Release Information – PSS®SINCAL Platform 19.5

This document describes the most important enhancements and changes in the new program version. See the product manuals for more detailed descriptions of the functionalities.

General Remarks

Licensing

PSS SINCAL 19.5 Platform uses the same license file as the preceding PSS SINCAL 19.0 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** (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 19.5.

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 and 2008 R2
SQL Server 2012
SQL Server 2014
SQL Server 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 extended example networks are available:

Network	Description
Example CA	New example network for the Contingency Analysis (CA) module. Creation, configuration and simulation of contingencies and outage sequences in the high and medium voltage network.
Example OT	New example network for the Optimal Branching (OT) module. Introduction to the Optimal Branching module based on selected examples.

Protection Devices

The library of protection devices has been expanded again in this product version. The new and modified devices are listed below. Comprehensive descriptions of the protective devices are available in the **Protection Coordination** and **Input Data** manuals.

New Protection Devices

The following new protection devices are available:

Protection device	Description
7SR224	Recloser
Micrologic_2x	LV-CB
Micrologic_3x	LV-CB
SIBA_10-17.5kV	Fuses
SIBA_10-24kV	Fuses
SIBA_20-36kV	Fuses
SIBA_27kV	Fuses
SIBA_3-7.2kV	Fuses
SIBA_38.5kV	Fuses
SIBA_40.5kV	Fuses

Modified Protection Devices

The following protection devices have been upgraded.

Protection device	Description
Micrologic_5x	Setting ranges corrected and ground zones removed (LV-CB)
Micrologic_6x	Setting ranges corrected (LV-CB)
Micrologic_7x	Setting ranges corrected and ground zones removed (LV-CB)
Micrologic_5	Ground zones removed (LV-CB)
REL670	Power supply corrected (CB with CT)
RED670	Power supply corrected (CB with CT)
REL650	Power supply corrected (CB with CT)
SIBA-HHD_6-12kV	Name change and double fuse removed (fuses)
Recloser	Extension with IEC and IEEE characteristics (recloser)
Tmax_80-100A	Moving from circuit breaker with transformer to (LV-CB)

The following circuit breakers with current transformers have also been corrected for the rated current reference and/or the additional characteristic.

Protection device
269Plus
7UT512
MOPN01
MOPN02
SPAC310C
7UT6_InS
7UM62_1
7UM62_5
MCX913
Mut1
VIP300_200
VIP300_400
VIP300_800
WIC1-W2
WIC1-W3
WIC1-W4
WIC1-W5
WIC1-W6
MiCOMP241
IMM7990
IMM7990_100%
IMM7990_80%
IKI-30

Deleted Protection Devices

The following protection devices have been removed.

Protection device
7TG1440
7TG1540
MiCOM_P241.Nor
MOPN0X
7SJ601
EMKR
7SJ82_1
7SJ82_5
SIBA
SIBA-6kV

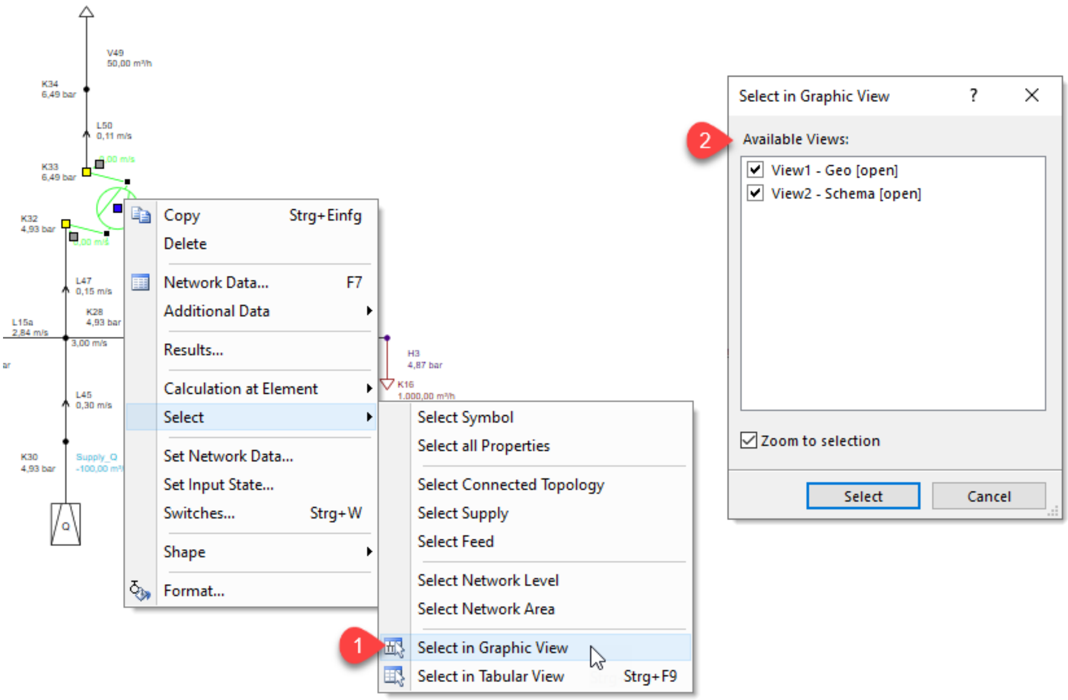
PSS®SINCAL

User Interface

General Extensions

Advanced Function for Selecting in the Pop-Up Menu

New functions are available in the pop-up menu of the network elements, allowing selection in all graphic views and in the tabular view.



The **Select in Graphic View** function (#1) is useful when there are multiple views in the network model. A dialog box (#2) is opened to select in which views the selection should be made.

By default, the shortcut key Ctrl + G is set for this function, this way it can be called from the keyboard directly.

Advanced SQL Functions in Database Queries

For network models using SQLite databases, extended functions are available in queries in the user interface. The following mathematical functions are now supported here in addition to the standard SQL functions:

acos(X)	cosh(X)	pi()
acosh(X)	degrees(X)	pow(X,Y)
asin(X)	exp(X)	power(X,Y)
asinh(X)	floor(X)	radians(X)
atan(X)	ln(X)	sin(X)
atan2(Y,X)	log(B,X)	sinh(X)

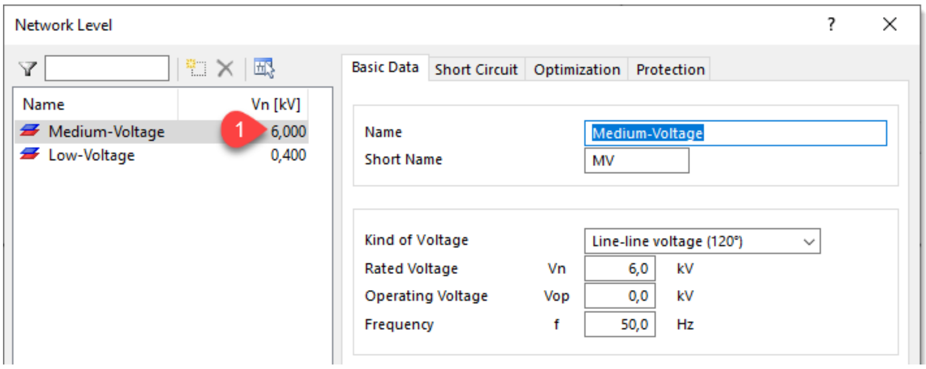
atanh(X)	log(X)	sqrt(X)
ceil(X)	log10(X)	tan(X)
ceiling(X)	log2(X)	tanh(X)
cos(X)	mod(X,Y)	trunc(X)

The arguments to math functions can be integers, floating-point numbers, or strings or blobs that look like integers or real numbers. If any argument is NULL or is a string or blob that is not readily converted into a number, then the function will return NULL. These functions also return NULL for domain errors, such as trying to take the square root of a negative number or compute the arccosine of a value greater than 1.0 or less than -1.0.

The mathematical functions can be used in SQL statements in text fields as well as in user-specific database queries in the tabular view.

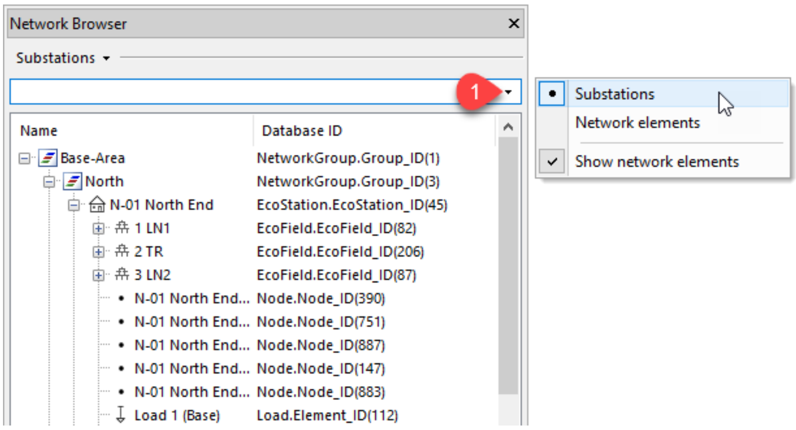
Changed Sorting in the Network Level Dialog Box

The **Network Level** dialog box has been extended. In addition to the name of the network level, the rated voltage is displayed and the network levels are automatically sorted in descending order by the rated voltage (#1).



Advanced Functions in the Network Browser

The display mode of substations in the **Network Browser** has been revised and extended. The main aim was to simplify navigation in the hierarchical structures of network areas, substations, bays and network elements that occur, for example, in CIM-compliant network models.



In the substation display mode, only those network elements are now displayed which are assigned to substations. To display all network elements, i.e. also those without substation assignment, is available as before in the topology display mode.

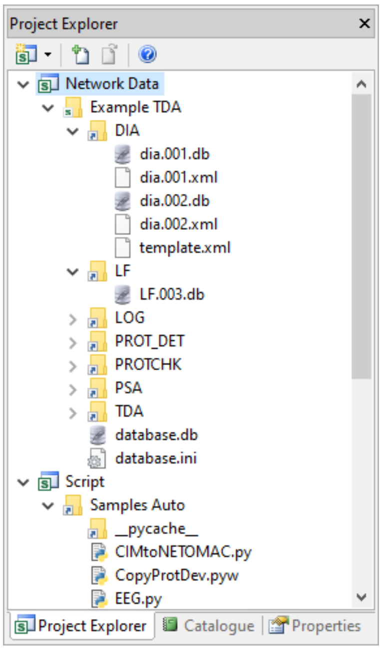
The integrated filter field can be used to conveniently reduce the scope of the list shown. The button in the filter field (#1) offers an extended feature. By pressing this button, a menu with the following options appears:

- Substations: The entered filter will be applied to the substations.
- Network elements: The entered filter will be applied to the network elements.
- Show network elements: If this option is enabled, the network elements assigned to the substations are displayed in the list.

The filter functions are now implemented to keep the nested hierarchical structure with active filtering. I.e. when filtering by network elements, for example, the corresponding network areas, substations, bays and network elements are displayed according to the hierarchy.

Extended File System Connection in the Project Explorer

Since PSS SINCAL 19.0, the directory listing of the current network model is available in the **Project Explorer**. In this product version, the implementation has been further improved. Now the displayed content in the project explorer is automatically updated when changes (renamed, new or deleted files) appear in the referenced directory.



Simplified Opening of Network Archives

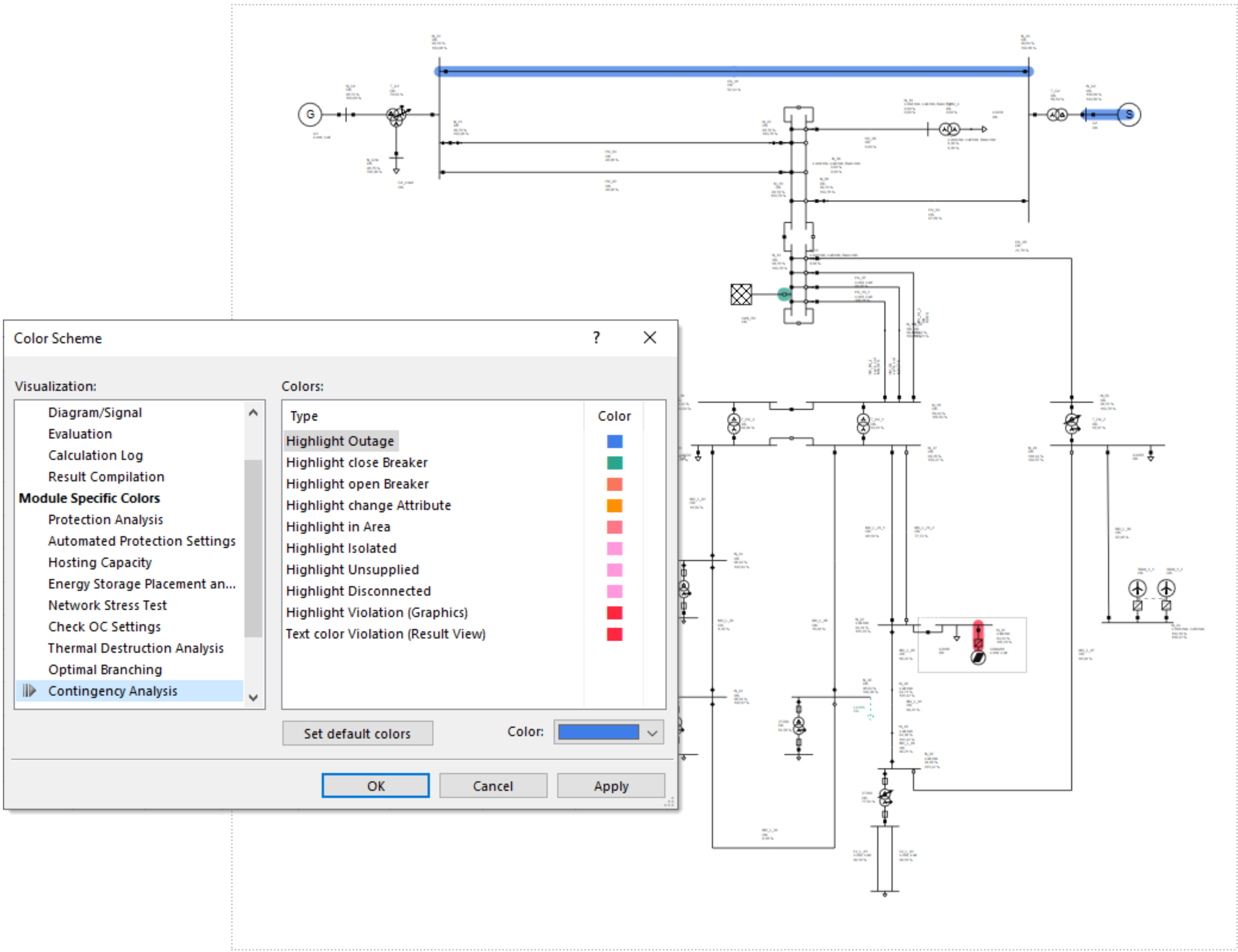
The opening of PSS SINCAL network archives has been extended. The archive (.sinx file extension) is now registered in the system in the same way as a normal network model file (.sin file extension). This way a network archive can be opened by double-clicking in Windows Explorer directly and will automatically be extracted and shown in the user interface afterwards.

New Color Palette

The configuration of colors in the user interface was already revised in the previous version. Further improvements have been implemented in the new product version.

The new default color palette follows the principles of accessibility for web content, provides separate color groups for evaluation depending on the semantics of the data to be visualized, and offers central setting of all colors used in the user interface by the user for (company-specific) visualization requirements.

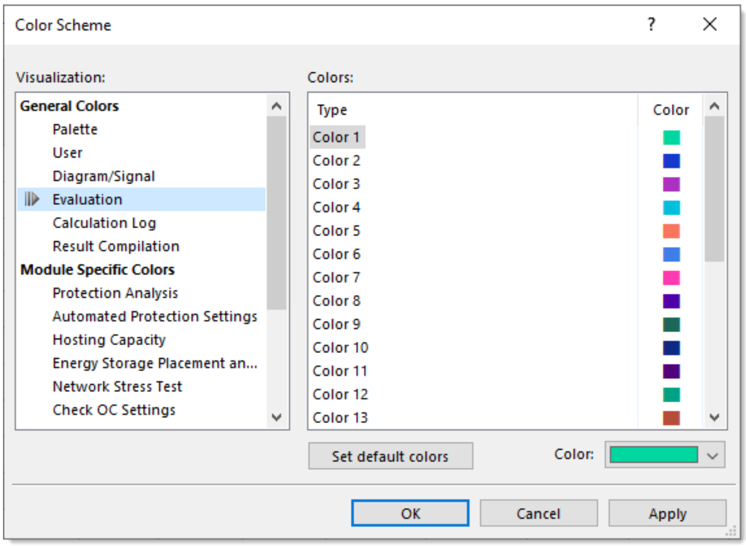
The following image shows the use of the new colors based on the result visualization for the contingency analysis module. Here, the **colors for evaluation** are used in the network graphic to visualize the actions and states performed, and the **colors for feedback** (for example red) are used to visualize limit violations on the elements.



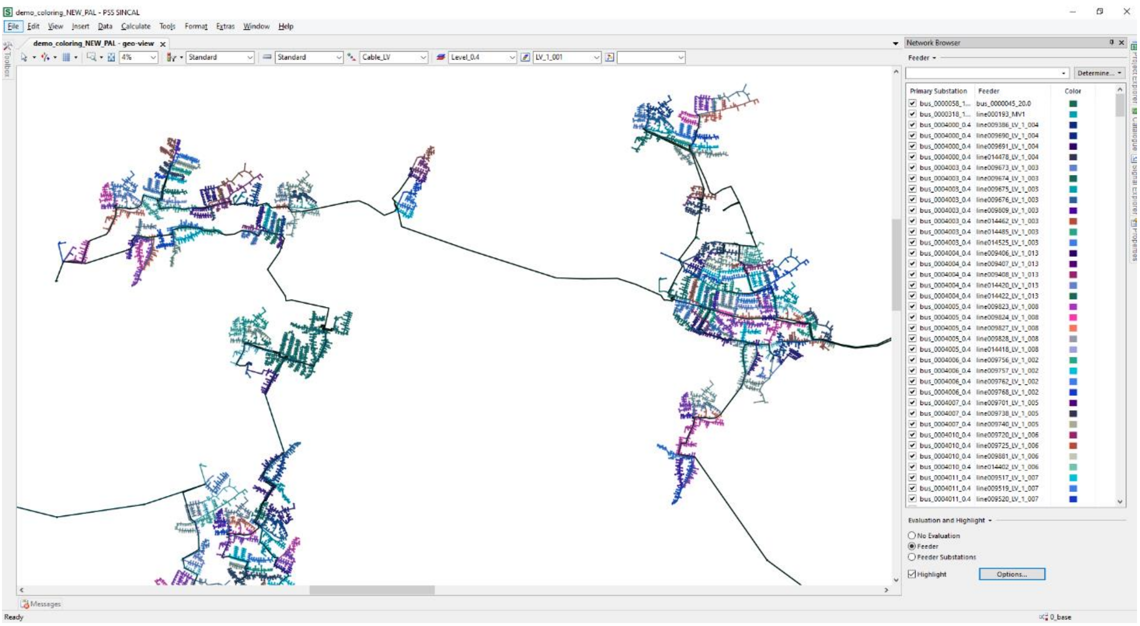
The implementation of the standard color palette for the color visualizations of further module-specific functions follows.

Extended Colors for Evaluations

In the document options of PSS SINCAL, the dialog box **Color Scheme** can be used to customize the colors for each network model. The color configuration for the **Evaluation** is new. This allows to configure the default colors for evaluations, which are used when states or results (on/off, voltages, ...) are not to be explicitly visualized, but only different data or assignments (line types, network levels of network elements, etc.).



The evaluation in the network graphic (e.g. as shown below of the feeders) then uses this color selection automatically.



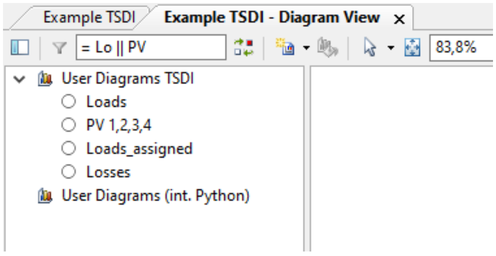
Diagrams

Multiple Filters in the Diagram View

Advanced filter functions are available in the diagram view browser. Thus, the scope of displayed diagram paces can be reduced by extended filter queries analogous to the signal explorer.

By default, a simple substring filter is active. I.e. the text entered in the filter field must appear in the name of the diagram pages.

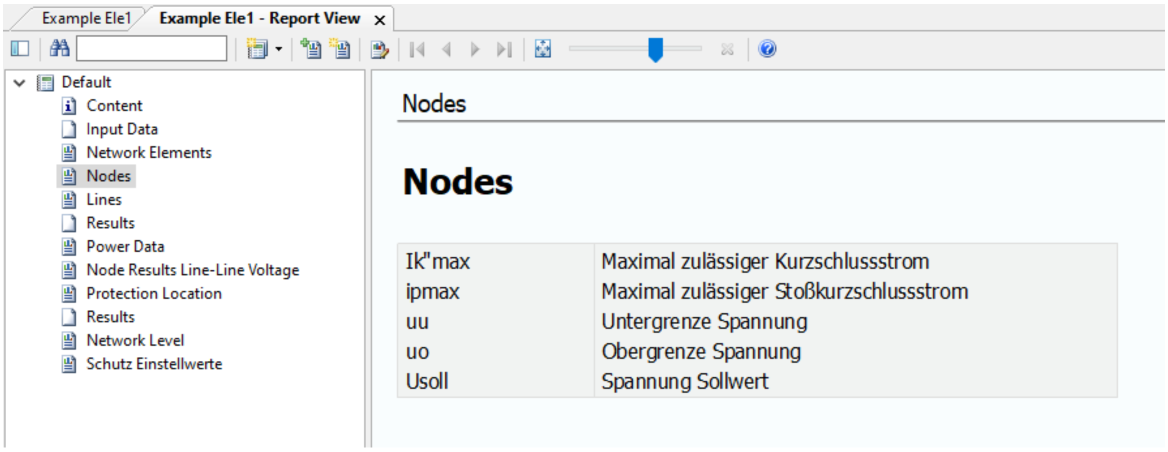
Entering the character "=" in the filter field activates the extended filter. Several filter criteria can be entered here. These can be logically linked by specifying the AND && or OR || operator. The filter is executed by pressing the Enter key. The extended filter checks the individual filter criteria for each list entry.



Reports

Advanced Functionality for Reports

In the report view, a new button is available in the toolbar that creates a new report.



Clicking the **New Report** button opens a wizard where the data for a new user-defined report can be defined.

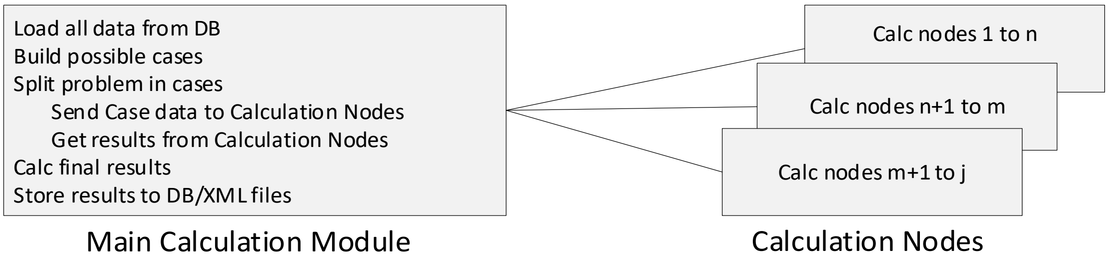
Electrical Networks

General Extensions

Advanced Control for Parallel Processing in the Calculation Modules

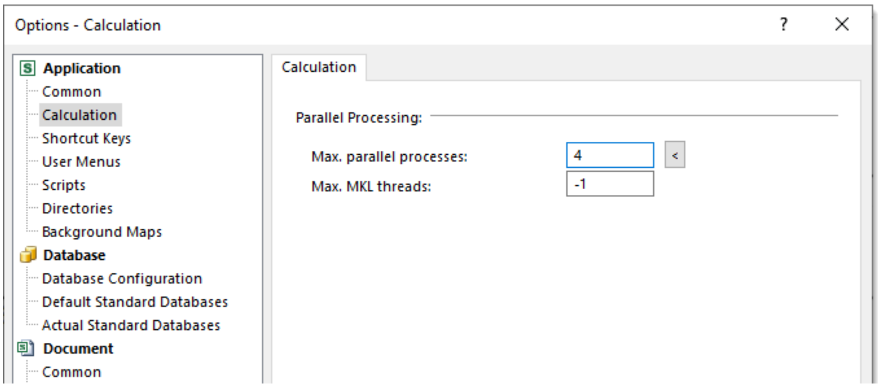
Many PSS SINCAL calculation modules can be executed in parallel. In this case, the calculation problem to be solved is distributed among several processes in order to use the available resources of the PC as efficiently as possible.

The following picture shows the function principle of the parallel processing. From the primary calculation process (Main Calculation Module), further processes (Calculation Nodes) are controlled, each of which solves sub-problems simultaneously.



In the primary calculation process, the network is loaded from the database and built up in the main memory as a network model. Individual sub-cases are then created for each calculation module/subset of tasks and distributed to the available calculation nodes.

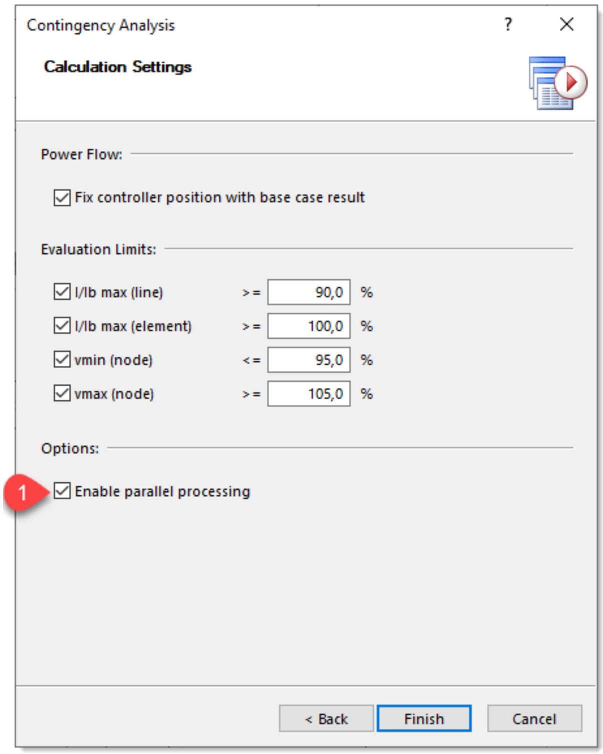
The maximum number of processes that can be created can be parameterized in the **Options** dialog box. From this version on, the configuration of the parallel processing of the calculation modules is no longer done individually per network model, but individually per PC. Now these options are available under **Application** in the **Calculation** tab. This ensures that the optimum settings are made to suit the respective PC.



The **Max. parallel processes** input field sets the maximum number of parallel calculation processes to be started. Next to the input field there is a button that can be used to determine the optimal number of parallel processes based on the available resources on the PC. The available cores (= all processor cores incl. HyperThreading cores) are determined and half of them are transferred to the input field as parallel processes. The actual number of processes used in the calculation is determined by PSS SINCAL itself based on the selected calculation methods and the current network configuration.

The input field **Max. MKL Threads** controls the use of the Intel Math Kernel Library. This allows to specify the maximum number of threads to be used for parallel processing. If 0 is specified, the use of MKL is completely disabled. If a value of "-1" is specified, PSS SINCAL automatically determines the appropriate number of parallel threads depending on the hardware configuration.

In order to enable or disable parallel processing for each network model and calculation module individually, the wizards for starting the calculation modules have been extended. For all calculation modules that allow parallel processing, the new option **Enable parallel processing** (#1) is available.



Importing PF Results

The **Import Results** function can be used to import the results of the power flow calculation into the input data of the network elements. This makes it possible, for example, to adopt the initial values for node voltages and generator powers or the tap position of controlled equipment and thus improve the convergence of repeated power flow calculations.

In this product version, the function has been extended. Previously, it was only available in symmetrical networks, but now it can also be used in unbalanced networks.

The following result data can be applied:

- Node voltages:
  - Symmetrical power flow: Voltage value and voltage angle of the node (power flow node results) are taken as **Initial Voltage** and **Angle – Initial Voltage** in the calculation data of the nodes.
  - Unbalanced power flow: Analogous symmetrical power flow, but here the average value of all existing phase-phase voltage values is taken over from the unbalanced power flow node results as **Initial Voltage** and **Angle – Initial Voltage** in the calculation data of the nodes.
- Generator powers:
  - Symmetrical power flow: The calculated powers of the generators from the power flow branch results are taken as **Initial Value Active Power** and **Initial Value Reactive Power** in the operating state of the generators.
  - Unbalanced power flow: Analogous symmetrical power flow, but here the average value of all existing power values is taken over from the unbalanced power flow branch results as **Initial Value Active Power** and **Initial Value Reactive Power** in the operating state of the generators.

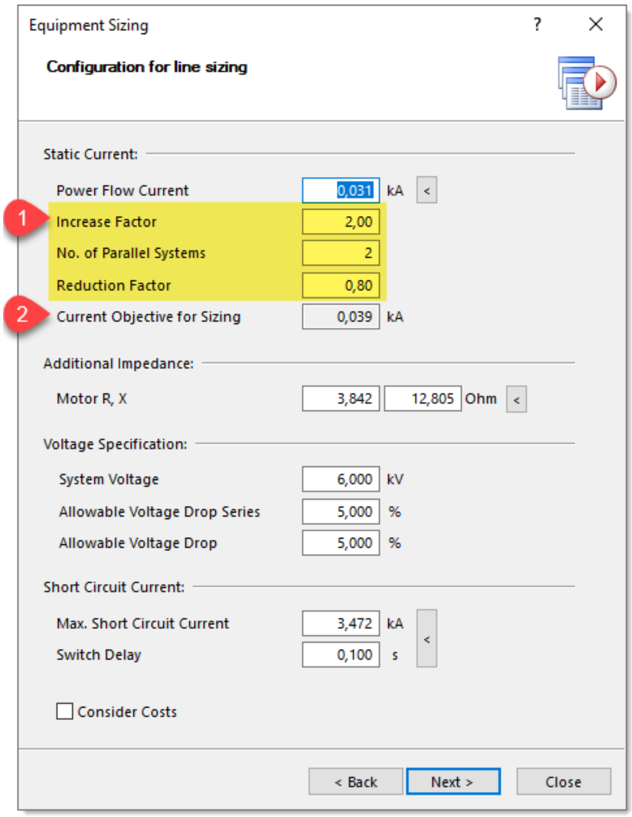
- Tap positions:
  With this option, the results for the tap position of transformers, shunt capacitors and shunt reactors (adjusted during the power flow) are set as the current tap position.

Advanced Equipment Sizing Network Planning Tool

This network planning tool helps to select a suitable line or transformer type. During the sizing process, equipment that meets the requirements for the power flow and short circuit best is selected from a pre-selection of standard types.

To start the equipment sizing, select a line or transformer in the network graphic. Then the network planning tool is started via the menu item **Tools** – **Determining Data** – **Equipment Sizing**. Depending on the selected element, a wizard for **Line Sizing** or **Transformer Sizing** is displayed to enter further parameters.

The **Equipment Sizing** wizard has been extended for the sizing of lines (overhead lines and cables). In addition to the increase factor (expected additional load/generation in future over the line), the number of parallel systems and the reduction factor (which can be determined in advance depending on the number of systems) can be specified (#1):



Based on the power flow current result (or a manually specified current) and the specified factors, the required current for the design of the cable or overhead line is determined and displayed directly in the dialog box (#2).

The selection of cables/overhead lines is then offered based on the criteria of current load, series voltage drop, voltage breakdown and short-circuit current capability.

Current load: The thermal limit current of the cable must be greater than the current required for the sizing.

$$I_{thK} \geq \frac{\frac{I_{thG}}{f_{red}}}{p} \times f_{ZU}$$

Series voltage drop: The maximum voltage drop on the cable must be set.

$$v_l \geq \frac{\left|\frac{(r + jx)}{p} \times I_{thG} \times \sqrt{3}\right|}{V_{start}} \times 100$$

Short-Circuit Current Capability: The maximum permissible short circuit current and the switch delay must be set. The thermal equivalent of the one second current of the cable must be greater than that of short circuit current and switch delay.

$$I_{1sK} \times I_{1sK} \geq I_{kmax} \times I_{kmax} \times t_s$$

f_{red}	…	Reduction factor
f_{zu}	…	Increase factor
I	…	Current with/without motor [kA]
I_{1sK}	…	One-second current of the cable [kA]
I_{kmax}	…	Maximum permissible short circuit current [kA]
I_{thG}	…	Set thermal limit current [kA]
I_{thK}	…	Thermal limit current of the standard type [kW]
l	…	Line length [km]
P	…	Number of parallel systems
r	…	Line reactance [Ω/km]
t_s	…	Switch delay [s]
V_d	…	Voltage after breakdown [kV]
v_d	…	Set voltage breakdown limit [%]
v_s	…	Permissible voltage drop [%]
V_{start}	…	Set system voltage [kV]
x	…	Line capacitance [Ω/km]
Z_L	…	Line impedance [Ω]
Z_M	…	Motor impedance [Ω]

Advanced Network Planning Tool Compensation Impedance

This network planning tool determines the impedance between a two-winding transformer and a node in the network model. The determined value for the impedance can be used in the transformer controller tab (input data dialog box) for the control function **Impedance** as compensation impedance. The compensation impedance is used to calculate a virtual voltage drop as voltage measurement input (if no direct feedback of the node voltage of the node to be controlled available) for the transformer control.

The network planning tool has been extended and is generating a name for the compensation impedance automatically that is composed of the names of the selected transformer and node.

New LEIKA Version

The current product version includes the new LEIKA 5.5 version, which can be used to calculate the characteristic values of overhead lines and cables with any arrangement and type of conductor cables and individual cables.

LEIKA 5.5 is now also available as 64 bit application. This means that only 64 bit programs are included in the PSS SINCAL platform 19.5 and therefore the 32 bit MSVC Redistributables are no longer required.

Contingency Analysis (CA)

The PSS SINCAL module contingency analysis (CA) has been completely re-implemented.

The module enables the creation, management and simulation of contingencies, remedial actions and operational sequences. The module has been revised completely in close cooperation with the user group to address the workflows for network and operational planning in a generic and flexible way. Key features are the auto-creation and manual configuration of contingencies and sequences, multicore calculation, contingency or equipment specific result views synchronized with the network graphic and interfaces supporting integration in automated tooling landscapes.

Different roles at power system operators with specific use cases have an interest in executing this extensive job for different time horizons, scenarios and applications. The number of cases to be considered depends on the equipment taken into account, at least proportional or even to the power of higher magnitudes depending on the combinations to be studied. Different operating conditions, time steps, parameter settings, switch states are additional dimensions increasing the number of cases.

A manual step-by-step approach is possible and very cumbersome. Therefore, a fully automated creation, calculation and evaluation of the cases which can be efficiently reproduced is offered within module CA.

Contingency Analysis addresses different operators and their use cases:

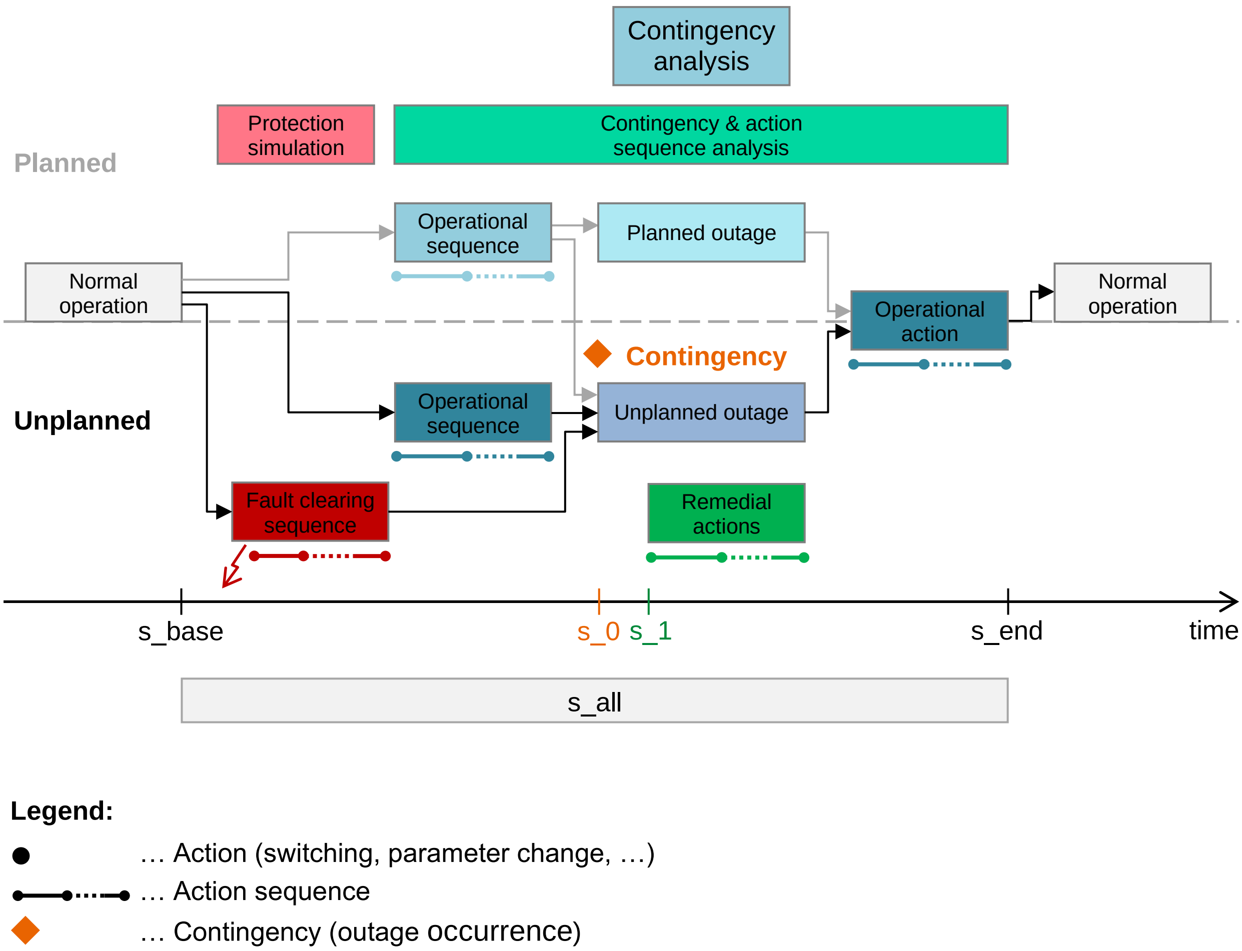
- **Grid Planner:**
  - Regular check of n-1/n-x/n-x-y security by external requirements
  - Regular check of n-1/n-x/n-x-y security by internal requirements
  - Reinforcement justification required by regulator
  - Verification of operational switching actions or schemes (back office)
- **Connection Engineer:**
  - Feasibility of connection requests for new consumers
  - Feasibility of connection requests for new generation
  - Determination of feasibility at alternative connection points
- **Grid Operation Planner:**
  - Security check for planned asset maintenance (n-(1p)-1)
  - Security check for planned switching scheme/action or time dependent (for example seasonal) network topology configurations
  - Verification of operational switching actions or schemes

Therefore, the design of the module addresses both, the asset- and the operations-focused strategy.

- Interaction with the existing modelling capabilities (modelling in the user interface or via the API) and tools (equipment sizing) to extend or to adapt the network model by additional or changed future equipment during the power system planning.
- Optional extension of the contingency analysis from a single point in time snapshot to a holistic analysis of a **sequence** containing consecutive further failures and actions for resupply and set point adaption of flexibility resources. This can support the analysis of planned operational sequences which can consist out of functional switching, set-point changes, load shedding etc. Their implementation and execution might be a permanent or temporary mitigation of reinforcements or modernizations which would else be necessary.

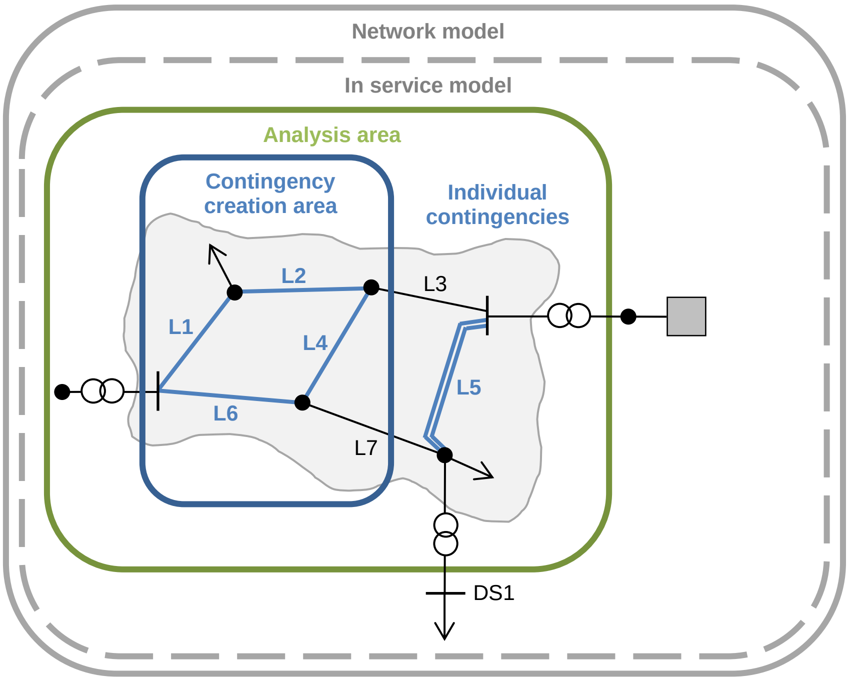
Based on this design, the functionality of the module does not only cover the contingency analysis, but **additionally a very generic calculation based sequential step analysis** of potential planned and unplanned actions during power system operation.

The following sketch illustrates the overall stages if the power system is moving from normal operation into planned or unplanned intermediate stages until it ends up in a state of normal operation again. The potential scope of application of the core functionality (contingency analysis) and the extended functionality (contingency & action sequence analysis) of the module is highlighted.



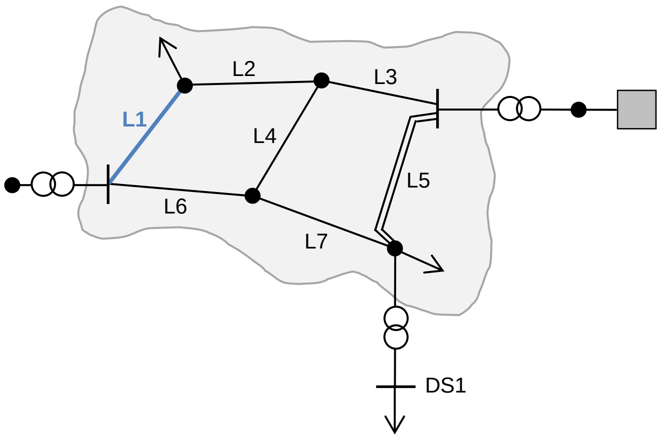
Conceptual Example

The concept of the scope configuration for creation, calculation and result evaluation is discussed based on an example below.

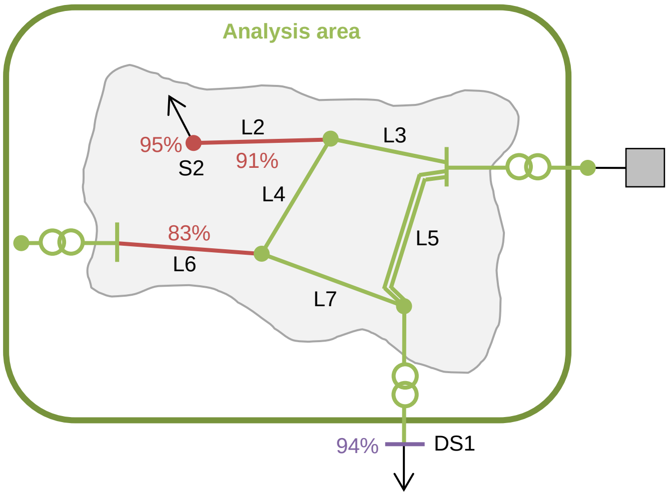


- Network Model and In Service Model are identical, comprise the whole system.
- The contingency creation is performed only in a subsystem with the criterion to automatically generate an outage (contingency) for each line. Four contingencies (L1, L2, L4, L6) will be created in the contingency list.
    - L1: unplanned outage line L1
    - L2: unplanned outage line L2
    - L4: unplanned outage line L4
    - L6: unplanned outage line L6
- In addition, an individual contingency (two parallel lines) is manually added to the contingency list.
    - L-5-2p: unplanned outage line L5_1 and L5_2
- Result analysis area is covering main part of the system but excludes equipment at boundaries.

The first contingency (L1) of the list will be calculated by taking out of service the line virtually in the network model.



Then a power flow is solved, and the results are analyzed based on the set limits for the evaluation and the analysis area.



- Two lines (L6 and L2) are loaded > 80% (congestion) and the voltage at one station (S2) is < 96%
- Equipment results (DS1) outside the analysis area (even if violations occur) are ignored.

Then the next contingency (L2) is taken from the contingency list.

Program Components of the Contingency Analysis

The contingency analysis consists of two main program components: the creation and the calculation of contingencies with the power flow module.

The idea is that the contingencies to be evaluated are created automatically and/or manually. If necessary, further actions are assigned to the individual contingencies. This can be e.g. the opening or closing of breakers to change the network configuration or the individual change of attributes of network elements to e.g. reduce the power of a load.

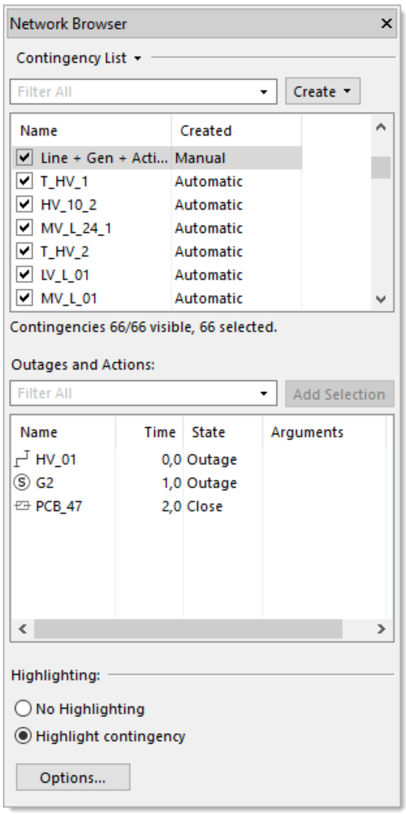
Workflow Toolbar

In PSS SINCAL, the **Workflow** toolbar is available, which provides the most important functions for various calculation modules. The toolbar can be activated via the menu item **View** – **Toolbars** – **Workflow**.

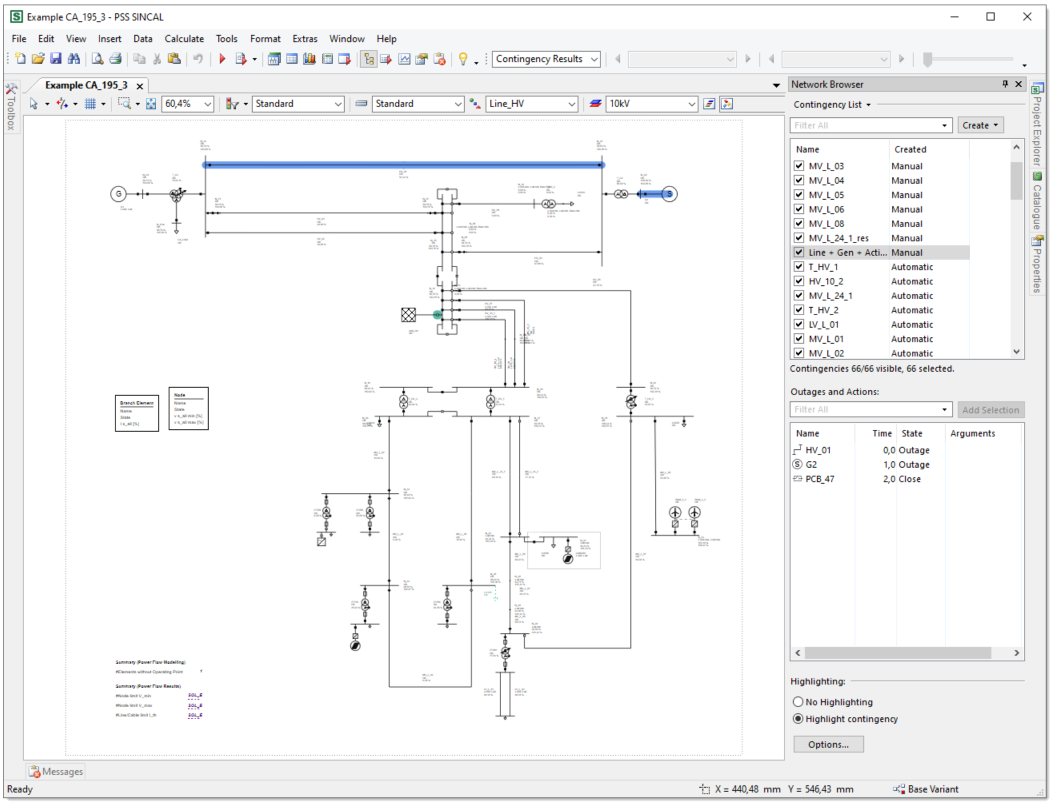
The calculation method can be selected in the selection field of the toolbar, which dynamically provides the buttons for the selected module. The following picture shows the toolbar for the contingency analysis.

Creation and Administration of Contingencies and Sequences

The generation and administration of contingencies and sequences is done centrally in the **Network Browser** in the new **Contingency List** display.

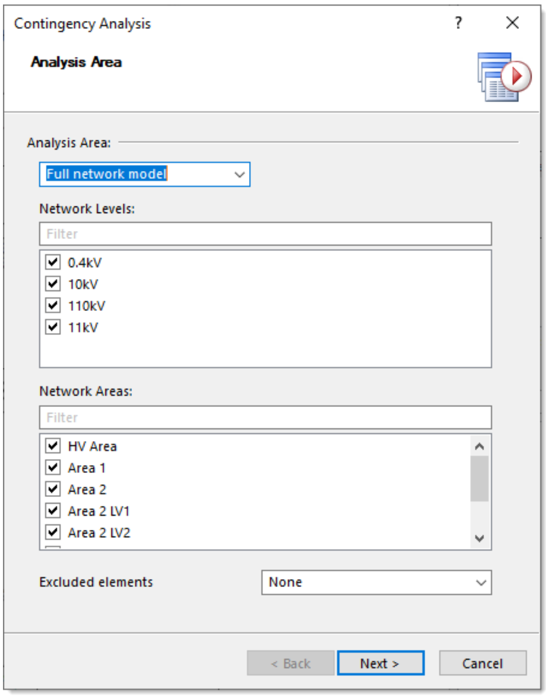


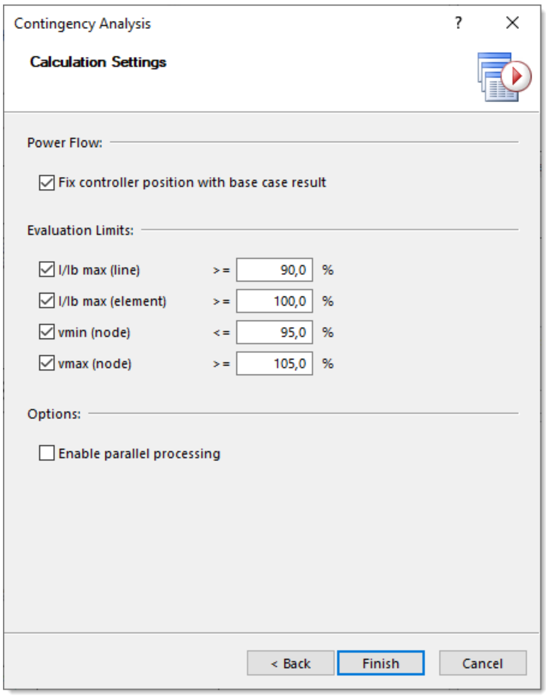
The visualization of the respective contingencies and sequences is possible in the network graphic.



Starting the Contingency Analysis

The calculation of all activated contingencies in the contingency analysis is started via the menu item **Calculate** – **Contingency Analysis**. A wizard guides step-by-step through the required settings.



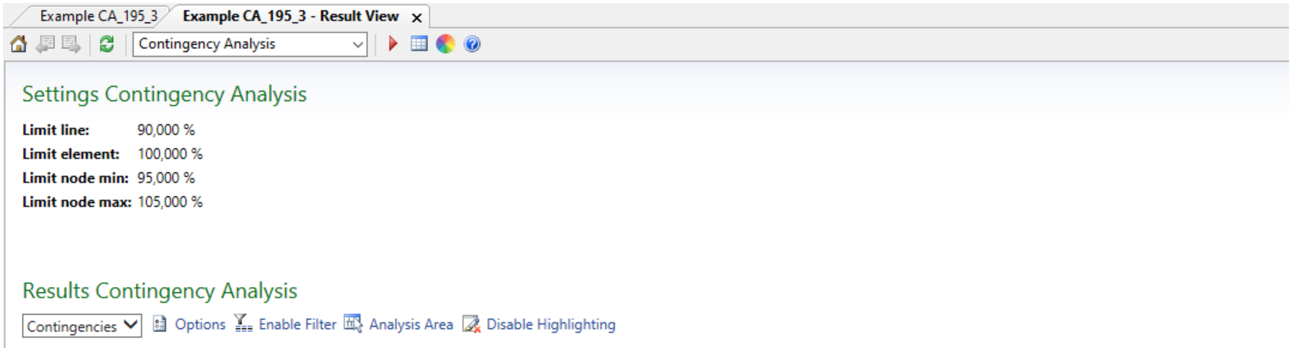


The first step is to define the **Analysis Area** (see above).

In the second step, the **Calculation Settings** are defined. The limit values are important here. These are used in the direct internal evaluation of the power flow results in order to log limit violations (min/max) and to post-process them for the use case specific result schema.

Results in the Result View

The results are summarized and visualized in the result view.



		Element Loading		Node Voltage				Unsupplied Consumption		Disconnected Generation	
Contingency	State	s_end I/Ib max [%]	s_all I/Ib max [%]	s_end vmin [%]	s_all vmin [%]	s_end vmax [%]	s_all vmax [%]	s_0 Psum [MW]	s_end Psum [MW]	s_0 Psum [MW]	s_end Psum [MW]
MV_L_24_1	Limit	101,83	101,83	95,20	95,20	104,43	104,43	0,00	0,00	0,00	0,00
MV_L_01	OK	99,13	99,13	98,02	98,02	104,51	104,51	0,00	0,00	0,00	0,00
MV_L_02	OK	99,71	99,71	97,23	97,23	104,43	104,43	0,00	0,00	0,00	0,00
MV_L_03	OK	99,69	99,69	97,25	97,25	104,43	104,43	0,00	0,00	0,00	0,00
MV_L_04	OK	99,65	99,65	97,29	97,29	104,43	104,43	0,00	0,00	0,00	0,00
MV_L_05	OK	99,13	99,13	98,01	98,01	104,51	104,51	0,00	0,00	0,00	0,00
MV_L_06	OK	99,12	99,12	98,02	98,02	104,50	104,50	0,00	0,00	0,00	0,00
MV_L_08	OK	99,65	99,65	97,29	97,29	104,41	104,41	0,00	0,00	0,00	0,00
MV_L_24_1_res	OK	96,01	104,21	99,34	93,24	104,59	104,63	5,60	0,00	0,95	0,00
Line + Gen + Action	Limit	101,02	108,13	95,97	95,97	103,43	105,82	0,00	0,00	0,00	0,00
T_HV_1	Unsup, Discon	73,80	73,80	99,40	99,40	104,65	104,65	6,02	6,02	0,95	0,95
HV_10_2	Limit	120,67	120,67	96,82	96,82	104,29	104,29	0,00	0,00	0,00	0,00

In the **Results Contingency Analysis** section, the results are displayed. It offers to interactively switch between different display modes using the integrated selection list:

- Contingencies
- Elements
- Nodes

The **Contingencies** display mode gives an overview of all calculated contingencies.

		Element Loading		Node Voltage				Unsupplied Consumption		Disconnected Generation	
Contingency	State	s_end I/Ib max [%]	s_all I/Ib max [%]	s_end vmin [%]	s_all vmin [%]	s_end vmax [%]	s_all vmax [%]	s_0 Psum [MW]	s_end Psum [MW]	s_0 Psum [MW]	s_end Psum [MW]
MV_L_24_1	Limit	101,83	101,83	95,20	95,20	104,43	104,43	0,00	0,00	0,00	0,00
MV_L_01	OK	99,13	99,13	98,02	98,02	104,51	104,51	0,00	0,00	0,00	0,00
MV_L_02	OK	99,71	99,71	97,23	97,23	104,43	104,43	0,00	0,00	0,00	0,00
MV_L_03	OK	99,69	99,69	97,25	97,25	104,43	104,43	0,00	0,00	0,00	0,00
MV_L_04	OK	99,65	99,65	97,29	97,29	104,43	104,43	0,00	0,00	0,00	0,00

The **Elements** display mode gives an overview of all elements in the analysis area. The focus is then on the network element, i.e. the occurred maximum and minimum values of all simulated contingencies are listed.

Element ↑	Type	Base I/Ib [%]	s_end I/Ib max [%]	s_all I/Ib max [%]	Count	s_end Limit Count	s_all Limit Count
2T256	Two-Winding Transformer	54,53	54,55	54,55	58	0	0
2T258	Two-Winding Transformer	54,53	54,55	54,55	57	0	0
2T260	Two-Winding Transformer	76,54	77,54	77,54	54	0	0
2T720	Two-Winding Transformer	25,94	25,94	25,94	55	0	0
CONV236	Converter	57,40	58,34	58,34	54	0	0
CONV88	Converter	99,64	101,83	104,21	58	13	14
G1	Synchronous Machine	52,25	103,99	103,99	65	4	5
G2	Synchronous Machine	37,11	66,02	66,02	64	0	0
HV_01	Line	14,54	52,44	52,44	64	0	0

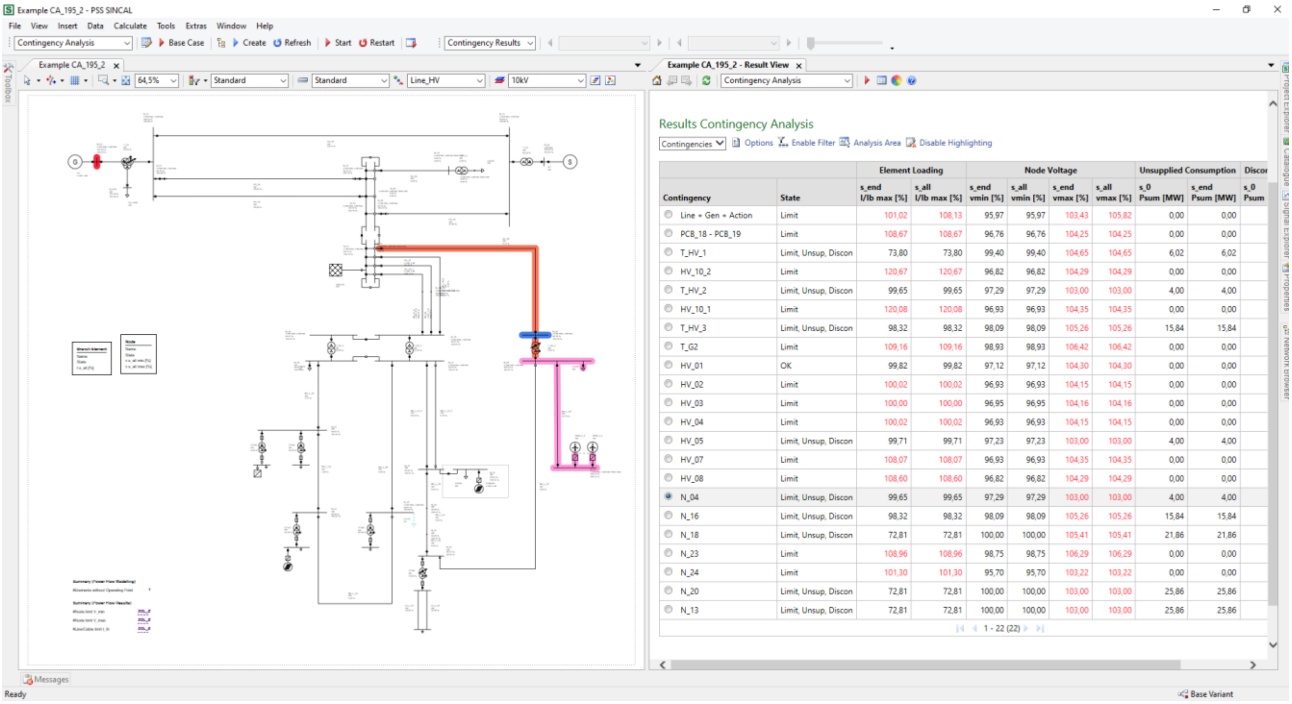
The **Node** display mode gives an overview of all nodes in the analysis area. The node is then in focus, i.e. the occurred limit values of all simulated contingencies are listed.

Node	Base v [%]	s_end vmin [%]	s_end vmax [%]	s_all vmin [%]	s_all vmax [%]	Count	s_end Limit Count	s_all Limit Count
N_43	104,44	103,19	106,42	103,19	106,42	58	8	9
N_49	99,49	99,29	101,64	98,96	101,64	53	0	0
N_30	97,30	95,20	101,42	94,80	101,42	55	0	1
N_04	101,27	99,70	103,78	99,70	103,78	62	0	0
N_31	97,51	95,42	101,20	93,24	101,20	58	0	1
N_44	98,29	97,01	100,47	97,01	100,47	53	0	0
N_32	97,51	95,42	101,20	93,24	101,20	59	0	1

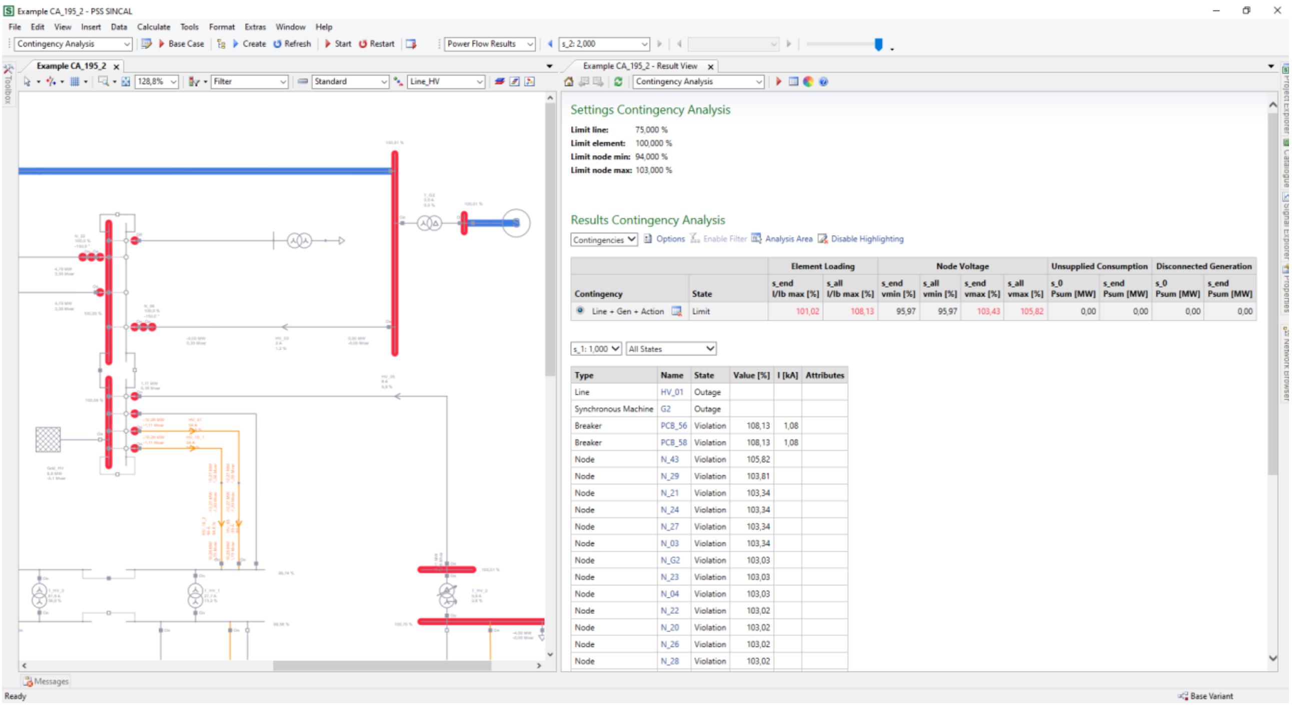
Results in the Result View and in the Network Graphic

The results presented in the result view are also displayed directly in the network graphic. The network elements associated with the contingency selected in the result view are visualized by highlighting to indicate the state of these elements (contingency, switching operations, attribute change, unsupplied elements, etc.).

In the following image, the contingency "N_04" has been selected in the **Contingencies** display mode. The contingency occurs at the corresponding busbar. This is highlighted in blue in the network graphic. The elements highlighted in red have a limit violation and the network elements highlighted in pink are either unsupplied or disconnected.

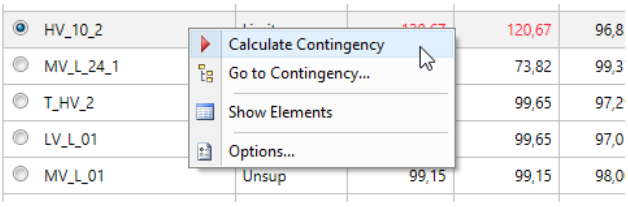


The detailed representation of the manually defined contingency "Line + Gen + Action" is shown in the following figure. Here, the common outage (contingency) of a line together with a generator is simulated. Changes are made to the network model in subsequent (time) steps. For each of these steps, results are generated that contain the states of the network elements. The step result can be displayed in the result view and visualized in the network graphic by highlighting. In the image, the outage of the line and the generator are highlighted in blue. The elements highlighted in red indicate limit violations.



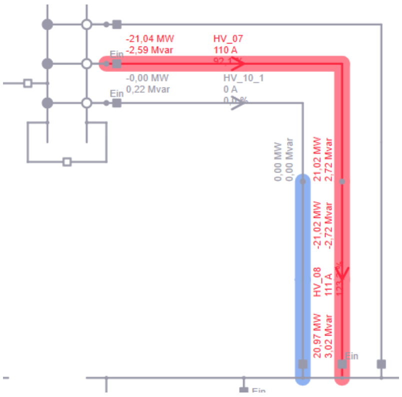
Recalculation & Visualization of Contingencies

Recalculation of a contingency (or sequence) is started via Calculate contingency in the pop-up menu of the list entry.



The line (or all individual elements marked as a contingency) is automatically temporarily taken out of service to replicate the contingency (outage), and a power flow is calculated.

The result automatically displayed in the network graphic is then the full set of power flow results and the appropriate annotations and filters are activated for the detailed analysis of the individual contingency.

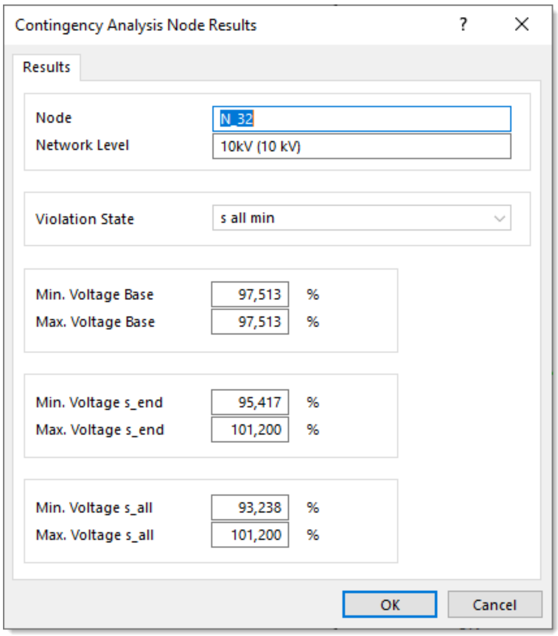


The pop-up menu entry to go to the contingency returns to the entry in the contingency list of the network browser.

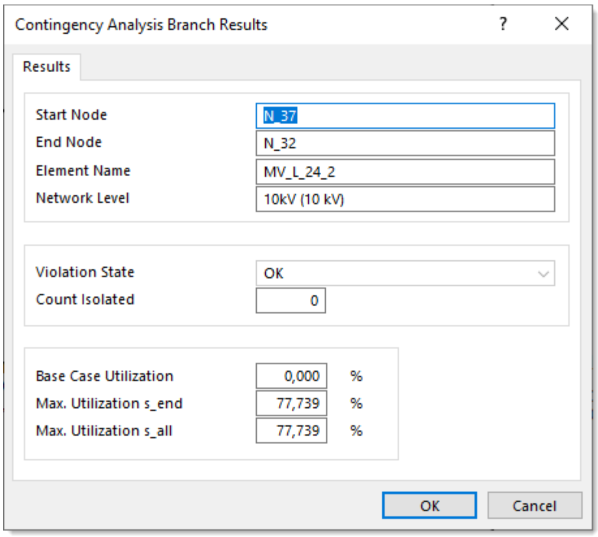
Results in the Network Graphic and in the Tabular View

Simplified node and network element results of the contingency analysis are available in the network graphic and in the tabular view. This can be used, for example, to perform graphical evaluations in order to visualize at which points in the network limit violations occur.

For the nodes, the state and the minimum and maximum voltage are available as a result. The voltages are available for the base case, at the end of the contingency steps (s_end) and during all contingency steps (s_all).



For the network elements, the state and maximum utilization are available for the base case, at the end of the contingency steps (s_end) and for all contingency steps (s_all).



Example Network and Documentation

A detailed description of the module can be found in the **Contingency Analysis Manual**. There, the basics of contingency analysis as well as the available functions for displaying and evaluating the results are explained.

In addition, an application example (Example CA) and the corresponding documentation are also available in the **Examples Manual**. In the chapter **Operational Network Planning – Contingency Analysis** all functions of the revisited module are presented.

Optimal Branching (OT)

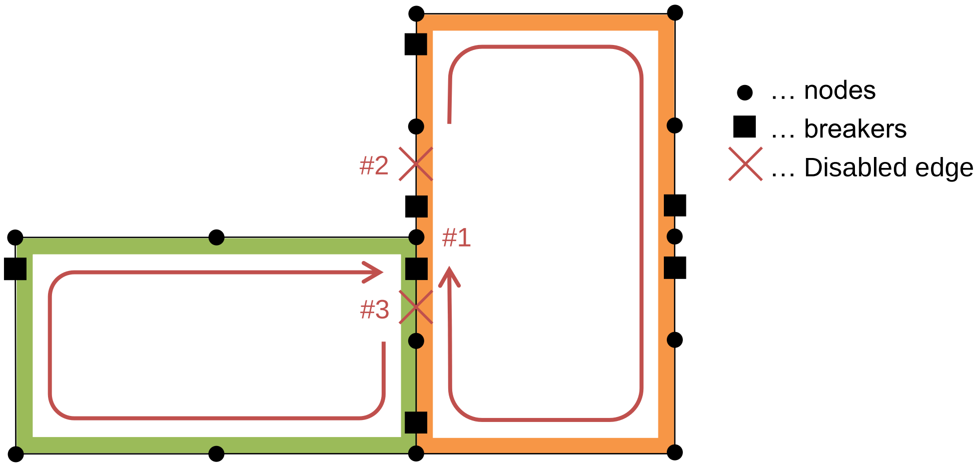
Already in the last product version a preview version of the newly designed Optimal Branching calculation module was provided, in this product version this module is now fully available.

The **Optimal Branching** module can be used to calculate the position of separation points in any meshed networks and to transfer them to the network model. The aim is to select the switching state in the network in such a way that a radial network with minimum transmission losses is created.

General Information about the Calculation Module

A prerequisite for converting a meshed network model into a radial network model is the determination of the meshes in the switch area.

To determine the meshes, the network model is converted into a simple node-edge model. To do this, all "spurs" are removed from the network model. Then one edge is removed from each node with more than 2 edges (#1). Then, Dijkstra's algorithm is used to find the shortest path from the end node of the first remote edge (#2) to the start node (#1). This leads to the orange mesh shown in the figure. Then the next edge (#3) is removed and the shortest path to the start node (#1) is determined again. This results in the green mesh. This process is repeated until all meshes in the switch area have been determined.

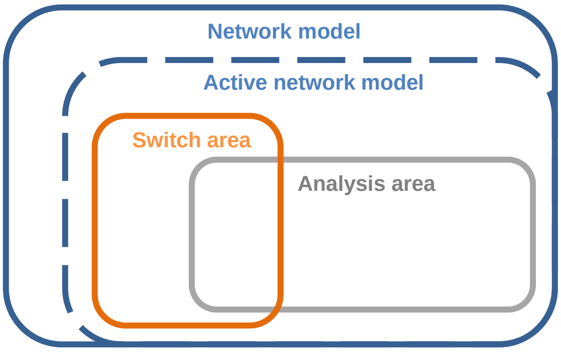


Typically, network models are created that span multiple voltage levels and geographic areas to model the interdependencies of power flows and controls. When it comes to the use of methods such as the determination of optimal separation points, the entire network model is calculated, but only parts of it are included in the application of measures and the evaluation of results.

To make this possible, the calculation module uses the switching area and the analysis area. The configuration of these areas is done by overlapping three categories:

- Complete model, network element group or a selection
- Network level
- Network area

The following figure shows the switch area and the analysis area in the network model.



- Network Model:
  The complete model included in the PSS SINCAL network.
- Active Network Model:
  Complete/partial network model provided to the simulation. Generally, this is a complete network model with all live and connected devices in operation (at the view date and time).
- Switch Area:
  Any part of the network model in which switch actions are performed. I.e. this area is to be converted from a meshed network to a radial network by suitable opening and closing of separation points.
- Analysis Area:
  When calculating the optimal separation points, a part of the active network model, the analysis area, is monitored. In this area, the losses are determined and it is checked whether the limit values are met.

Methods for Determining Optimal Separation Points

Two methods are available in the calculation module to determine the optimal separation points:

- Minimum losses
- Voltage based

The **Minimal losses** method, as the name implies, focuses on minimizing transmission losses.

To achieve this goal, all possible potential combinations of separation points are investigated in order to create a radial network. For each combination of separation points, a power flow calculation is performed to determine the losses and, optionally, to check whether specified limits for voltages and loadings are met.

This calculation method starts with a power flow calculation to determine the losses with the current switching state of the network. Then the meshes in the switch area are determined.

After that, the evaluation of the possible combinations of separation points is performed. One separation point is opened for each mesh. All breakers with "State optimal branching = Free" and all terminals with the setting "Potential separation point = Yes" are taken into account. After opening one separation point per mesh, it is analyzed whether a radial network without isolated subnetworks is present. If this is the case, a power flow calculation is performed to determine the losses and check the limit values for voltages and loads. The process is repeated until all possible combinations of optimal separation points have been calculated.

The **Voltage based** method focuses on the efficient determination of the combination of optimal separation points for a radial network. This calculation method starts with a determination of the meshes in the switch area.

A separation point is created where, starting from one node, all other neighboring nodes have a larger voltage. The connection to the neighboring node with the smallest voltage difference is disconnected at the node under consideration. Normally, this is the connection with the smallest current. Outgoing spurs from the node under consideration are not taken into account, since an isolated network would be created if the node were disconnected.

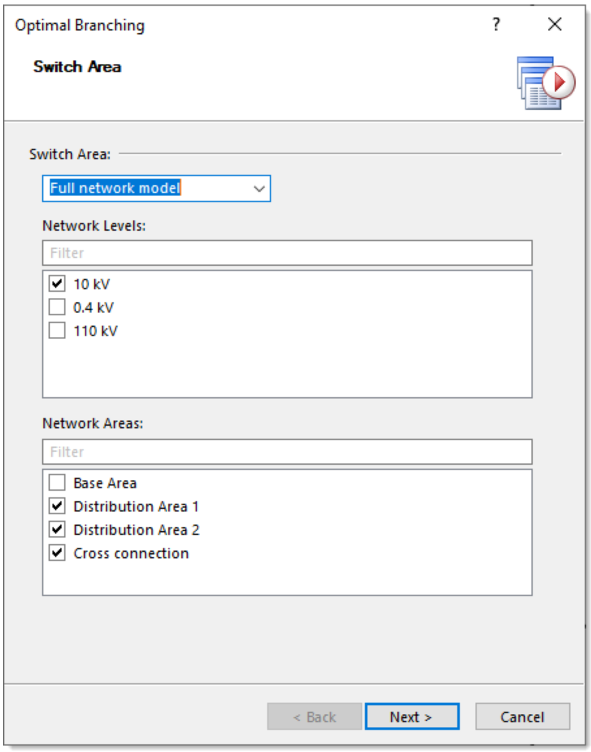
For the separation point search, the respective subnetwork under consideration ends after each transformer. The transformer is thus included in the network level on the upper and lower voltage side (necessary because of parallel transformers). However, the separation points are determined jointly for all network levels that have been activated in the switch area. All breakers with "Consider in Optimal Branching = Unlocked" and all terminals with the setting "Potential Separation Point = Yes" or all terminals can be considered.

The decisive factors for opening separation points are the voltages at the nodes and the currents in the branches of the network. A complete power flow calculation must therefore be carried out before determining the optimum separation points.

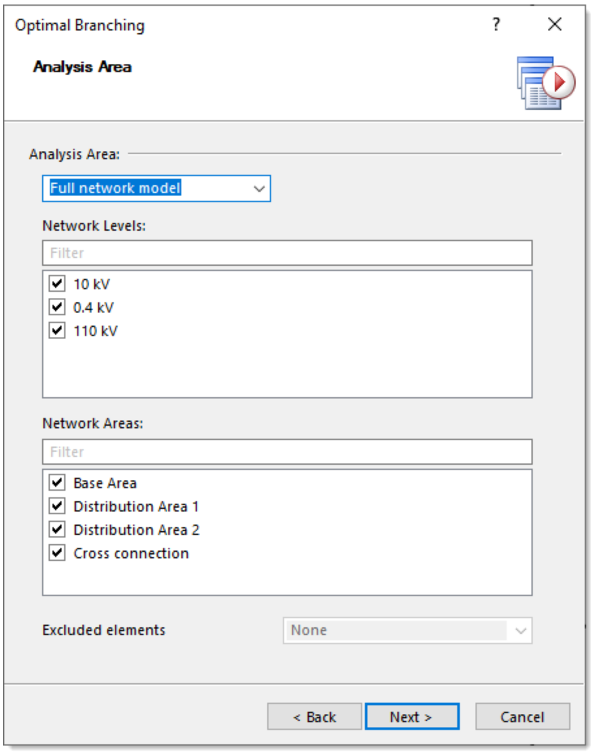
Within the optimization of the separation points, also multi-sided fed subnetworks (e.g. via several transformers or generators) are correctly considered. I.e. these subnetworks are switched in such a way that radial networks with only one feeder each result.

Control of the Calculation Module

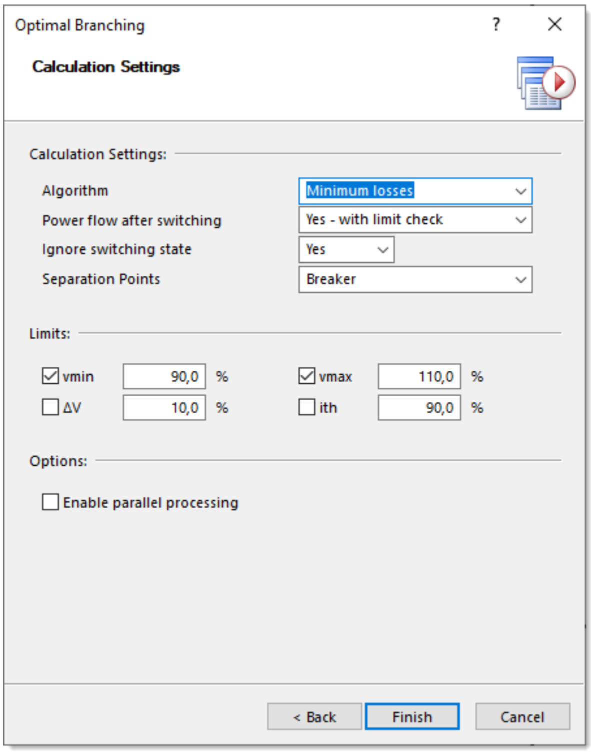
The calculation module is started via the menu item **Calculate** – **Optimization** – **Optimal Branching**. This opens a wizard in which all the required data can be defined step by step. At the beginning, as with most PSS SINCAL calculation modules, the area in which the separation points are optimized is defined here. This is the **Switch Area**.



Then the definition of the **Analysis Area** follows on the second page. The limit values of the network elements in this range are monitored.



On the last page of the wizard, the actual **Calculation Settings** are made.



In the **Algorithm** selection field, the choice of the separation point optimization method is set.

The **Power flow after switching** field can be used to configure whether a power flow calculation is performed after each opening of a disconnection point.

The **Ignore switching state** option causes all breakers open in the switching area to be considered closed when determining the separation points. This means that the present tripping state of the network is not considered and a meshed network is used to determine the disconnecting points. PSS SINCAL only considers disconnecting points at branch elements (lines, transformers, etc.) to be closed. Supply sources and consumers that are switched OFF are not affected by this option.

The **Separation points** field can be used to parameterize how optimal branching is carried out:

- Breaker:
  This option determines the separation points for breakers only.
- Breaker and potential sep. point:
  This option is used to determine the separation points at breakers and those network element connections that are marked as potential separation points.
- All terminals:
  This option causes the separation points for the terminals of all network elements to be determined. This option is only available for the **Voltage based** method.

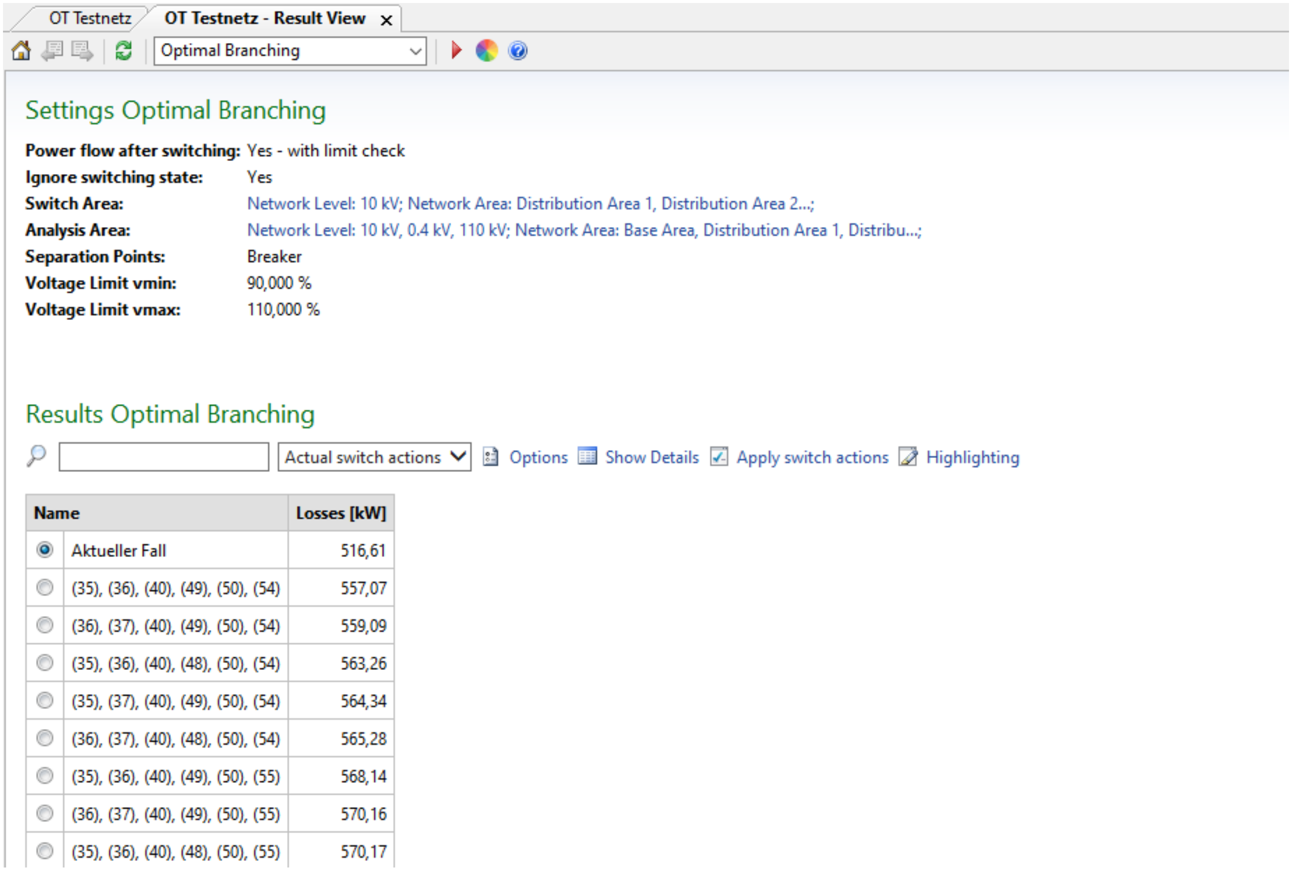
In the **Limits** section the limits for the power flow calculation are defined, which are allowed to occur in the analysis area:

- The **vmin** and **vmax** fields specify the permissible limits for the voltages in the power flow.
- The **ΔV** field defines how much the voltage may change to the base load case when the separation point is opened.
- The **ith** field defines the maximum current load that may occur on the equipment in the analysis area.

With the **Enable parallel processing** option, a parallel calculation distributed over several processes can be executed. Especially with larger network models or many possible combinations of optimal separation points, this can lead to a significantly shorter calculation time.

Results of the Optimal Branching

The results of the optimal branching are visualized in the result view. The result view is displayed automatically after the calculation, but can also be opened manually via the menu item **View** – **Result View**.



In the section **Settings Optimal Branching** the control settings of the calculation are presented.

In the section **Results Optimal Branching** points the results are displayed. It offers to interactively switch between different display modes using the integrated selection list:

- Actual switch actions
- Meshes

The **Actual switch actions** display mode lists the determined combinations of optimal separation points:

Name	Losses [kW]
Aktueller Fall	516,61
(35), (36), (40), (49), (50), (54)	557,07
(36), (37), (40), (49), (50), (54)	559,09
(35), (36), (40), (48), (50), (54)	563,26
(35), (37), (40), (49), (50), (54)	564,34
(36), (37), (40), (48), (50), (54)	565,28

A special feature here is the first line in the table. It represents the network model without changed separation points. The **Name** column contains a listing of all switch changes for the calculated combination of optimal separation points. The **Losses** column contains the losses in the network model when the calculated combination of optimal separation points is active. Thus, by comparing the different variations, the combination with the preferred separation points and the lowest losses can be selected.

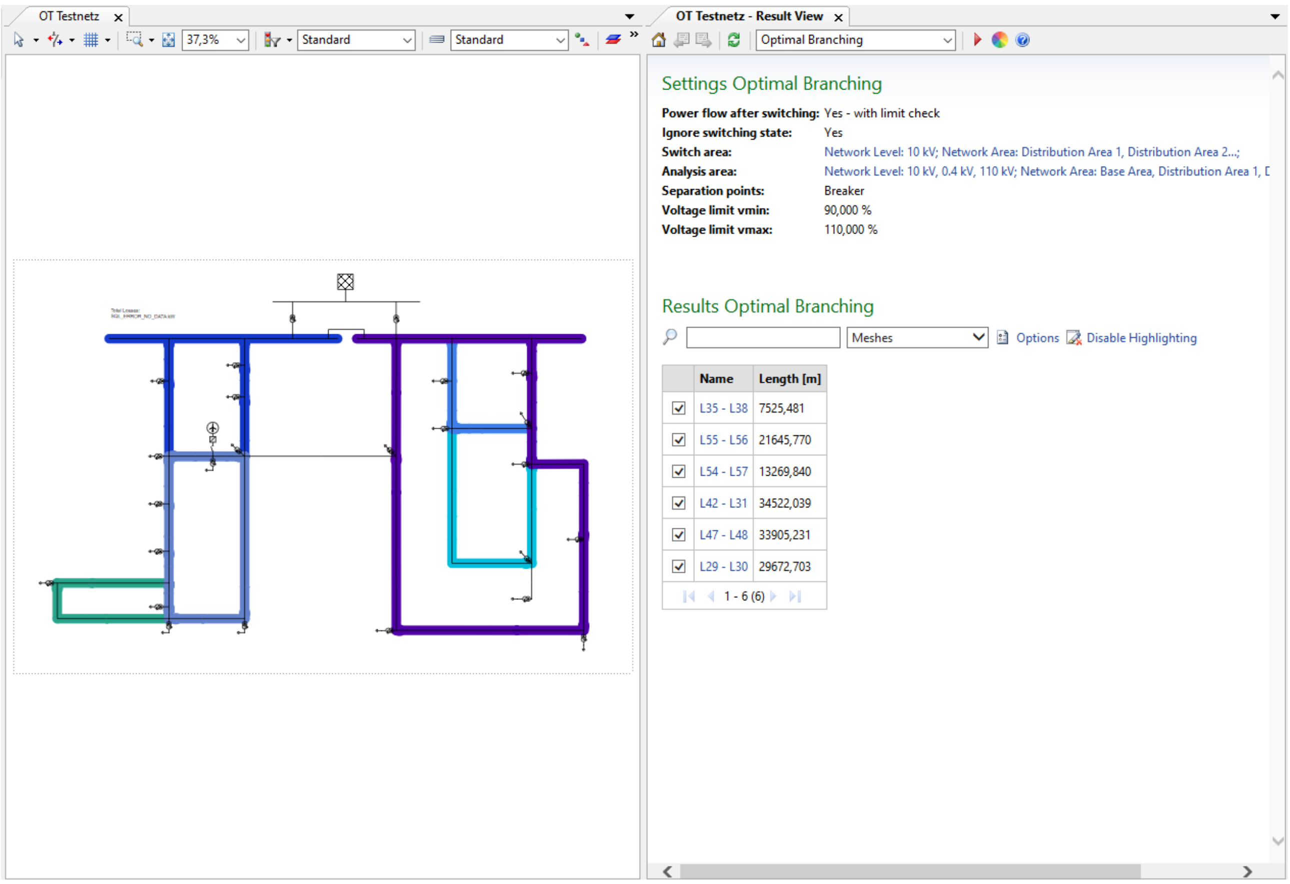
The pop-up menu or the **Show Details** button can be used to display the switch actions for the selected combination of optimal separation points.

	Name	Losses [kW]
◉	(35), (36), (40), (49), (50), (54)	557,07

	Separation Point	State
☑	Breaker (35)	Open
☑	Breaker (36)	Open
☑	Breaker (40)	Open
☑	Breaker (49)	Open
☑	Breaker (50)	Open
☑	Breaker (54)	Open
	1 - 6 (6)	

In this table all switch actions are listed. In the first column of the table the respective breaker/terminal can be activated for editing. The **Separation Point** column contains the name of the breaker or the terminal. This is executed as a hyperlink and can be selected by clicking on it in the graphics editor. The **State** column indicates whether the breaker/terminal has been opened or closed.

In the **Meshes** display mode, the determined meshes in the switch area are listed. Each row in the table represents a mesh in the network model.



The determined meshes can also be visualized directly in the network graphic by highlighting them. During visualization, the checkbox in the table is taken into account, i.e. only those meshes are highlighted which are selected in the table of the result view.

Example Network and Documentation

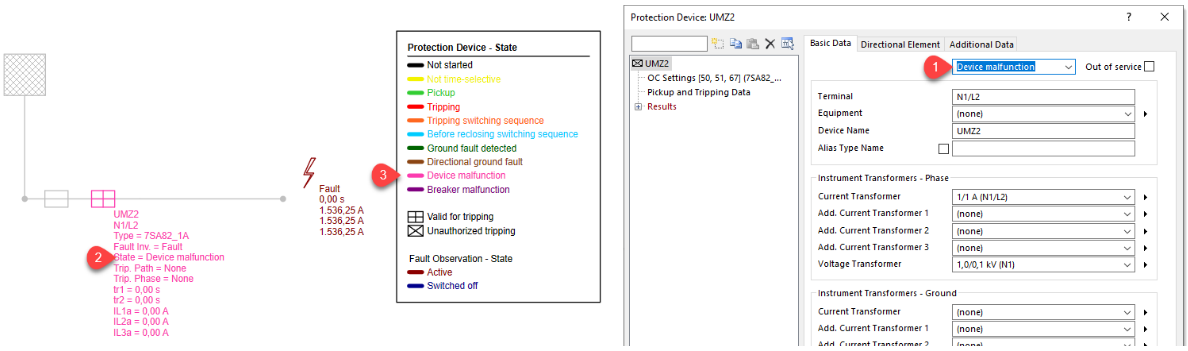
A detailed description of the module can be found in the **Optimizations** manual in the chapter **Optimal Branching**. Here, the basics of the calculation module as well as the available functions for displaying and evaluating the results are explained.

In addition, an application example (Example OT) and the corresponding documentation are also available in the **Examples Manual**. In the chapter **Operational Network Planning – Optimal Branching** all functions of the new module are presented.

Protection Coordination (OC, SZ, DI)

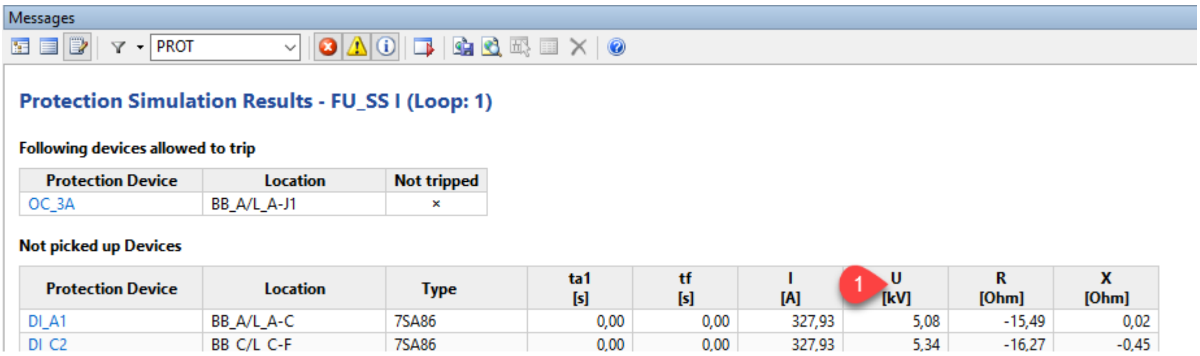
Extended State for Protection Devices in the Results Table

In the result of the protection simulation (ProtOCResult) the **state for protection devices** has been extended. A distinction is now made here between **device malfunction** and **breaker malfunction**. The state is shown here according to the setting on the device (#1) and can also be displayed in the label of the network graphic (#2) and visualized in the legend (#3).



Output of the Measuring Voltage in the Message Window

In the message window, extended information on the currently selected circuit is displayed in the log view after the protection simulation. Here it is listed which protection devices are allowed to trip, which ones have tripped and which ones are picked-up.

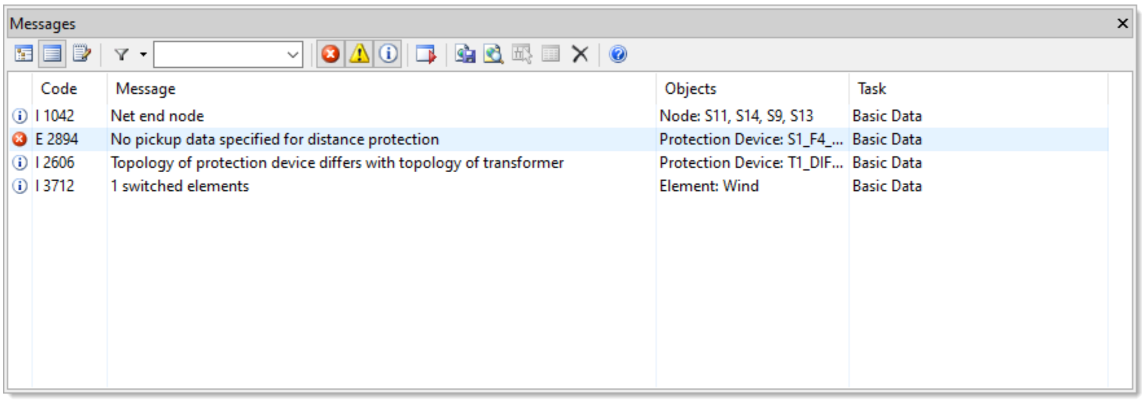


Now the measuring voltage on the protection device is also shown (#1), as its importance is increasing due to the voltage protection functions in the decoupling protection of generating units.

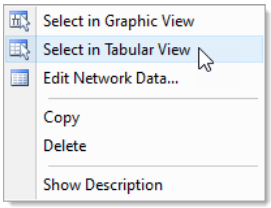
Changed Operation of the Distance Protection Devices

The operation of the distance protection devices has been changed in this product version. Previously, if no pickup was defined, the rated transformer current was used as the pickup current. This is now no longer supported, since the pickup is an essential function in distance protection and must therefore also be parameterized correctly.

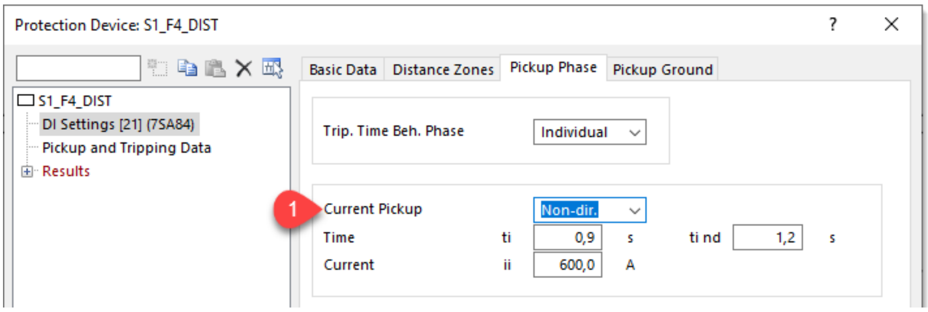
If distance protection devices without pickup data are present in the network model, the calculation is now terminated with the error code "E 2894 No pickup data specified for distance protection".



All affected devices are displayed in the error message and can either be selected in the graphic view or tabular view via the pop-up menu in the message window or edited directly.



If no suitable pickup data are known, a current pickup can be defined for these devices (#1). This can also be done via the Pickup table in the tabular view for all devices at once.



Extensively Revised Modeling of the Distance Protection Devices

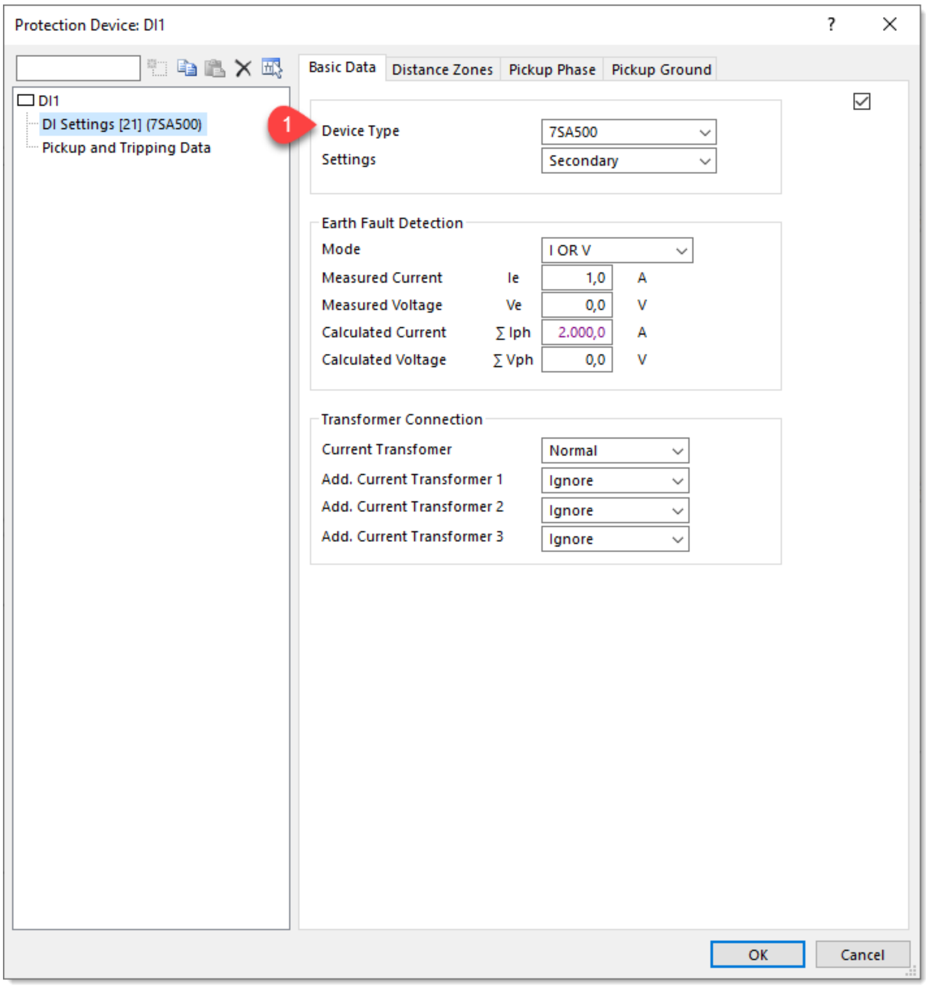
The modeling of distance protection devices in PSS SINCAL has been fundamentally revised in this product version. Data input is now better adapted to the functionality of real distance protection devices. The primary goal was both to simplify data entry and to avoid redundant entries.

The new data input is illustrated below using the settings of a 7SA500 distance protection device. In the newly arranged protection device dialog box, four tabs are available for distance protection devices in the data screen form, in which all data can be defined:

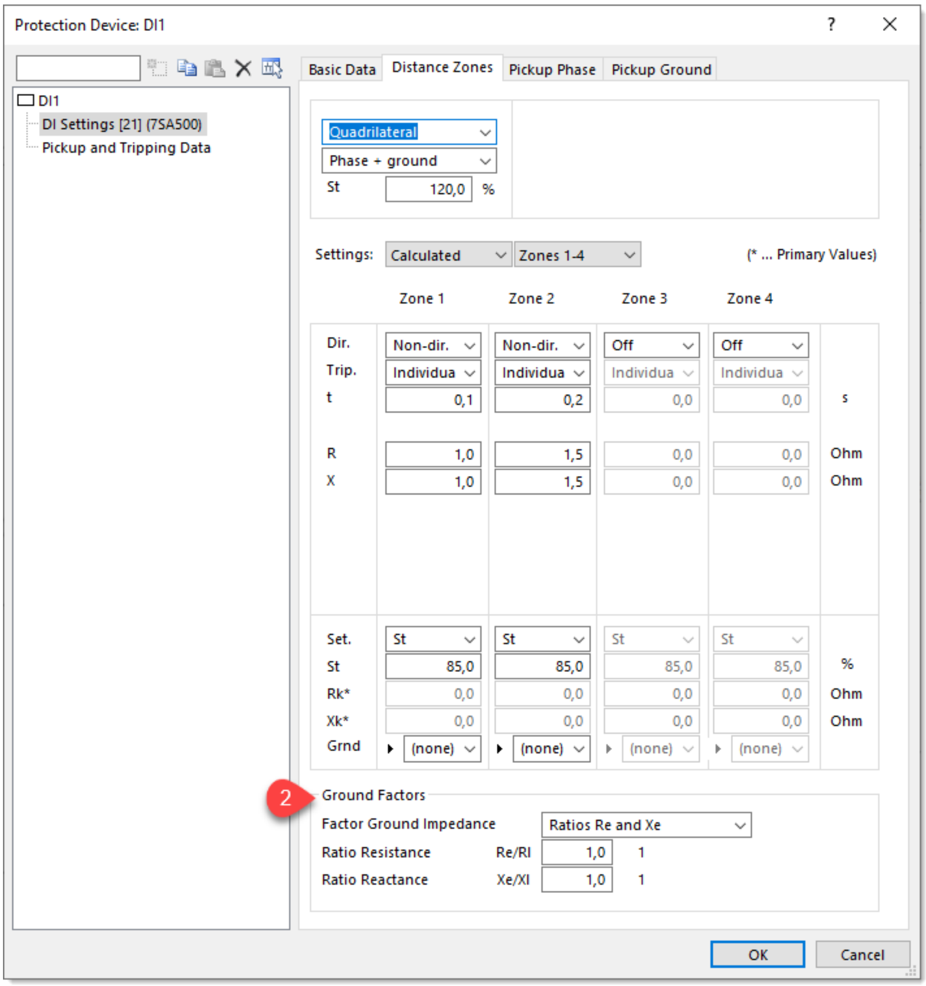
- Basic Data
- Distance Zones
- Pickup Phase
- Pickup Ground

A significant change here is that the pickup data are now also combined with the settings of the distance protection. This means that some definitions only have to be made once, e.g. whether the settings are defined as primary or secondary or also the use of the current transformers.

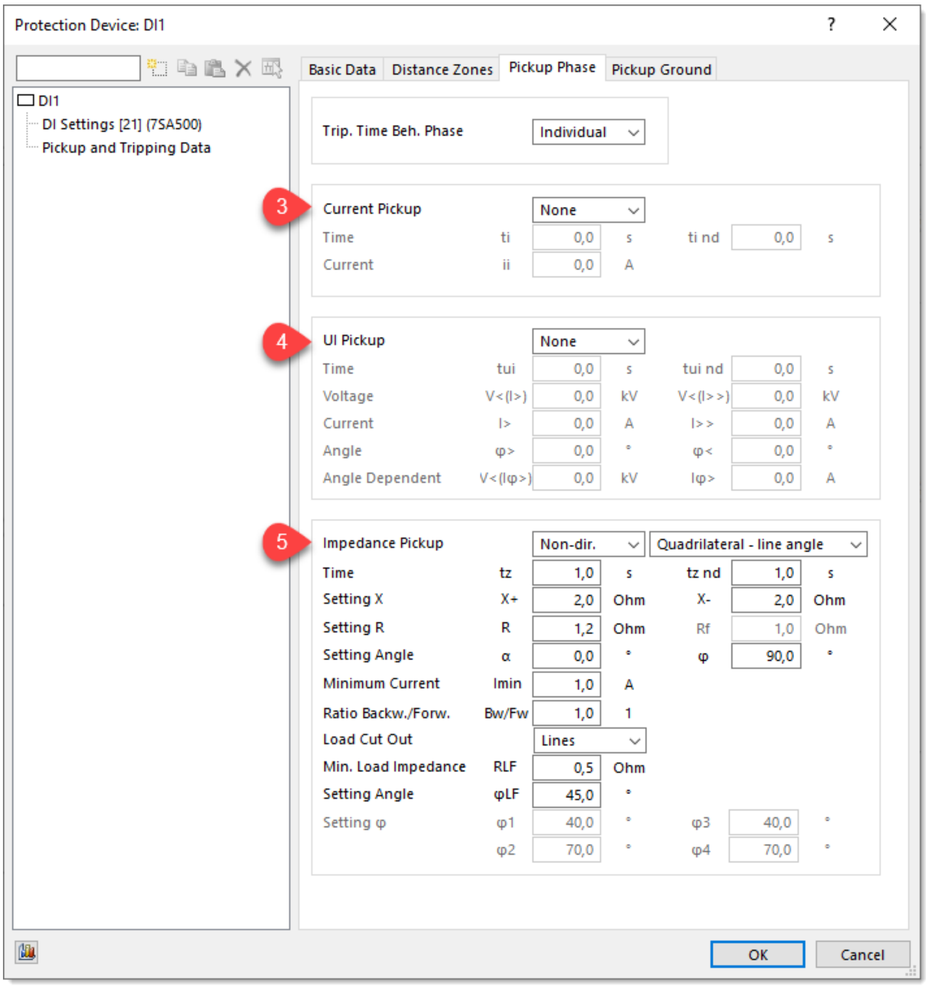
In the **Basic Data** tab the device type and the type of settings (#1) are defined and also other general data like earth fault detection and transformer connection.



In the **Distance Zones** tab the data for the individual zones of the protection device are entered. The data input here largely corresponds to the previous version, the only new feature is the section for entering the ground factors (#2).



The pickup data for the protection device are defined in the **Pickup Phase** and **Pickup Ground** tabs. In the previous version, this data was not defined directly on the distance protection device, but separately under the **Pickup** item in the browser.



The input of the pickup data has been completely revised. The main changes are:

- The definition of whether to use primary or secondary values is taken from the basic data.
- There are no longer separate inputs for directional and non-directional current pickup, but only a single section for **Current Pickup** (#3) where both can be defined.
- The **Undervoltage Pickup** with current criterion has been removed. This function is no longer supported and can be emulated using signal interlock if necessary.
- The voltage-dependent current pickup is defined, as before, in the **UI pickup** section (#4).
- The pickup by impedance area (#5) has been redesigned. An important change here is that the possible shapes of area are automatically determined based on the selected device type. This means that only those shapes of area can be selected that are actually supported by the selected protection device.

For impedance pickup, new area shapes are available for some device types. The following area shapes are now additionally supported:

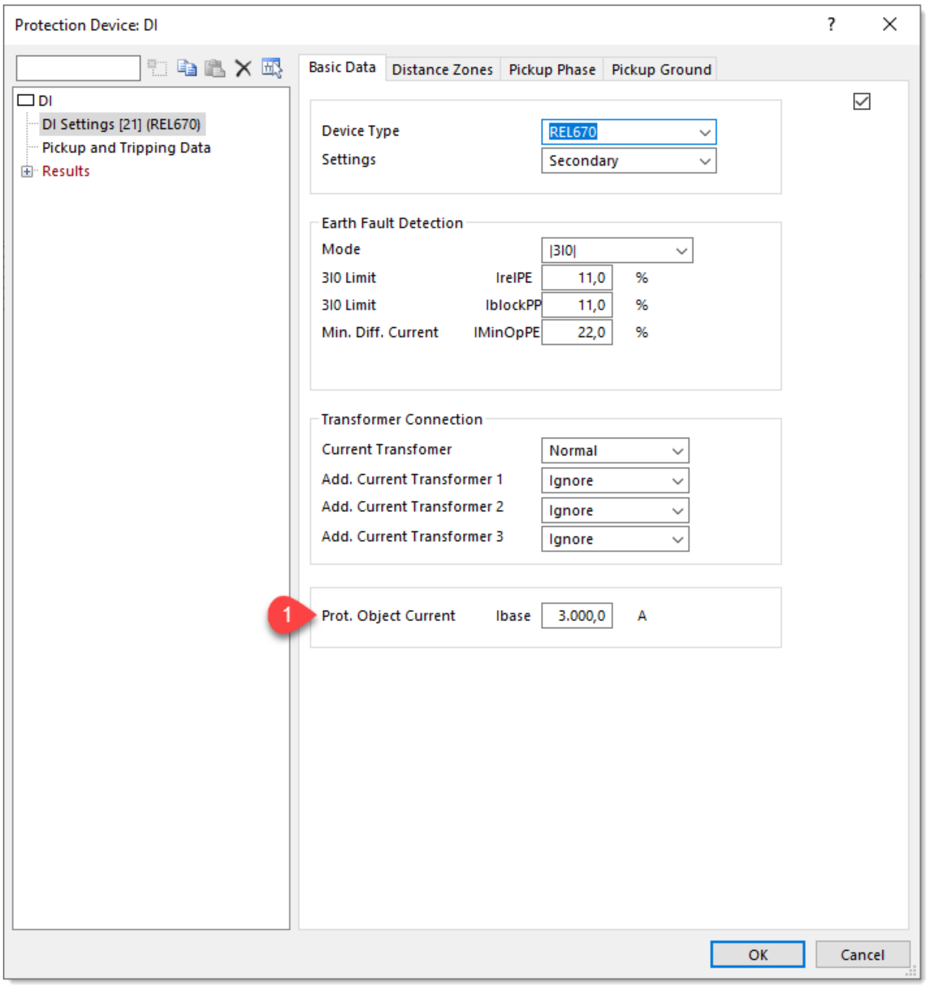
- SPRECON-E-P-DD6
- SIPROTEC 3
- REF630
- SIPROTEC 5
- P54x
- SIPROTEC 4

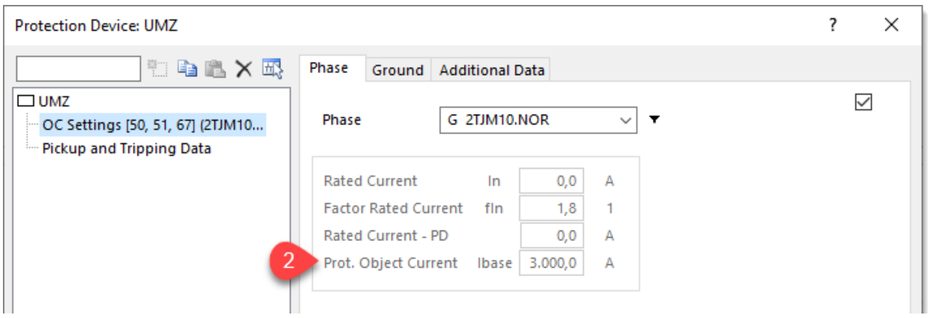
- Easergy P3

Protection Object Current for DI and OC Devices

For some protection devices, a protection object current Ibase is required. The current-based settings of the protection functions are then defined as a percentage in relation to this current.

To enable this input, the Ibase protection object current is now available in the basic data of DI protection devices and OC protection devices (#1/#2).





For distance protection devices, the base current is only displayed if it is also available at the device. This applies, for example, to the REL670 and REL650 devices, where the setting of the current threshold values is in percent.

Advanced Reports

The functionality to generate **reports only for selected protection devices** has been improved. Now it is possible to select the protection devices directly in the graphics editor and then generate reports only for these selected devices.

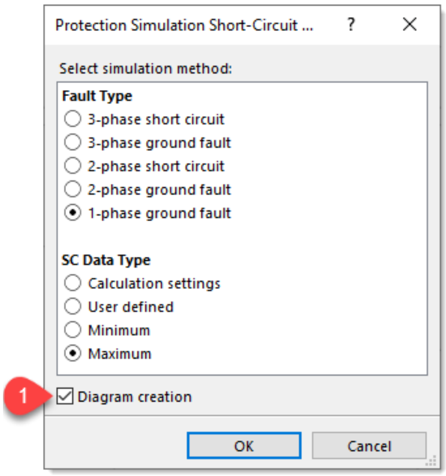
The "Protection settings" report has been extensively revised. The changed functionality for the distance protection devices is now taken into account in the report.

Advanced Result Diagrams

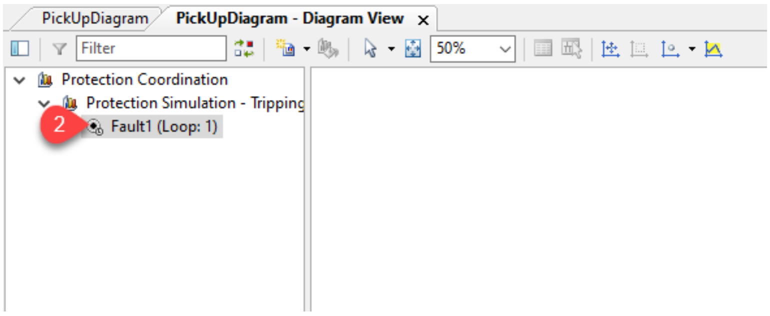
The following result diagrams are now automatically generated for the protection simulation, based on user requests:

- Tripping characteristic diagrams for overcurrent protection
- Tripping area

The automatic generation of the diagrams can be activated via the control dialog box when starting the protection simulation. For this purpose, the **Diagram creation** option (#1) must be activated.

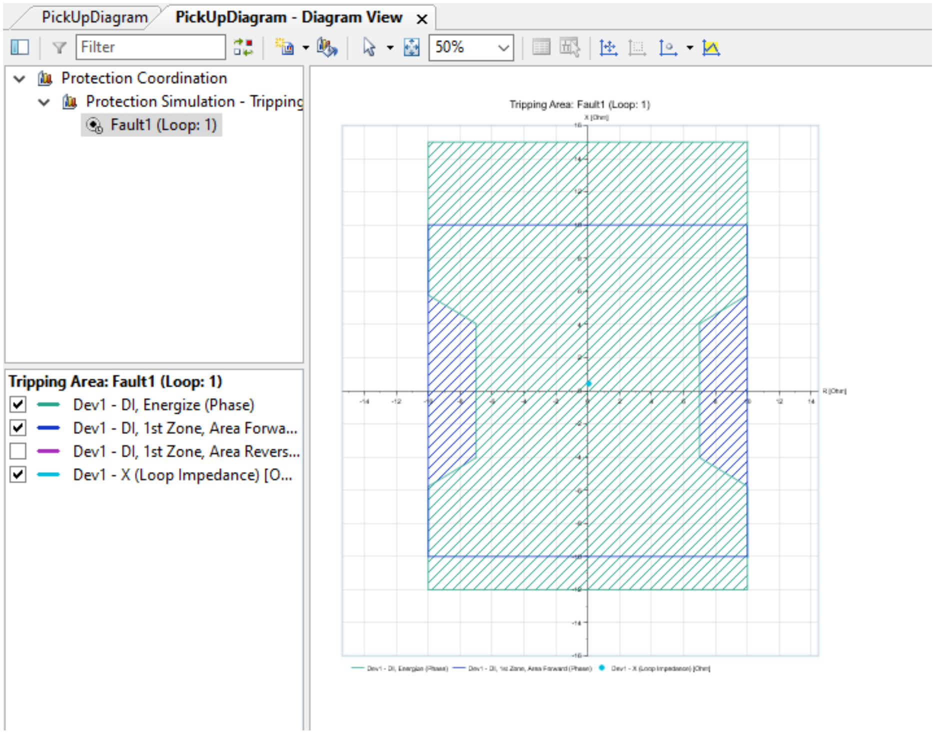


The diagrams are made available temporarily in the same way as the protection routes, i.e. they are deleted when the calculation is restarted. The temporarily generated diagram pages are also specially marked in the diagram view browser (#2). This makes it immediately recognizable that it is a diagram page that is not permanently available.



Using the pop-up menu in the browser, the temporary diagram pages can be converted into normal permanently available diagram pages. The **Save permanently** function is available for this purpose.

The pickup area, which is specified in the protection device for area pickup, is now also shown in the tripping area diagrams of the protection simulation (#1).

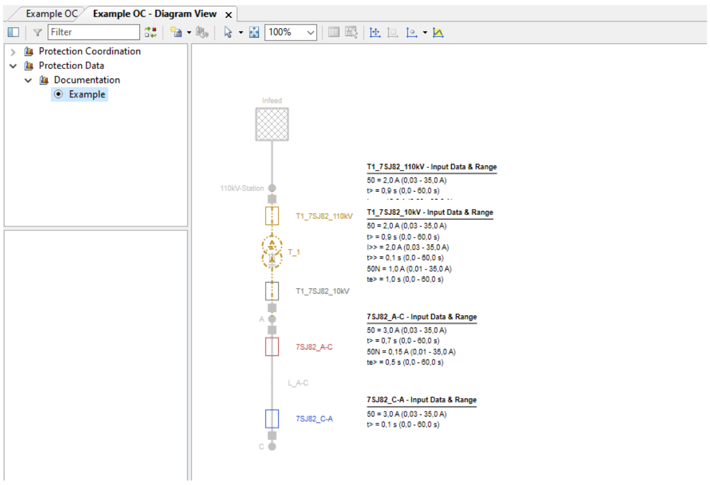


This is particularly important for the REL670 distance protection, since the load cut out is rotated depending on the type of fault, but also for any other distance protection. The pickup, here mainly the load cut out, and the zone setting together form a tripping area.

Protection Documentation

The functions for automatic graphic generation in the protection documentation have been improved to better visualize more complex arrangements of protection devices and breakers in the network model in the diagrams. The lengths of the branch elements are now dynamically adjusted so that all attachments and network element symbols are displayed without overlaps.

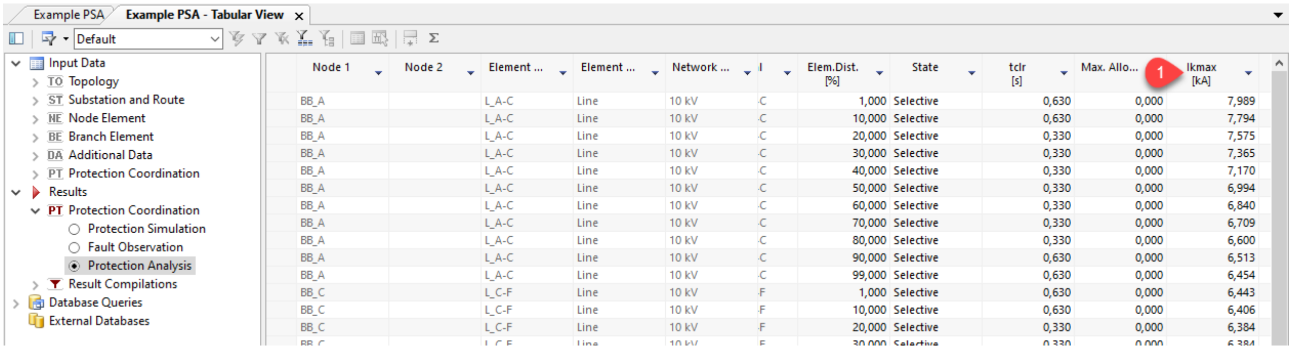
In addition, the placement of the settings displayed next to the protection devices has been improved.



Protection Analysis (PSA)

Extended Attributes in the Results Table

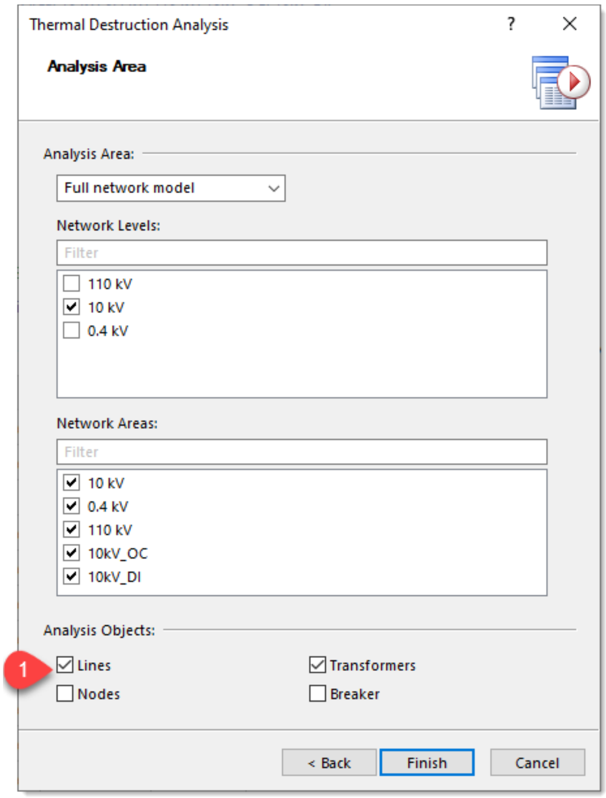
To improve the evaluation options of the protection analysis results in the tabular view, the results table (ProtAnalysisResult) has been extended. Now the maximum fault current Ikmax is also available in the table.



Thermal Destruction Analysis (TDA)

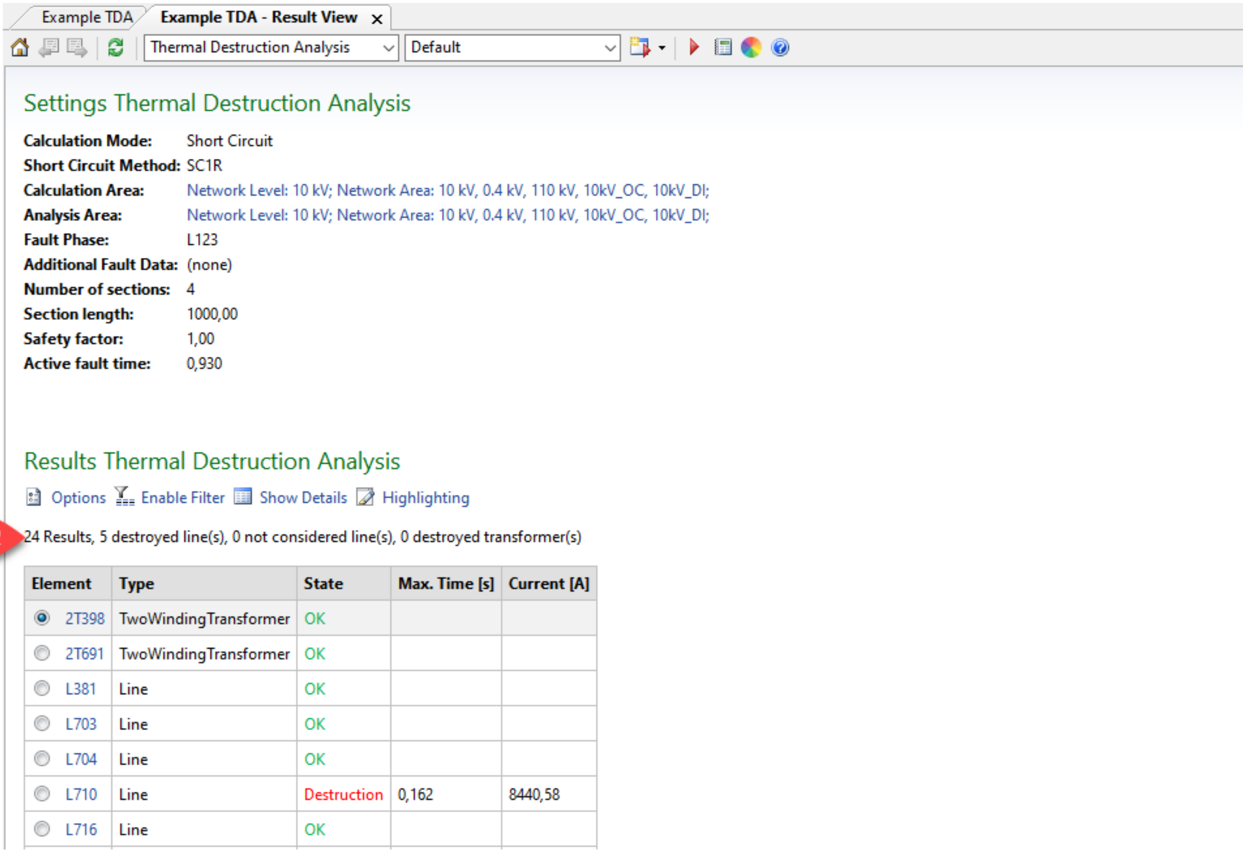
Advanced Control of the Calculation Module

Until now, the thermal destruction analysis was performed for all lines, transformers, breakers and nodes in the analysis area. The wizard allows now to configure which equipment should be checked (#1).



This makes it easy to restrict the analysis to certain object/equipment types without the need to use a separate network element group or selection in the graphics editor.

The visualization in the result view is then also carried out according to the set analysis objects. I.e. only those objects are listed that have been checked (#2).



Advanced Result State

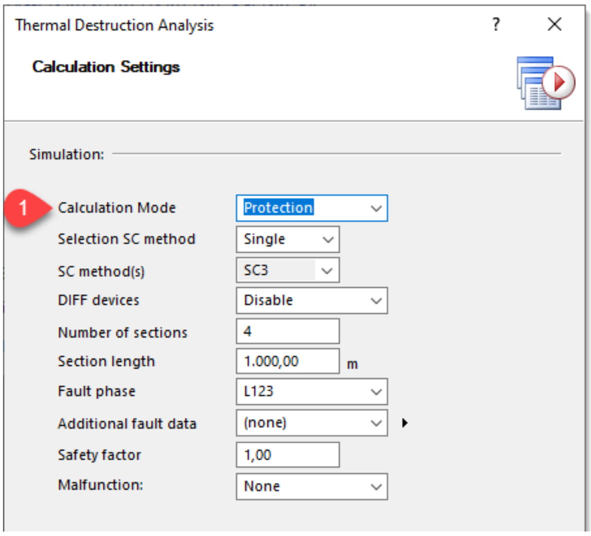
Nodes and breakers in the analysis area for which no **Rated Short Time tkr** or no **Max. SC Current Ik"max** is defined are not taken into account in the thermal destruction analysis. The same applies to lines for which no **Ref. SC Current I1s** is specified.

For these elements the state "Not considered" is displayed in the result view.

Element	Type	State	Max. Time [s]	Current [A]
BB_C	Node	Not considered		
BB_E2	Node	Not considered		
BB_E1	Node	OK		
BB_J	Node	Not considered		
BB_A	Node	Not considered		

Consideration of Reclosers

An extended consideration of reclosers has been implemented in the calculation module. The reclosers are active only in the protection simulation, i.e. only when the **Calculation Mode Protection** is used (#1):



In this calculation mode, the thermal short circuit current capability of the equipment is checked on the basis of the protection devices present in the network model and their clearing time of the faults. With reclosers, sequences of disconnections and reconnections are executed. Here, the active fault times are added and also output in the result view.

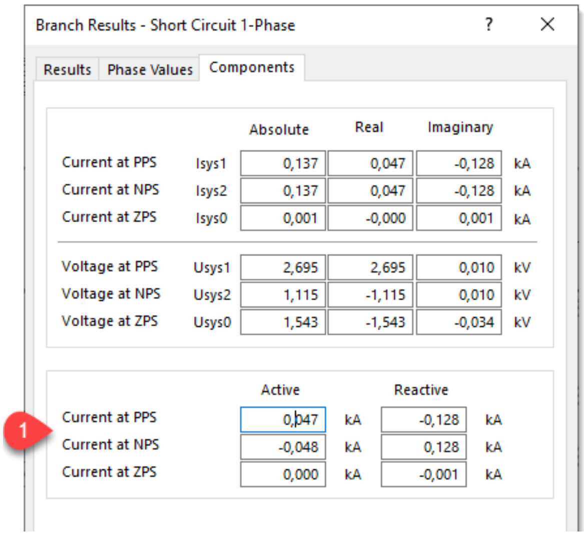
Improved Performance in Large Networks

The performance of the calculation module in large networks has been significantly improved. The calculation module now does not take into account subnetworks that are topologically separated from the analysis area.

Short Circuit (SC)

Extended Results

The branch results of the short circuit calculation have been extended (#1). The active and reactive components of the sym. component currents related to the component voltages are now also provided.

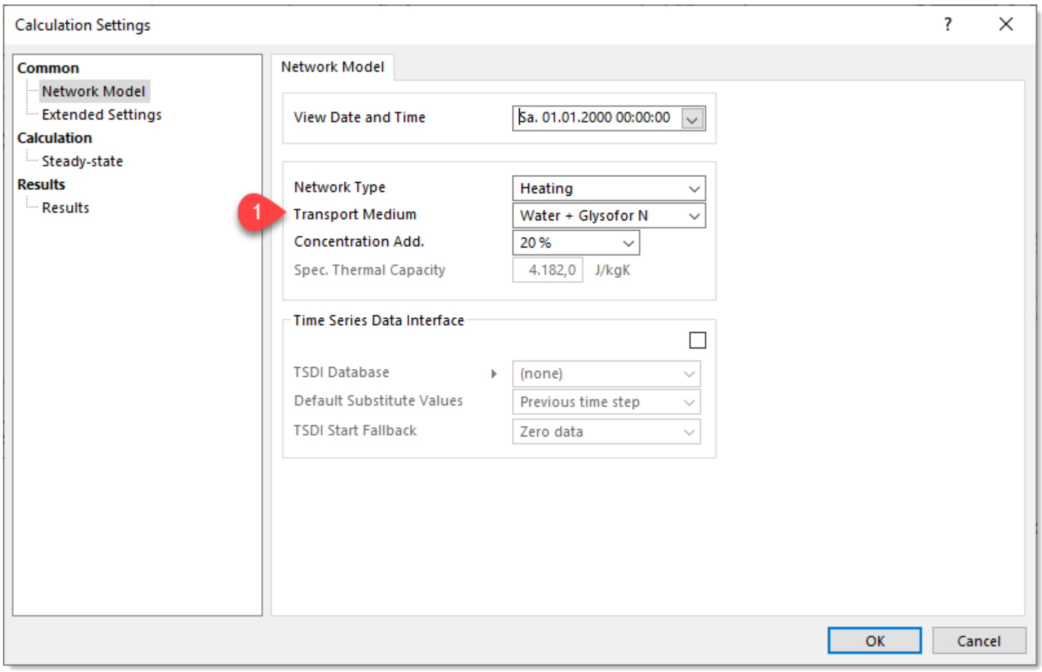


Pipe Networks

Extensions for District Heating Networks

Consideration of the Heat Transport Medium in District Heating Networks

For district heating networks, an extended parameterization of the heat carrier is now available. This supports the hydraulic calculation in local or district heating networks which use a mixture of water and antifreeze and corrosion inhibitor concentrates as medium.



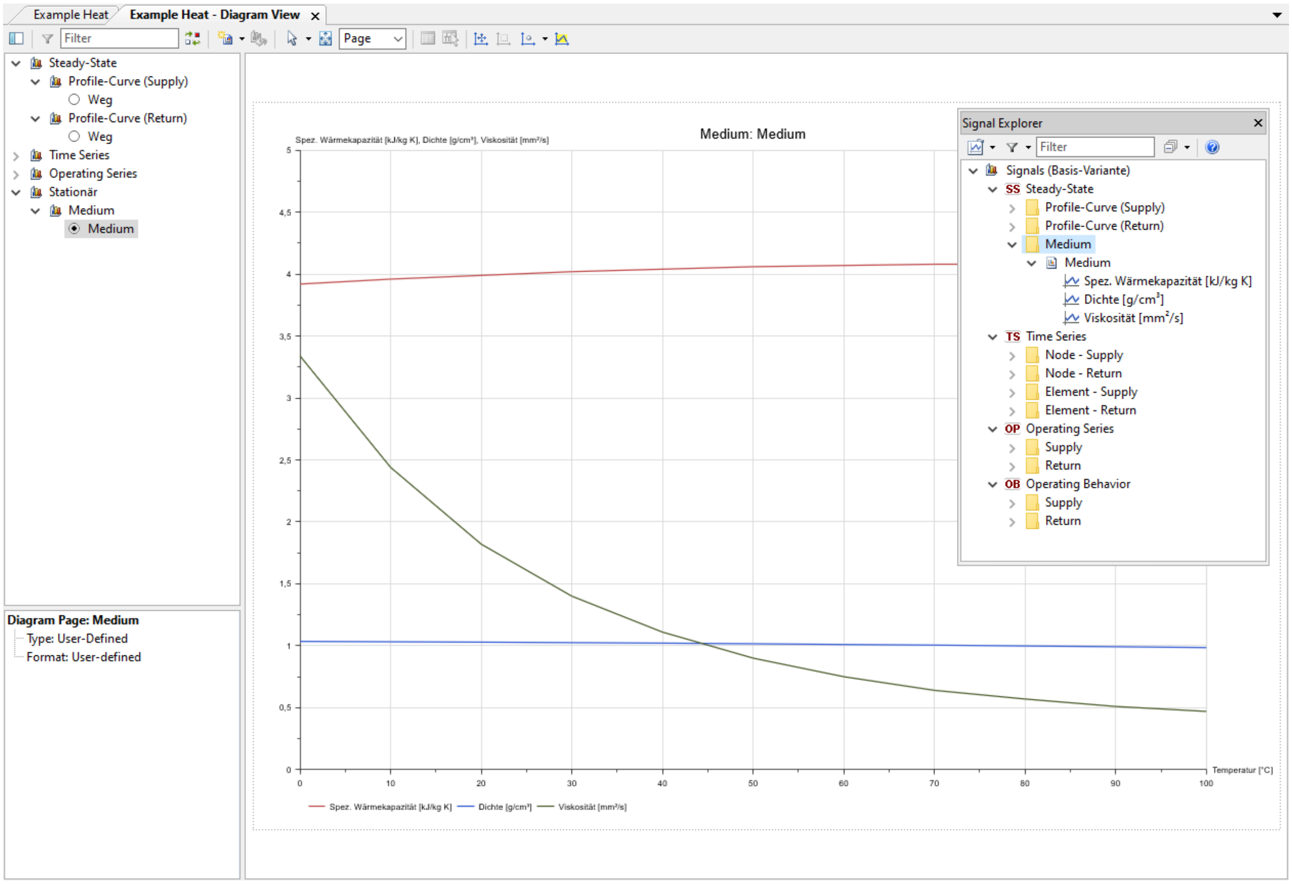
The transport medium can be selected in the calculation settings (#1) from two options:

- Water
- Water + Glysofor N

When selecting the transport medium **Water + Glysofor N**, the percentage of Glysofor N can be defined in the **Concentration Add.** field. The properties of the transport medium are automatically determined in the simulation using stored data tables.

New Signals for Temperature-Dependent Medium Settings

Signals illustrating the temperature-dependent behavior of the transport medium are now provided by the district heating calculation. The specific thermal capacity, the density and the viscosity are determined as a function of the temperature. This supports the analysis of the input data for the heat transport medium.



API (Programming Interfaces for Automation)

API of the User Interface

Example of using the Python Library NetworkX

NetworkX is a free Python library in the area of graph theory and networks. The library provides a scalable and very portable framework for the analysis of networks in Python.

To show how easily NetworkX can be used in conjunction with PSS SINCAL, the new automation example "NetAutoSincal.py" is available. The example shows how to find shortest paths in PSS SINCAL network models and how to detect meshes. All examples are programmed to work interactively with the PSS SINCAL user interface, where they also visualize the results.

The following example shows how the shortest connection between two nodes can be determined using the routing functions of NetworkX. In the example, the network model is loaded from the PSS SINCAL network database and all lines are entered into a MultiGraph object. Then the switched elements are removed and finally the shortest_path() function is used to determine the shortest path between two nodes marked in the PSS SINCAL GUI. This path is then visualized in the GUI by coloring the network elements.

```
# Find shortest path between 2 nodes
def DoPath():
    # Create the graph object
    G: nx.MultiGraph = SetupGraphFromDB(strNetwDB)
    if G == None:
```

```
        print("Error: Setup graph for {strNetwDB} failed!")
        CleanupAndQuit()

    SincalSel = SincalDoc.GetSelection()
    lstSelNodes: list = list()
    for SincalObj in SincalSel:
        iDBID = SincalObj.DB_ID
        iRowType = SincalObj.RowType
        if iRowType == sincal.DBRowType.Node:
            lstSelNodes.append(iDBID)

    if len(lstSelNodes) != 2:
        print(f"Error: select 2 nodes in GUI for path detection!")
        CleanupAndQuit()

    AddLineAttrToGraph(strNetwDB, G)

    # Filter out disabled/switched elements
    def valid_edges(n1, n2, e):
        if G[n1][n2][e].get("Opened", 0) != 0:
            return False
        return True

    view = nx.subgraph_view(G, filter_edge=valid_edges)

    iNode1 = lstSelNodes[0]
    iNode2 = lstSelNodes[1]
    print(f"\nShortest path from {iNode1} to {iNode2}")

    # Calculate shortest path between 2 nodes
    try:
        dLen = nx.shortest_path_length(view, iNode1, iNode2, "len")
        print(f"   Length: {dLen:n} km")
    except:
        print(f"   No path found!")
        return

    path = nx.shortest_path(view, iNode1, iNode2, "len")
    print(f"   Nodes: {path}")

    edges: list = []
    for iNode1, iNode2 in nx.utils.pairwise(path):
        for iElement in view[iNode1][iNode2].keys():
            edges.append(iElement)
    print(f"   Edges: {edges}")

    # Colorize the path in network diagram
    if bShowInGUI:
        ResetView()
        if edges:
            SetColor(RGB(128,128,128))
            SetElementColor(edges, RGB(255,0,0))
            RedrawView()

    return
```

API of the Calculation Methods

Advanced Examples of Calculation Automation

The automation example for the calculation methods "SimAutoSincal.py" (can be found in the "PSS Files/Samples Auto" directory) has been extended. The following new functions are available in the example:

- DoTS()
  This function demonstrates the use of power flow and time series calculation in conjunction with the TSDI module.
- DoCA1()
  This function demonstrates how contingencies can be generated automatically or manually for the contingency analysis module.
- DoCA2()
  This function demonstrates how to run the contingency analysis for a selected view date and time as well as the evaluation of the results accessing the result database.

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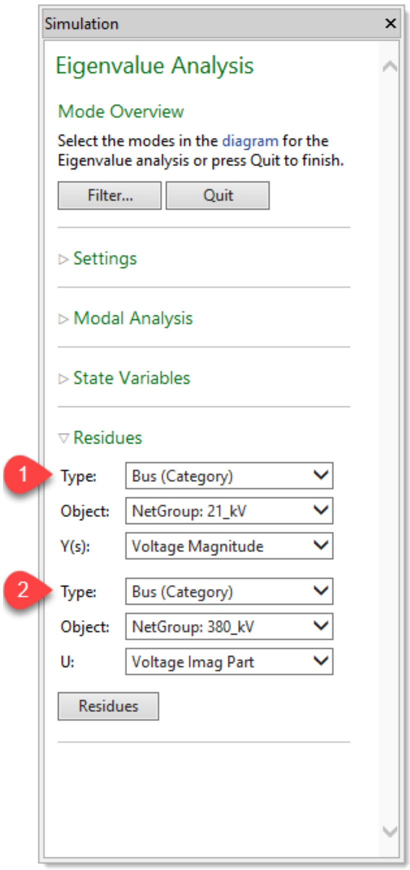
Simulation

Determination of Residues in Eigenvalue Analysis (EVA)

With the **determination of the residues** available in the eigenvalue analysis, advanced evaluations of the eigenvectors can be performed, for example, to determine the positions for the optimal placement of controllers.

In the simulation dialog box of the eigenvalue analysis, the output signal Y(s) and the input signal U can be defined with any sizes. For this purpose, the type is selected in each case and then the corresponding object is identified. Finally, the desired signal Y(s) and U for the selected object can be selected.



Until now it was possible to select either a single object or all objects of the network model for the selected type. When selecting all objects for the output signal Y(s) and the input signal U, the computing time requirement is very high for large networks.

In order to enable a simple reduction of the analysis scope here and thus also a significant reduction of the computing time, extended filter functions were implemented. Both output signal Y(s) (#1) and input signal U (#2) have new types identified with "(category)". Thus, only those objects that are assigned to the selected category are then taken into account when determining the residues. The categories for the objects are taken from the NZD file. These can be network levels, network groups and also any individual categories to which objects were assigned in the NZD file.