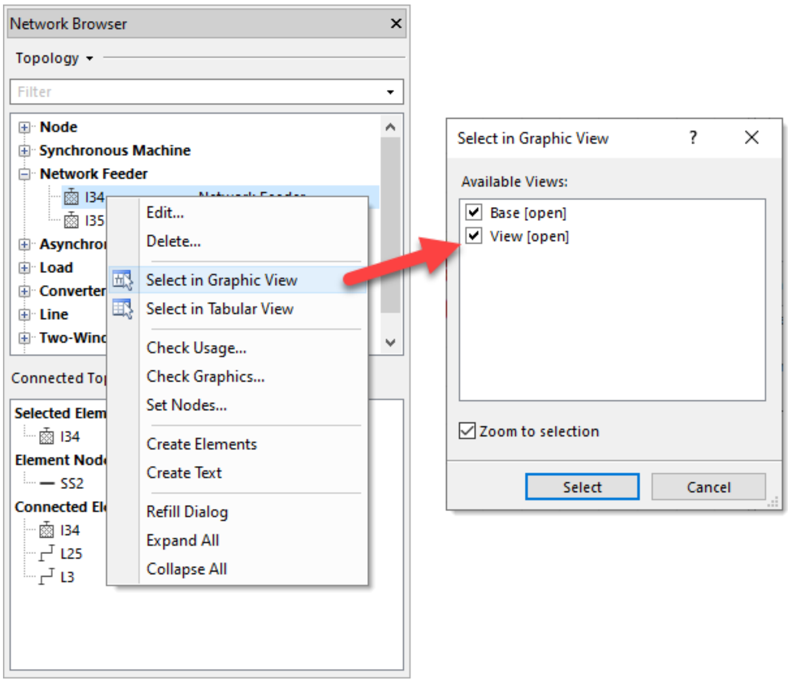
In the options of the dialog box Find (#1) the search for master resources can now be activated.



If the **Master resource** option is enabled, the display in the **Find** dialog box is changed (#2). Then only those elements of the network are displayed to which master resources are assigned. For each element the master resource, the name and the type are displayed.

Advanced Selecting of Network Elements

The selection functions in the graphics editor have been enhanced to support network models with multiple graphical views. It is now determined in which views the elements to be selected are represented. For this determination, it is irrelevant whether the views are already open or not. In the **Select in Graphic View** dialog box all views are then listed in which the searched element is present.

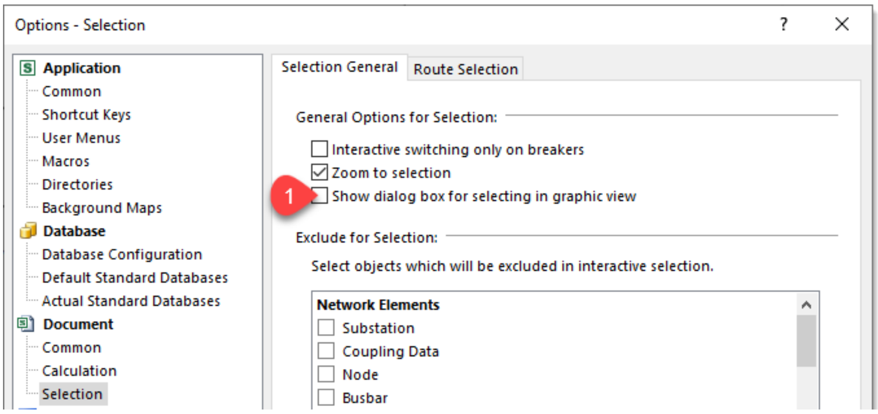


In this dialog box you can choose in which views the searched elements should be selected. If the views are not already open, they will be opened automatically.

The new function is integrated in all relevant places of the user interface, including the Network

Browser, the Result Browser, the Message window and the Result Views.

If the previous simplified function for selecting in the main view without dialog box is preferred, the advanced selection of network elements can also be deactivated. This is available in the **Options** dialog box in the document settings under **Selection** (#1).

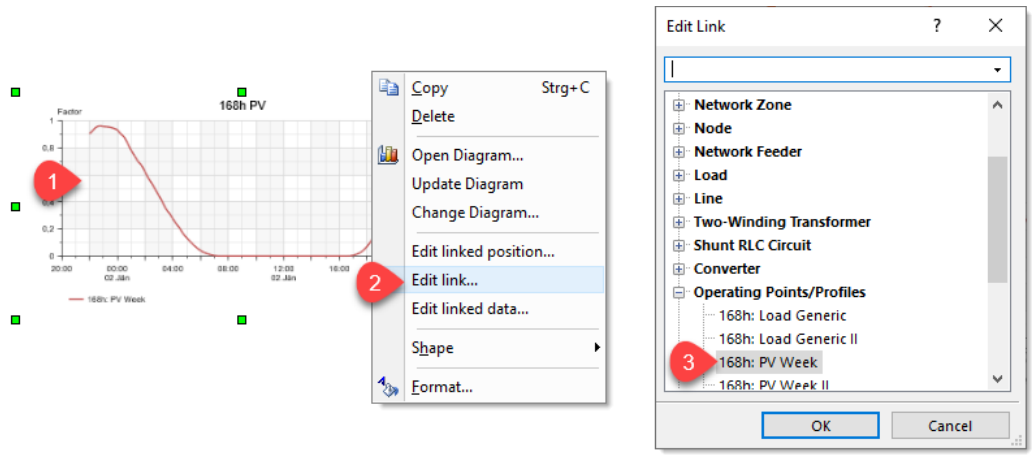


In addition, a simple but practical additional function is available when selecting. If the Shift key is pressed when calling the function via the pop-up menu, the functionality is reversed. I.e. if the option is active, the dialog box is not displayed, if it is not active, the dialog box is displayed.

Graphic Objects with Links to Network Data

A new function is available in the graphics editor that allows all graphic objects to be linked to network data. Once such a link has been defined, the network data can be displayed by double-clicking in the graphics editor.

To define the link, the graphic object is selected in the graphics editor (#1) and the pop-up menu is opened. In the pop-up menu, the **Edit link** function (#2) is then selected. This opens the **Edit Link** dialog box, in which the desired network data (#3) can be assigned.



If network data is assigned, it will be displayed when you double-click the graphic object. In the example shown, profile data has been assigned. Therefore, the dialog box for editing operating points/profiles is opened here and the assigned data is selected.

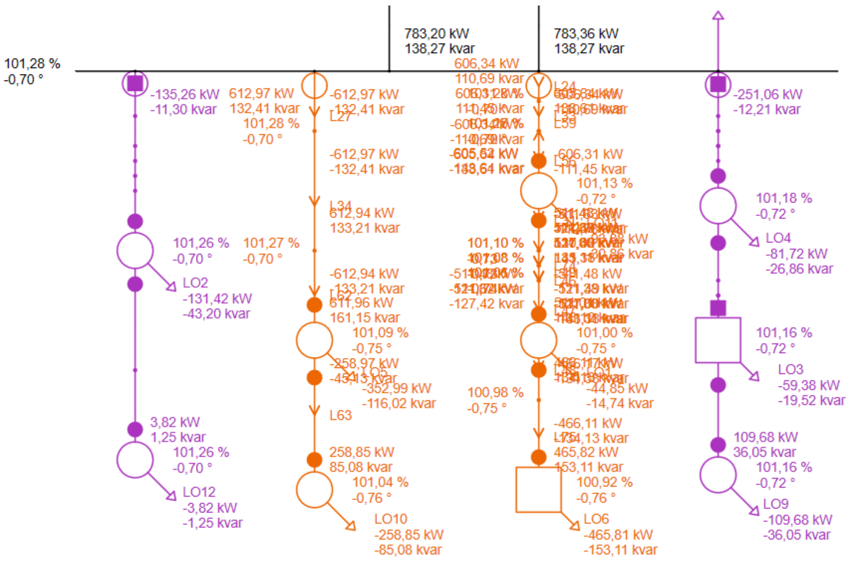
This new function also allows separate consideration of model levels for equipment, control and communication systems. In this way, the additional levels for control and communication signals can be superimposed or subimposed on the power level and set off against it in color. The connection to the input data and models behind it is given by the link.

New Graphic Element Container

A new graphic element container is available in graphic views, whose primary task is to reduce the displayed information radically in order to create more clarity in the network graphic.

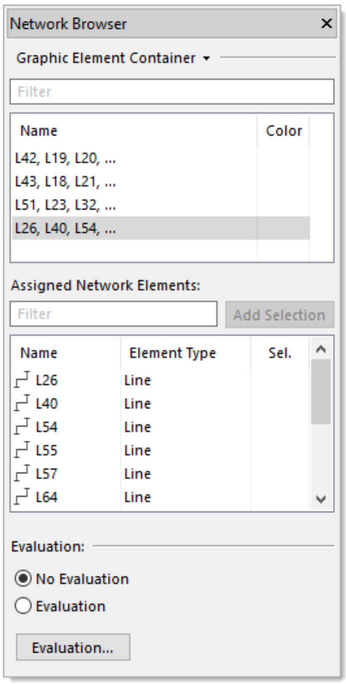
The following figure shows a network section in which the feeders consist of many joints and lines/cables as well as distribution stations in between. The display of the input data and results for the many elements is not readable for the user any more due to the overlaps (if the font size is not to be reduced even further).

The two outer purple feeders are modeled as graphic element containers and contain all graphic line elements of the feeder. The two inner orange feeders do not. The representation with the graphical element container provides a clearer and more structured representation but still allows to visualize all essential information (e.g. the power consumption and voltage at the substations).



Any network elements can be assigned to a graphical element container. The representation of the assigned network elements is then automatically done in a reduced "black box" representation. I.e. the boundary elements of the element container are determined by a topological network analysis. At all boundary elements the labels and element symbols are displayed. At all other elements (within the graphical element container) the annotation text is suppressed. Thus, only the input and output of the element container is visualized.

The graphic element container can be created directly in the network graphic. To do this, the desired network elements are selected in the graphics editor and the **Create Graphic Element Container** function is called up via the pop-up menu. The graphical element container is then created. It can then be edited in the **Network Browser** afterwards. Existing element containers can be deleted here, and the later addition and removal of network elements is possible. Selecting in the graphics editor is also possible. In addition, the network elements enclosed by a graphical element container can also be visualized with an evaluation in the network graphic.

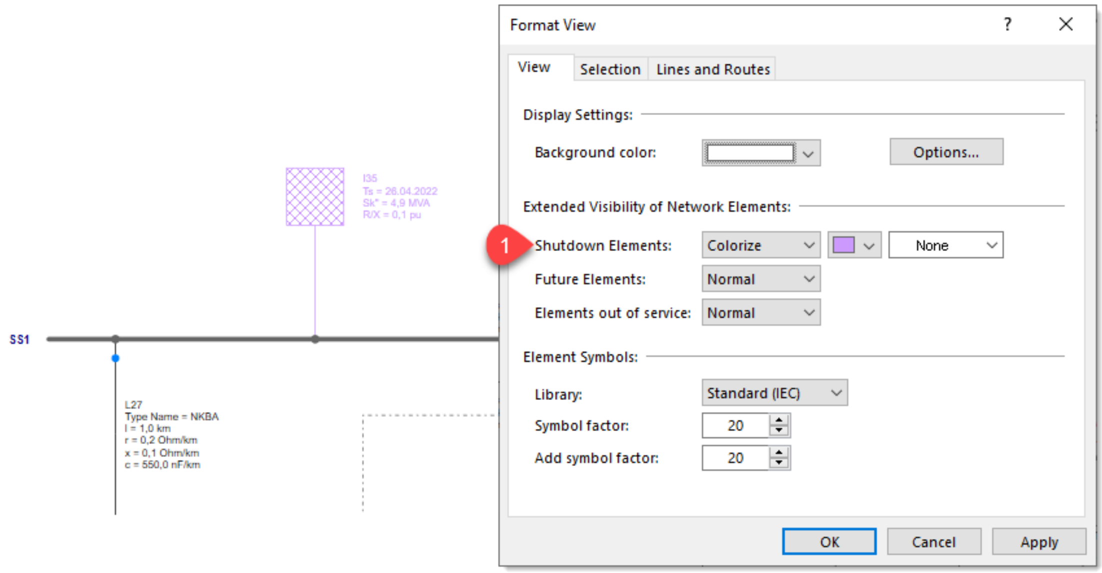


The new element container thus reduces the scope of information shown in the graphic view without losing flexibility in editing the network model or reducing the model. It is also possible to quickly switch the view style between the underlying complete network model representation (all information shown) to the style with the graphical element containers. For this purpose, the **Show Element Containers** option is available in the properties of the view.

New Visualization for Shutdown Elements

A new function is available in the graphics editor to explicitly visualize shutdown network elements. In the **Format View** dialog box, it is now possible to visualize the Shutdown elements (#1) analogous to the Future elements and Elements out of service.

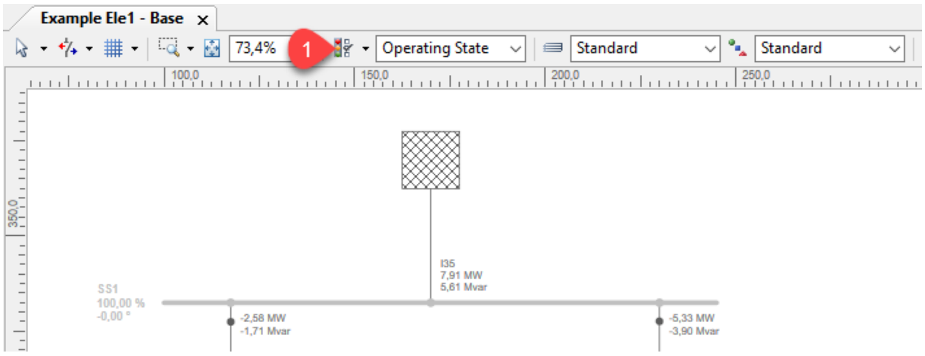
In order to determine whether a network element is available, the **View Date** from the calculation settings is used. Here it is checked whether the network elements have a defined shutdown that lies before the view date. If this is the case, the network element is either colored with the set color and line type (e.g. dashed) or completely hidden.



In this context, it is also new that as part of the textual representation of the input data of the network elements, the establishment and shutdown date can now also be shown in the view.

New Selection for Evaluations and Filters

The integration of the evaluation and filter functions into the user interface has been simplified. As before, the functions are directly available via the toolbar integrated in the graphics editor (#1), but there is now also a selection field that shows the respective selected visualization function.



New evaluation for Result Scope Settings

For electrical networks and pipe networks the new evaluation **Scope of Results** is available, which can be used to visualize the status of the result storage for nodes and network elements. It indicates the set options for nodes, terminals and elements which determine whether their results are stored internally or externally and if the recording of signals is activated.

Enhancements for Heat-Map

With the heat map, a selectable parameter can be graphically visualized in an area in the graphics editor by coloring - or more precisely by a color gradient. This color gradient in the visualization area is determined by interpolation between those points for which values of the parameter are available.

A temporary background image (PIC file) is created for the visualization, which is displayed as an additional graphic layer (subordinate) in the network graphic. This can be parameterized (and optionally also permanently saved) via the dialog box **Background Images**. The settings made here were previously lost when the heat map was updated. The settings made in the dialog box are now also kept when the heat map is updated.

A new visualization for the power flow results in electrical networks is also available. Now the voltage angle at the nodes (angle to the slack voltage) can also be visualized as heat map. This enables the user to visually evaluate the voltage angle as an indication of the power distribution occurring in the network to better analyze transfer flows and their root causes, for example.

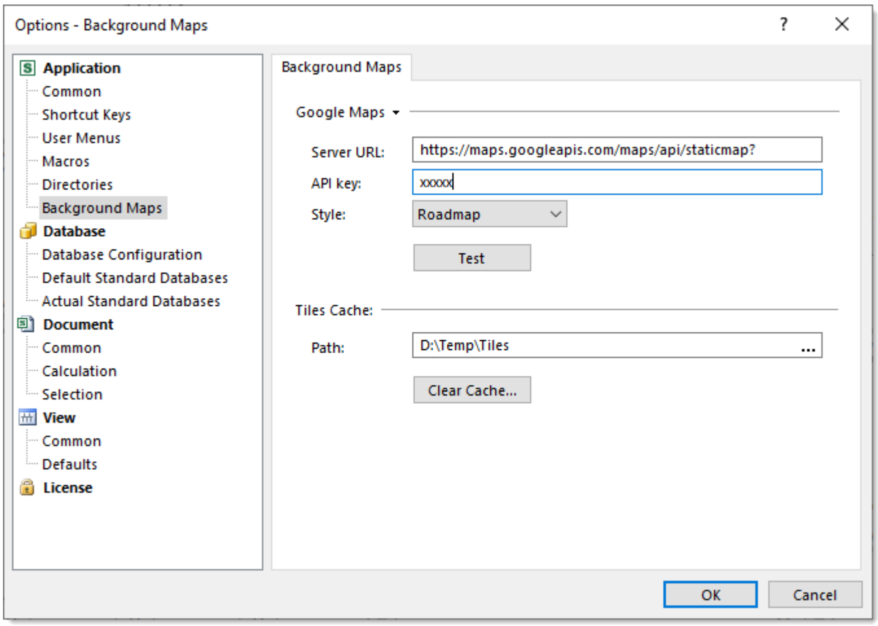
Background Maps with Google Maps

PSS SINCAL offers the possibility to display maps from the Internet in the background of geographic views. Maps in Open Street Map Tile format can be used here.

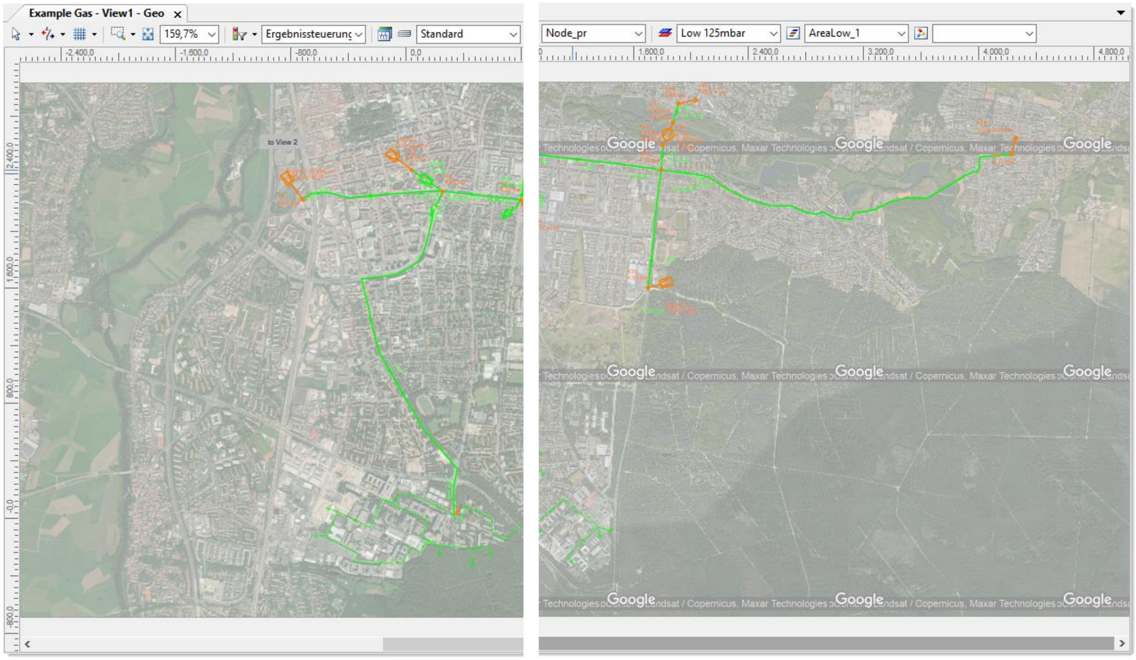
The following free and commercial map providers were already available:

- MapBox
- Cloudmade
- Bing
- OpenStreetMap
- Generische OSM Provider

In addition to these map providers, **Google Maps** is now also supported. The use of Google Maps is not free of charge, i.e. the authorization to use this service must be purchased from Google. Google Maps is configured in the same way as all other map providers, in the **Options** dialog box under **Background Maps**. Here, only the web address of the map service and the API key for use are stored.

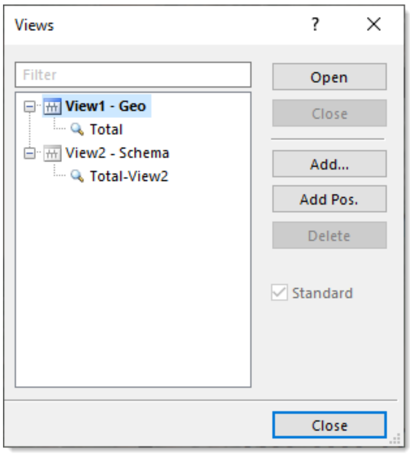


The following images show a diagram section in a gas network model from the map service MapBox (left) and from Google Maps (right). As can be seen in the image, the quality of the background maps is equivalent in each case, but with Google Maps the Google logo is always present in the tiles.



Improved Management of Views

In PSS SINCAL, any number of different graphic views of a network model can be created and managed, each with a completely individual graphic. This means, for example, that a network can be represented both in a geographic view and in one (or more) schematic views. The management is done via the **Views** dialog box, which can be opened via the menu **View** or via the pop-up menu of a network view.



The network model may contain any number of additional views. One of them is the **standard view**. While the additional views can be opened and closed by the user as needed, this is not possible with the standard view. The standard view is always loaded when the network model is opened. Closing the standard view causes the network and all additional views to be closed. The standard view of the network model is set by activating the **Standard** option.

For better identification of the views, the standard view is now colored with a differently colored symbol than the additional views in the dialog box and also in the user interface.

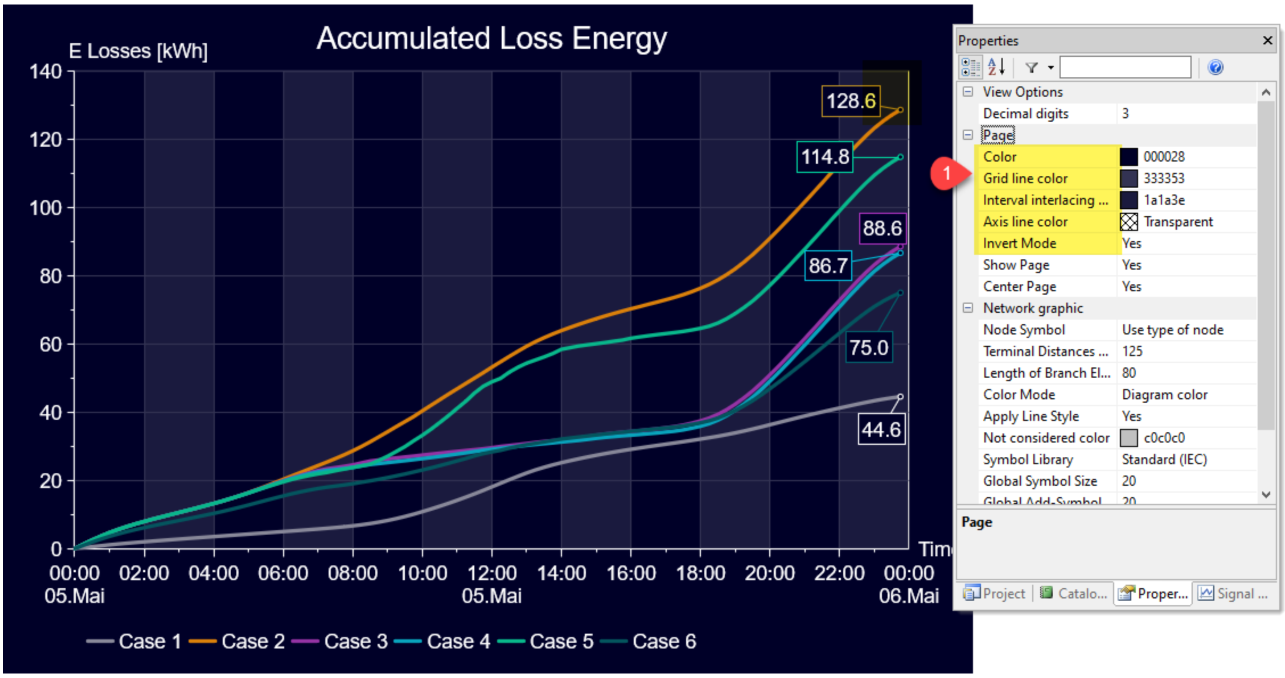
Another new function is the reordering of views in the dialog box. To do this, a view is selected and the position of the view can then be reordered with Shift-CursorUp or Shift-CursorDown.

Diagrams

Advanced Background Colors in Diagrams

The diagrams have been extended so that a display with a dark page background is also possible here, analogous to the graphics editor.

For the diagrams, the invert mode (#1) can now be activated via the **Properties** window. In addition, the colors for diagram background, interval interlacing, grid lines and axes can now be configured.



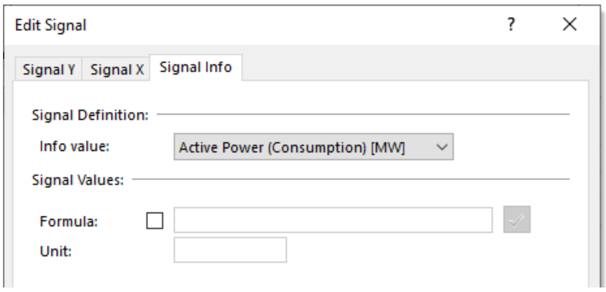
Advanced Format Diagram Dialog Box

The dialog box **Format Diagram** can now be scaled as desired. This also allows signals to be displayed more clearly in the longer names.

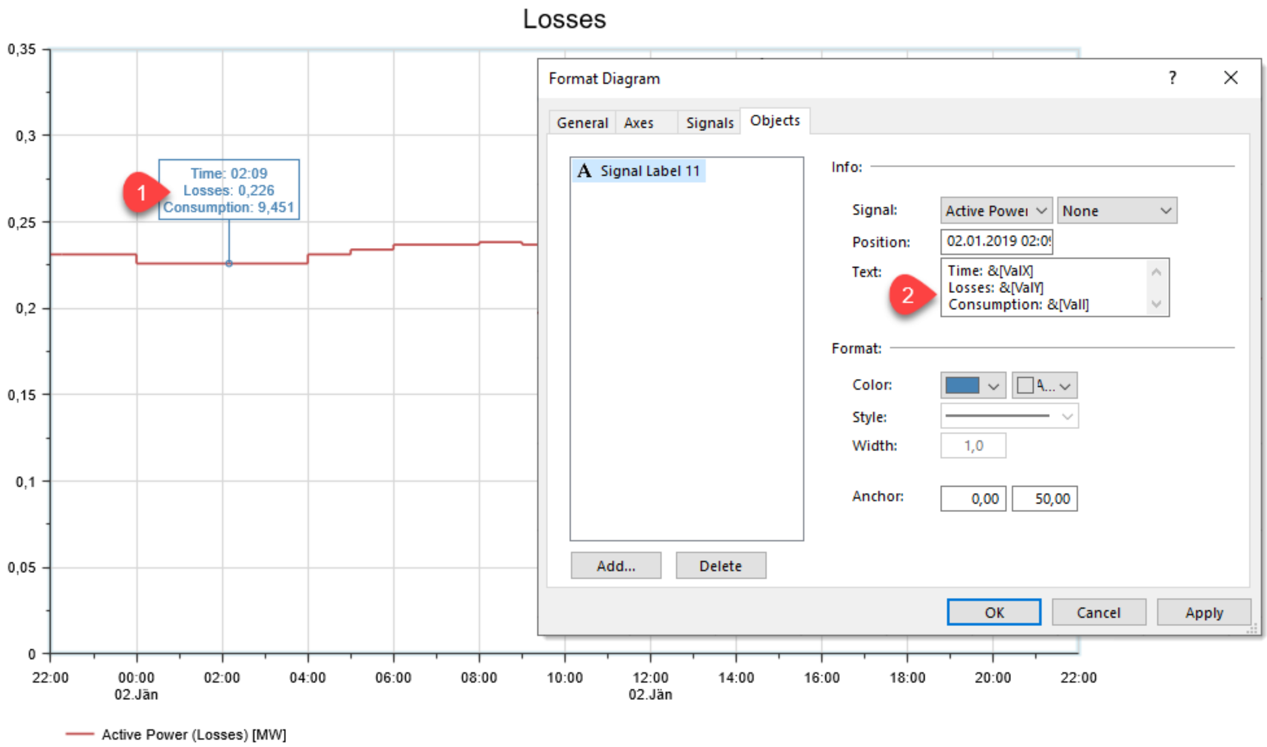
Display of Additional Information in Diagrams

A signal is typically described as a series of x/y value pairs, where the function y(x) is visualized in the diagram. Now, additional associated information can also be assigned to the signal, i.e. i(x), which can also be visualized.

Assigning the signal information is done with the **Edit Signal** dialog box. The new tab **Signal Info** is available here. In this tab, any related signal can be assigned as information.



This information assigned to the signal can be displayed with the signal label or in tooltips when showing data points. The following figure shows the time history of the active power losses in a network area. The consumption in the network area has also been assigned to the signal as information. This information can be displayed for each time of the signal (#1). For this purpose, the new **&[ValI]** token (#2) is available at the signal label, with which the associated information value can be output.



Especially for characteristics diagrams, users can now easily determine the main dimensions in time or frequency to better understand the trajectories of the signals.

Interactive Positioning of Labels in the Diagram

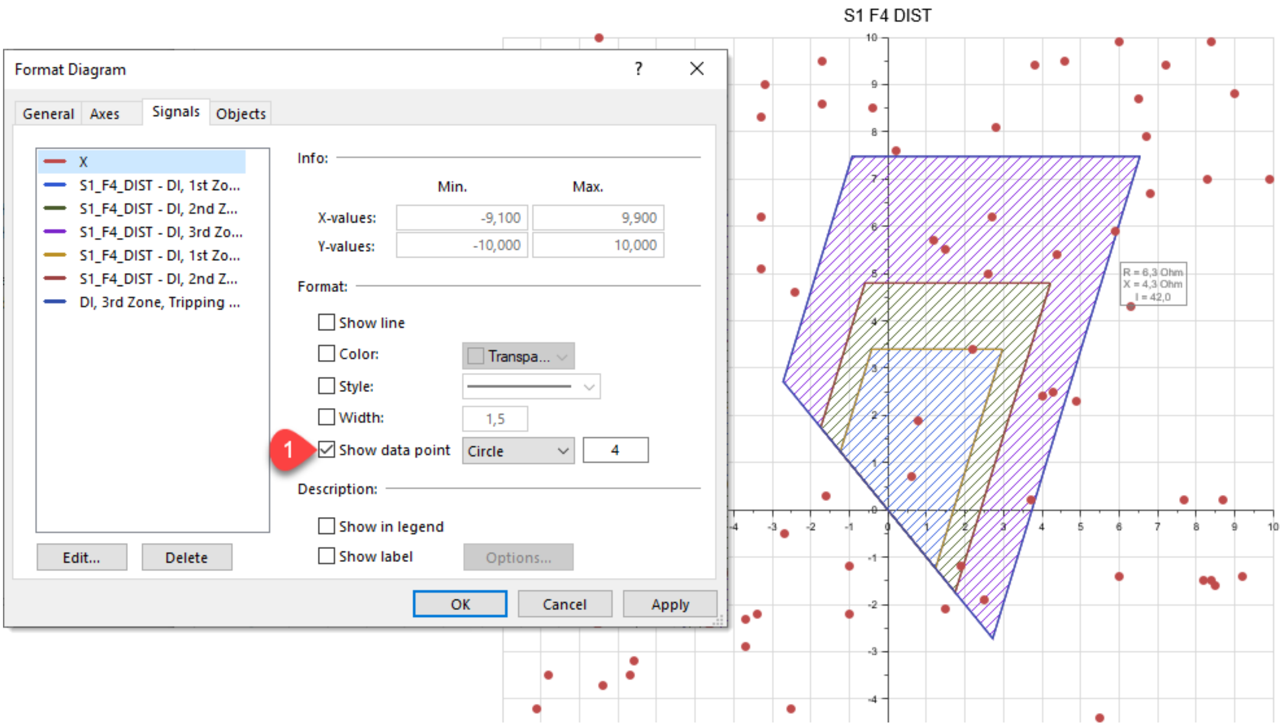
The names of the signals from the legend can optionally also be displayed directly as labels in the diagram. Here, the labels can be displayed at the beginning of the signal, at the end of the signal or at any position. Until now, positioning was only possible by entering the X and Y values in the Format dialog box. Now, however, the labels can also be placed interactively in the diagram using the mouse.

Display of Point Clouds

In the diagrams the new visualization style **Data Points** is available. This allows signals to be displayed with selectable data point symbols. This display format is helpful if the signal values are to be visualized on two separate axes, each with the signal value as a scale, rather than the plot over time of two signals. Typical applications for this new functionality can be the visualization of measured values of a protection device or a PQ feeder measurement as point clouds. If deactivating the line representation of a signal, the interpolation between the data points used is not shown any more and user may only address the actual data by the data points.

The following figure shows the R/X tripping areas of the different zones of a distance protection device. The diagram additionally visualizes the impedances (R/X) of various fault cases registered in the protection device in the field from a CSV file in the form of data points.

The new display form can be activated individually for each signal in the diagram in the **Format Diagram** dialog box. For this purpose, the **Show data point** option is activated, and the desired symbol is selected (#1).



Tabular View

In the tabular view, the **Fill Selection** function is available to facilitate copying data in a column:

 Filling data

The function transfers the value of the focused cell to all selected cells in the column. Until now, the selected cells had to be present as a contiguous block. This has now been changed so that all cells of the column can be selected in any form.

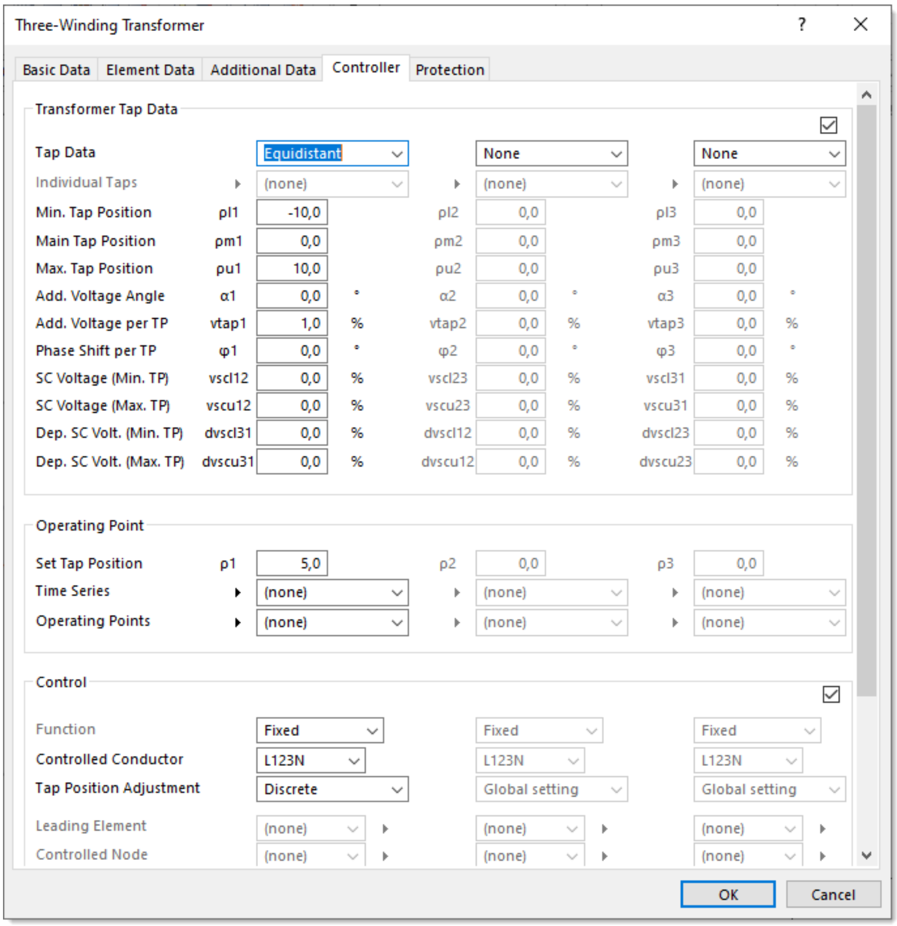
Electrical Networks

General Improvements

Revision of the Input of the Element Controllers

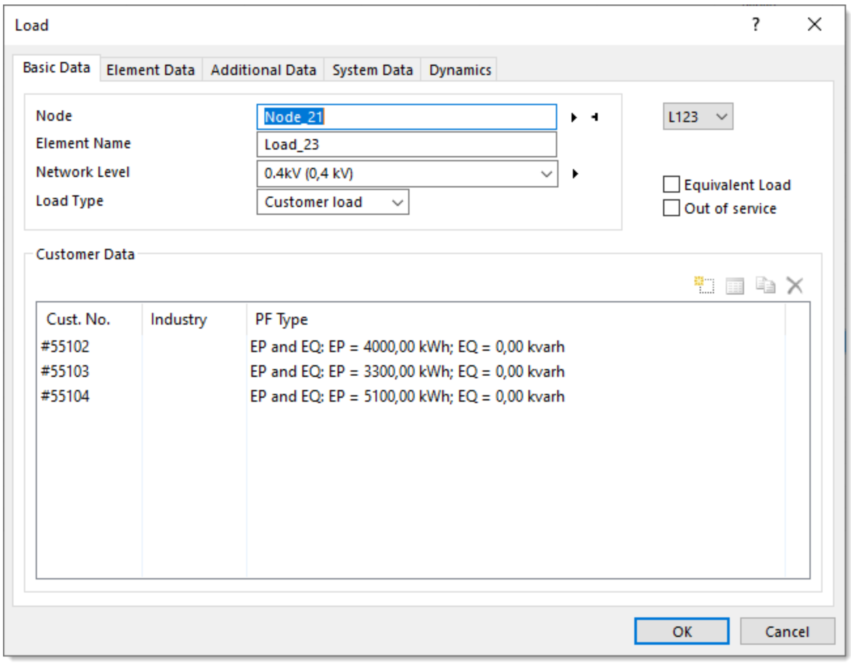
The input of the taps and, if available, the additional controllers have been further aligned for all network elements. Already in the previous version, the controller data of the two-winding transformer were revised to make the definition of the complex parameters easier and clearer. In this product version, the controller data of the remaining network elements, such as the three-winding transformer, shunt reactor and shunt capacitor, have also been adapted to the new concept.

The biggest changes have been made to the three-winding transformer, as this also has the most complex tap and controller data section. Here, the tap changer data, the operating state (set or start value in the power flow calculation) and then the parameterization of the (optional) control are now also clearly separated from each other.



Extended Display of Customer Data in the Screen Form

For **Loads** with the **Load Type = Customer load**, the display of the assigned customer data in the data screen form has been improved. The customer data is displayed larger, and it is also visualized which input data is stored for the different customers.



Improvements when using Instrument Transformers

The assignment of ground current transformers for protection devices has been simplified. The terminal that was also used for the phase current transformer is now automatically preselected.

Another new feature is that the "Name" attribute for the instrument transformers has been extended from 16 to 50 characters. This makes it possible to use longer names to identify the instrument transformers.

Simplified Parameterization of the BOSL Models

The parameterization of BOSL models that require a definition of remote nodes and remote network elements has been simplified. If the remote elements are not explicitly defined here in PSS SINCAL, the network element to which the BOSL model is assigned to is now automatically used. For the empty remote nodes, the node from the first terminal of the network element is automatically assigned. By this, user does not have to care about definition of measurement nodes.

Advanced Line Modeling

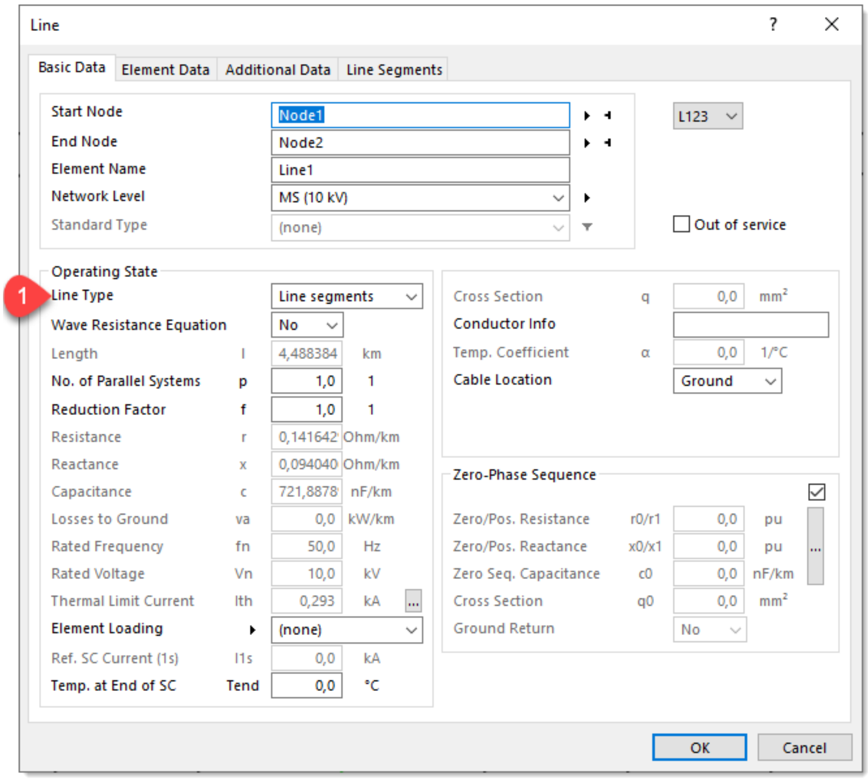
Both the **Line** and the **Line Segments** were extensively revised to meet the current requirements of increasingly detailed network modeling.

The purpose of the line segments is to keep the network model as simple as possible for electrical calculations and to reduce the model order at the points where this is possible (model order reduction), because not all results are relevant for the analysis of the overall system. This strategy can already be used, directly during the model import (e.g. via a GIS interface), for example.

Several lines can be combined into a single representative combined line. For this purpose, the original lines are described by individual line segments, but their parameters are assigned to a new representative line, i.e. a new line element. The relevant electric parameters to determine the line impedance such as length, resistance, reactance etc. of the line segments are used to calculate the equivalent values of the combined line. The additional data of the combined line are selected from the segments in such a way that it has the same electrical properties (or the minimal value to represent the worst case) of all assigned line segments.

In order to be able to save all essential data for the line segment (as before for a line/cable), the line segment model has been extended. Now, the same attributes are available as for the line and a standard type can be selected to define all parameters of the segment based on a local or global standard type. The **Data – Standard Types – Update Standard Types in Use** function has also been extended. The function now also considers the line segments and updates the data here according to the assigned standard types.

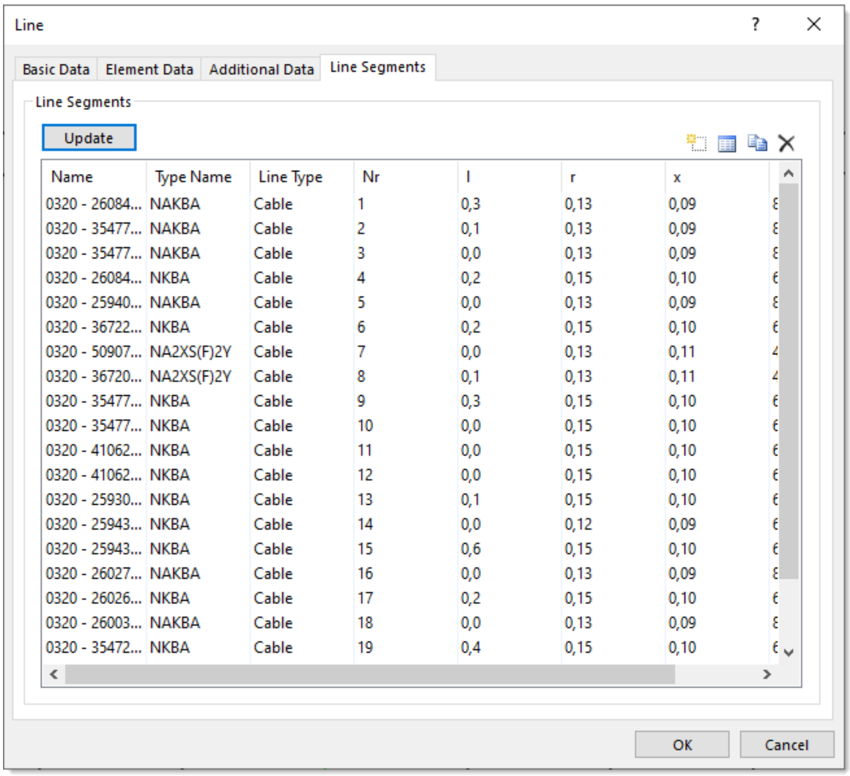
The management of line segments in the **Line** dialogue has been redesigned. The new **Line Segments** (#1) type is now available for the **Line Type**.



If the line segments option is selected, all values which are now depending on the containing segments are blocked.

The use of line segments does not change the processing of the line data in the calculation. The line data defined in the **Basic Data** tab are always used here. I.e. here the functionality corresponds to that with use of standard types, only the data of the line are determined on the basis the above formulas from the assigned line segments.

To make it easier to use the line segments, they are now available directly in a separate tab of the **Line** screen form.



In the new tab, line segments can be added, removed and changed. Clicking the **Update** button updates the line data with the data determined from the line segments.

The attributes of the line are determined based on the listed line segments as follows:

$$l = \sum l$$

$$r = \frac{\sum(r \times l)}{\sum l} \qquad x = \frac{\sum(x \times l)}{\sum l} \qquad c = \frac{\sum(c \times l)}{\sum l}$$

$$f_n = \sum_{i=1}^{1} f_{ni}$$

$$V_n = \min V_n$$

$$v_a = \frac{\sum v_a}{\sum l}$$

$$I_{th} = \min I_{th} \qquad I_{th1} = \min I_{th1} \qquad I_{th2} = \min I_{th2} \qquad I_{th3} = \min I_{th3}$$

$$I_{1s} = \min I_{1s}$$

$$q = \min q$$

$$\alpha = \frac{\sum(\alpha \times l)}{\sum l}$$

$$\frac{X_0}{X_1}, \frac{R_0}{R_1} \rightarrow Conversion\ to\ r_0\ and\ x_0$$

$$r_0 = \frac{\sum(r_0 \times l)}{\sum l} \qquad x_0 = \frac{\sum(x_0 \times l)}{\sum l} \qquad c_0 = \frac{\sum(c_0 \times l)}{\sum l}$$

$$q_0 = \min q_0$$

In addition, the following applies to overhead lines:

$$d = \min d \qquad d_a = \min d_a \qquad V_{max} = \min V_{max}$$

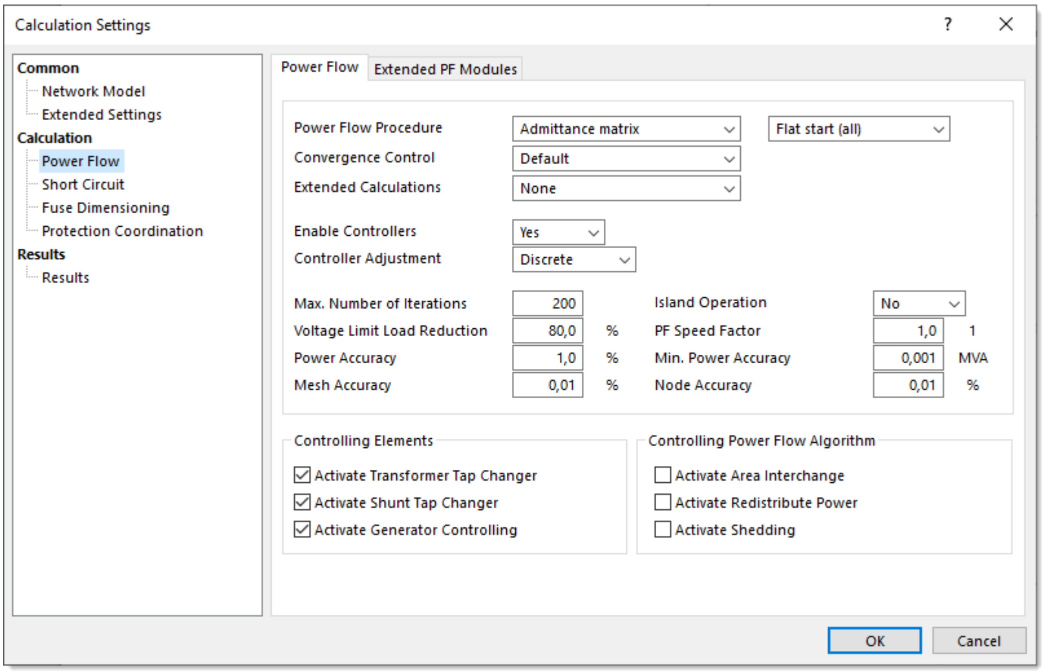
For easy visualization of the different line types (overhead line, cable, connector, line segment) the corresponding evaluation has been extended.

The Excel import has also been extended. Now lines with their line segments can be imported.

Power Flow (PF)

Simplified Calculation Settings

The calculation settings for power flow calculation have been aligned further to reduce complexity. In the tab **Power Flow** now only those parameters are available, which are needed for the basic control of the power flow algorithms.



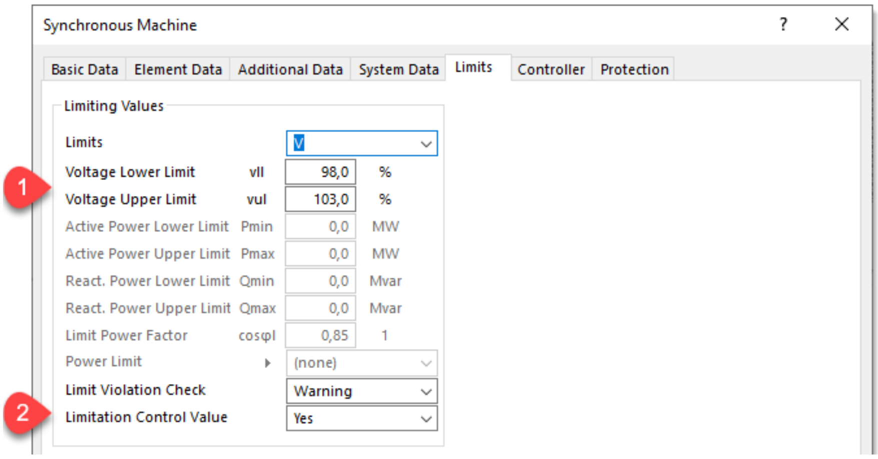
The **limit values for voltages and utilizations** are now available under **Results** and are only used to evaluate the result of the power flow calculation (influencing the states for exceeding limit values in the node and branch results). In those modules where the global limit values were previously used as calculation settings, they can now be specified directly in the individual control dialog boxes of the calculation modules. These applies for the modules Optimal Branching, Contingency Analysis, Transformer Tap Detection, Resupply and Capacitor Placement.

The global option for **Impedance Load Conversion** has been removed. This was previously available to allow calculation in incorrectly modeled non-convergent network models. With this option, all loads were automatically modeled with the load behavior of a constant impedance. That means the power consumption of the loads was determined based on the node voltage. This is nonrealistic to be applied to all loads in the network model, therefore this load behavior must now be activated individually for load elements (or for several or all via the available functions of the user interface or tabular view) if desired by the user.

Voltage Limits for Supply Sources

The voltages specified for supply sources in the **Limits** tab (#1) are now also considered within power flow in the control algorithms. The prerequisite for this is that the **Limitation Control Value** option (#2) is activated:

- Yes: The control value is limited and the result of the power flow calculation is within the limits.
- No: The control value is not limited and the result of the power flow calculation can be outside the limits.



Advanced Checks for Controller Settings

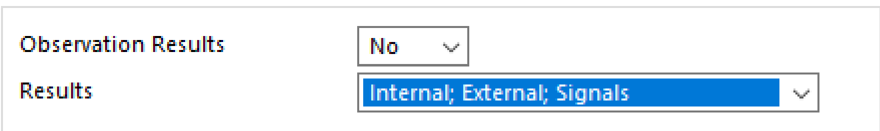
New checks have been provided for the controller settings for network feeder, power unit, synchronous machine, converter, two-winding and three-winding transformer. Now, warning or error messages are written if inadmissible combinations of controllers and power flow type are specified here, for example the combination of superimposed control with other individual controls on the network element.

New Status for Breaker Results

Similar to the branch results of the network elements, a status attribute is now also available for the breaker result. This status indicates whether a limit violation has occurred for the breaker. The status can be displayed in the tabular view and also in the annotation in the network graphic view. Visualization by coloring the breakers in the network graphic using filters and evaluation is of course also possible.

External Results Database

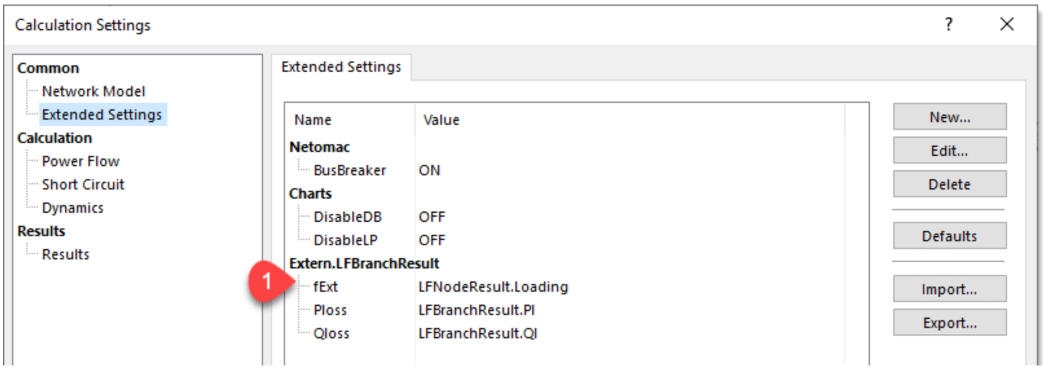
The simulation of large network models for many scenarios, operating or time points generates large amounts of result data for the later analysis. To ensure that such result data can also be processed and evaluated in a meaningful way, PSS SINCAL offers a wide range of options for configuring the scope of results, which should be stored in the network database (internal) or the result databases (external). The individual identification of nodes and network elements for result storage is particularly efficient here:



For external result databases, a simplified structure of the result tables is used. Connection results (node + terminal) are stored here. Previously, both the nodes and the terminals of the network elements had to be identified for results storage in the external results databases. This has been changed to improve manageability. Now, it is sufficient if the identification is done at the terminal of the network element.

The external result databases are designed in such a way that they can be used as efficiently as possible, and the storage of large result sets is also possible with them. Therefore, the result structures in this database are kept very compact. Only a few attributes are available: Node voltages and voltage angles, powers at the terminal, current and utilization.

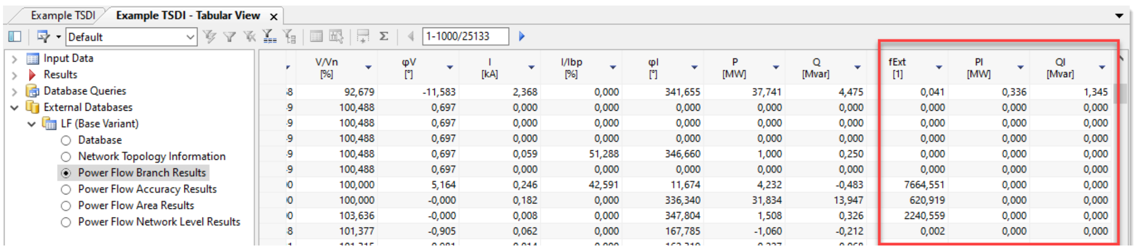
To increase the flexibility of the external result databases, additional result attributes from the node and branch result tables of the power flow calculation can now be added here individually. The configuration is done by means of extended calculation settings (#1):



In the example shown, three additional attributes are added to the LFBranchResult table:

- fExt – Factor of extended calculation from power flow node results
- Ploss – Active power losses from the power flow branch results
- Qloss – Reactive power losses from the power flow branch results

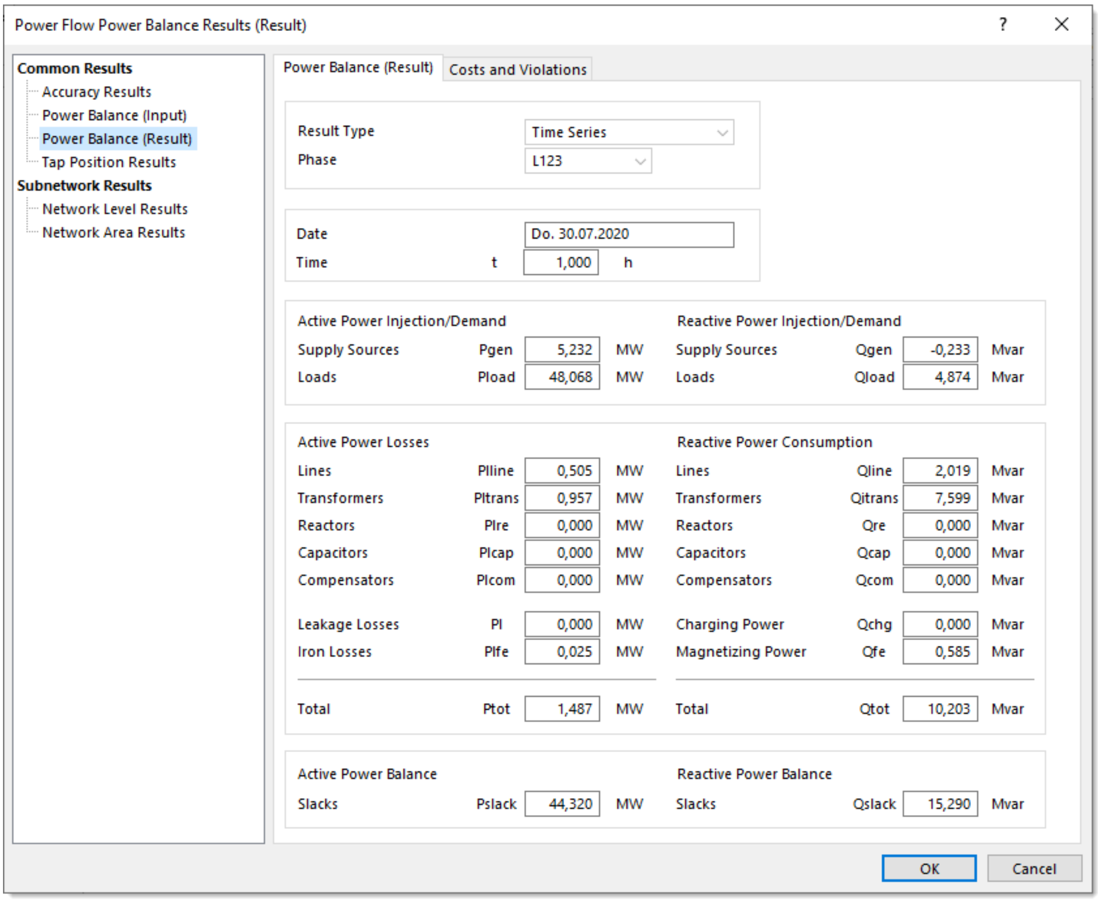
When providing the results in the external result database, the result table **LFBranchResult** is automatically extended with the additional attributes and these are filled with the result values:



Revised Power Flow Result Screen Forms

The result screen form for the **Power Balance** of the power flow calculation has been improved. The objective was to visualize more clearly which injections and demands in the network were modeled, which losses occur and which power is required to produce the balance. Therefore, the data screen form is now divided into three areas:

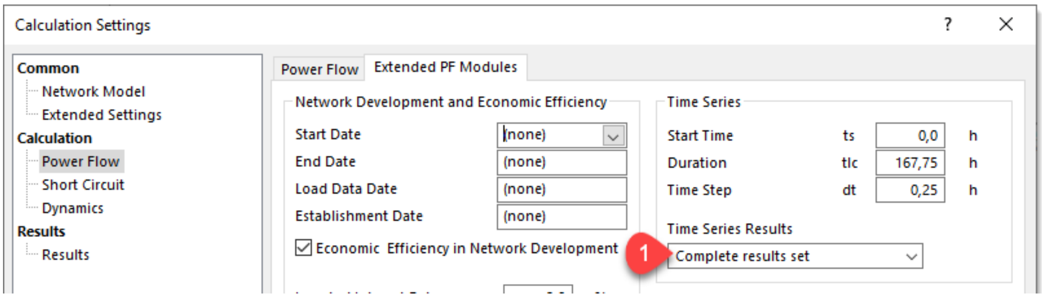
- Injection/Demand
- Losses
- Balance



Time Series Calculation (LP)

Changed Calculation Settings

The parameters for controlling the calculation module have been revised. The setting of the results to be generated and saved is now available directly in the control settings for the time series calculation (#1):



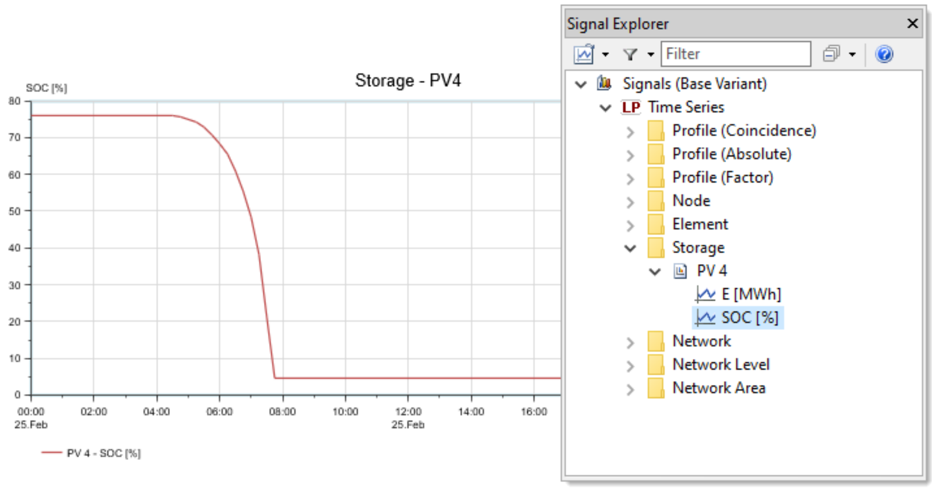
Here, a distinction is made between complete results for all calculated points in time or a single worst case result:

- Complete results set: All time points are calculated and the results of all time points are made available.
- Worst Case: All time points are calculated, but only one result with the worst case is provided.
  The criterion for the worst case of network elements is their maximum load.
  The criterion for the worst case of the nodes can be:

- Node Vmin: Minimum reference node voltage
- Node Vmax: Maximum reference node voltage
- Node VPI: Maximum node VPI

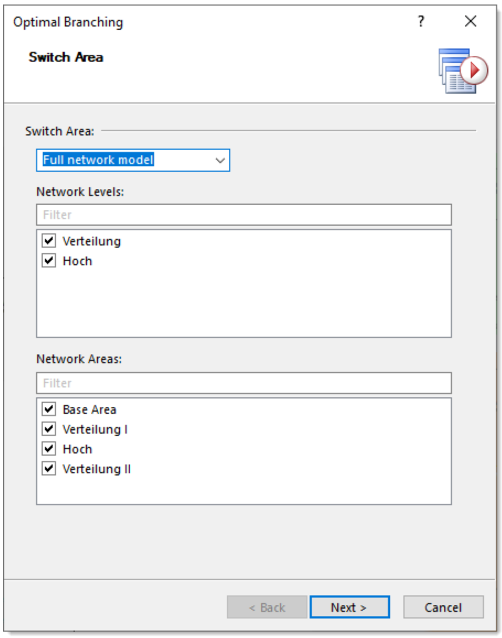
New Signal for Energy Storage SOC

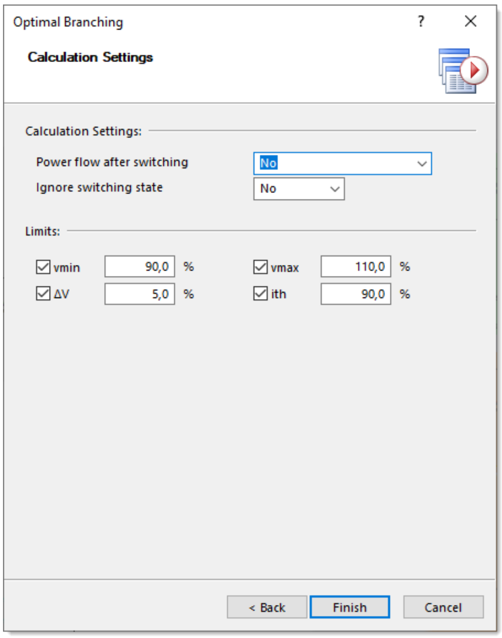
For the energy storage, the new result signal state of charge (SOC) is provided in the time series calculation, which visualizes the SOC in percent. The signal is available in the Signal Explorer under Storage and can be transferred to your diagrams using Drag & Drop:



Optimal Branching (OT)

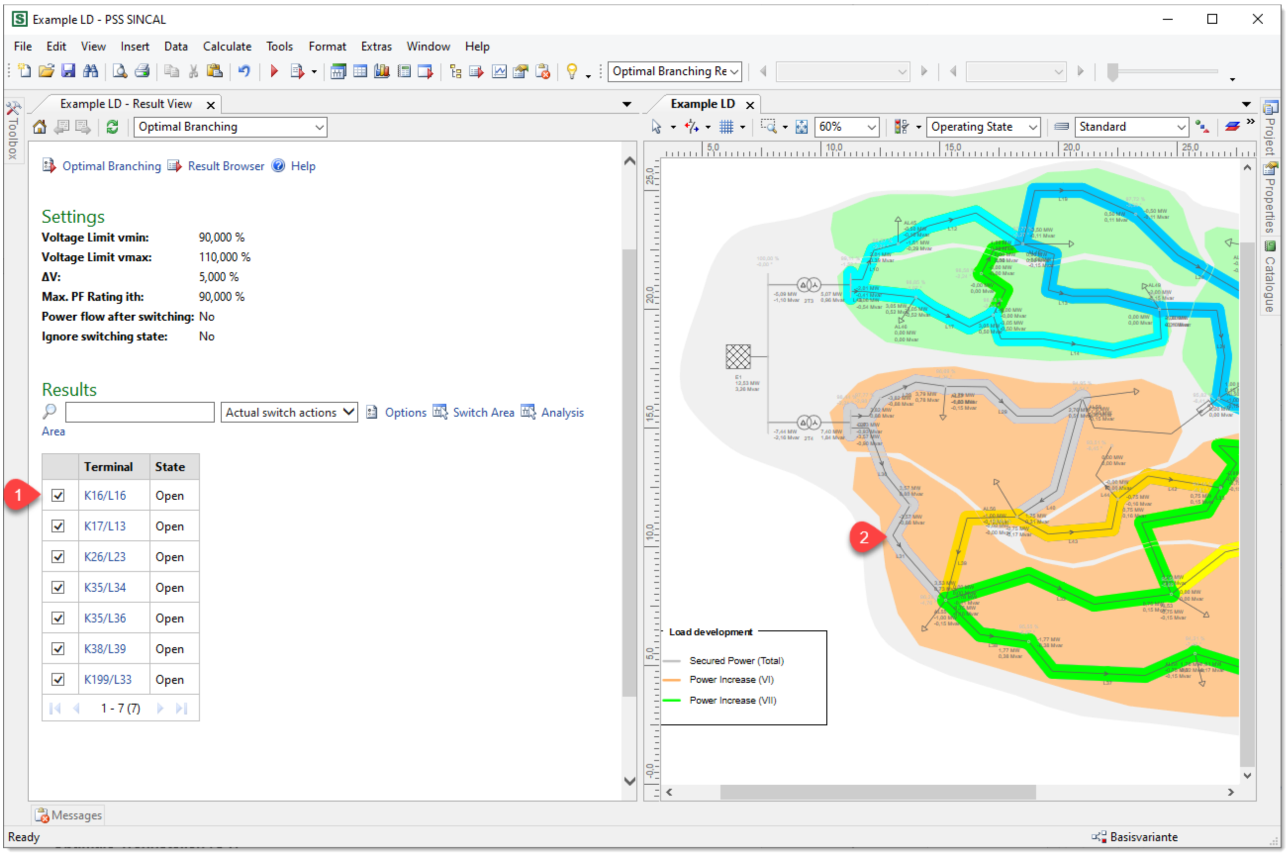
The module for determining the optimal branching has been extensively revised. Similar to other newly implemented modules, it now has a wizard that can be used to define in detail where changes are to be made in the network model (switch area) and which areas of the network are to be monitored (analysis area).





In the wizard it is also possible to define the control settings essential for the calculation module and to specify the limits for voltages, voltage change and utilization.

All results of the calculation module are stored in an external SQLite results database. This is available in the "_files" directory of the network model in the "OPTBR" folder. This database can also be read out and evaluated with your own tools if required. In the user interface the results are visualized in the result view. The disconnection points to be changed are listed here (#1) and their switching states can also be transferred directly to the network model.

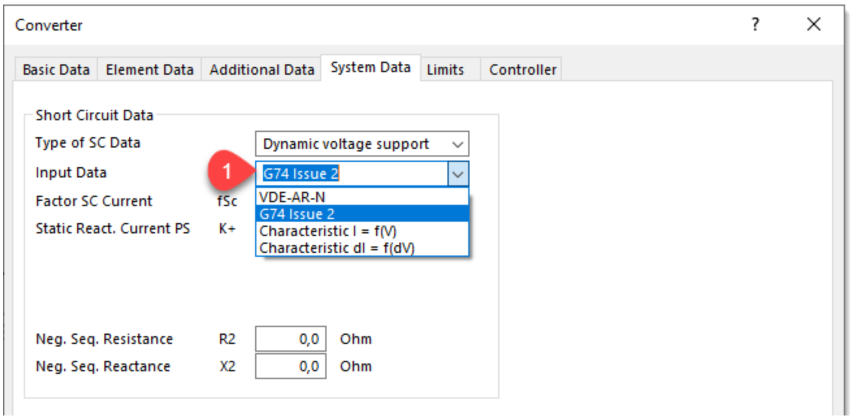


Another new functionality is the graphical visualization of the meshes in the network model. This visualization by highlighting (#2) can be activated in the **Options** dialog box in the **Results View**.

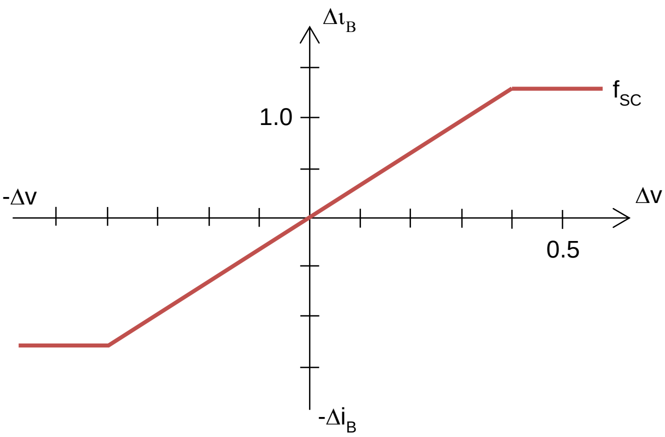
Short Circuit (SC)

Enhanced Dynamic Voltage Support in Short-Circuit Calculation

Depending on the network operator and country-specific regulations/standards, there are different requirements for dynamic voltage support. To meet these requirements, the implementation of dynamic voltage support in the short circuit calculation has been extensively expanded. This can now be activated individually for all equipment with converter data (Converter, Synchronous Machine, Asynchronous Machine, Power Unit, Serial DC Element (HVDC) and Static Compensator) according to **VDE-AR-N**, **G74 Issue 2**, **Characteristic I = f(V)** and **Characteristic ΔI = f(ΔV)** (#1):

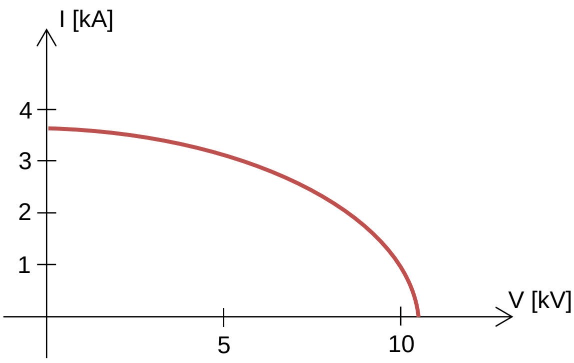


The **G74 Issue 2** option is new. The short-circuit current is determined interactively depending on the voltage at the connection node before and after the fault occurrence with the help of the rated current and the reactive current control characteristic. The rated current is determined with the rated apparent power and the rated voltage of the element.

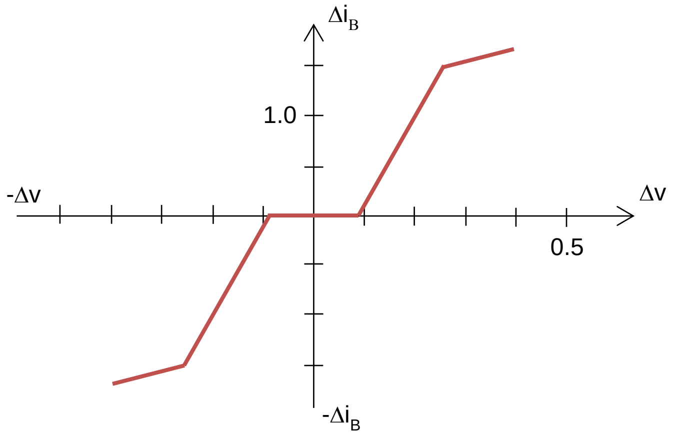


G74 Issue 2:
The voltage difference load voltage minus short-circuit voltage results with the help of **the React. Current Characteristic** an additional reactive current in the positive sequence system for supporting the voltage in the network. The additional reactive current is limited by the maximum reactive current in the positive sequence system.

Also new are the options **Characteristic I = f(V)** und **Characteristic ΔI = f(ΔV).** This allows dynamic voltage support to be modeled with freely definable characteristic curves. The short-circuit current is determined iteratively depending on the voltage at the connection node with the help of the rated current and the characteristic curve. The rated current is determined with the rated apparent power and the rated voltage of the element.



Characteristic I = f(V):
The short-circuit current is determined depending on the voltage at the connection node with the help of the rated current and the voltage support absolute characteristics.

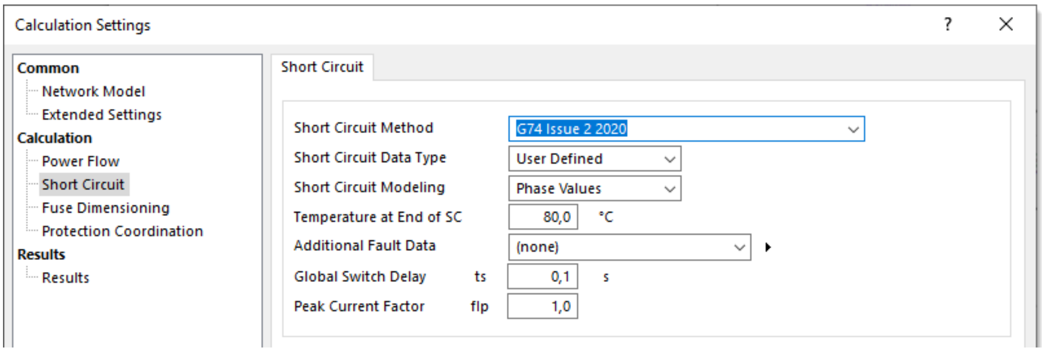


Characteristic ΔI = f(ΔV):
The voltage difference load voltage minus short-circuit voltage results in an additional reactive current for supporting the voltage in the network with the help of the characteristics.

The **results of the short-circuit calculation** have also been extended to clearly show the **contribution of the dynamic voltage support** of converters to the short circuit current. For this purpose, the active and reactive current components of the dynamic voltage support are now available for the 1-, 2- and 3-phase branch results. For the 3-phase short-circuit the injected current in the positive sequence is shown and for the 2- and 1-phase short-circuit both the current in the positive sequence and in the negative sequence.

G74

The short circuit calculation according to the G74 standard has been extended. Now the calculation according to the **G74 Issue 2 2020** standard is also supported. Analogous to all other supported short-circuit standards, this can be selected in the **Calculation Settings** dialog.

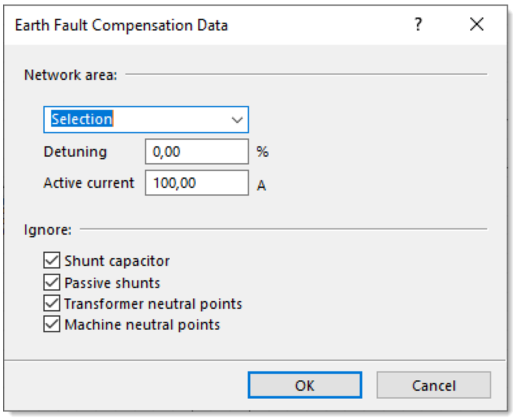


The main changes to the previous G74 standard are here:

- Consideration of short-circuit current contributions from converter-based network elements.
- New factor in short circuit for "Converter Driven Plant".
- Changed Kappa factor and thus changed peak short-circuit current calculation. Different processing of the capacitances is required here.
- DFIG: Other modeling in the short circuit as a combination of impedance and dynamic voltage support.
- DC-elements: Modified modelling for CSC and VSC. Consideration of dynamic voltage support.

Earth Fault Compensation Data

The **Earth Fault Compensation Data** tool can be used to determine earth fault compensation data for compensated and isolated networks. This tool has been enhanced to enable new calculation approaches. In addition to the already available full compensation by determining R and X of the neutral point impedance, there is now the possibility to define a **Detuning** and an **Active current**.



The **Detuning** v in the compensated network is the ratio of capacitive earth fault current I_c and the reactive current across the neutral point impedance I_{stp}.

$$v = \frac{I_c - I_{stp}}{I_c}$$

From the short circuit calculation to determine full compensation, the neutral point reactance X_E corresponds to the negative capacitive resistance X_c of the lines.

$$X_c = -X_E$$

With detuning, the neutral point reactance X_{ev} results to:

$$v = \frac{\frac{V}{X_c} - \frac{V}{X_{ev}}}{\frac{V}{X_c}} = \frac{1.0 - \frac{1}{X_{ev}}}{\frac{1.0}{X_c}} = 1.0 - \frac{X_c}{X_{ev}}$$

$$v \times X_{ev} = X_{ev} - X_c$$

$$-v \times X_{ev} + X_{ev} = X_c$$

$$X_{ev} \times (1.0 - v) = X_c$$

$$X_{ev} = \frac{X_c}{1 - v}$$

The minimum earth fault active current I_{actmin} to be achieved can be specified under **Active Current** in PSS SINCAL. If full compensation results in an active earth fault current that is lower than the active earth fault current to be achieved, the neutral point resistance is adjusted.

The current across the neutral point is given by the source voltage and the neutral point impedance.

$$I_{stp} = \frac{V_k}{\sqrt{3} \times (R_E + jX_E)}$$

The voltage at the neutral point resistance results from the source voltage and the current drop at the element impedance.

$$V_{Stp} = \frac{V_k}{\sqrt{3} - (R_{0Element} + jX_{0Element})}$$

The neutral point impedance with consideration of R_{ed} of the active current is given by:

$$R_{ed} = \frac{V_{stp}}{I_{actmin}}$$

The results of the determination of the earth fault compensation data have also been extended. Here the designations have been adapted to the attributes in the screen forms at the neutral point and the **reactive current component** of the earth fault current **IEr** is now also shown.

Results

Options

Node	REp [Ohm]	XEp [Ohm]	R0 [Ohm]	X0 [Ohm]	R0p [Ohm]	C0p [nF]	IEa [A]	IEr [A]	Neutral Point
N2	346,41016	134,57461	0,24966	-421,00368	709940,64335	7560,73612	0,16102	271,53044	STP_2

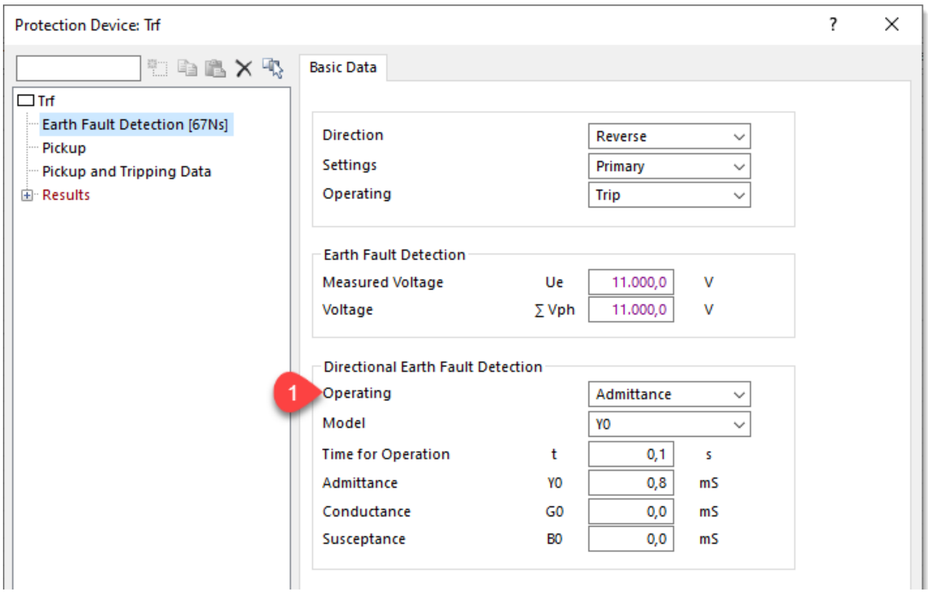
1 - 1 (1)

Protection Coordination (OC, SZ, DI)

Earth Fault Detection with Admittance Method

The earth fault detection takes over the task of detecting earth faults in networks with an earth fault extinguishing coil connected or isolated neutral point. In addition to the Wattmetric Method, the Admittance Method is now also available.

The parameterization is done directly at the protection device with the data for **Earth Fault Detection [67Ns]**. Here the data mask was extended to allow the selection between the operating mode **Admittance** or **Wattmetric** (#1):

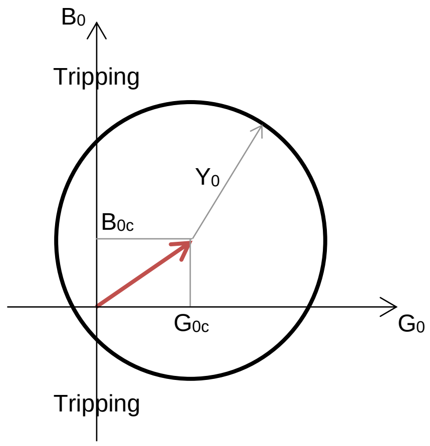


The new Admittance Method can be used with three different methods: Y0, G0 or B0.

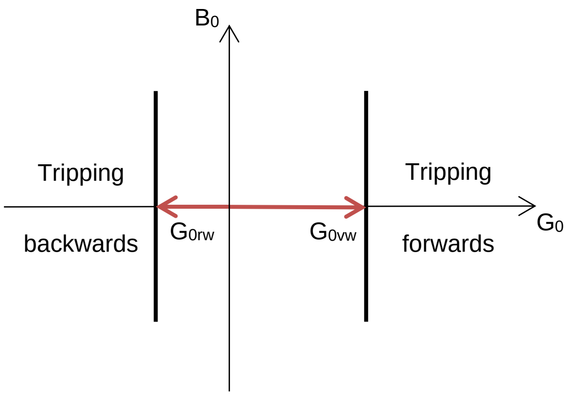
As soon as an earth fault is detected, the zero admittance is determined from zero voltage and zero current:

$$Y_0 = \frac{3 \times I_0}{V_0} = G_0 + jB_0$$

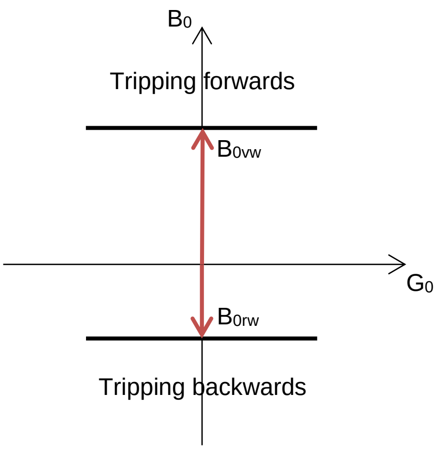
This admittance is the basis for the operation depending on the selected working method.



Method Y0:
This working method checks whether the determined admittance Y0 is outside the area. No direction can be specified.



Method G0:
This working method checks whether the determined conductance G0 is outside the conductance band. For positive/negative conductances, the tripping takes place in the forward/backward direction.

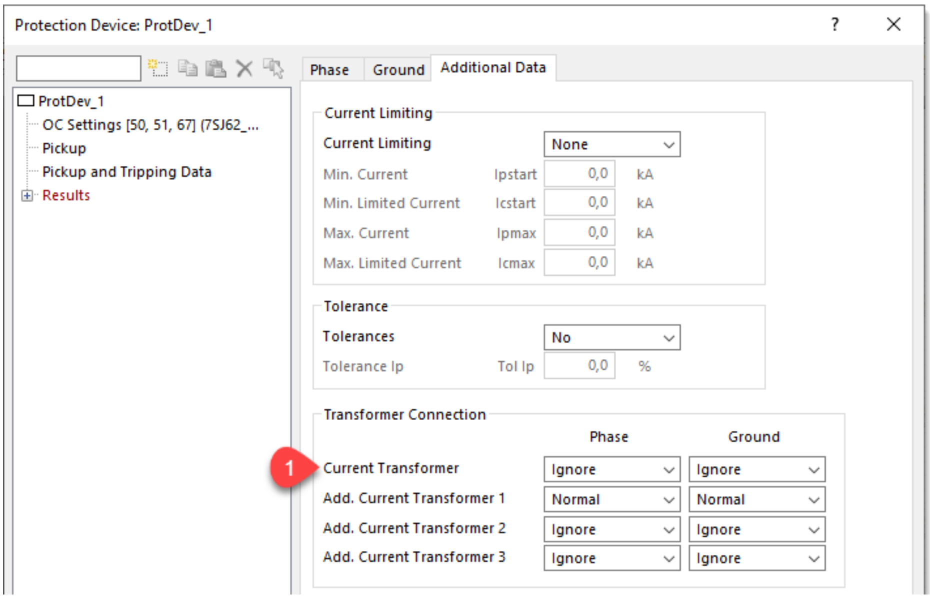


Method B0:
This working method checks whether the determined susceptance B0 is outside the susceptance band. For positive/negative susceptances, the tripping takes place in the forward/backward direction.

Earth fault detection is now also supported for teleprotection. Like all other signals, this can be used both at the receiver and the transmitter to define complex behavior for interlocking, blocking, and tripping of protective devices.

Extended configuration for current transformers

The assignment of the current transformers has been made more flexible. On the protection device, 4 current transformers can be assigned for phase and another 4 for ground. Which of these current transformers are used by the defined OC or distance protection device functions can now be defined in the **Additional Data** tab under **Transformer Connection** (#1).

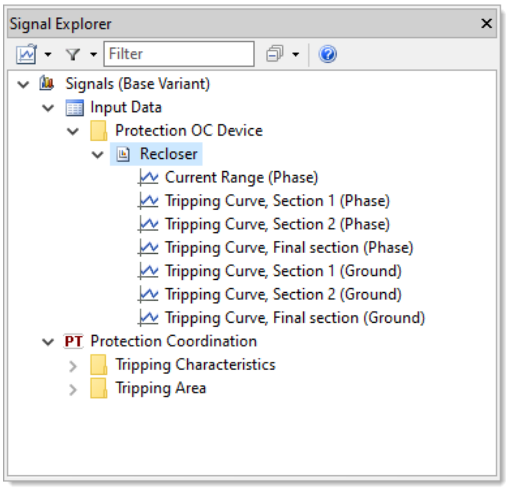


The following options are available:

- Ignore: The current transformer is not used.
- Normal: The currents of the transformer are considered in the calculation.
- Inverse: The currents of the transformer are used inverse in the calculation.

Recloser with improved trip characteristic visualization

The generation of signals for the tripping characteristics from the recloser has been improved. Individual signals are now provided for each segment in the Signal Explorer.



Voltage at installation location of current transformer as reference in diagram

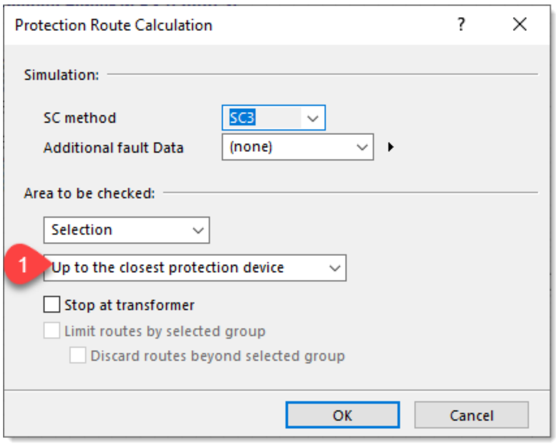
For protection devices, the voltage at the installation location of the current transformer is now used as the reference for the It diagram.

Extended display of the motor startup characteristic in the It diagram

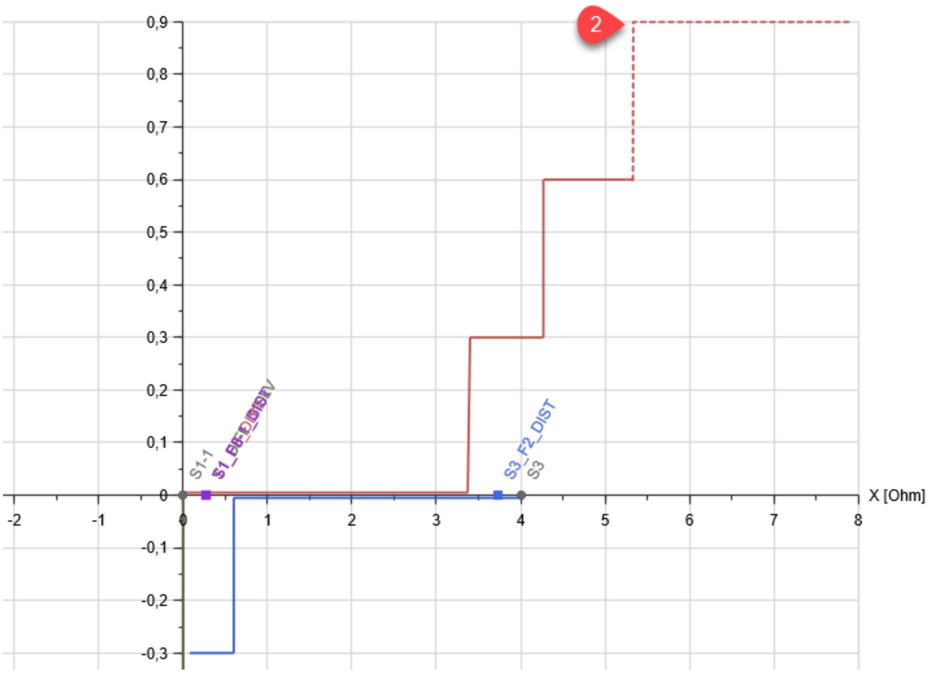
The display of the motor starting characteristics in It diagrams has been improved. When determining the characteristic curve in the time range of 10 ms, the transient DC current is considered, this decays with a time constant.

Extended control of the protection route calculation

In the protection route calculation, a new option (#1) is available in the calculation dialog for controlling the reach. Here, the calculation can optionally be performed from the next to the 9th nearest protection device.



Also new in the protection route calculation is an **improved display of the directional end time** in the grading diagrams. This is visualized by a dashed line (#2).



New distance protection devices

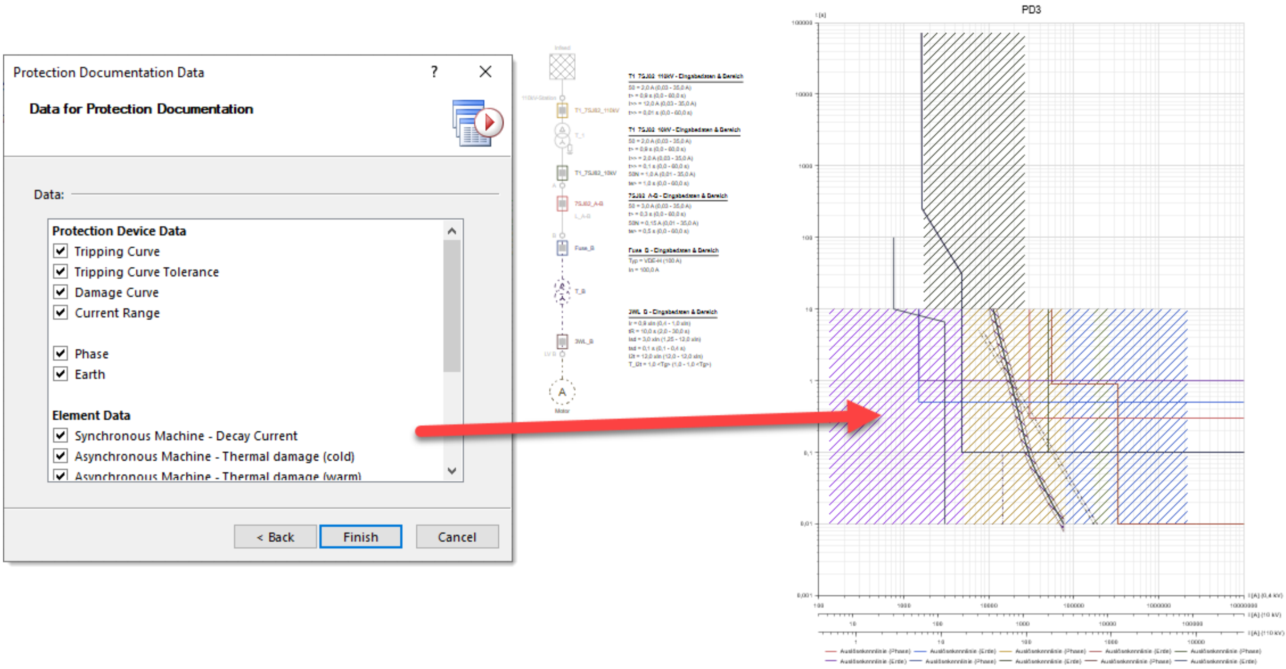
The following new distance protection devices are available in PSS SINCAL:

- **Easergy P3**
  Digital protection devices with setting values R, X und angle φ.
- **7SL82, 7SL86**
  Digital protection devices with setting values R, X, Z, angle φ und angle α.

Overcurrent Time Protection (OC)

Advanced Wizard for Protection Documentation

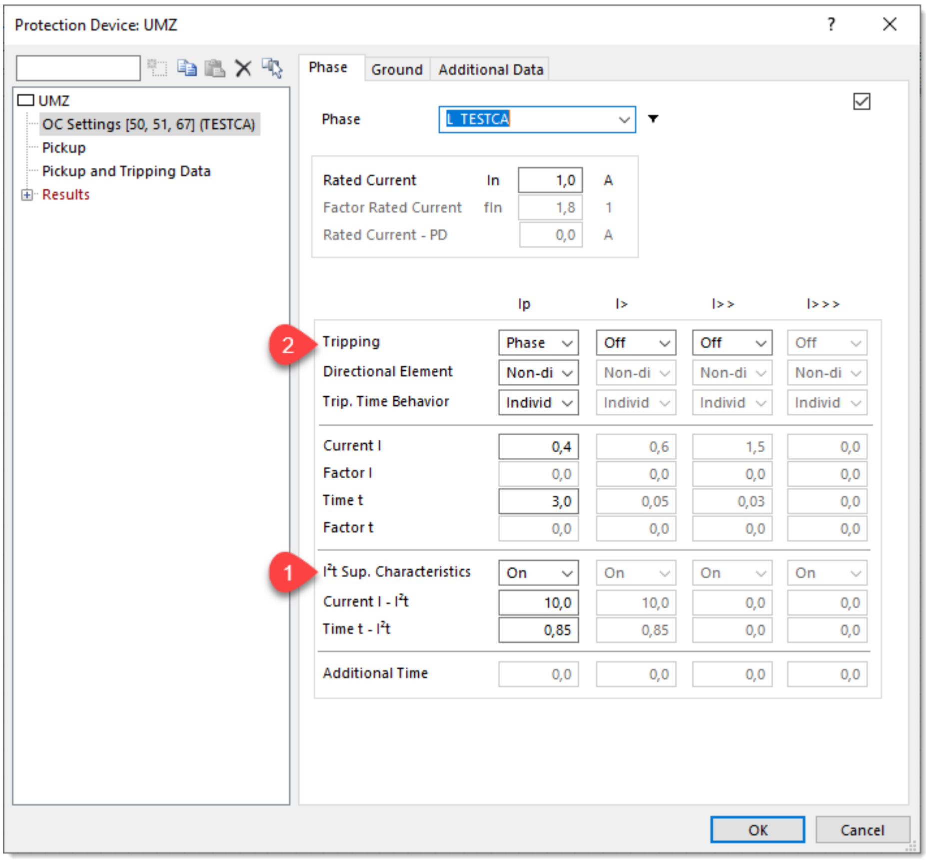
The wizard for creating the protection documentation has been extended. Now it is possible to parameterize in detail which data are to be visualized in the It diagram on the new dialogue page **Data for Protection Documentation** already during creation. Tripping curves, tolerances and current ranges of the protection devices can be selected, as well as the data of the network elements such as thermal damage, mechanical damage, inrush of transformers, motor starting curves, etc.



Ip-Zone Enhancement

Some circuit breakers have the option of setting either an equation or an I²t characteristic for the overload zone. This can now be modeled in PSS SINCAL via the Ip zone with the I²t Sup. Characteristic. For this purpose, the following extension has been implemented in the functionality for the OC protection devices:

- If the I²t Sup. Characteristic of the Ip zone is switched on (#1), this is used and the stored characteristic of the Ip stage (#2) is ignored.
- If the additional characteristic of the Ip zone is switched off, the stored characteristic is used.



Advanced control for I²t transition characteristic

When modeling OC protection devices, it was previously only possible to set the reference to "I>" for the final zones. This has now been extended so that a reference to "Ie>" is also possible here.

Protection Analysis (PSA)

Consideration of coupling data

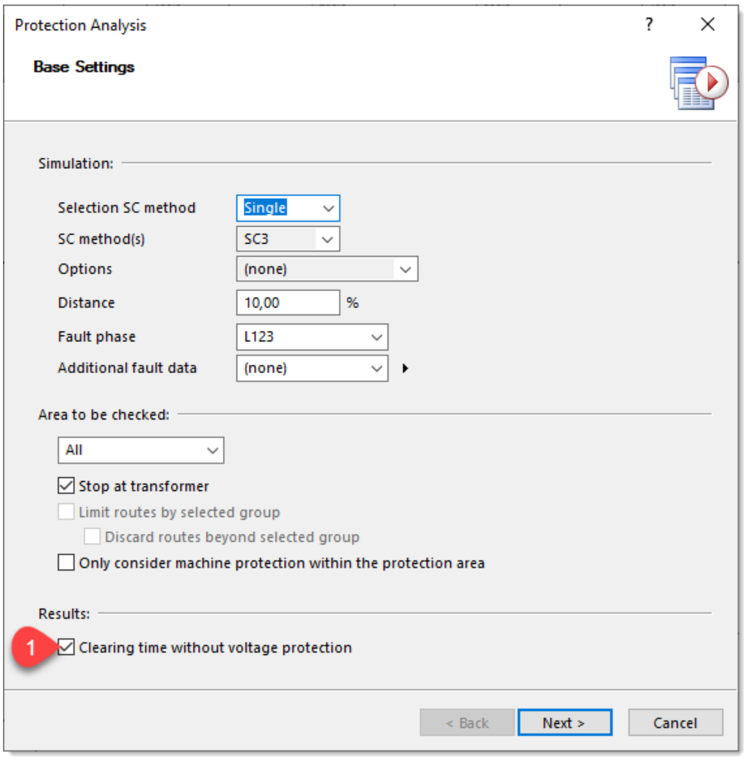
The algorithms of the protection analysis have been comprehensively extended so that this calculation module can also be used for lines with coupling data. Previously, this was not possible. An error message was generated if coupling data were assigned.

Now, when generating the variable fault observations on the lines with coupling data, all assigned lines are also divided. The coupling data are then determined proportionally on these lines.

Distinction between Short-Circuit Protection and Tripping by Decoupling Protection

If generating units with decoupling protection are assigned in the analysis area, the clearing times in the result matrix are dominated by the strongly delayed tripping times of the decoupling protection of the generating units. The significantly shorter and more interesting tripping times of the line protection are thus no longer visible at all.

To easily solve this problem without manually disabling decoupling protection in the entire analysis area, a new option is now available in the wizard for Protection Analysis to control which results are generated (#1):



With the option **Clearing time without voltage protection**, the tripping of the voltage protection is not considered in the results in the clearing time. However, the pick-up and tripping during the fault clearing takes place with consideration of the voltage protection.

Removing Thermal Destruction in the Protection Analysis

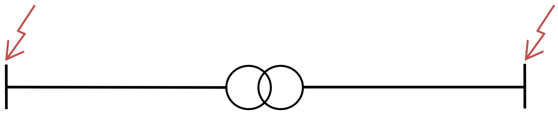
The determination and display of thermal destruction of equipment is no longer available in the Protection Analysis calculation module. The previous functionality and much more is available in the new Thermal Destruction Analysis module.

Thermal Destruction Analysis (TDA)

The operating equipment of the network must be designed to withstand short circuits. To check this, extensive manual short-circuit calculations were previously necessary for the entire network area, taking into account the switch-off times of the network protection.

The Thermal Destruction Analysis calculation module enables both the network planning and protection departments to perform an automated check for thermal destruction for lines, transformers busses and breakers present in the network.

The calculation module works like the Protection Analysis module. Automatically generated faults are calculated in the network to identify all possible problems.

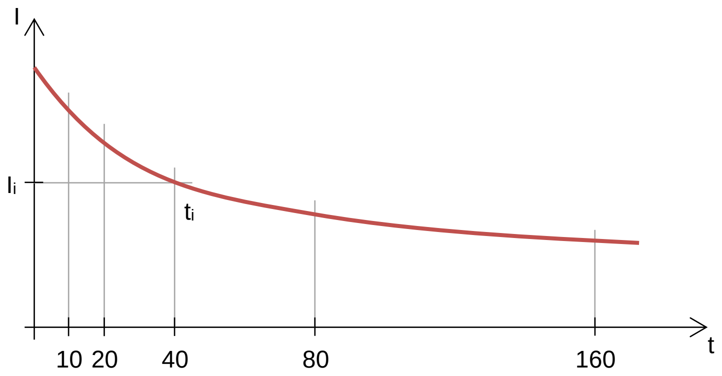
Lines	Generated fault locations:
Lines 	**Generated fault locations:** - Fault at start node - Fault shortly after the start node - Fault acc. to subdivision specification (here 3 parts = 2 faults). - Fault shortly before the end node - Fault at end node
Transformers 	**Generated fault locations:** - Fault at start node - Fault at end node

For each of these generated faults, the thermal stress of the network elements is checked. Here, the maximum possible thermal withstand of the network element must be greater than the determined thermal stress.

The check for thermal destruction usually takes place either in the network planning or in the protection department. While a detailed model of the network protection is usually available in the protection department, this is usually not the case in network planning. Therefore, the two following modes are available for the check.

- Short Circuit:
  The protection systems are not modeled in the network to be analyzed. The thermal withstand capability of the lines and transformers is therefore checked for a maximum fault clearing time. This maximum fault clearing time should correspond to the maximum clearing time of faults by the network protection.
- Protection:
  A calculation is made with the protection simulation. Protection devices must be present in the network and correctly parameterized. The thermal short circuit withstand capability is checked based on the fault clearing time of the protection system.

To consider the decay process of the short-circuit current of machines, the calculation is performed in special time steps for each fault location. At fault occurrence, the time is 0.0 milliseconds. The first time point is set at 10 milliseconds. The next time point is obtained by doubling the time since fault occurrence, and so on.



The thermal stress in the fault case is given by the discretized Joule integral as follows

$$E_k = \sum I_i^2 \times (t_i - t_{i-1})$$

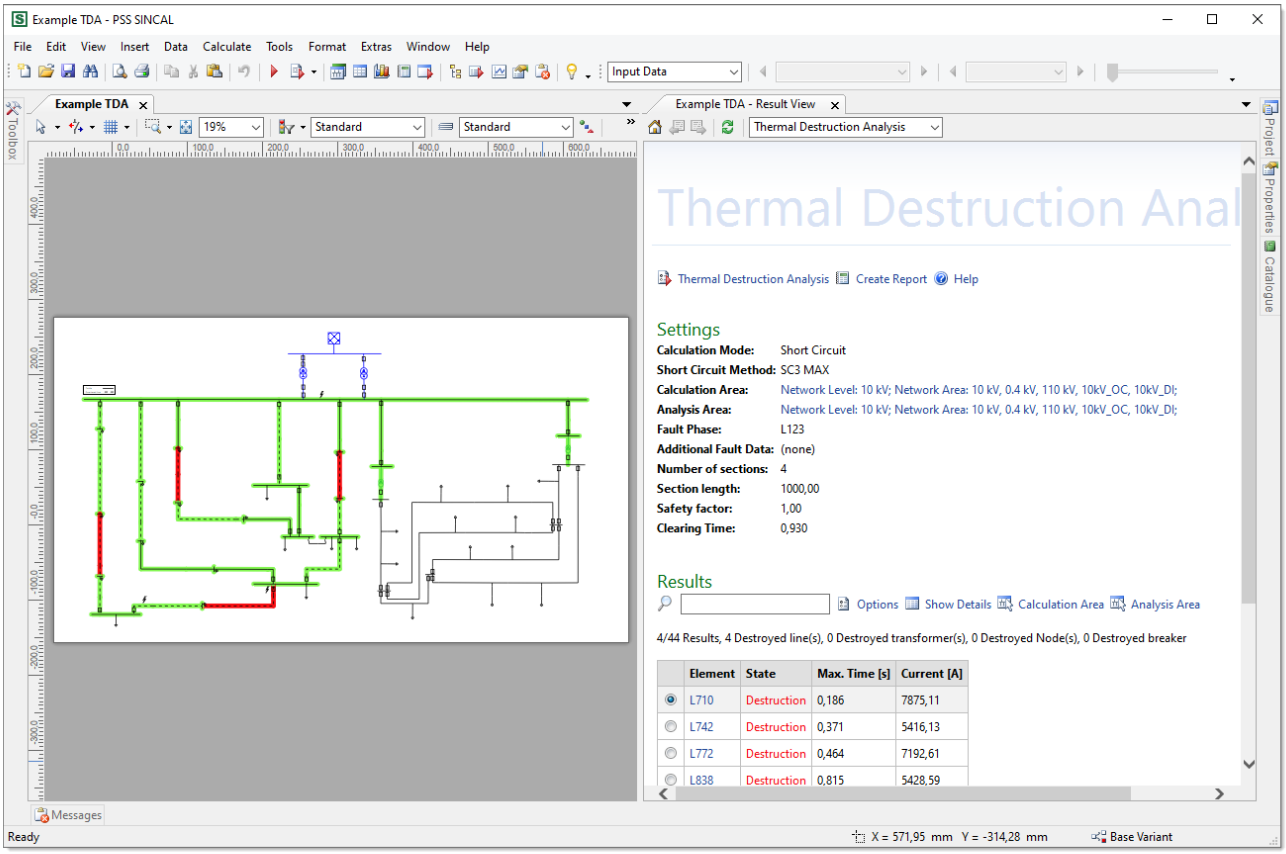
with

$$i = 10, 20, 40, 80, 160, \ldots$$

The calculation of a fault is terminated when the following condition is met.

- For short circuit:
  When the specified fault-clearing time T_{Clear} is reached.
- For protection:
  If the fault was cleared and the fault-clearing time T_{Clear} was determined.

As a result of the calculation, a clear representation of all the equipment that is not thermally short-circuit-proof is made available in the results view. Detailed analyses in the network can also be started directly from the results view. Based on the results, measures regarding network protection or network expansion can be derived and their effectiveness can be checked by the thermal destruction analysis.



The Thermal Destruction Analysis calculation module was already released with PSS SINCAL 18.0. In this product version, feedback from pilot users was integrated and the functionality was extended.

Enhanced Checks for Breakers, Busbars and Nodes

Previously, the calculation module could be used to check the short-circuit capability of lines and transformers. Now, breakers as well as busbars and nodes can also be checked. In the following it is shown how the checks and evaluations of the thermal destructions are carried out for the different equipment.

The maximum thermal short-circuit withstand capability of the **Line** is determined by the permissible short-circuit current.

$$E_L = I_{1s}^{\ 2} \times 1\ sec$$

If the condition $E_L > E_k$ is not fulfilled, the line is destroyed.

The maximum thermal short-circuit withstand capability of a **Transformer** results from 25 times the rated current at 2 seconds. In addition, transformers are short-circuit resistant for 2 seconds.

$$E_T = (25 \times I_N)^2 \times 2\ sec$$

$$T_{max} = 2\ sec$$

If the conditions $E_T > E_k$ and $T_{Clear} < T_{max}$ are not fulfilled, the transformer is destroyed.

The maximum thermal short-circuit withstand capability of **Busbars and Nodes** is determined by the maximum admissible short-circuit current and the rated short time.

$$E_N = I''_{k\,max}{}^{2} \times t_{kr}$$

If the condition $E_N > E_k$ is not fulfilled, the busbar or the node is destroyed.

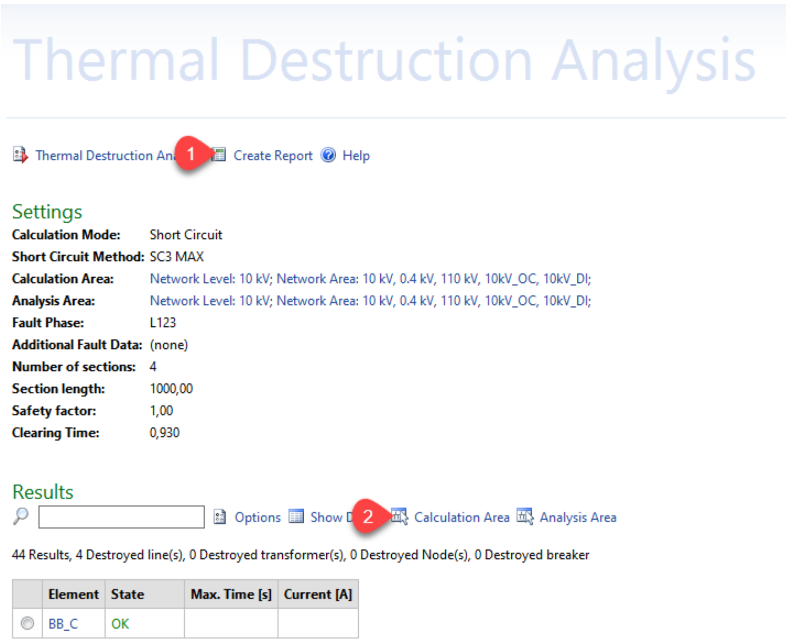
The maximum thermal short-circuit withstand capability of **Breakers** is determined by the maximum admissible short-circuit current and the rated short time.

$$E_B = I''_{k\,max}{}^{2} \times t_{kr}$$

If the condition $E_B > E_k$ is not fulfilled, the breaker is destroyed.

New Functions in the Result View

In the results view, the **Create Report** function is now available in the toolbar, which can be used to export the results as a report to a PDF file (#1). The report displays the information that is visualized in the results view.



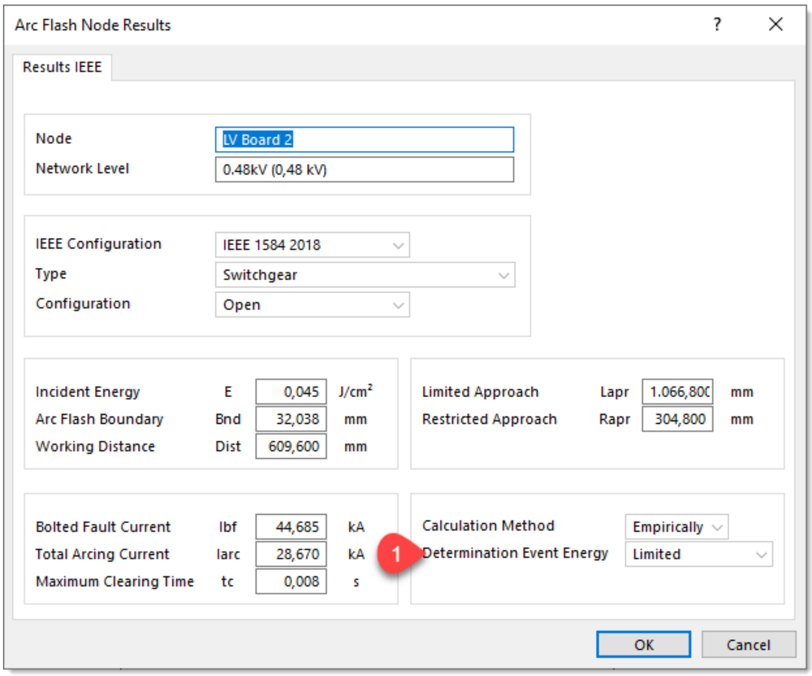
Also new here are the functions for visualizing the **Calculation Area** and **Analysis Area** in the

Graphics Editor (#2). By clicking on the link, the corresponding network elements are selected in the graphics editor and can thus be used for further editing and analysis.

Arc Flash (AFH)

Current Limitation of Fuses

At high currents, fuses trip within the first half-period. The rms value of the initial short-circuit alternating current determined via the short-circuit current calculation therefore does not occur at all. In this case, a smaller rms value can be used to determine the incident energy. This limitation was also always considered in PSS SINCAL according to the standards used for the calculation but was not visible in the results. Therefore, the results of the Arc Flash calculation were extended (#1):



The field **Determination Event Energy** indicates whether adjustments have been made in determining the event energy (reduced arc current, current limitation of protection devices).

Tripping time correction for fuses for IEEE 1584

For fuses, a change has been made in determining the trip time for the current IEEE 1584 2018 standard. The following now applies:

- IEEE 1584 2002:
  For fuses, a factor of 1.1 is applied to the clearing time. A factor of 1.15 is used for clearing times shorter than 0.03 s.
- IEEE 1584 2018:
  A factor of 1.1 is applied here to the clearing time of fuses. A correction time of 0.004 s is also added.

For both methods, a clearing time of 0.01 s is specified as a minimum.

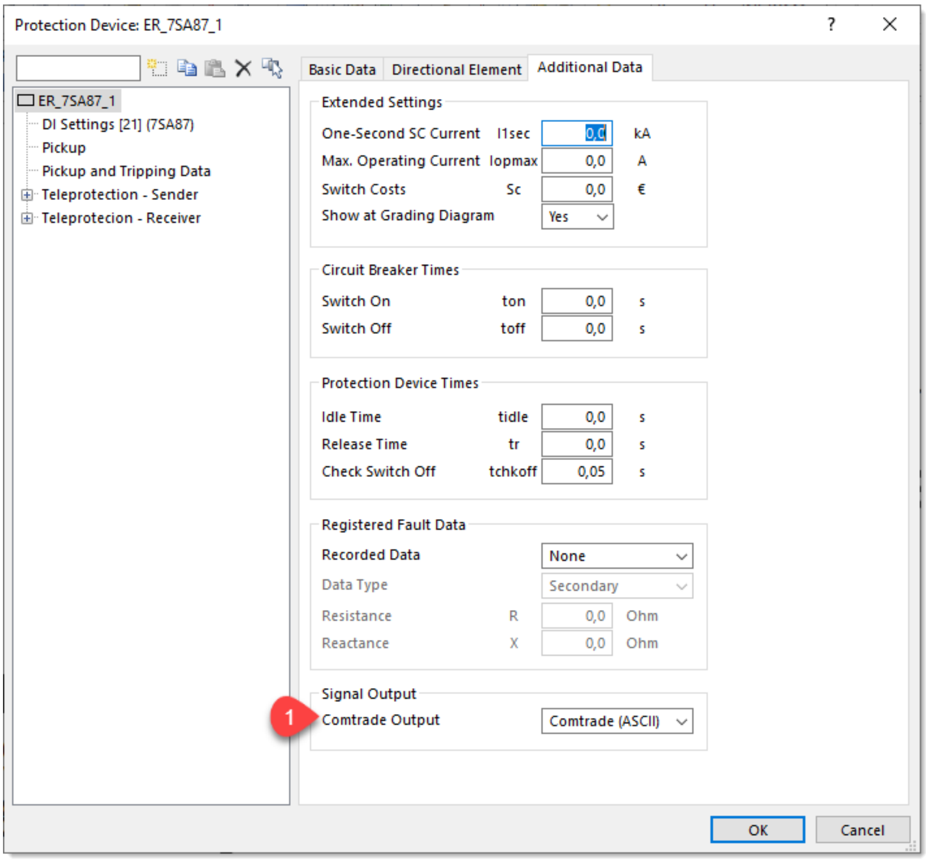
Dynamics Simulation (ST, EMT)

The increase of DER generation goes along with some challenges related to power system stability, control, and protection. Different analysis methods address these challenges. For general grid planning, in most cases steady-state methods are utilized. Any further and deeper technical aspects require the analysis in time and frequency domain. Therefore, in this product version, enhancements have again been made in dynamics simulation.

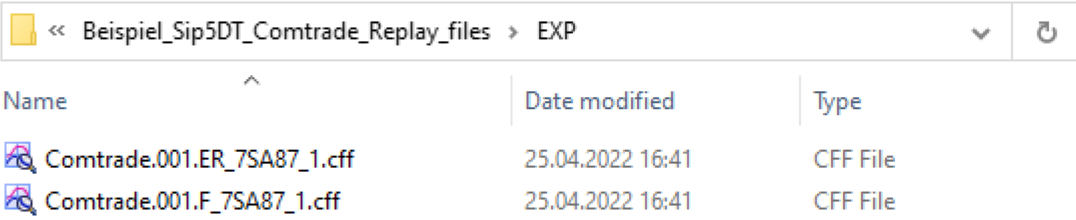
Comtrade Files in EMT Simulation for Protection Devices

The Comtrade data format defined in the IEC 60255-24 standard enables a standardized information exchange of instantaneous value records for the analysis of transients during faults and other events. On the one hand, these data can be used for validation of models and comparison to simulation (EMT). On the other hand, they are used in the interaction of simulation with digital-analog amplifiers, for example, for testing protection devices and their algorithms.

With this version, the integration of the Comtrade export function in PSS SINCAL has been comprehensively extended to make it even more convenient for users. **Comtrade Output** (#1) can now be activated directly on the protection device under **Additional Data**.

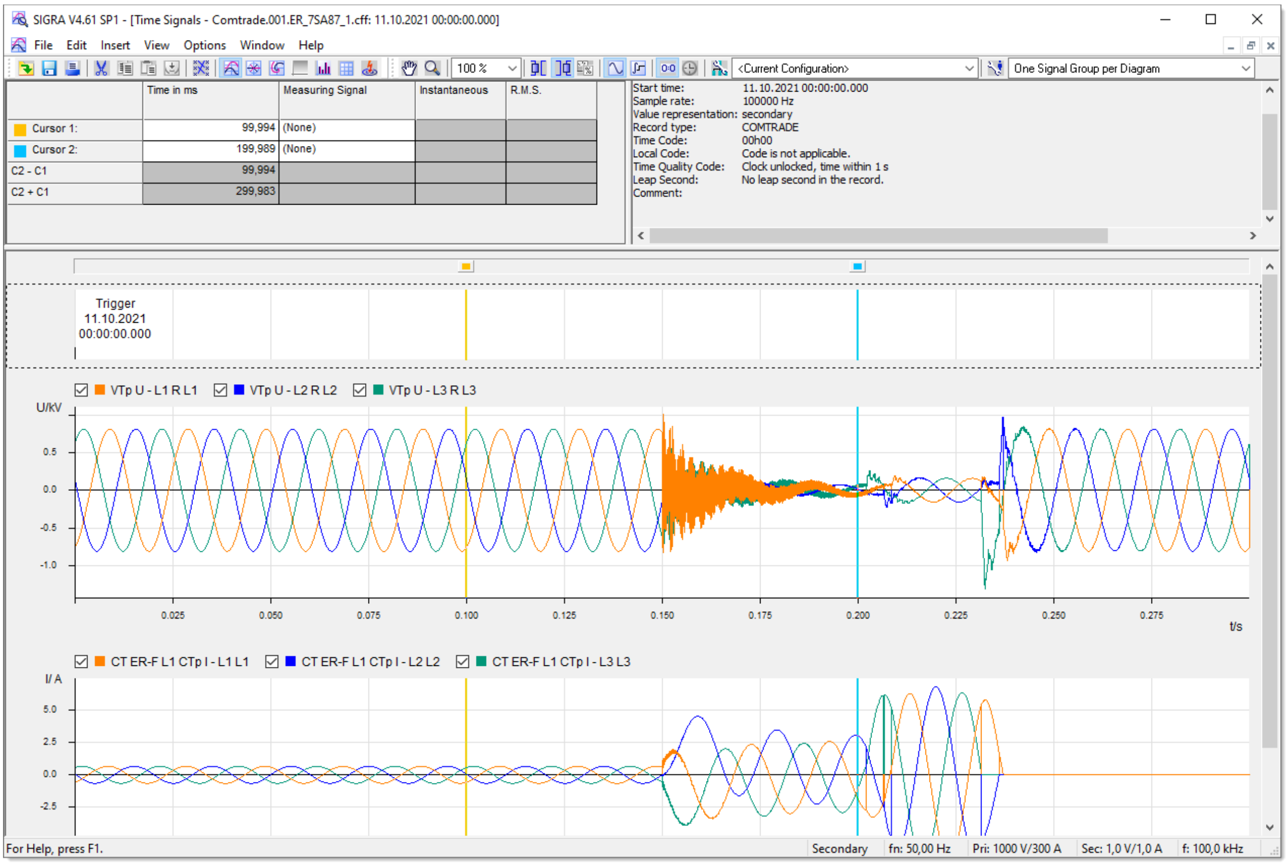


This generates an individual Comtrade file in the selected format (ASCII or binary) in the EMT simulation for all protection devices parameterized in this way. The secondary side signals of the assigned measurement transformers (currents and voltages) are automatically recorded in the file. The measurement transformer ratio is of course also stored in the Comtrade file. The generated Comtrade files are provided in the directory "xxx_files\EXP":



The file names contain the variant number, the station (if available) and the name of the protection device. This information is also stored in the header of the Comtrade file.

The following picture shows the analysis of a Comtrade file generated by PSS SINCAL in SIGRA evaluation tool. Here, signals, conductor information, measurement transformer ratios, etc. are all visualized correctly based on the information stored in the file.

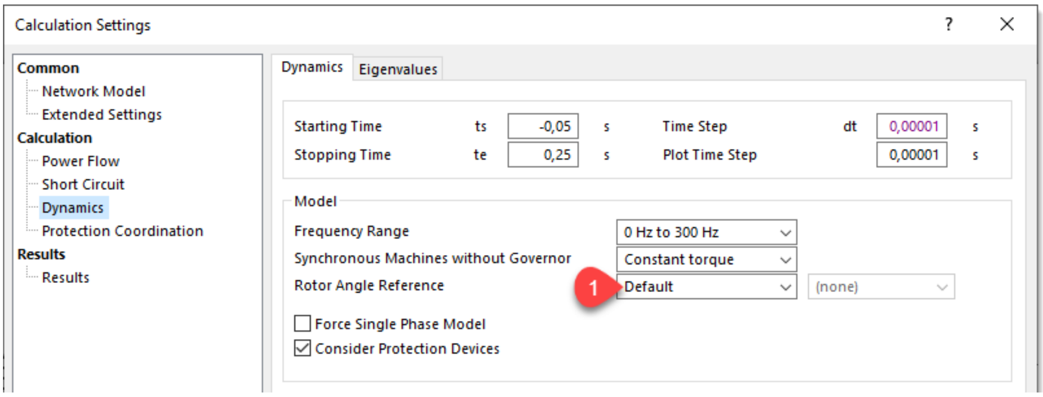


Extended functionality for rotor angle reference

The functionality for defining the rotor angle reference has been extended. Up to now, it was the case that a machine could be marked as a reference machine in the network model. This is impractical in handling, since changes are not easily possible, and it is also not immediately apparent which machine has been marked accordingly here.

Now the reference value for all rotor angles can be defined directly in the Calculation Settings for the dynamics simulation using the **Rotor Angle Reference** field. The following options are available here:

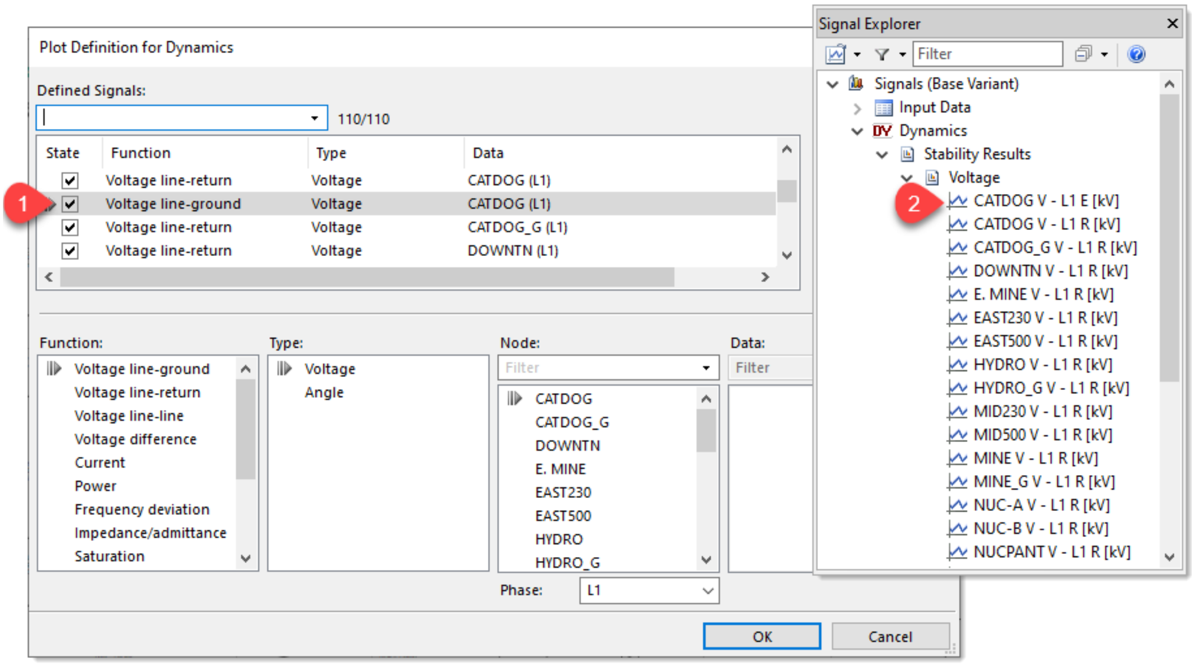
- Default:
  The inner voltage of the primary infeeder is used and its angle is set to be the reference. As it is a fixed frequency source, the coordinate system rotating with rated frequency is relevant. If there is no network infeeder, the rated frequency coordinate system is the reference value.
- Reference machine:
  The rotor angle of the reference machine is the reference angle.
- Reference source:
  The angle of the internal voltage of the reference supply is the reference angle.
- Center of Inertia (COI):
  The Center of Inertia is the reference angle. It is derived from weighted average of all rotor angles in the grid.
- Terminal voltage:
  The individual terminal voltage is the reference angle.



Due to the change, it is immediately visible in the Calculation Settings which settings are active for the rotor angle reference. In addition, it is easy to switch between the different options for different evaluations.

Extensions for Plotting Voltages

Plotting of voltage signals in dynamics simulation has been extended.



Now in the **Plot Definition for Dynamics** dialog box you can choose between the output of phase-to-ground voltages and phase-to-return voltages (#1). This differentiation in plotting is important for unbalanced network models as well as for those with isolated neutral points.

The display of voltage signals in the **Signal Explorer** has also been improved (#2). All essential data is now displayed to easily identify and assign the signal.

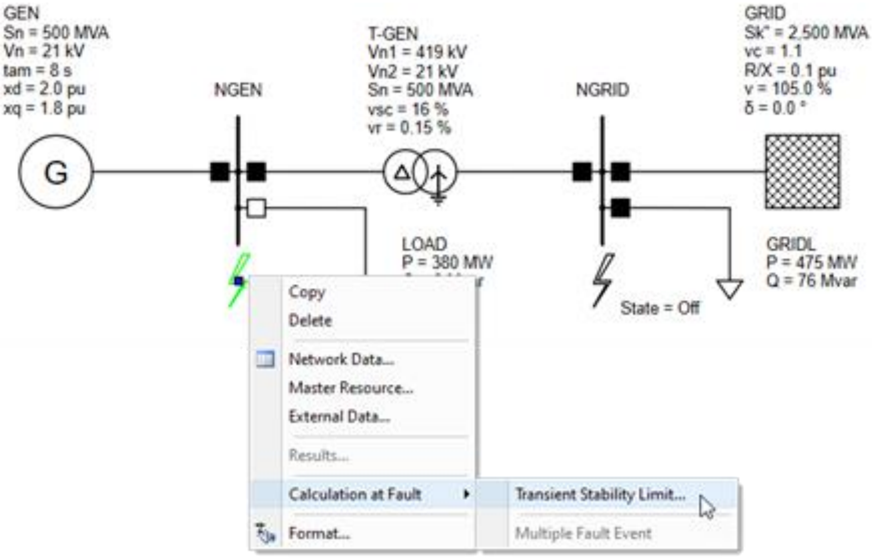
Sample: CATDOG V – L1 E [kV]

- Node name: CATDOG
- Signal type: V
- Conductor: L1, L2, L3
- Ground/Return Line: E, R
- Unit: [kV]

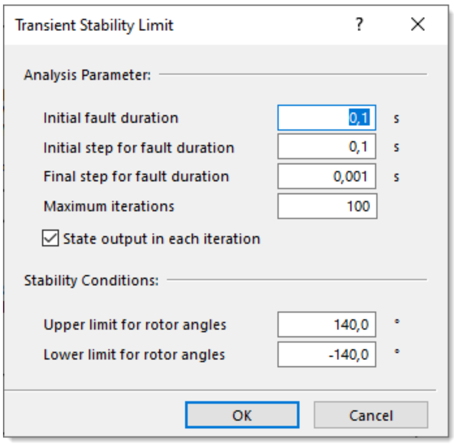
Transient Stability Limit

This simulation method is used to determine the critical fault clearing time (CFCT) in a grid. CFCT is defined by the fact that after a fault clearing all generators can again be synchronized to each other, and the rotor angle stability is maintained. As criteria for the instability, user-defined limit values are specified for the minimum and maximum rotor angles of the synchronous machines related to a reference angle in the calculation parameters.

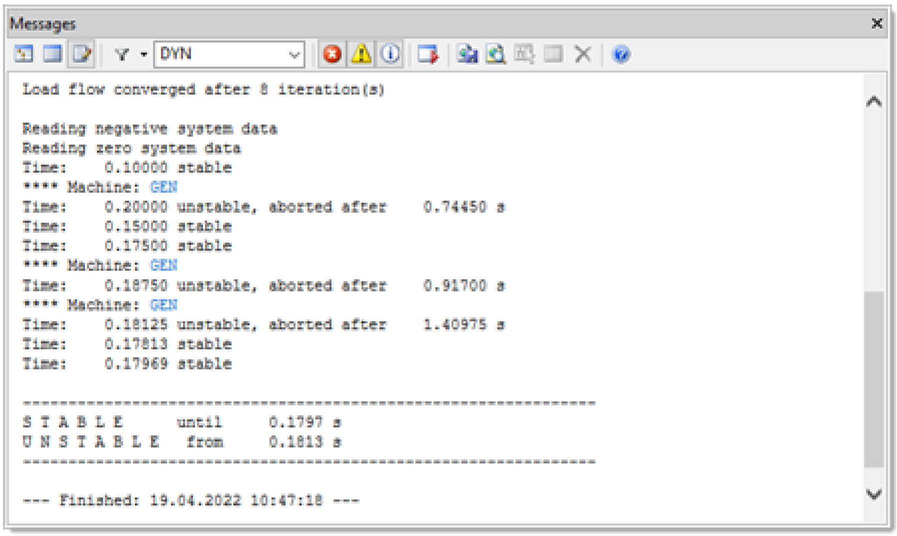
The determination of the transient stability limit is started via the context menu of a Fault Observation.



The parameterization for this simulation method has been comprehensively revised. This is now done via a new dialog that is opened directly when the simulation method is started. All essential parameters can be specified in the dialog. The **upper limit** and the **lower limit for rotor angles** are relevant and can be used to determine instability. Starting from an initial fault duration, the duration is successively increased and the simulation is repeated in each case. As soon as one of the two values in relation to the reference angle is exceeded for a synchronous machine in the network, a change of direction and a step halving take place when adding or subtracting the step-size of the fault duration. This is carried out until the change is below a minimum value and thus the critical fault duration is found.



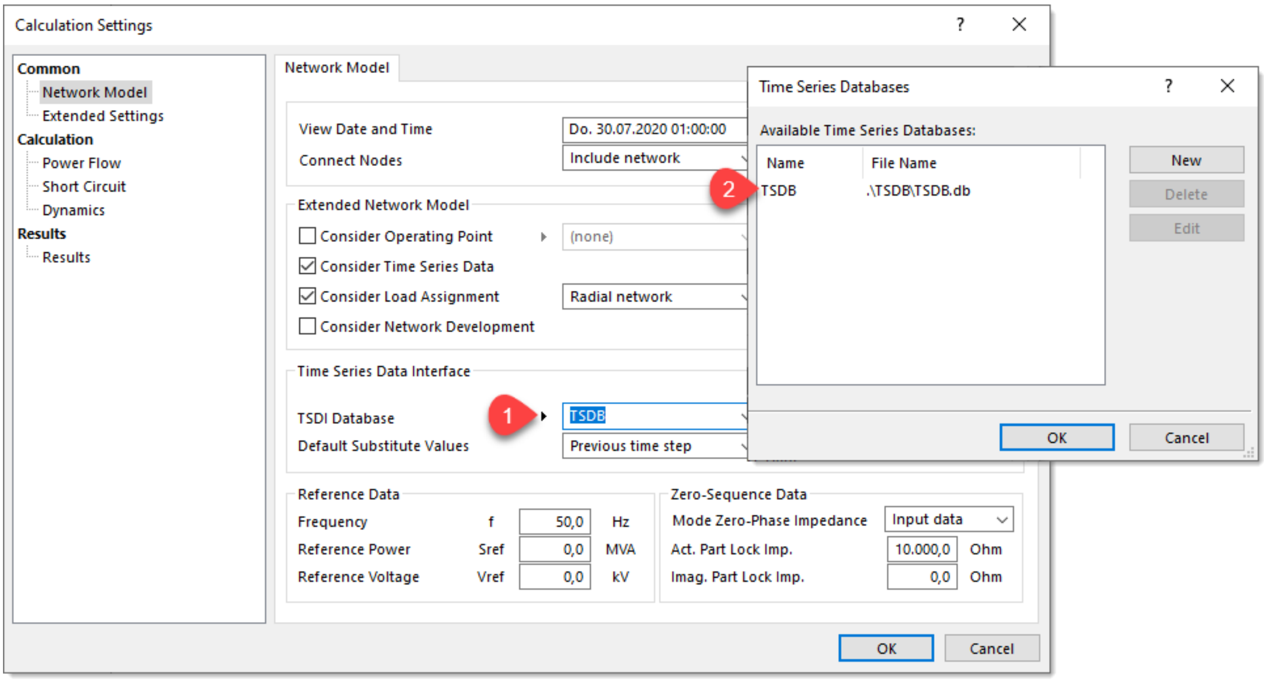
The results of the transient stability limit calculation are available in the message window in the HTML log. The log contains the individual states of each iteration with varied fault durations and at the end of the log the fault duration for the transition from "stable" to "unstable" is displayed.



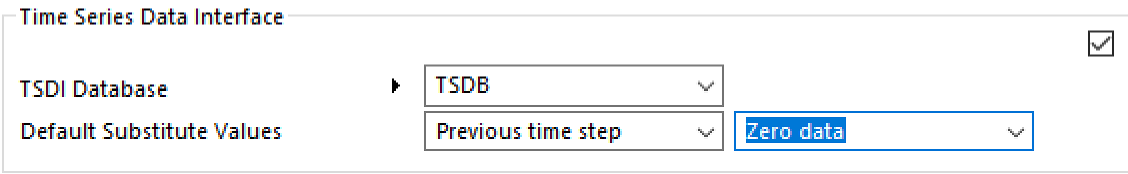
Time Series Data Interface (TSDI)

Advanced Configuration of the Time Series Data Interface

The linking of databases for the Time Series Data Interface (TSDI) in the Calculation Settings has been simplified. In the **Network Model** tab, new TSDI databases can now be linked or edited directly by clicking the **>** button (#1). This opens the dialog for assigning and managing linked databases (#2).



Also new is the option for extended predefinition of the **Default Substitute Values** when using the **Previous time step** option.



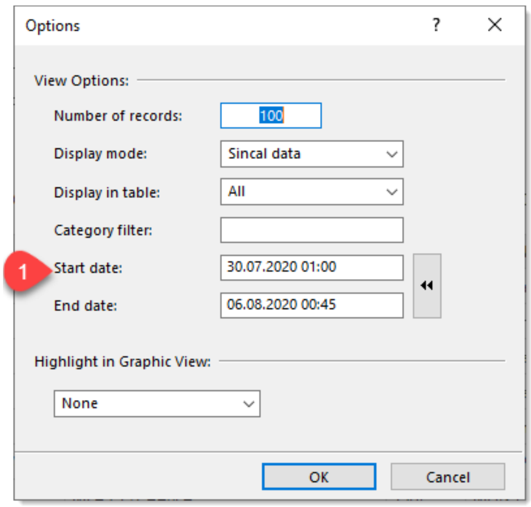
An additional dropdown allows to specify the TSDI behavior in case no TSDI data is available before the start time of the calculation or the start of a measurement series for an invalid or zero value. The following options are available:

- Zero data:
  The power is set to zero.
- Input data:
  The input data of the element are used.
- Profile data:
  The profile data of the element are used.
- Profile or zero data:
  If there is no profile data for the element, the power is set to zero.
- Profile or input data:
  If there is no profile data for the element, the input data is used.
- First valid TSDI data:
  The first valid TSDI data found for the object will be used.

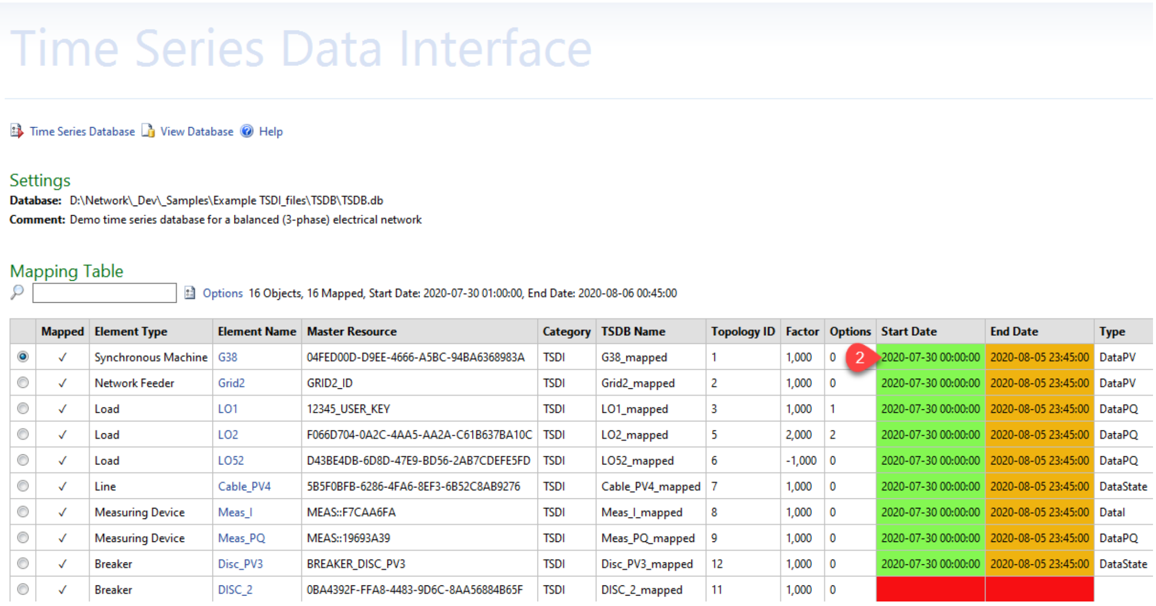
Advanced Visualization of the Mapping

In the results view, additional information from the database connected via the TSDI can be visualized in the PSS SINCAL user interface.

To make it easier to see at which points in time TSDI data is available, there is now an extended visualization in the result view. If a filter range for the date is defined in the **Options** dialog box (#1), then the date columns in the result view are colored accordingly. Taking over the values set in the calculation parameters for start and end date is also easily possible. To do this, simply click the << button.



The following picture shows the result view of the time series data interfaces with date coloring enabled (#2):



Time Series Data Interface

Time Series Database View Database Help

Settings

Database: D:\Network_Dev_Samples\Example TSDI_files\TSDB\TSDB.db

Comment: Demo time series database for a balanced (3-phase) electrical network

Mapping Table

Options 16 Objects, 16 Mapped, Start Date: 2020-07-30 01:00:00, End Date: 2020-08-06 00:45:00

	Mapped	Element Type	Element Name	Master Resource	Category	TSDB Name	Topology ID	Factor	Options	Start Date	End Date	Type
◉	✓	Synchronous Machine	G38	04FED00D-D9EE-4666-A5BC-94BA6368983A	TSDI	G38_mapped	1	1,000	0	2020-07-30 00:00:00	2020-08-05 23:45:00	DataPV
○	✓	Network Feeder	Grid2	GRID2_ID	TSDI	Grid2_mapped	2	1,000	0	2020-07-30 00:00:00	2020-08-05 23:45:00	DataPV
○	✓	Load	LO1	12345_USER_KEY	TSDI	LO1_mapped	3	1,000	1	2020-07-30 00:00:00	2020-08-05 23:45:00	DataPQ
○	✓	Load	LO2	F066D704-0A2C-4AA5-AA2A-C61B637BA10C	TSDI	LO2_mapped	5	2,000	2	2020-07-30 00:00:00	2020-08-05 23:45:00	DataPQ
○	✓	Load	LO52	D43BE4DB-6D8D-47E9-BD56-2AB7CDEFE5FD	TSDI	LO52_mapped	6	-1,000	0	2020-07-30 00:00:00	2020-08-05 23:45:00	DataPQ
○	✓	Line	Cable_PV4	5B5F0BFB-6286-4FA6-8EF3-6B52C8AB9276	TSDI	Cable_PV4_mapped	7	1,000	0	2020-07-30 00:00:00	2020-08-05 23:45:00	DataState
○	✓	Measuring Device	Meas_I	MEAS::F7CAA6FA	TSDI	Meas_I_mapped	8	1,000	0	2020-07-30 00:00:00	2020-08-05 23:45:00	DataI
○	✓	Measuring Device	Meas_PQ	MEAS::19693A39	TSDI	Meas_PQ_mapped	9	1,000	0	2020-07-30 00:00:00	2020-08-05 23:45:00	DataPQ
○	✓	Breaker	Disc_PV3	BREAKER_DISC_PV3	TSDI	Disc_PV3_mapped	12	1,000	0	2020-07-30 00:00:00	2020-08-05 23:45:00	DataState
○	✓	Breaker	DISC_2	0BA4392F-FFA8-4483-9D6C-8AA56884B65F	TSDI	DISC_2_mapped	11	1,000	0			

The colors in the date columns are determined as follows.

<table>
<tr><th>Color</th><th>Start date</th><th>End date</th></tr>
<tr><td>Red</td><td colspan="2">Start and end date TSDI element outside filter area</td></tr>
<tr><td>Orange</td><td>Start date TSDI element
>
Start date filter range</td><td>End date TSDI element
<
End date filter range</td></tr>
<tr><td>Green</td><td>Start date TSDI element
<=
Start date filter range</td><td>End date TSDI element
>=
End date filter range</td></tr>
</table>

Import and Export (INT)

PSS E Loc Import

The import function for graphic data from PSS E in Loc data format has been extended. Now also the new Loc files of PSS E V34 can be processed and the use of Loc files in GEOPHYSICAL format (longitude and latitude for positions) is now possible.

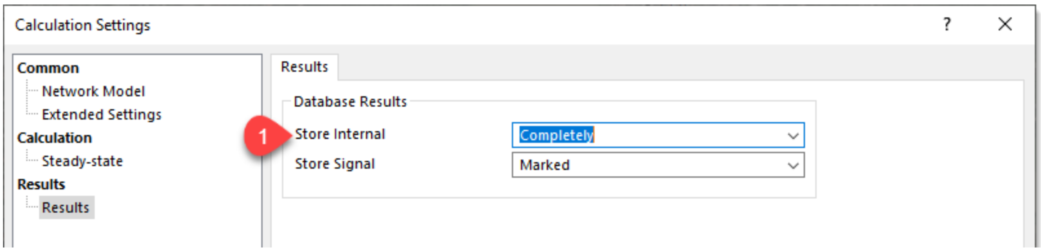
Pipe Networks

General Improvements

Advanced Control of the Scope of Results

The performance of the calculation of large network models depends significantly on the scope of the generated and stored results. The user now has extended possibilities to configure and control the scope and thus to increase the performance.

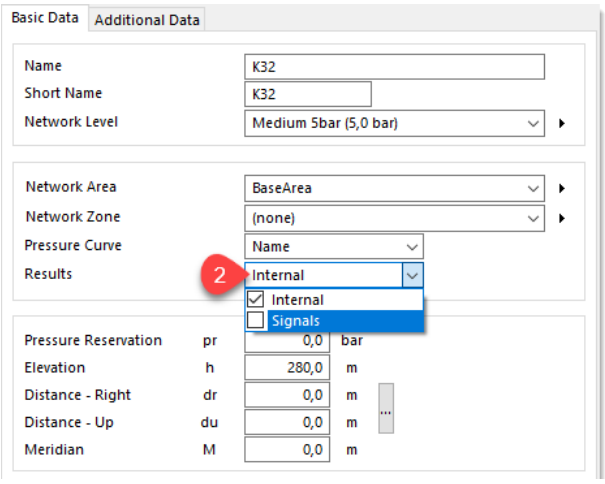
Analogous to the electrical networks, it is now possible to flexibly control which scope of results is to be stored in the network database and in the signal database. The configuration is done in the **Results** tab (#1) of the calculation settings.



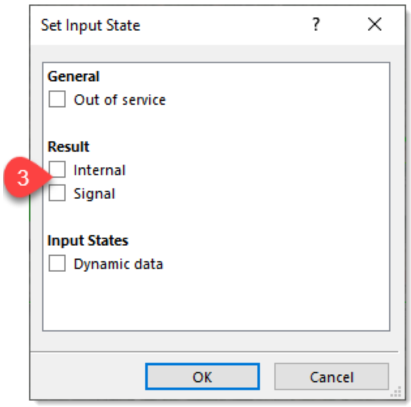
You can choose between the following options:

- **None**: No results are stored.
- **Completely**: All results are stored.
- **Marked**: Results are saved only for those elements where the corresponding result generation (at least one of the "Internal", "Signal" options on the respective element) has been activated.

The **Marked** option is recommended when calculations are performed in large networks and/or provide extensive results (e.g. time series calculation) when results are only of interest at certain points in the network. The result marking can be done individually for nodes, network elements, network levels and network areas.



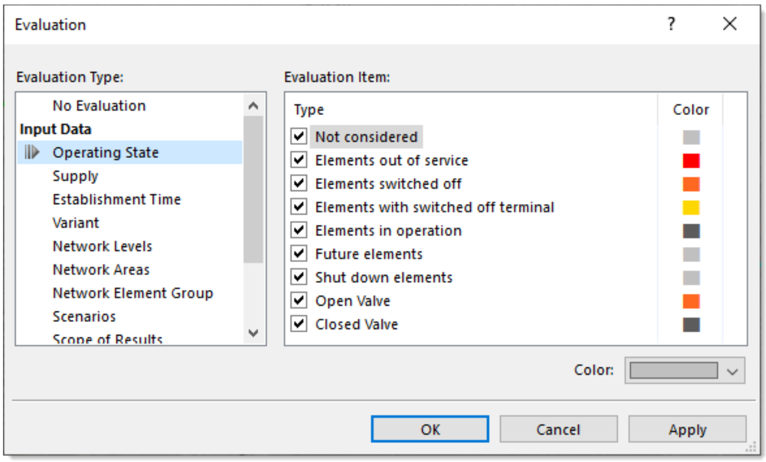
Configuration of the result scope can be done comfortably with the **Set Input Status** dialog box as well. This allows you to configure result saving for all nodes and network elements marked in the graphics editor (#3).



Display of the Valve Position in the Network Graphic

Valves can now be opened and closed interactively with the switch mode. They also show their position in the network graphic and the status can be synchronized from other systems using API or import function.

In addition, the valve position can also be visualized with the evaluation of the operating status. The valves and non-return valves are colored appropriately here according to the status (open/closed).

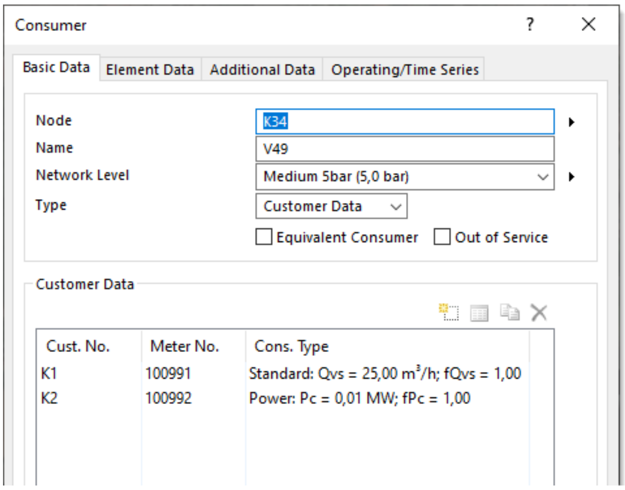


Enhancements for Gas Networks

Extended Display of Customer Data in the Consumer Screen Form

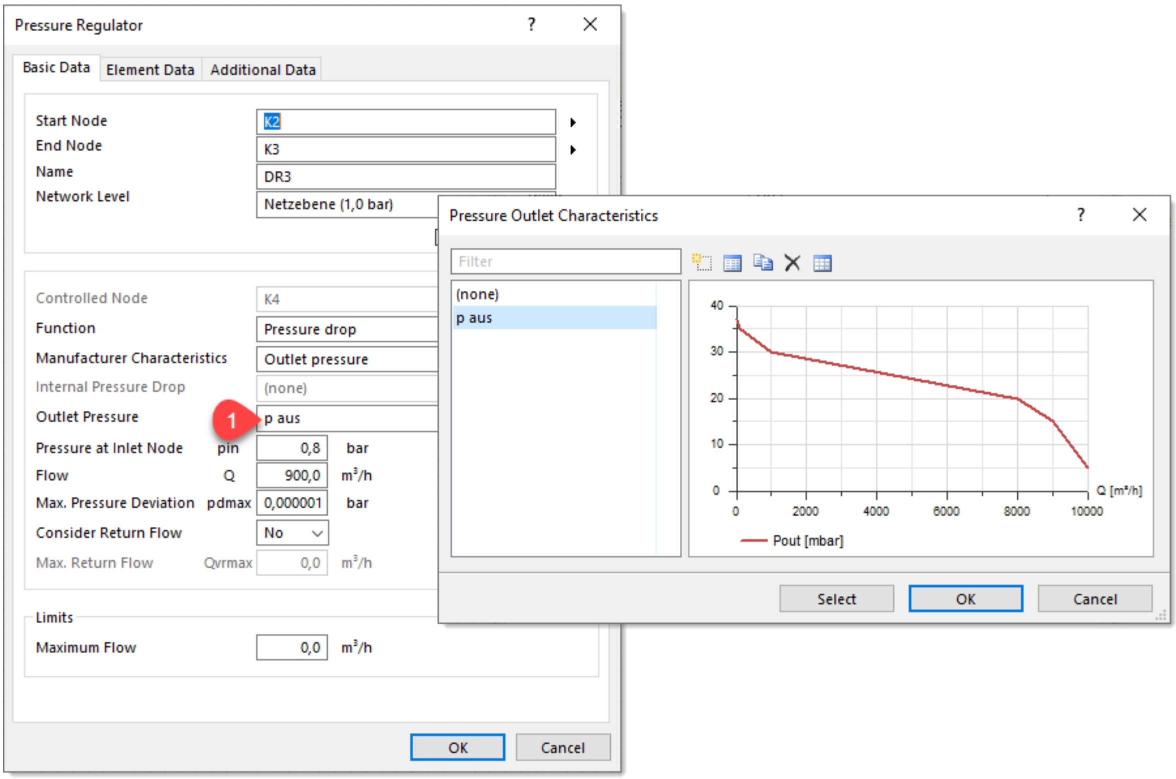
To reduce the size of the model for gas networks, consumers can be combined in customer loads in order to keep the meter or customer reference to other systems (billing system, forecasting system). In the network model, only one representative consumer element is required containing all end consumers (and meters) in it.

The possibility of assigning customer data has already introduced in product version 18.0. In this version, the display of customer data in the data screen form has been made more informative. In addition to the customer and meter number, the consumption type of the consumer is now also available in the screen form. This shows at first glance which types of consumption are assigned to the consumer.



Improved Input of p(Q) Characteristic for Pressure Regulator

The input of p(Q) characteristics for pressure regulators has been extended. Modeling of gas pressure regulating systems by flow-dependent control of outlet pressure allows easier simulation of limited flow capacity and the resulting pressure drop at high flow rates.



The output value for determining the outlet pressure is the flow Q at normal condition determined by the steady-state simulation.

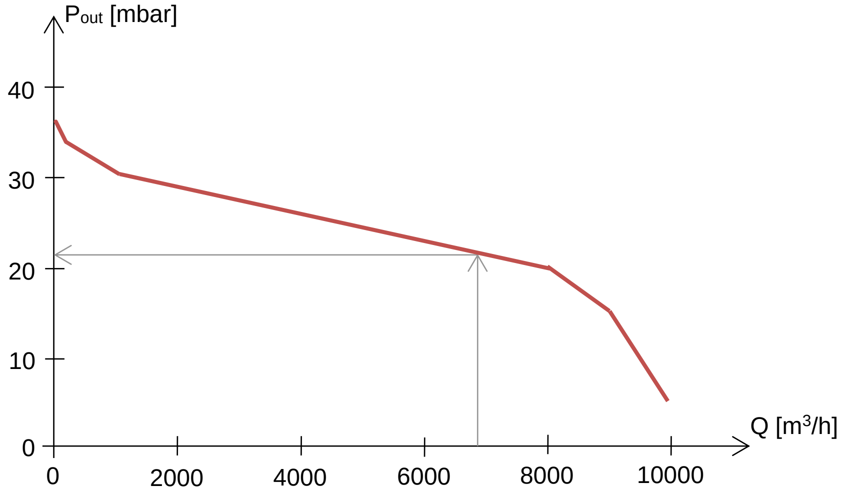
This results in an outlet pressure p at the outlet or controlled node based on the outlet pressure characteristic.

Pressure outlet characteristics are described from value pairs of **Q** (flow) and $\mathbf{p_{out}}$ (outlet pressure).

The value pairs for the characteristic curve (flow Q_{Kl} and pressure drop Δp_{outKl}) result after multiplying the value pairs from the dialog box with the factors from the basic data of the pressure outlet characteristic curve.

$$Q_{Kl} = Q \times fQ$$

$$p_{outKl} = p_{out} \times fp$$



The input value is the flow Q across the pressure regulator determined by the steady-state iteration.

This results in an outlet pressure p_{out} for the next iteration via the outlet pressure characteristics.

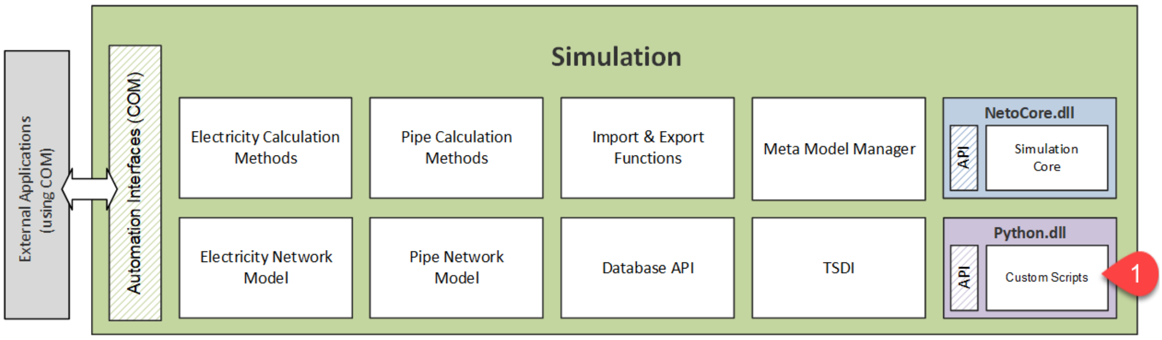
Automation (Programming Interfaces)

The PSS SINCAL Platform has an open architecture and provides a variety of APIs that can be used to automate the user interface and calculation modules in custom applications and scripts.

To create individual automation solutions, all programming languages (C++, C#, VB/VBA/VBS, Python, ...) that support the Windows Component Object Model (COM) can be used. The use of Python is recommended because it is particularly powerful and offers an almost unlimited number of add-on packages for all conceivable use cases that can be easily installed and used.

In principle, PSS SINCAL does not have any special requirements for the version of the programming languages used. However, this does not apply to the **internal automation of the calculation methods**.

This form of automation allows to run own scripts in the calculation modules. The scripts run then not outside of the calculation, but directly in the individual calculation modules (#1). Thus, various possibilities result to access the internal data, to control the behavior of the calculation modules and also to evaluate and process the internal results, before these are written into the database.



The internal automation of the calculation is only possible with the Python programming language. For this, the appropriate Python version must also be installed and available in the search path (PATH variable). Up to now Python 3.7 was required and from PSS SINCAL 18.5 on **Python 3.10** is required.

Automation of the Calculation Methods

Improved Performance for Tabular Object

With the tabular object, the input data and results in the network database can be easily read out in the automation. Here, the data is accessed at attribute level. I.e. the data is processed row by row and each attribute is then addressed using the API function **Rows.Item()**. This is simple and flexible to use, but it is not very efficient for large amount of data.

Therefore, a new API function **Rows.FetchAll()** is now available at the tabular object, which can be used to fetch all data from the tabular object with a single command. The following Python snippet shows how to use it:

```python
# Get a row object from DB for further processing
strTable = "LFNodeResult"
Rows = SimulationDB.GetRowObj(strTable)
if Rows == None:
    print(f"Error: Getting {strTable} object failed!")
    SimulationDB = None
    CleanupAndQuit()

# Get all data via FetchAll
if Rows.Open() == 0:
    # Select specific attributes
```

```
    Columns = ["Result_ID", "Node_ID", "U", "U_Un", "phi", "P", "Q"]
    rows, cols = Rows.FetchAll(Columns)
    # Show available attributes
    if cols:
        print(f"\nTable {strTable}: Attrs={len(cols)}")
        for i, col in enumerate(cols):
            print(f"  {i+1:4}: {col}")
    # Print result values
    if rows:
        print(f"\nTable {strTable}: Rows={len(rows)}")
        for iRow, row in enumerate(rows):
            strRow = ""
            for i, itm in enumerate(row):
                if len(strRow): strRow += ", "
                strRow += itm
            print( f"  {iRow+1:4}: {strRow}")
        Rows.Close()
```

Here, two arrays are returned by the API function. The first two-dimensional array contains a table with data rows and with the attributes. The second array contains a listing of the attributes.

The main advantage of the new API function is the improved performance with large amount of data. Here, all data is transferred with a single API call. The following output shows as a comparison the times of **Rows.MoveNext()** and **Rows.Item()** to the new function **Rows.FetchAll()**:

```
Table LFNodeResult: Rows=2114, Cols=23
MoveNext 3.206115 sec (Rows=2114, Items=48622)
FetchAll 0.031274 sec (Rows=2114, Items=48622)
```

Even with a small amount of about 2100 data rows with 23 attributes, the new function is about 100 times faster. This factor becomes even greater with more extensive data sets.

SQL Queries for Virtual Results

The calculation modules can manage input data and results in a "virtual" network database. These data are then kept only in the main memory and the use is thus very performant. The use of the virtual database is activated via the API function **BatchMode()**.

The data in the virtual network database can now be evaluated with SQL queries using the new API function **SimulationDB.Fetch()**. The following Python snippet shows the usage of the new function:

```
# Enhanced select query with Database object
strSQL = ("SELECT VL.Name AS NetwLevel, "
          "       N.Name  AS Node1, "
          "       E.Name  AS Element, "
          "       E.Type  AS Type, "
          "       LFN.U_Un, "
          "       LFN.U, "
          "       LFN.phi, "
          "       LFB.I_Inp, "
          "       LFB.P, "
          "       LFB.Q, "
          "       LFB.I, "
          "       LFB.phiI "
          "FROM LFBranchResult LFB "
          "     LEFT JOIN Terminal T ON (LFB.Terminal1_ID = T.Terminal_ID) "
          "     LEFT JOIN Node N ON (T.Node_ID = N.Node_ID) "
          "     LEFT JOIN Element E ON (T.Element_ID = E.Element_ID) "
          "     LEFT JOIN VoltageLevel VL ON (N.VoltLevel_ID = VL.VoltLevel_ID) "
          "     LEFT JOIN LFNodeResult LFN ON (N.Node_ID = LFN.Node_ID) "
          "WHERE T.TerminalNo = 1;")

rows, cols = SimulationDB.Fetch(strSQL)

# Show available attributes
if cols:
```

```
    print(f"\nSQL Query with multiple tables: columns={len(cols)}")
    for i, col in enumerate(cols):
        print(f"  {i+1:4}: {col}")

# Print result values
if rows:
    print(f"\nQuery Result: Rows={len(rows)}")
    for iRow, row in enumerate(rows):
        strRow = ""
        for i, itm in enumerate(row):
            if len(strRow): strRow += ", "
            strRow += itm
        print( f"  {iRow+1:4}: {strRow}")
```

The **SimulationDB.Fetch()** API function can be used to execute arbitrarily complex SQL queries with joins over multiple tables. In the snippet shown, a query is executed that reads the branch results of the power flow calculation and combines them with the Node and Element tables. This gives the following result for a power flow calculation in the sample network "Example Ele1":

```
SQL Query with mutliple tables: columns=12
     1: NetwLevel
     2: Node1
     3: Element
     4: Type
     5: U_Un
     6: U
     7: phi
     8: I_Inp
     9: P
    10: Q
    11: I
    12: phiI

Query Result: Rows=33
     1: Medium-Voltage, N12, 2T7, TwoWindingTransformer, 94.061, 5.644, -2.919, 25....
     2: Medium-Voltage, N8, 2T11, TwoWindingTransformer, 93.207, 5.592, -2.89, 110....
     3: Medium-Voltage, N5, 2T13, TwoWindingTransformer, 98.174, 5.89, 0.073, 26.98...
     4: Medium-Voltage, N16, 2T17, TwoWindingTransformer, 97.913, 5.875, 0.082, 52....
     5: Medium-Voltage, SS2, L3, Line, None, None, None, 0.0, 0.0, -0.0, 0.0, 0.0
     6: Low-Voltage, SS1-C, L9, Line, 97.061, 0.388, -0.616, 0.0, -0.021, -0.011, 0...
     7: Low-Voltage, SS1-B, L14, Line, 95.816, 0.383, -1.329, 0.0, 0.0, 0.0, 0.0, 0...
     8: Medium-Voltage, SS2-A, L20, Line, 94.316, 5.659, -2.94, 70.518, -1.72, -1.1...
     9: Medium-Voltage, SS2-A, L21, Line, 94.316, 5.659, -2.94, 98.619, -2.474, -1....
    10: Medium-Voltage, SS2-A, L22, Line, 94.316, 5.659, -2.94, 16.778, -0.421, -0....
    11: Medium-Voltage, SS2-A, L23, Line, 94.316, 5.659, -2.94, 8.875, -0.211, -0.1...
...
```

In addition, the new API function can be used to reduce the data volume even before the actual processing in the automation solution. For this purpose, the result set is restricted in the SELECT statement by a suitable WHERE condition. This means that, for example, only those records can be processed where voltages at the nodes (U_Un) are outside the permissible range or where the network elements are overloaded (I_Inp).

PSS®NETOMAC

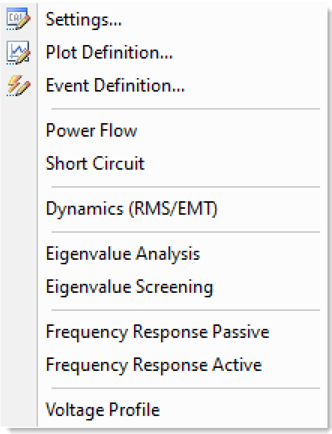
User Interface

General Improvements

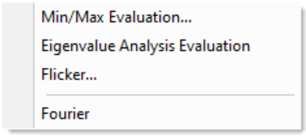
Menu for Calculation and Post-Processing

The menus in the user interface for calculation and post-processing were simplified and made clearer. The aim was to name the functionalities more clearly and to assign the various functions correctly according to topics.

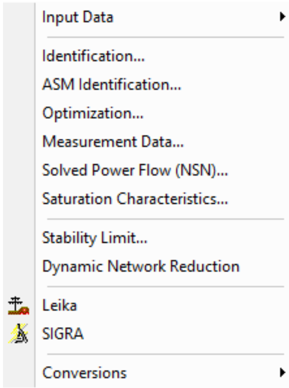
Calculate:



Post-Processing:



Tools:



Calculation Methods

General Improvements

Extended Input for Nonlinearity Arrester (U line)

The manufacturer specifications of arresters usually contain logarithmic representations of the arrester characteristics, which must be considered in detail to be able to correctly determine the absorbed energy. Until now, however, PSS NETOMAC only offered 8 data points to describe the arrester characteristics. This has now been extended. Additional subsequent lines can be defined by identifier "+" in the Izus column. Now up to 180 data points can be defined.

```
T1......12......23......3AA1....12....23....34....45....56....67...78...89...9ZZ
U         RST      Arrester #i1  #i2  #i3  #i4  #i5  #i6  #i7  #i8  #Emax
                            #u1  #u2  #u3  #u4  #u5  #u6  #u7  #u8        +
                            #i9  #i10 #i11 #i12 #i13 #i14 #i15 #i16
                            #u9  #u10 #u11 #u12 #u13 #u14 #u1  #u16       +
                            #i17 #i18 #i19 #i20 #i21 #i22 #i23 #i24
                            #u17 #u19 #u19 #u20 #u21 #u22 #u23 #u24
```

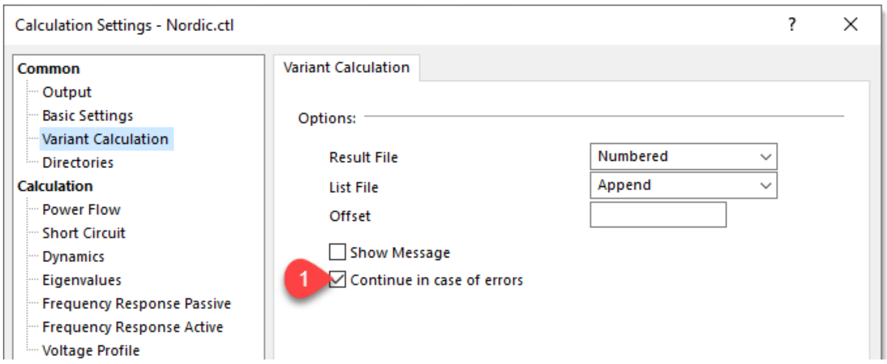
Simulation

Extended Variant Calculation

PSS NETOMAC offers a very flexible and powerful system for variant calculation. Here, practically all input data can be changed in variants and thus considered in further calculations. Nested execution of the variant calculation in up to 9 loops is also possible with this.

Due to this flexibility, it often happens that a large number of variants has to be calculated in projects. It can happen that the variants may contain changes in the initialization or lead to errors. In this case, the calculation run was previously stopped when the first error occurred and was not continued. I.e. the user then had to clarify why the error occurred, correct it, then restart the calculation with all variants and check whether further errors occur.

This behavior has been improved. Now it is possible to define in the calculation settings whether the variant calculation is aborted or continued when an error occurs (#1) in one of the variants.



If the **Continue in case of errors** option is active, then at the end of the variant calculation a summary is output in the LOG file, which clearly shows which variants could be calculated and where errors occurred.

```
--- Started: Network NORDIC.net, Configuration Default, Variant 1, 28.04.2022 17:10:37 ---

...

Load flow converged after 152 iteration(s)

--- Finished: 28.04.2022 17:11:27 Variant 54 ---

Variant calculation summary
-----------------------------------------------------------------------
Variant 1 was successfully calculated without errors.
Variant 2 was successfully calculated without errors.
Variant 3 was aborted with errors.
...
Variant 49 was successfully calculated without errors.
Variant 50 was successfully calculated without errors.
Variant 51 was aborted with errors.
Variant 52 was successfully calculated without errors.
Variant 53 was aborted with errors.
Variant 54 was successfully calculated without errors.
-----------------------------------------------------------------------
Number of variants finished without errors: 36
Number of variants aborted due to errors: 18
-----------------------------------------------------------------------
```