Release Information for PSS®SINCAL 7.0

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

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1 General Remarks

1.1 Licensing

To operate PSS SINCAL 7.0, new license files are required. Once the program is installed, these can be requested at the **PSS SINCAL Support** hotline (phone +43 699 12364435, email sincal@simtec.cc).

1.2 Modified Definitions

Dynamics

Dynamics replaces the term **Stability** that was used previously. We used this name because many years ago PSS SINCAL was only used for observations in the area of generator stability. Now, however, that PSS NETOMAC has been totally integrated into PSS SINCAL, all the different types of dynamic observations are possible from normal stability and electromagnetic transients to the Eigenvalue calculations of the network. The new term is used in the data input forms, when selecting the simulation procedures or when entering the respective supplementary data.

Model

Model replaces the term **Stability Macro** that was used previously. This has been changed to clearly state the functionality. A model describes the dynamic behavior of equipment; i.e. their behavior is modeled under different conditions. The change also enables conformity with other PSS® programs (e .g. GMB – Graphical Model Builder).

Include Network

Include Network is now used instead of the term **Network Macro**. The old term sometimes lead to confusion with the normal macro (used to record work sequences). The new term also makes it clear how this actually works: a network is "included" in the calculations.

2 User Interface

2.1 Direct2D Support

An essential characteristic for how PSS SINCAL works is that it can display very large schematic and geographic networks on the screen both rapidly and in the highest quality while, at the same time, providing comprehensive and easy-to-use editing functions.

The graphics library used for the screen display of the network diagram and, of course, also for printing, is based on the GDI interface. Microsoft developed this interface back in the 90s as a flexible way to render graphics on different devices. In the meantime, however, state-of-the-art technologies have been developed that use hardware to render graphics both extremely quickly and in a better quality.

The **Direct2D** interface is provided to assure "modern" graphic visualization on the screen. Essentially, this graphic interface, which was introduced in Windows7, uses the graphics card for hardware-supported graphic rendering.

Using Direct2D increases the quality of the graphics display so that it meets modern standards. The most important key terms describing this new feature are: it can display objects transparently and smooth the edges with "Antialiasing". The following illustration shows a simple graphic object, rendered one time with Direct2D and one time with GDI. The differences in quality should be obvious.

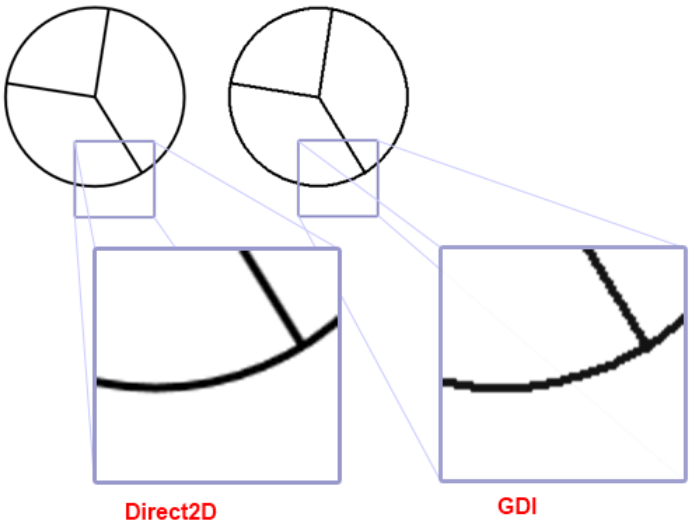

Illustration: A comparison of display quality – Direct2D vs. GDI

In addition to improving display quality, Direct2D makes it easier to organize interactive editing in network diagrams. This graphic hardware makes editing functions even more fluid and, most importantly, completely flicker-free.

PSS SINCAL automatically switches ON this new graphic rendering, as long as the computer has the appropriate Direct2D functions. If you prefer, you can use the dialog box **Extras – Options…** under **User Interface Settings** to switch enhanced graphic rendering ON/OFF manually.

2.2 New Dialog Boxes for Results

Some PSS SINCAL calculation methods generate results that are so complex that they can no longer be evaluated properly by using purely tabular views or displaying them in the network diagram. A good example of this would be the results for Contingency Analysis. PSS SINCAL generates these results in different results tables for all the malfunctions to document malfunctioned elements, overloaded elements, unsupplied consumers, etc. User-friendly interactive evaluation is only possible with a specially programmed dialog box that can organize all the necessary data in a sensible way and, at the same time, provide proper analytical functions. The same is true for other kinds of results, such as those for optimal network structure, compensation power calculations, capacitor placement, etc. All these special dialog boxes were available in PSS SINCAL before, but only as modal dialog boxes. This means the entire application was blocked while these dialog boxes were open. Since this made truly interactive evaluation and analysis of results impossible, all the important dialog boxes for evaluating results have been redesigned for the new version.

PSS SINCAL's new smart tool window for **Results** contains all these new dialog boxes. The window can be docked anywhere in the PSS SINCAL main window or even be used as a stand-alone window, just like the Network Browser. The illustrations below show the new Results window with different kinds of results.

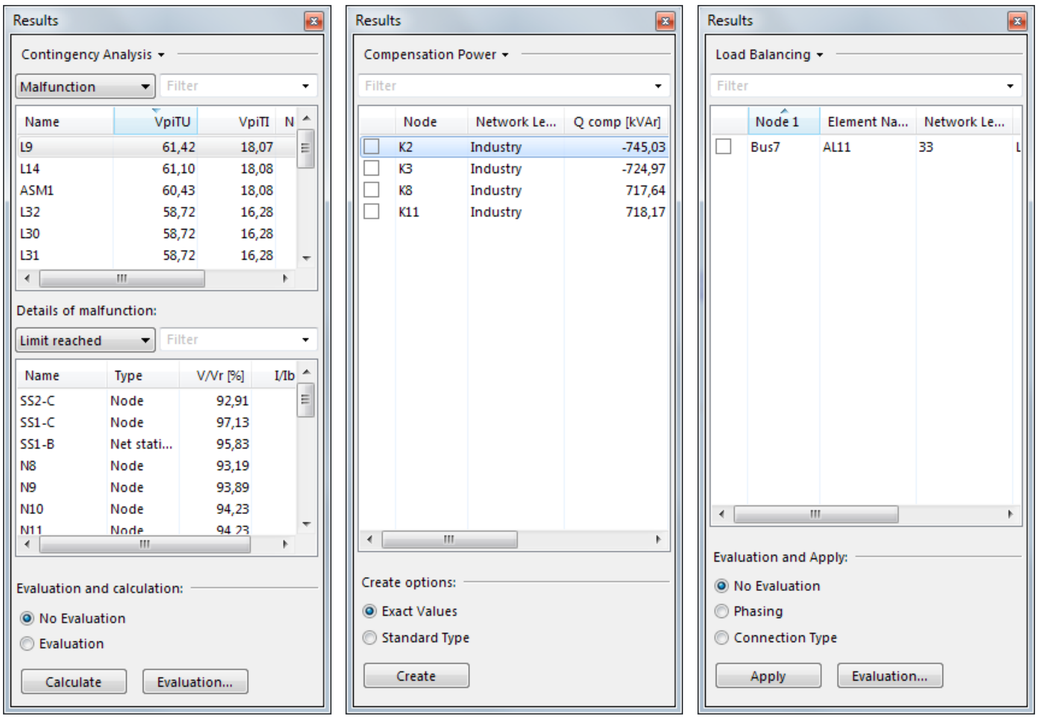

Illustration: New results window

How this new window works is relatively simple: The selection button under the title bar lets you switch between currently available results. Depending on what results have been selected, PSS SINCAL provides appropriate functions for analysis and evaluation. The Results window is automatically synchronized with the active network. This means the Results automatically updates when there are any network changes or new calculations are started.

The following types of results data are provided in the new Results window.

- Contingency Analysis
- Restoration of Supply
- Optimal Branching
- Optimal Network Structure
- Load Balancing
- Load Allocation
- Load Trim
- Compensation Power
- Capacitor Placement
- DI Device – Settings
- Protection Route

Generally speaking, PSS SINCAL analyzes and evaluates results just as before. The main difference is, however, that you can continue working normally with the program. With the Results window, you can select a definite network element and analyze its input and output data in data screen forms without the Results window having to be closed. This means that the new implementation concept lets you create completely new interactive sequences to evaluate the results that optimally combine the different PSS SINCAL functions.

To simplify the evaluation procedure, the interactivity of the visualization functions has been greatly improved for different types of results. **Load Allocation** is a good example of this new functionality. The illustration below shows how the Results window looks immediately after the calculations.

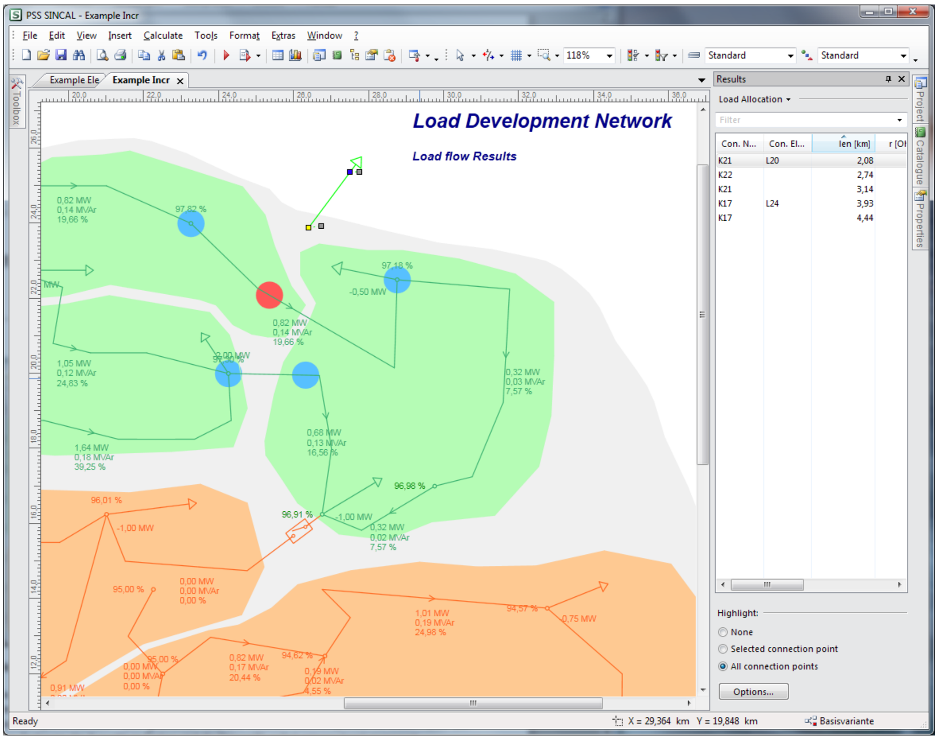

Illustration: Results window for load allocation with visualization in the network diagram

Any possible connection points for the new load are listed in the Results window. These same points are also highlighted at the same time in the network diagram. The connection point selected in the Results window is displayed in red and all the other connection points are displayed in blue. When the selection in the Results window changes, the network diagram immediately adapts to show the changes.

2.3 Enhanced Network Planning Tool for Feeders

Based on the requests of different users, PSS SINCAL's network-planning tool for feeder analysis has been comprehensively redesigned.

Users of PSS SINCAL have mentioned repeatedly that they would like to manually assign **colors and names** to feeders so that feeders will look the same and have the same colors even when there is a change in network topology. The problem with this is that the feeders are only virtual structures defined by the switching state of the network. For this reason the primary substation and the first network element connected to it are used to assign the respective attributes. Both these elements are used to identify a feeder. The illustration below shows how feeders are visualized in medium-voltage networks.

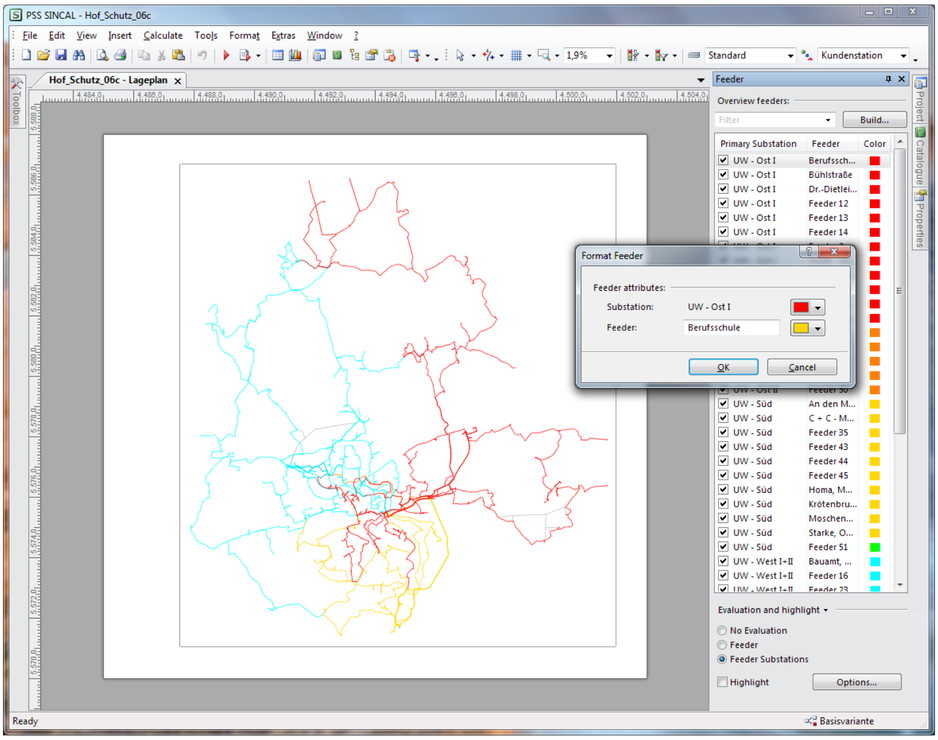

Illustration: Network with feeders

Format Feeder in the pop-up menu lets you assign individual attributes. This function opens a new options dialog box for editing attributes.

Another frequent user request was to be able to **store** calculated feeders **in the database** to make it easier for external applications to access any feeders calculated by PSS SINCAL. For this reason, the data model has new tables for both **FeederResult** and **FeederElemResult**. These tables contain important feeder data, as long as the corresponding option has been switched ON while the feeders are being generated. Any results stored in these tables can also be evaluated directly in Tabular View, too.

The Help Window for feeder visualization has also been redesigned. Functions for evaluating and highlighting are now even more intuitive. The evaluation you select will be immediately displayed in the network diagram. Any changes in the Results window will also be displayed in the diagram at the same time. A check box lets you switch between evaluating and highlighting. Both visualization forms will always use the same colors. To improve legibility, colors used for evaluations are displayed in their own column in the Results window.

2.4 Functional Improvements

Select by Type

The function that lets you select elements according to their type has been completely reorganized.

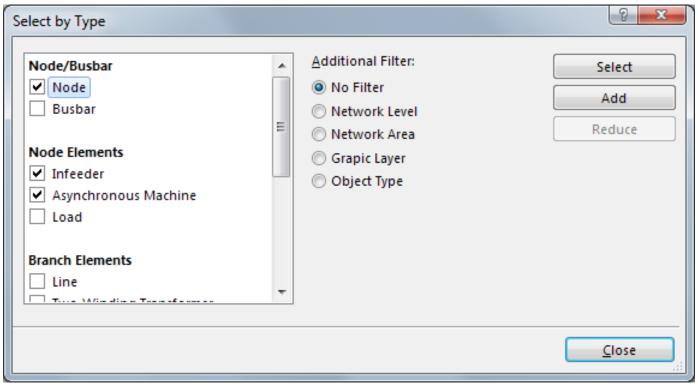

Illustration: Dialog box for Select by Type

The **Select by Type** dialog box now lists all the different types of elements in the network (nodes/busbars, node elements, branch elements and supplementary graphic elements). This list lets you select the types to be selected in the network diagram.

An additional filter function can be used to restrict selecting to definite network levels, network areas, graphics layers or object types.

Buttons in the dialog box control what is actually selected in the network diagram:

- **Select**
  Elements in the Graphics Editor are selected with the help of the settings in the dialog box. This function resets any element selections.
- **Add**
  Selecting is enhanced, i.e. elements selected in the dialog box are also selected in the Graphics Editor, and any elements already selected keep this status. This lets you simply extend existing selection.
- **Reduce**
  This function reduces what has already been selected in the network to match the selection in the dialog box. This is mainly useful if all elements in a graphic area have already been selected and this selection needs to be reduced to show specific types.

Improved Editing Functions in the Network Diagram

The functions for **interactive editing** in the network diagram have been improved. In particular, functions for creating network elements while scrolling sections on the screen have been improved.

Together with Direct2D, **attaching elements at nodes/busbars** has been reorganized optically to be more appealing. PSS SINCAL now displays any possible connections transparently.

Another very practical function for creating new elements is the **editing possibility right after elements are created**. Before you needed to switch ON Selection mode. Now, however, newly created elements can be edited already in Insert mode.

Positioning network elements with **Format – Position and Scale – Position…** has been improved as well. Entries for position now refer to the selected master elements.

Rectangular alignment of the element contour is now also available for node elements connected to busbars. This aligns node elements on to busbars.

Editing Routes

The graphic display for route nodes has been improved. Now route node symbols show whether a station has been assigned. A differentiation is made between the following symbols:

- Round route node:
  Normal connecting point between two routes without any additional data.
- Rectangular route node:
  Special connecting point to which a primary substation is assigned.
- Rhombic route node:
  Special connecting point to which a network station is assigned.

If stations assigned to route nodes are created graphically, PSS SINCAL will display this connection as soon as the route is selected.

To make it easier to edit data for route nodes and any stations assigned to them, the pop-up menu for routes has been enhanced.

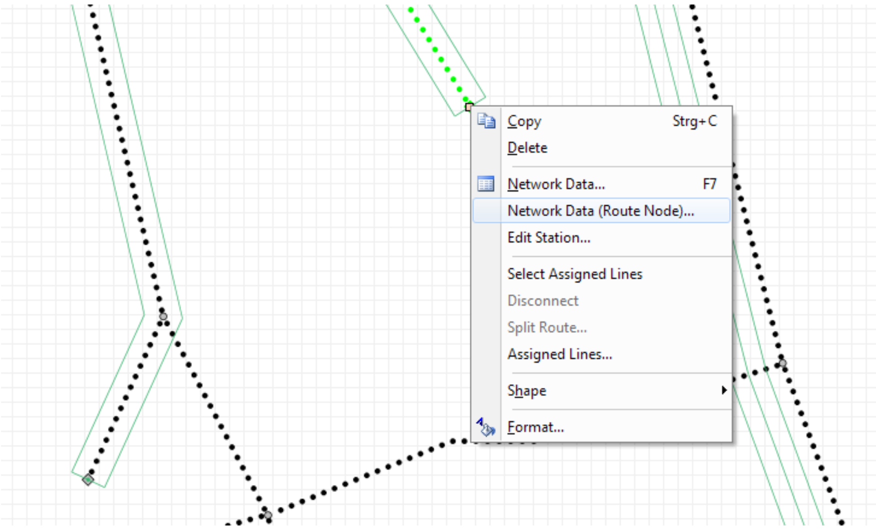

Illustration: Enhanced pop-up menu for routes

When the pop-up menu for a route node is opened, PSS SINCAL provides additional editing functions for route nodes and stations.

Extended Data for Nodes

PSS SINCAL now provides universal extended data for the nodes and busbars similar to those for network elements. These extended data can have any kind of external information on a node.

Extended data are stored in the NodeExt table in the network database. External programs can also easily fill the table if you want to store additional information. The advantage of this over using already available generic data is the simple structure of the **NodeExt** table. This table only has a secondary key for the node, a data key, and the real data.

Extended node data can be edited directly in the user interface. To do this click **Additional Data – Extended Node Data…** in the node's pop-up menu.

In the same way as for network elements, external extended node data can be displayed in the element annotation of the network diagram. The **Annotation and Filter** dialog box even has a new attribute to set parameters for how extended data will be displayed.

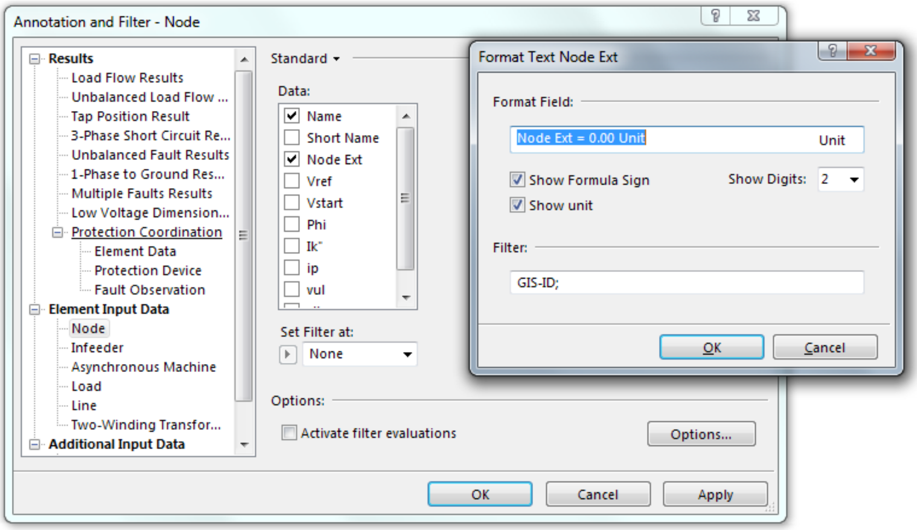

Illustration: Configuring the display for extended node data

With the filter field in the **Format Text** dialog box, extended data to be displayed at the respective network element type are selected. You can define filter criteria for the names for extended data. Multiple filter criteria can be entered by separating them with a ";". PSS SINCAL displays all the extended data that match one of the filter criteria in the network diagram.

New Features for Breakers

In PSS SINCAL, add elements for modeling breakers have been enhanced. The data model has a new attribute to define whether the breaker is a remote-controlled breaker. This attribute identifies any breakers that are remotely controlled. At this time, this attribute is only used for documentation, but in the medium-term it will also be used in the calculation methods.

Remote-controlled breakers can be specially marked in the network diagram, similar to the marking for regulated network elements. This means that, in addition to the actual symbol, there is a special overlay. The **Format View** dialog box configures the extended display for breakers.

Some users wanted interactive switching to be possible only for "real" breakers. Now the interactive switching mode can be restricted to switching for terminals involving "real" breakers. In the **Selection Settings** in the **Extras – Options…** dialog box, the switching function can be restricted.

Selecting Manipulators

The **Insert – Manipulation…** dialog box used to administer manipulators has a new function for selecting network elements in the Graphics Editor that have manipulators assigned to them in the dialog box.

Improvements in Background Images

How PIC background images are processed has been completely reworked. In particular, the performance for very large background images has been greatly improved. This has been achieved by optimizing the drawing functions and using Q-trees for visibility determination. Beside this very large PIC background images can now be loaded much faster.

Together with these optimizations, the functionality has also been enhanced. Now individual layers of the PIC background picture can be assigned minimum and maximum zoom factors to define when elements in this layer become visible. This lets you flexibly control how much information will be displayed.

The dialog boxes for managing background images and setting parameters for additional display options have been enhanced.

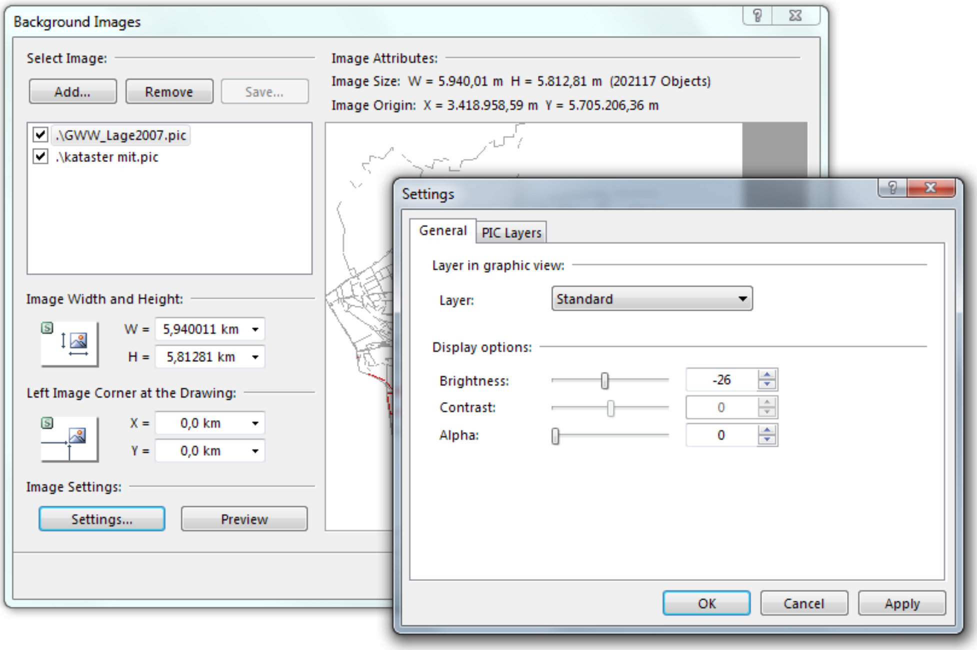

Illustration: New dialog boxes for Background Images

The **Settings** dialog box now contains all the settings for background images. There is an additional tab for PIC background images where additional settings can be defined.

Enhanced Highlighting for Network Elements

Highlighting network elements has been enhanced by a simple – but very useful – function. In addition to the width of the highlighting, a minimum line width in pixel can be entered. When the minimum line width is defined, highlighting will have at least this line width. This assures that the highlighting remains visible in smaller zoom steps where the contour of the network element might have covered it up.

Master Resources for All Network Elements

Since PSS SINCAL 6.0, special keys for identifying network elements have been stored in the **MasterResource** table. The main purpose of such keys is to make elements uniquely identifiable (worldwide).

Up to now, Master Resources have only been used in PSS SINCAL for CIM import/export. CIM functions store special Universally Unique Identifier (UUID)s in the MasterResource table to uniquely identify power system resources worldwide.

In the new PSS SINCAL version, Master Resources can also be used for other purposes. This is particularly useful if you want to store special keys for a network element for coupling with external systems (GIS, SCADA, NIS).

PSS SINCAL has a new dialog box for editing and displaying Master Resources. Select **Additional Data – Master Resource…** in the network element's pop-up menu to open this dialog box.

Evaluating Line Types

For electricity networks and pipe networks, a new evaluation type now is available that colors the network diagram based on assigned line types.

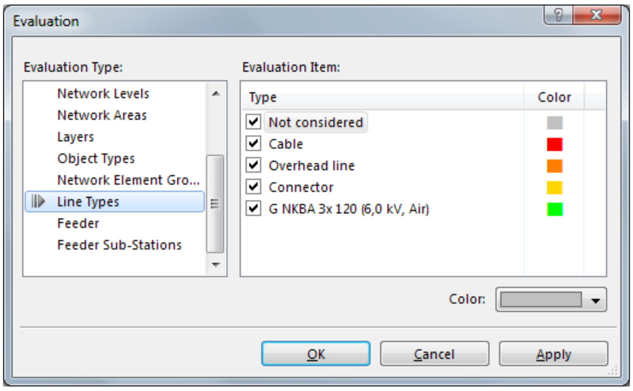

Illustration: Evaluation dialog box with Line Types

Networks are colored according to assigned standard types. In electricity networks, you can distinguish between cables, overhead lines and connectors, if no standard type has been assigned.

Check Graphics

The function for checking the completeness of the graphics (**Tools – Check Graphics…**) has been enhanced. Now you can check simultaneously whether all the network elements are present in the current view.

Check Names

The function for checking the uniqueness of names (**Tools – Check Names…**) has been enhanced. Now you can check simultaneously the uniqueness of names for all the node/busbars and network elements.

Locking Editing for Local Standard Databases

Based on various client requests, editing in local standard databases can now be locked. This locking can be switched ON directly in the database. Simply enter "*Locked*" in the "Author" attribute in the Version table.

Enhanced Excel Import

Excel Import for electricity networks has been enhanced so that

- load increases,
- daily series,
- weekly series and
- yearly series

can be imported for all network elements that have these data.

The enhanced Excel import can also be used for updating existing data. This is an easy way to exchange characteristic curves with metered data from external applications.

3 Electrical Networks

3.1 Enhanced Operating Behavior for Network Elements

GNE/I Models

All network elements that already support the GNE/PQ model (synchronous machine, power unit, infeeder, load, etc.) now also support the GNE/I Model.

The GNE/I Model lets you feed rated currents (reference power of 1 MVA) to the connection node of the respective network element. The present node voltage determines the power of the network element.

Shedding Over- or Undervoltage

Network elements above or below voltage limits normally need to be removed from the network for safety reasons. This is true for both consumers and supply sources. In PSS SINCAL, voltage-dependent shedding can be used to simulate this behavior.

Shedding for undervoltage was already available in the reliability calculations. In the new version, this functionality has been generalized. Detailed parameters can be set for shedding, and shedding can even be done for load flow calculations, short circuit and motor start-up.

PSS SINCAL supports voltage-dependent shedding for the following network elements:

- Synchronous machine
- Infeeder
- Asynchronous machine
- DC-infeeder
- Load

Shedding can be configured individually for each network element. The **Reliability** tab is used for configuration. Voltage limits for shedding are defined globally in the load flow calculation settings.

In **Normal Load Flow Calculations**, shedding is done if this option has been switched ON at network elements and the limits have not been met.

In **Short Circuit Calculations**, shedding can also affect tripping current. If the shedding requirements for short circuit are met on entry, the time needed for shedding can be less than switch delay time. In this case, the network element does not actually contribute to the tripping current, since this element has already been removed from the network.

In **Motor Start-Up**, you can switch ON an option for shedding in the motor start-up calculation settings. Normally, shedding takes place immediately and is electronically regulated. Electronic motor start-up takes place, if the voltage will be available again for a specific time. Since the amount of time needed is normally longer than the time needed for start-up, there is no restart at the end of motor start-up calculations.

Shedding when Regulation Limits are Exceeded

If appropriate contractual agreements exist, consumers can even be shed independent of the voltage to meet power limits for supply sources or zone exchange powers. In PSS SINCAL, power-dependent shedding simulates this behavior.

Power-dependent shedding exits for the following network elements (with consumption or motor operation):

- Synchronous machine
- Infeeder
- Asynchronous machine
- Load

Shedding can be individually configured for each network element. The **Reliability** tab is used for configuration. Note that this type of shedding only takes place if extended regulation has been switched ON in the load flow calculation settings. PSS SINCAL only calculates the zone exchange powers if this has been switched ON.

Voltage-Dependent Supply for Reactive Power

To avoid overvoltages, network operators require voltage-dependent infeeding of inductive reactive power from external decentralized supply sources. Decentralized supply sources usually operate with a power factor of 1.0. Within a specified voltage range, the power factor must have a maximum underexcitation (e.g. 0.95).

In the PSS SINCAL Load Flow, this behavior can be switched ON for the following network elements:

- Synchronous machine
- Infeeder
- Power unit
- DC-infeeder

Voltage-dependent reactive power is defined in the **Controller** tab for the network element.

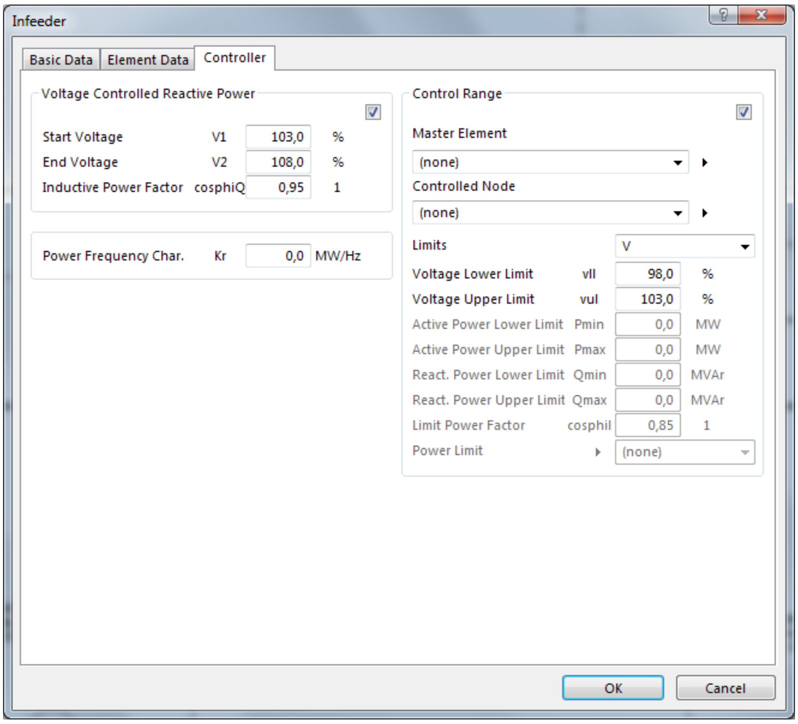

Illustration: Data screen form for the Controller of the Infeeder

The fields for **Start Voltage**, **End Voltage** and **Inductive Power Factor** prescribe voltage-dependent reactive power to support the voltage in the network.

3.2 Load Flow

Phase Rotation for Voltages

Up to now, PSS SINCAL symmetrical load flow results could be stored selectively in the database with or without considering the phase rotation. Internationally, voltage is normally defined with phase rotation. For some evaluations, however, voltage angles without phase rotation are also required.

For this reason, voltage angles with phase rotation are stored in the database along with those without phase rotation. This means both these voltage angles are always available as results in the database. Both values are displayed in the data output form with the node results. If you want, you can, of course, display these in the network diagram as well.

Tap Zone Detection

Up to now, when tap positions were calculated, voltage losses at the secondary feeder were not considered. Since the network for the tap zone detection is modeled in a simply way, secondary voltage loss cannot be calculated.

To solve this problem, estimated minimum and maximum voltage loss have been added to the measurement data for the load. PSS SINCAL considers these estimated voltage losses when it calculates the respective secondary voltage.

3.3 Short Circuit

Based on the wishes of many users, the results for asymmetrical faults (one- and two-phase short circuits) have been changed.

PSS SINCAL calculates the current in the return conductor and the voltage displacement and provides these as results for short circuit, for protection coordination and for multiple fault calculations.

For the **current in the return conductor**, the formula sign of IL0 was changed to 3I0, since this makes it easier to tell what resulting values are being prepared: 3I0 = IL1+IL2+IL3.

The **voltage displacement** now has the formula sign U0 and indicates the actual voltage: U0 = (UL1+UL2+UL3)/3.

3.4 Contingency Analysis

Help Window for Evaluating the Results

The dialog box for analyzing results has been comprehensively enhanced and attached to the new **Results** window to enable completely interactive evaluation and analysis.

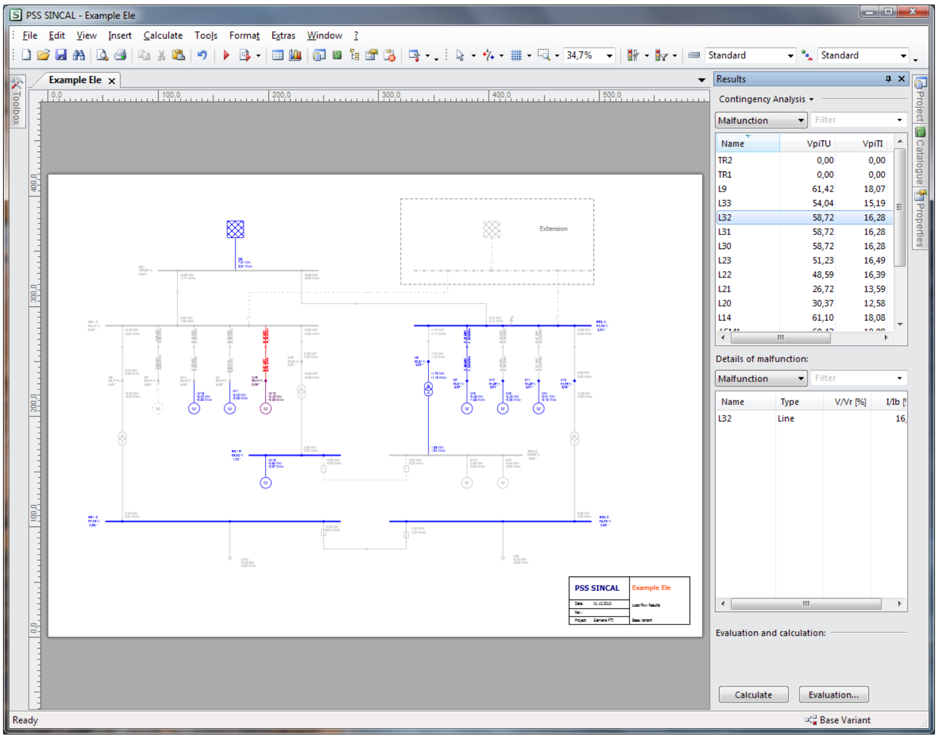

Illustration: Electricity network with Contingency Analysis Results window

Since the dialog box has been integrated into the **Results** window, you can now work normally in the entire network even while contingency analysis results are being displayed. The function for analyzing the results has been greatly improved. When the evaluation is switched ON, PSS SINCAL automatically colors the network diagram according to what has been selected in the Results window. This makes analysis and evaluation very intuitive: In the Results window any existing malfunctions can be arranged due to the requirements for evaluations. Simply select a malfunction to visualize the effected elements in the network diagram.

New Results

The output scope for Contingency Analysis has been enhanced to include maximum values and not delivered power:

- **Maximum values:**
  The maximum flow or maximum power/utilization is a criterion for constructing the network element. Previously, the results did not show this maximum. Branch results for Contingency Analysis now have one additional entry per network element with the status "Maximum".
- **Not delivered power:**
  The not delivered power is a measure for evaluating any loss in income. The network results for Contingency Analysis now also include this information.

The new results are available in the Results window and in Tabular View.

3.5 Optimal Network Structure

Enhanced Optimization Procedure

Up to now, **Rotating Ray** could only generate loops for single primary substations. Starting from the primary substation, Rotating Ray goes through the entire network and uses the results to group all the network stations into loops. To use this optimization procedure properly, all the primary substations need to be automatically considered.

To resolve this problem, the data undergo pre-analysis before actually being optimized. In this pre-analysis, calculated weighting are used to assign network stations to the primary substations. The weighting for each network station is determined under consideration of the route model. The maximum power of the primary substations is also considered.

The illustration below shows how this is assigned. It is easy to see that a network station has been assigned to the Primary Substation PS1 that actually is closer to Primary Substation PS2. This can, for example, be caused by exceeding the maximum power limit for Station PS2 as well as higher installation costs for the routes.

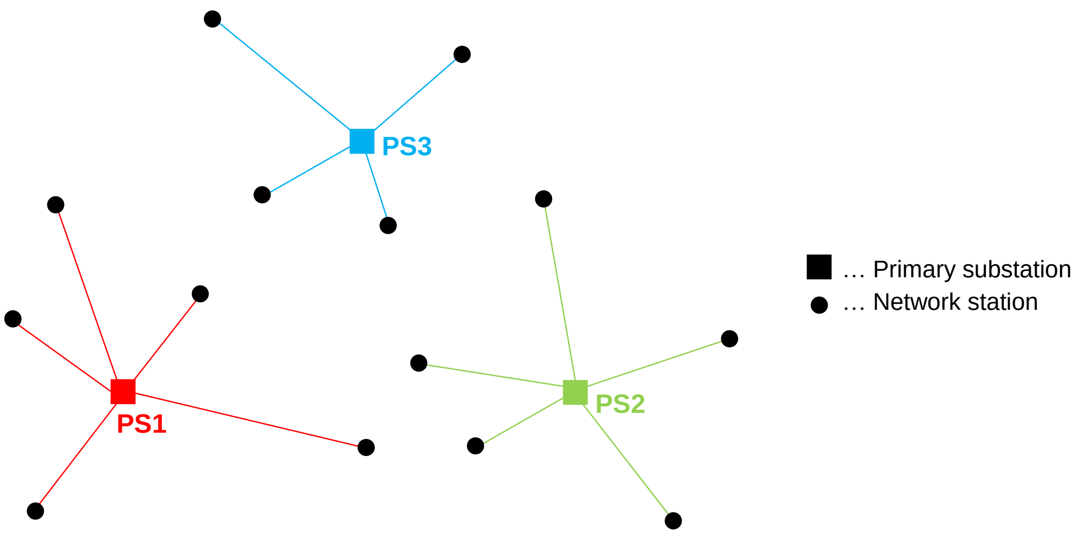

Illustration: Pre-analysis for rotating ray

Another important new function in the optimization procedure is **generating links**. This means – if it proves to be more cost effective – a connection will be generated between two primary substations. This connection is not a loop – it is a link. An attribute in the settings for optimal network structure switches this procedure ON or OFF. Also new is the possibility that a link has to be generated between two primary substations. PSS SINCAL has a new data screen form under **Insert – Additional Data – Optimal Network Structure Links…** where these connections can be predefined. These predefined links are generated even if they are not the most economical variant.

The optimization procedure uses internal **weighting** consisting of **costs and losses** to evaluate calculated network structures. Now two new factors control individual weighting of losses and costs. Depending on how the factors are used, the following can be achieved:

- Most economical network structure
- Network structure that causes the least losses
- Network structure, where a well-balanced ratio exists between costs and losses

The new weighting factors can be defined in the data screen form for **Optimal Network Structure Settings**.

There is even a new function for **Post-Optimization** to perform additional optimizations after an optimization result. This is mainly useful if the first optimization step encounters multiple network structures where an appropriate selection for post-optimization would be possible manually. In the course of this post-optimization, all the maximum possible optimization functions are normally switched ON (3-Opt-Lin, station swap, etc.). This requires a lot of calculations, but, in the course of the post-optimization, this is only done for a single network structure and not for many different ones, as is the case with base optimization.

Improved Graphic Display for the Results

The optimization procedure generates complex results that include – in addition to general data such as costs, losses, etc. – topological data for the line model. These data are already provided in the Results window, where they can be evaluated according to different criteria.

To make interactively analyzing results even simpler, graphic visualization of optimal network structures has been greatly improved.

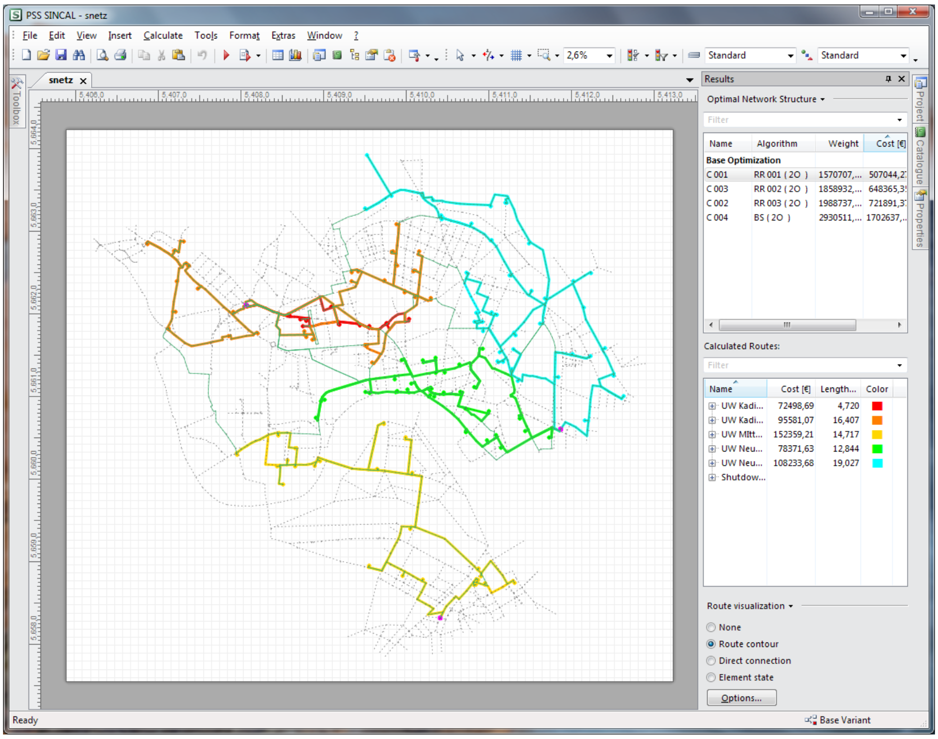

Illustration: Route visualization for optimal network structure

To help you visualize Optimal Network Structure, PSS SINCAL has the following options:

- **Route contour:**
  Creates highlighting along the contour of the selected network or routing elements.
- **Direct connection:**
  Creates highlighting to the route points with direct lines.
- **Element state:**
  Uses the element state to create the highlighting. This means route sections are colored depending on how they will be used later (new element, reuse or shutdown).

When results undergo interactive analysis, the direct visualization of selected results is particularly practical. As soon as route visualization is switched ON in the Results window, PSS SINCAL immediately displays this in the network diagram. This also happens when the selection is modified or when filter functions are used to reduce the amount displayed on the screen.

Exporting Results for External Processing and Analysis

The results of network structure optimization are stored in a comprehensive XML database. If needed, this database can even be read by external applications without any problems, but this is a relatively complex process. To make it easier for external programs to do analysis and evaluations, Excel results documentation has been implemented.

The Results window can be used to set parameters for Excel results documentation. You can select both Excel file and enhanced documentation options. Press the **Documentation** button to fill the Excel Workbook with the data.

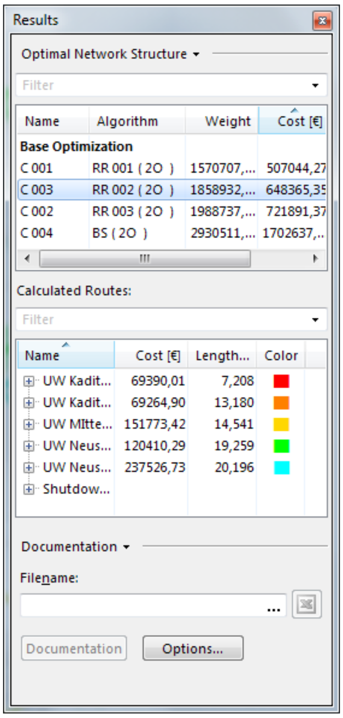

Illustration: Documentation for optimal network structure

Documentation can be done either for the optimization results selected in the dialog box or for all available optimization results. A number of sheets are generated in Excel. The first sheet contains the general output data. The other worksheets contain the details of the optimization results. For each sheet, PSS SINCAL generates an optimization result with the calculated routes (= loops) with all the sections of the route and their data.

Generating the Network using Optimization Results

This new function creates the real network structure from the results of the optimization. This serves as the basis for a detailed investigation of the new "optimal" network for simulation procedures such as Load Flow, Short Circuit, Contingency Analysis, etc.

In the Results window, you can select the optimization results you want and use the pop-up menu to start generating the network structure.

For the network to be generated, a new variant needs to be created. This is a subvariant of the currently active variant. In this new variant, first all lines that have routes are deleted. After these are deleted there is only a remaining network. This network includes all the network elements without any route assignment and – of course – also the route model.

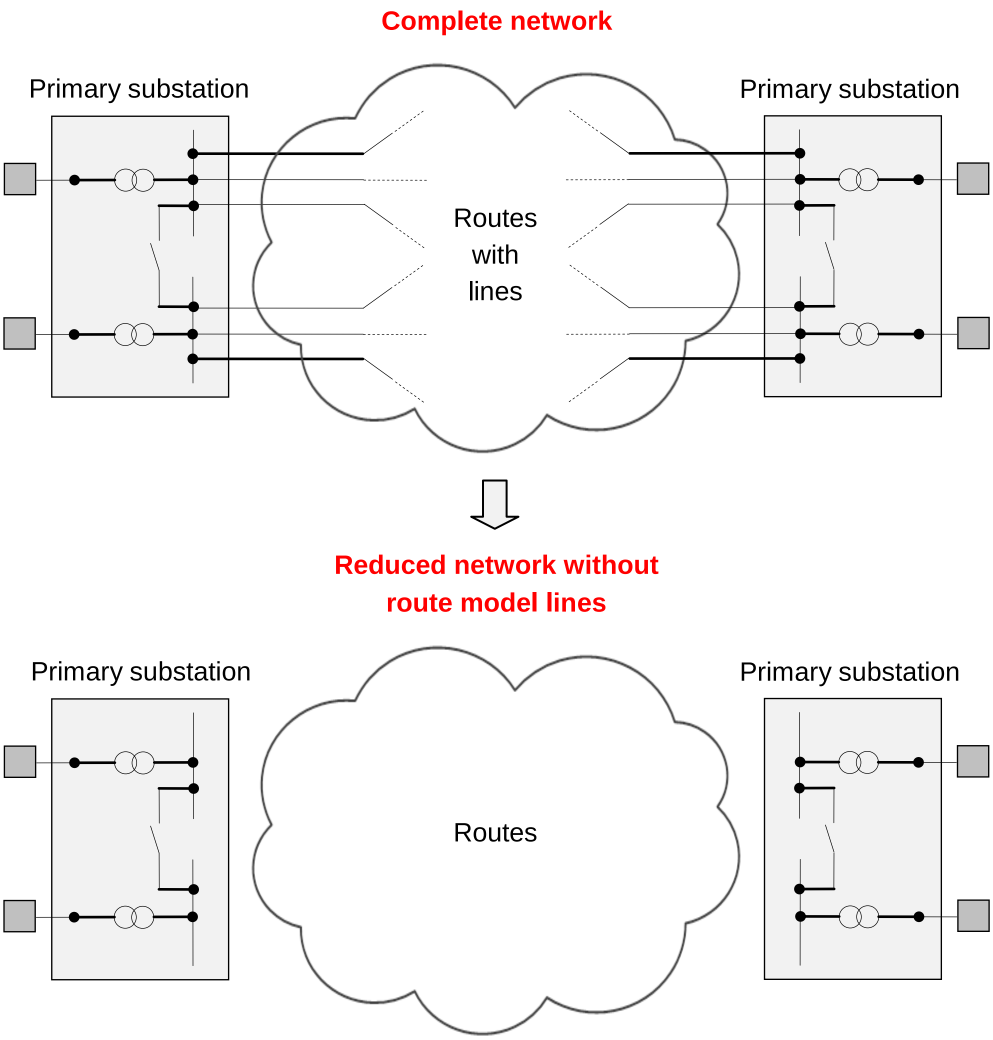

Illustration: Procedure for generating the network

In the next step, the optimization results are used to rebuild the network model based on routes in the variant. The lines are generated completely; i.e. both the network data and the graphic data are created and connected to the route model.

XML Database of Optimization Results

All the results of the optimization are stored in an XML database. Your own programs will have no trouble reading this database for analysis. The XML database is stored in the OPT directory of the active network:

```
snetz_Files
|    database.dia
|    database.ini
|    database.mdb
|
\---OPT
        snetz.xml
```

For a detailed description of the XML database, see in the document on PSS SINCAL File Formats (Installation CD "Doc\English\Misc\SINCAL File Formats.pdf").

3.6 Harmonics

PSS SINCAL can simulate external networks for the harmonic calculations with the network element for **Resonance Network**.

PSS SINCAL calculates the resonance network's effective impedance for any frequency. The effective impedance of a resonance network is specific impedance within a permissible impedance range that considers factors such as different network switching or load conditions. Impedance areas for resonance networks can be stored according to frequency. These impedance areas are then used to automatically determine the effective impedance.

Shunt Harmonics Resonance Network

PSS SINCAL determines the effective impedance automatically. Generally speaking, this impedance is on the outside curve of the selected area.

Depending on whether the effective impedance produces the highest or smallest impedance from the connecting node, this produces either

- the greatest voltage distortion (V-MAX) or
- the greatest current (I-MAX)

at the connecting node for the resonance network.

The shunt resonance network is completely passive. The network represented by the resonance network does not provide any (or a negligibly small) part of harmonic current or voltage distribution.

Serial Harmonics Resonance Network

This is a new branch element in PSS SINCAL.

PSS SINCAL automatically calculates the effective impedance. Unlike the shunt resonance network, this can be anywhere in the impedance area.

Depending on whether the effective impedance produces the highest or smallest impedance from the end node, this produces either

- the greatest voltage distortion (V-MAX) or
- the greatest current (I-MAX)

at the end node for the resonance network.

The resonance network is active. The network represented by the resonance network provides a part of the harmonic current or voltage distribution. The respective harmonic inputs need to be placed on the initial node side of the serial resonance network.

New Data Screen Forms and Input Data for Resonance Networks

In the course of developing new features for serial harmonic resonance networks, the input data and the data screen forms have been redesigned.

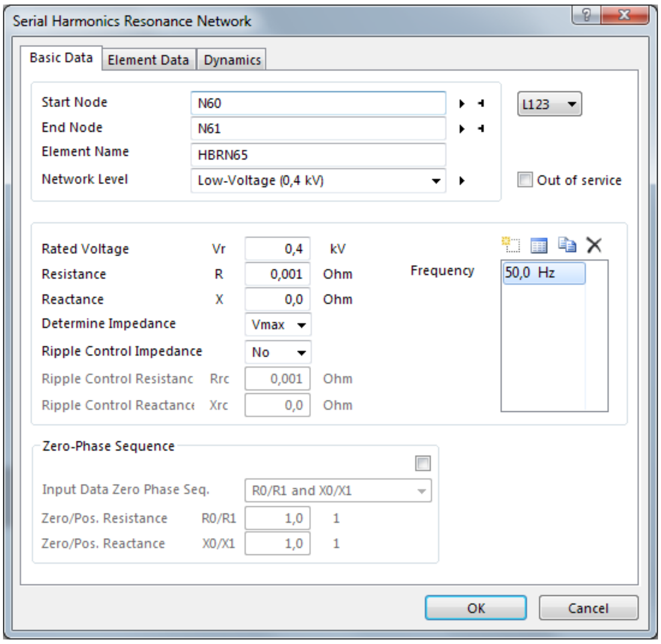

Illustration: Data screen form for Harmonics Resonance Network

For both serial and shunt resonance networks, an individual network type that models the impedance area can now be used for any frequency. The following kinds of modeling are possible:

- General over coordinates
- General with angles
- R/X curve
- Z/phi curve
- 2 lines and 2 circles
- 3 lines and 1 circle
- 4 lines and 1 circle
- Impedance area

3.7 Protection

Graphic Visualization of Protection Zones

This new function highlights protection zones for a protection device in the network diagram.

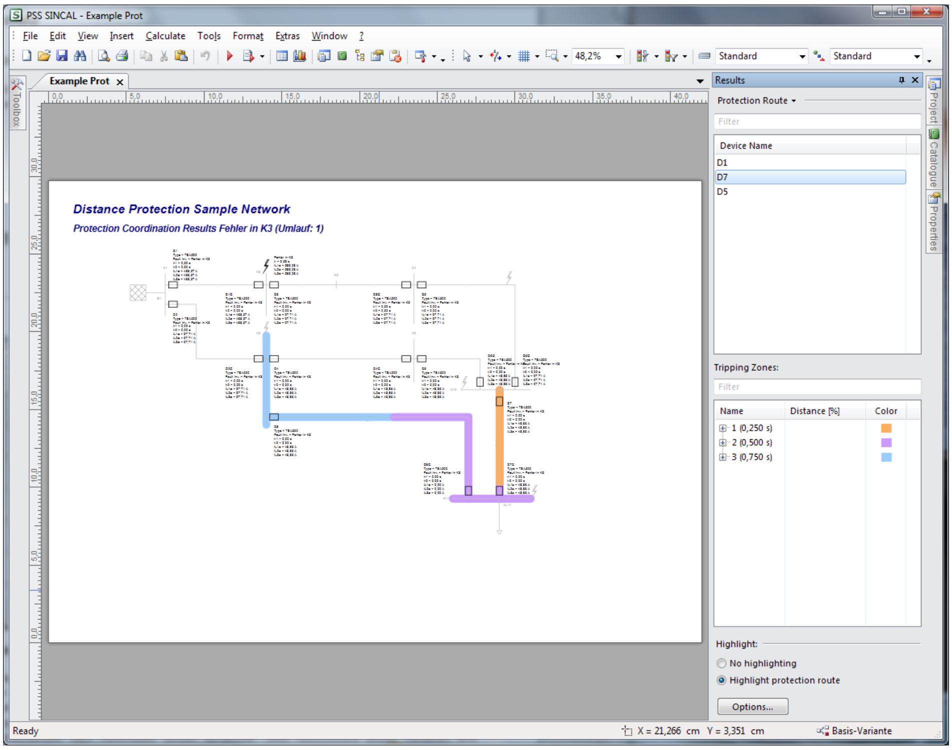

Illustration: Visualizing protection zones

When **Protection Route** calculations start, PSS SINCAL documents protection zones for all the protection devices that are active in the network in a database. This information is displayed in the new Results window. In the illustration above, Protection Device D7 has been selected in the Results window. **Tripping Zones** lists the different zones of the protection device sorted according to tripping time. Each tripping zone has a list of all the protected network elements. As soon as **Highlight protection route** is switched ON, protection routes are visualized in the network diagram. In the example above, orange is for the first zone, purple is for the second zone, and blue is for the third zone.

Improved Determining for Distance Protection Settings

Up to now, the function for determining settings aborted in case of a zone that goes backward, since the primary network impedance is only determined forward. This is, however, not necessary if you are specifying an boundary impedance in ohms, since this impedance has been defined by the user. The criterion for aborting backward has, therefore, been changed.

New Function Simplifying how Settings are Determined

When overhead lines are converted to cable networks, some users have experienced the following again and again. The calculated boundary need to be fixed for all the protection routes (except for those that have been converted from overhead lines to cables), when they really only want new settings for the present route.

PSS SINCAL has a new **Set Boundary Impedance** function that can be switched ON in the pop-up menu of the protection devices.

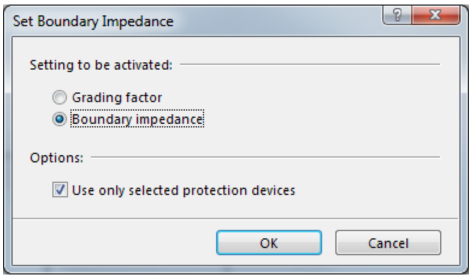

Illustration: Dialog box for Set Boundary Impedance

This function can be used to change the method for primary network impedance determination at protection devices:

- **Grading factor:**
  For all the protection devices where the status of the settings has been set to "Calculated" and direct entries for boundary impedance are used for grading, the grading is changed to grading factors.
- **Boundary impedance:**
  For all the protection devices where the status of the settings has been set to "Calculated" and grading factors are used for grading, the boundaries from the calculated settings are used and the grading is changed to the direct entry for boundary impedance.

Either only the selected protection devices or all the protection devices in the network are processed.

Data exchange with PSS PDMS

PSS SINCAL can now use settings for protection devices from a PSS PDMS protection device database for planning tasks in the present network.

The device's unique GUUID creates the connection for the protection devices in both systems. PSS PDMS has this for every device. And in PSS SINCAL, the GUUID can be assigned at the location of the protection device.

For the settings to be assigned, they have to be correctly specified in PSS PDMS. In PSS PDMS, special keys can be assigned to individual settings that act as codes for PSS SINCAL. Several hundred predefined keys (OC.P.I>, OC.P.fI>, OC.P.tp>, etc.) exist to precisely define the function of the setting. This key lets you assign the settings to the respective attributes of the protection device in the PSS SINCAL network database. For a detailed list of all the keys, see the PSS PDMS documentation in the chapter on **Protection Device Coupling**.

Click **Import and Export – Import Settings from PDMS…** in the protection device's pop-up menu to start data exchange with PSS PDMS.

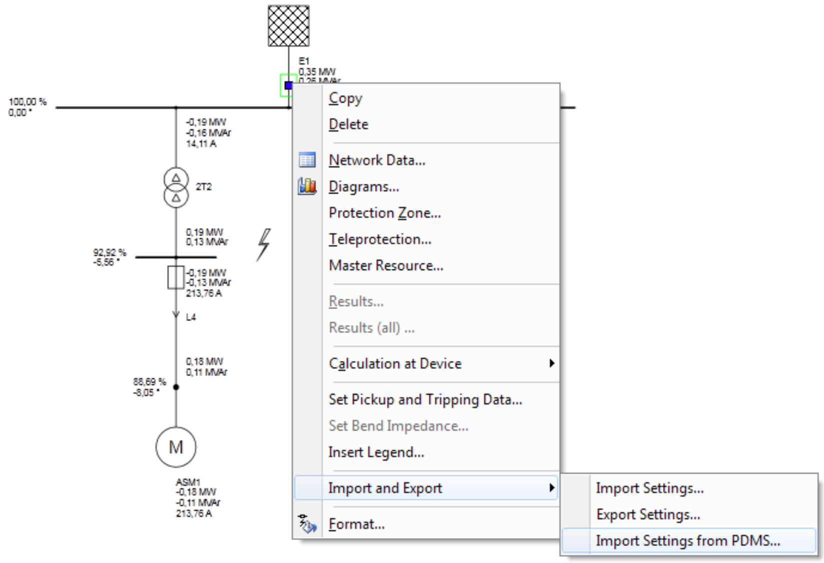

Illustration: Enhanced pop-up menu for protection devices

Import Settings from PDMS… starts up a special Import Wizard where you can select a PSS PDMS database.

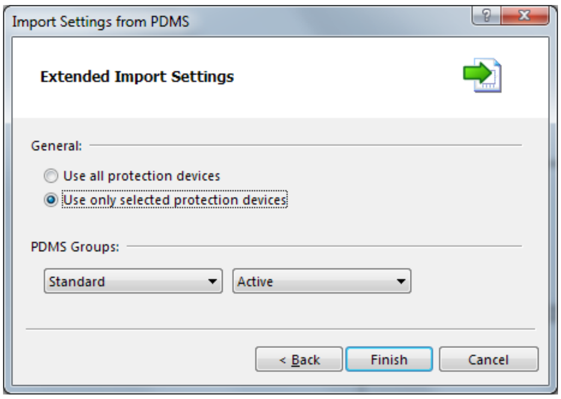

Illustration: Import Wizard in PSS SINCAL

In this dialog box, any additional settings for importing can also be selected. Selecting groups is particularly important. PSS PDMS can manage multiple setting groups, but PSS SINCAL can only work with the one single setting for the complete protection device.

3.8 Low-Voltage Dimensioning

Up to now, low-voltage dimensioning only considered fuses at branch elements with a rated voltage under 1 kV. To check household fuses that are still the responsibility of the energy supplier, an additional line needed to be created and the load placed at the end of the line.

A much simpler way to do this is to place the fuse direct at the load (i.e. at the node element). This is now possible. A special protection zone is created for this kind of fuse, which has only this one fuse and the total value at the node is used for the short circuit current. When you specify service connection impedance, this is included as usual.

3.9 Reliability Calculations

Monte-Carlo Method

In addition to the analytic calculation method, PSS SINCAL now also uses the Monte-Carlo method. The difference in the two procedures is as follows:

- At the **Analytic Calculation Method** all failure combinations are generated in combinations. Only those combinations having a probability above a given threshold value are further regarded in the calculation. Another possibility to limit the number of the combinations to be regarded in the calculations is the limitation of the order, i.e. the number of simultaneously failed elements, of the combinations.
- The time-sequential **Monte-Carlo Method** simulates outage occurrences in the power system, i. e. the time correlated sequence of equipment states. This method allows a more detailed modeling of the events in the power system but consumes more calculation time correspondingly.

New Load Flow Algorithm: "Network State Analysis"

Load flow calculations determine the supply levels for the reliability calculations. Depending on number of the malfunction combinations and, of course, the size of the network under investigation, the large number of load flow calculations can be quite time-consuming.

In practice, however, complete load flow calculations are often not required because of the existing network structure. In these cases, the new network state analysis can be used instead of load flow. Only one topological check of the connections is performed to determine whether consumers are actually supplied. Simple network state analysis is much faster than load flow, but there is a limitation: without complete load flow calculations overloads cannot be recognized. Depending on the network structure, this limitation can, however, be entirely tolerable.

Simple radial networks may not have overloads, because only subnetworks are shed.

When you use adjacent feeders for resupply, you have to be sure the malfunctioning feeder does not create supply problems. If networks have been planned correctly, there will be no overloading during resupply. For such networks, calculating the complete load flow is unnecessary, too. The network state can be derived from the network analysis as follows:

- Supplied nodes receive a voltage and a supply level of 100 %
- Unsupplied nodes receive a voltage and a supply level of 0 %

Based on this network state, resupply is carried out.

This procedure does not affect any changes in resupply strategy or measures to restore supply (busbar change, etc.).

Improved Performance

The internal processing functions in the reliability calculations have been optimized, mainly to greatly improve performance in large networks.

Calculations for **Unnecessary Protection Operation** malfunctions have also been optimized. In this case, short circuit calculations determine the pickup for protection devices. These short circuit calculations are now done with sparsely populated node-point admittance matrices to speed up the processing in large networks.

3.10 Dynamics

Malfunction Criteria for Injecting Reverse Arc Voltage

Special malfunction criteria can now be entered to inject reverse arc voltage at the **Element Switch Time**. The EMT simulation procedure needs this to construct breakers.

Two different characteristic curves (U over I, and e over t) define the reverse arc voltage. During the simulation, the reverse arc voltage at the switched network element is assigned the closest possible time to the switching time.

3.11 Import and Export

CIM with ENTSO-E Dynamics Profile

PSS SINCAL now has a first draft version for the ENTSO-E Dynamics profile for both CIM Import and Export. The following profile is attached:

- CIM 14 profile V15 from June 2010

The ENTSO-E Dynamics profile is based on the ENTSO-E profile. Basically, the existing profile has been enhanced for use with dynamic machine data and controller data. In addition, many structural changes have been made to the CIM format. This means that the new CIM files are not compatible to the preceding versions.

The new profile is, however, still not "officially" available, as it is still in the standardization phase. So maybe there will be some inconsistencies both in importing and when exporting, as long as the profile is being modified.

Enhanced Information for CIM Import and Export

When you are importing and exporting, the message window displays enhanced logging information to make it easier to recognize errors in CIM.

3.12 External Tools

NetCad

The PSS SINCAL installation CD has a **new version of PSS NetCad**. This new version has an improved user interface and many new functions. For more details, please see the NetCad documentation.

To make PSS NetCad even easier to start, it now has its own program icon in the Windows Start menu ("PSS SINCAL 7.0 – Tools – PSS NetCad").

Leika

PSS SINCAL now also includes a new version of Leika (a program for calculating overhead line and cable characteristics).

The most important changes are:

- Conductor cables can be selected from a database with standard cables ("WireBase.mdb").
- Semi-conductor layers on the cable surface and under the shielding can be considered.
- Lines can have more than one segment with different sequences – this means, for example, that cables with Cross Bonding for the shielding can be simulated.
- Currents induced in double-sided grounded conductors (ground cables for overhead lines, double-sided grounded cable shielding) and voltage induced in one-sided grounded conductors (one-sided grounded cable shielding, secondary technical cables) can also be calculated.
- The user interface has a new look and the new input data dialog box is even more user-friendly.

Caution: Leika files (*.leika) are stored in XML format. Old Leika files (*.lei) are imported, but not written any more.

4 Pipe Networks

4.1 Contingency Analysis

The output scope of Contingency Analysis has been enhanced to include maximum values and the not delivered flow/power:

- **Maximum values:**
  The maximum flow or maximum power/utilization is a criterion for constructing the network element. Previously, the results did not show this maximum. Branch results for Contingency Analysis now have one additional entry per network element with the status "Maximum".
- **Not delivered flow/power:**
  The power that is not delivered is a measure for evaluating any loss in income. The network results for Contingency Analysis now also include this information.

Malfunction Scenario

As with electrical networks, pipe networks now also have enhanced definitions for malfunctions. There can be definitions for:

- Elements that malfunction
- Reconnectable elements

The **Malfunction Scenario** dialog box is used to define scenarios for malfunctioning and reconnecting elements.

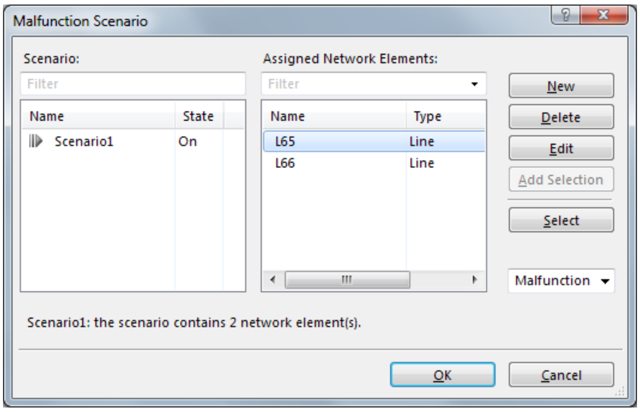

Illustration: Dialog box for defining malfunction scenarios

Scenarios defined in the dialog box are considered in Contingency Analysis along with the automatically generated malfunctions. The name of the malfunction scenario becomes the malfunction key.

5 Universal Protection Database – PSS PDMS

5.1 Workflow States

PSS PDMS now has Workflow States to display the work sequences for setting administration.

Integration into the Data Model

The following illustration shows how the Workflow States are included in the data model.

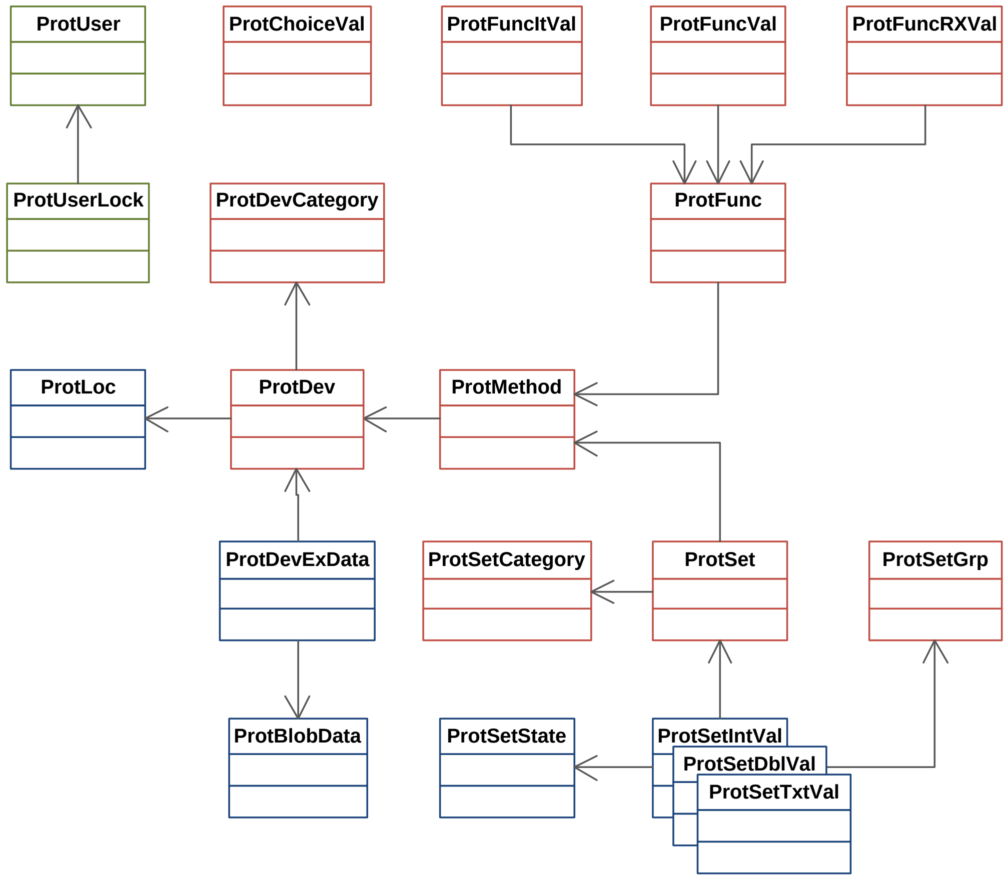

Illustration: Database structure of the protection device database

The **ProtSetState** table displays the Workflow States. This table has an attribute to describe the state of the setting (ProtSetIntVal, ProtStDblVal, ProtSetTxtVal). The following states can be displayed: Planning, Approved, Active, Historic.

In addition to the state, this new table also stores information on dates and users, so you know when a particular state was assigned and who assigned it.

Workflow States are of course, assigned to individual settings, but editing, however, is always only done for a complete setting group (ProtSetGrp). This combines the present settings and creates a valid setting for the protection device.

Integration in the User Interface

To assure unauthorized users cannot modify Workflow States, PSS PDMS user administration has been enhanced. This lets you define the state alterations individual users are allowed to make. This is configured in the **Options – User Administration** dialog box.

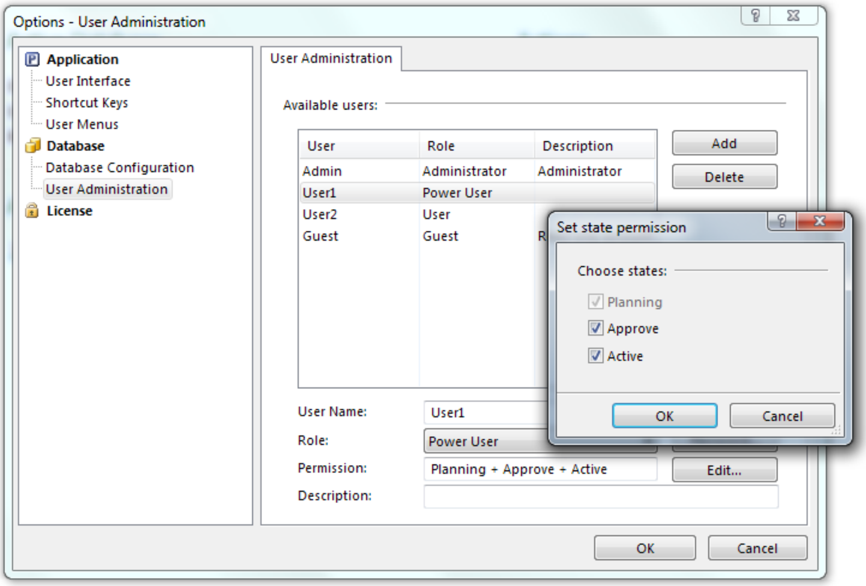

Illustration: Dialog box for User Administration

To integrate Workflow States, the editing functions for the settings for protection devices have been completely reworked.

The following overview shows the available states and how these occur:

- **Planning:**
  The settings are in planning, i.e. they are neither approved nor are they assigned to the protection device. This state is available as soon as settings have been saved.
- **Approved:**
  The settings are planned and already approved and can later be assigned to a protection device.
- **Active:**
  After the settings have been planned and approved, the state can be made Active. So the settings are assigned to the protection device.
- **Historic:**
  This state is created automatically, if the state Active already exists. The old Active state becomes the state Historic and is still available. This means that there can be more than one setting that is Historic.

Settings can only be edited in the **Planning** state. As soon as a setting is modified, all the settings for this group are store in the Planning state. The state used for the individual values is displayed directly behind the group. The lists are used to switch between available states.

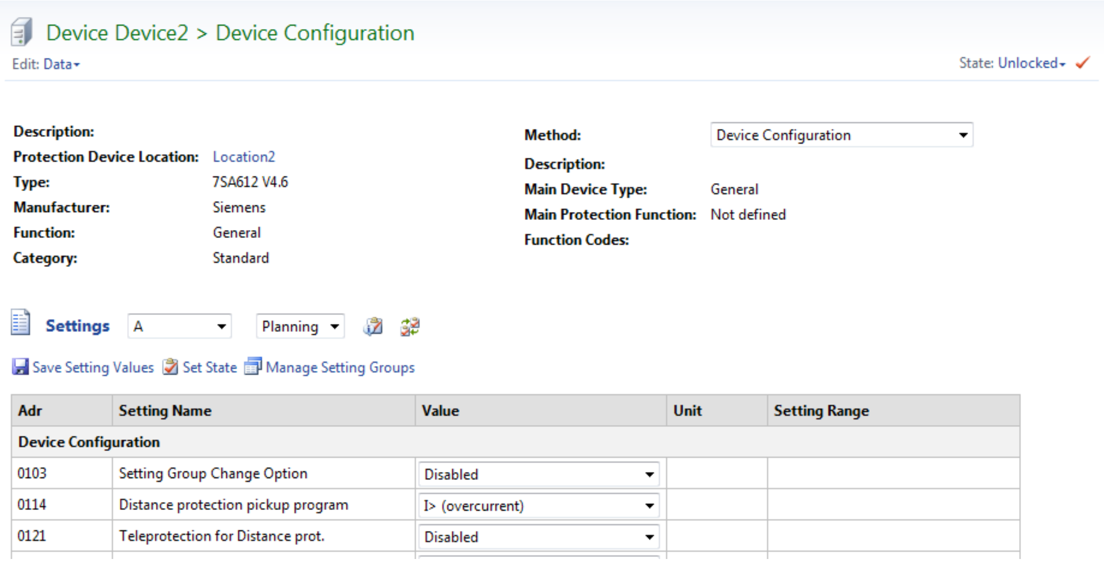

Illustration: Editing settings

After the planning is finished, the settings have to be checked. Only a properly qualified user can do this. When the check is over, the **Set State** function is **Approved**.

As soon as the checked settings are made at the device, the state of the settings becomes **Active**. If there already are active settings at the device, these are stored as **Historic**.

New Comparison Function for Settings

This new function makes it easy to analyze changes between different setting groups or states for a setting group.

You can click **Compare setting groups and states** ( ) to open a dialog box where parameters can be set for the comparison function. When comparison functions are switched ON, PSS SINCAL displays additional settings alongside any settings being processed. The illustration below shows the settings of Group A in Planning. For comparison, the settings with the state Active have been selected. The respective values are displayed in their own column and values that are different are highlighted.

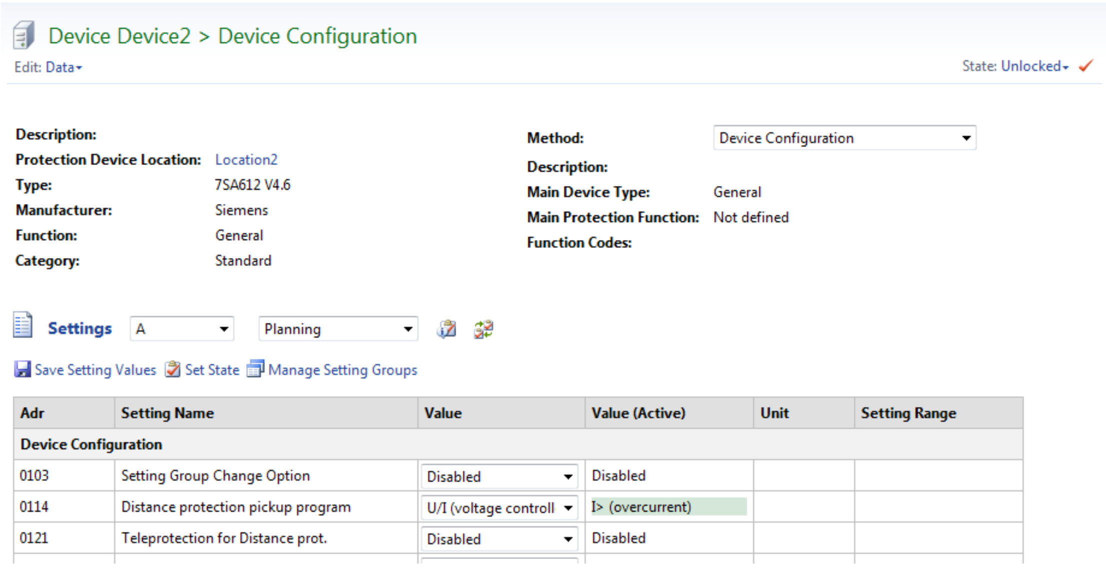

Illustration: Comparing settings

5.2 Enhanced Import and Export Functions

Data Exchange with PSS SINCAL

This new import function enables data exchange with PSS SINCAL.

The device's unique GUUID creates the connection for the protection devices in both systems. PSS PDMS has this ID for every device. And in PSS SINCAL it can be assigned at the location of the protection device.

For the settings to be assigned, they have to be correctly specified in PSS PDMS. In PSS PDMS, special keys can be assigned to individual settings that act as codes for PSS SINCAL. Several hundred predefined keys (OC.P.I>, OC.P.fI>, OC.P.tp>, etc.) exist to precisely define the function of the setting. This key lets you assign the settings to the respective attributes of the protection device in the PSS SINCAL network database. For a detailed list of all the keys, see the PSS PDMS documentation in the chapter on **Protection Device Coupling**.

File – Import – Settings from SINCAL… in the menu starts this function. The Import Wizard is used to select the PSS SINCAL network database from which the settings for the active protection device are imported.

DIGSI XML File Update

Up to now settings for protection devices could already be exported in Siemens DIGSI XML format. But this has two basic problems:

- Only values stored in PSS PDMS can be exported.
- The XML implementation in DIGSI is extreme sensitive (mixing up capitals and small letters or an extra comma in a number leads to an error).

To prevent such problems, a special DIGSI XML export is now available to update existing XML files with PSS PDMS attributes. The scope and the structure of the XML file remain exactly the same and only the actual settings are replaced by new values.

File – Export – DIGSI XML Update… in the menu now has this new function. This starts the Export Wizard where you can select the DIGSI XML file to be updated. The Export Wizard can also configure the setting groups to be exported or the mapping to the fixed DIGSI groups "A", "B", "C" and "D".