Release Information – PSS®SINCAL Platform 10.0

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

1 General Remarks **2**

1.1 Licensing 2

1.2 Documentation 2

1.3 Updated Add-On Programs 2

2 PSS SINCAL **2**

2.1 User Interface 2

2.2 Electrical Networks 4

2.3 Pipe Networks 22

3 PSS NETOMAC **23**

3.1 User Interface 23

3.2 Calculation Methods 28

1 General Remarks

1.1 Licensing

To operate the PSS SINCAL Platform 10.0, new license files are required. Once the program is installed, these can be requested at the **PSS SINCAL Support** (phone +43 699 12364435, email sincal@simtec.cc).

1.2 Documentation

As with every new PSS SINCAL version, the documentation has been once more improved and extended. This primarily involves the improved and clearer description of the input data for electrical networks and some revisions to the content.

1.3 Updated Add-On Programs

LEIKA

PSS SINCAL Setup contains the new LEIKA 4.4 version. This features some improvements to the user interface and a new XML exchange format for coupling data specially designed for PSS SINCAL.

PSS NETCAD

The PSS NETCAD used in PSS SINCAL was also updated. Version 9.5 is now integrated. PSS NETCAD features improvements to the user interface and various debugs. Refer to the product documentation for further information on this.

PSS NEVA

PSS NEVA 3.97 is integrated in PSS SINCAL 10.0. This is also the program version that was already provided with the Update 3 for PSS SINCAL 9.5.

2 PSS SINCAL

2.1 User Interface

Display of the Manipulators in the Table View

Many users utilize the manipulators in PSS SINCAL in order to modify the input data ergonomically and clearly, and to adapt to various analysis requirements. However, up until now it was only possible to display and edit the manipulators in the data screen form. The manipulators are now available in the table view and can thus quickly enable a clear analysis of the network elements for which the input data are changed by manipulators.

Comparison of Variants in the User Interface

This new function enables the documentation of the different changes made to the input data of a network.

The new variant comparison function can be started with **File** – **Variants** – **Variant Comparison**.

This function is implemented here in the same way as the history of changes in the master database. The variant comparison enables the visualization of the changes between any two variants. These two variants do not have to be in the same variant tree, i.e. any combination is possible for the comparison. The comparison itself is carried out on the level of the database table.

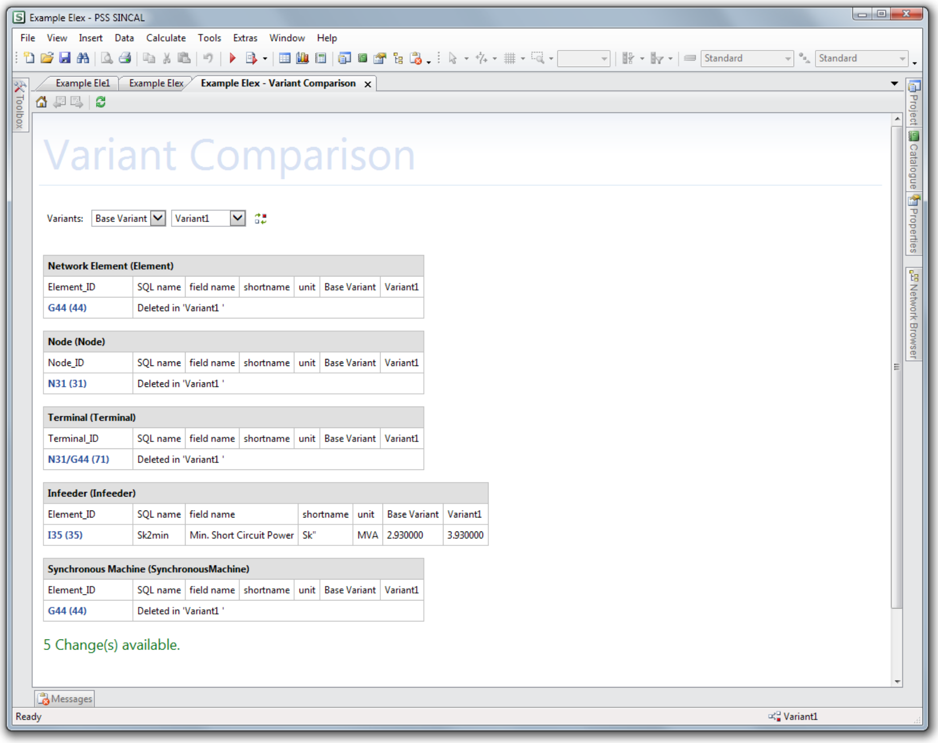


Illustration: Variant Comparison View

The results of the variant comparison are displayed in a special view. Any change to an attribute is shown and naturally the deletion and adding of records is also logged.

Enhanced Report Functions

PSS SINCAL provides several reports for input data and results. However, these always contain all the data of the current network. This means that the reports for larger networks are very extensive.

Although it is possible to restrict the amount of data in the reports to the elements selected in the network diagram. This firstly requires a great deal of effort and secondly only works with reports that directly access network elements and nodes. New filter functions were therefore provided in order to globally reduce the amount of data in the report. These are based on the network level, network area, network zone and substation topology structures. This therefore makes it possible to only generate reports for topology structures selected beforehand (e.g. only the network area results for selected network areas).

The new filter functions are defined in the Report Options dialog box. This is used to select the topology structures for which the assigned elements are output in the report.

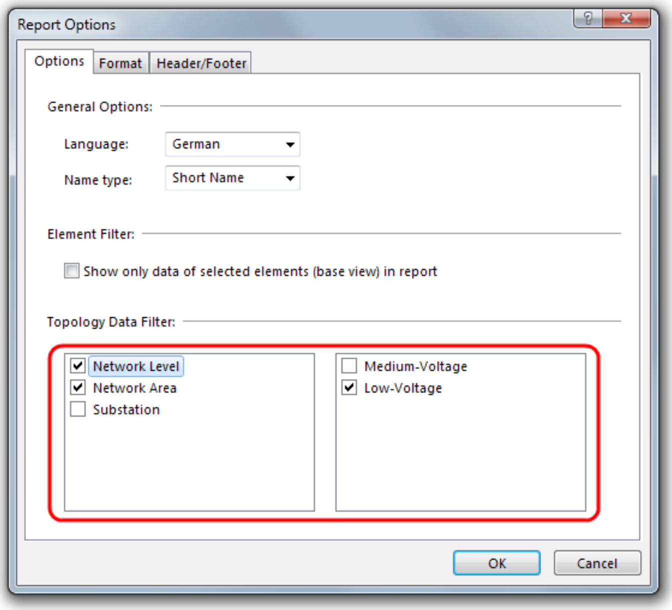


Illustration: Report Options dialog box with new filter functions

Improved Performance for SQL Server Databases

With large networks or networks in which large volumes of data are generated (e.g. load profile simulation), the network data and results must be stored in a proper RDMS. A management of the data with Access is then no longer physically possible (limit of the MDB file at 2 GB, practical limit actually at approx. 500 MB). PSS SINCAL therefore provides the option of using Oracle or SQL Server.

The performance of both RDBMS in normal operation is very good, but the SQL Server in particular is really problematic when filling the database. A special load balancing function is always active here on the SQL Server, which limits the number of possible SQL Insert commands. Unfortunately, this load balancing function cannot be deactivated and therefore the filling of the database takes a long time, particularly with large networks. To rectify this problem the mass data is now transferred to the SQL Server using special bulk inserts. This enables the data to be inserted around 10x faster than before.

2.2 Electrical Networks

Enhanced 4-Wire Load Flow

A 4-wire load flow has been provided since PSS SINCAL 9.5. This function uses precisely the same input data as all other load flow procedures. The only significant difference is the fact that in the 4-wire load flow procedure return conductors and the transition from the return conductor to ground can be modeled. In other words, the structure of the network modeled is physically correct with all four phases, i.e. RSTN, and the grounding impedances can likewise be modeled. Inside the program the 4-wire load flow naturally has a completely different design than the other load flow procedures based on the MGN system.

In PSS SINCAL 10.0 the new 4-wire load flow is now fully integrated in all load flow based procedures. This ensures that the extended results are available in all procedures.

Enhanced Restoration of Supply Calculation

The simulation procedure available in PSS SINCAL for calculating the restoration of supply has been extensively enhanced. Besides the previous resupply function a new method is now provided for feeder-based restoration of supply.

As before, the restoration of supply is started with **Calculate** – **Restoration of Supply** in the pop-up menu of a selected network element. This then opens the new dialog box for controlling the restoration of supply calculation, in which either of the two calculation modes **Standard** or **Feeder based** can be selected.

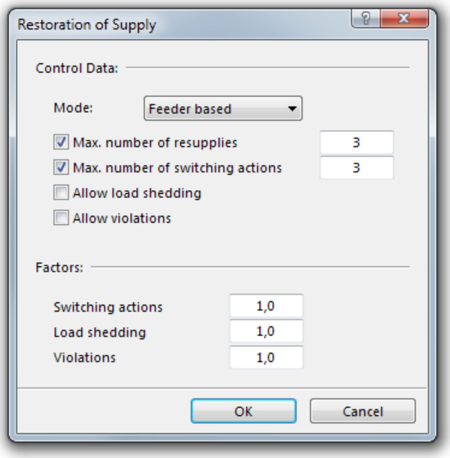


Illustration: Dialog box for controlling the restoration of supply calculation

The new restoration of supply calculation is activated when **Feeder based** mode is selected. In the event of a malfunction in the feeder this tries to carry out the optimum switching to one or several adjacent feeders in order to ensure that as many consumers as possible are supplied. The aim here is to not overload the elements in the adjacent feeders and also to keep the voltages in the permissible range.

For this the following procedure is used:

- All feeders with their adjacent feeders are identified.
- A search is made for the feeder containing the faulty element.
- All switches are searched for that disconnect the faulty feeder from the others.
- The switches that are located downstream of the faulty element are filtered from this.
- These switches are able to restore the power supply to the unsupplied subnetwork.

The following illustration shows a fault in the middle of a feeder that causes the loads not to be supplied. By restoring supply it should be ensured that all loads are correctly supplied and that the network is in a permissible operating state.

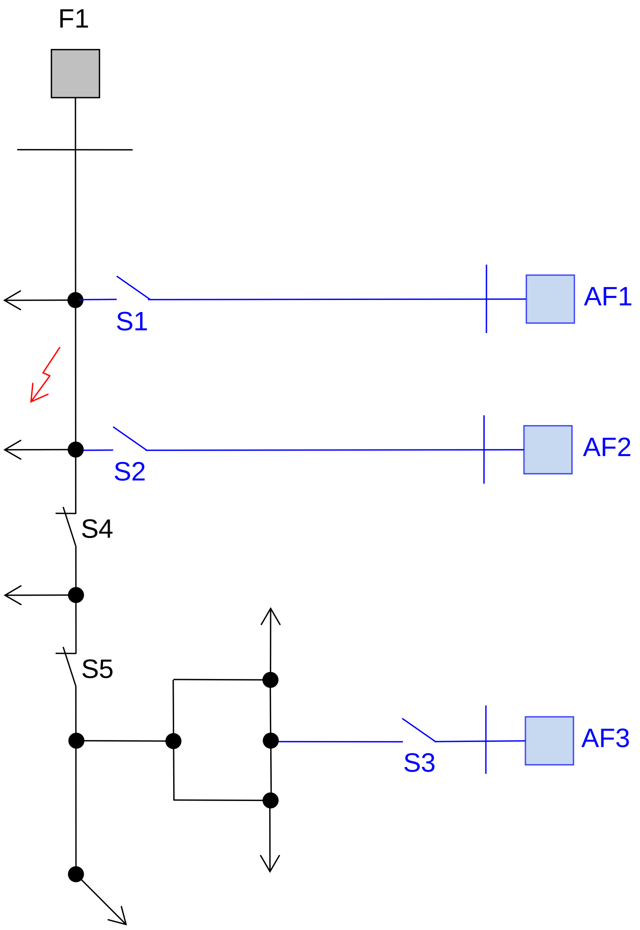


Illustration: Feeder-based searching in the network to find valid switches

It is assumed that the fault in feeder F1 is isolated. In other words, the faulty line is completely switched off. This prevents the supply of the loads behind the fault.

In the example shown here, three adjacent feeders (AF1, AF2 and AF3) are determined. The feeders suitable for restoring supply are AF2 and AF3, as the switches S2 and S3 are located downstream of the fault. These enable the unsupplied loads downstream of the fault to be supplied.

The supply restoration algorithm then tries to restore the correct operational state through the connection of feeder AF2 by closing switch S2. If the feeder AF2 is overloaded by the number of additional loads to be supplied, an attempt to share the load must be made by connecting another adjacent feeder. In the example shown, feeder AF3 would then be connected by closing switch S3. At the same time, however, it is ensured that the two adjacent feeders are not switched together. In other words, the corresponding switches in feeder F1 are opened. In the example these are switches S4 and S5. The opening is executed so that the loads to be supplied are shared as optimally as possible between the adjacent feeders with also as few switching measures as possible.

The results of the restoration calculation are shown in the Results browser. As complex networks offer a range of different solutions for the restoration of supply, the results are shown in groups. Each group represents a possible restoration of supply variant and contains the respective switching measures to be carried out and the required load shedding operations.

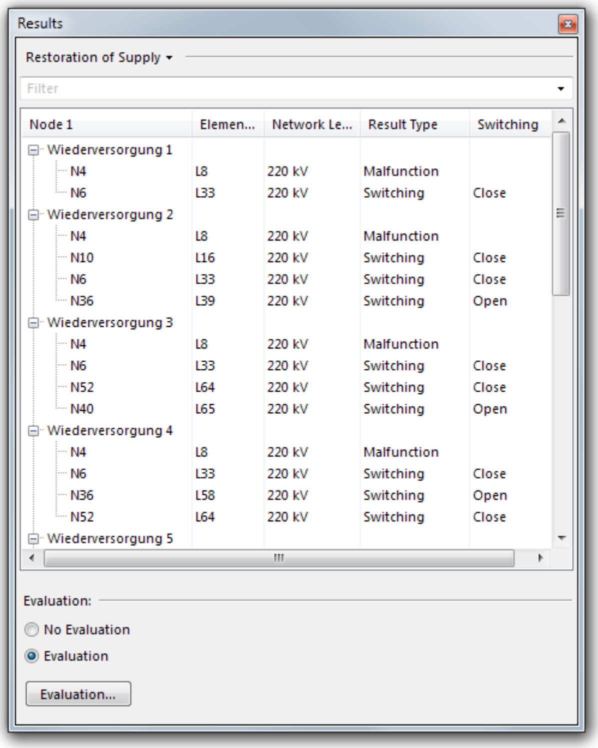


Illustration: Results browser with restoration of supply results

The groups are arranged on the basis of an evaluation function in which the "best" restoration of supply variant is displayed at the very beginning.

Enhanced Contingency Analysis Calculation

The possibility to control malfunctions with the **Unavailability** function has been provided from PSS SINCAL 9.5 onwards. This determines the unavailability of the network elements based on the reliability input data for failure frequency Hu and outage duration Tu in order to control the generation of the malfunctions. The unavailability limit is now defined via the network areas in the same way as the other control data for contingency analysis.

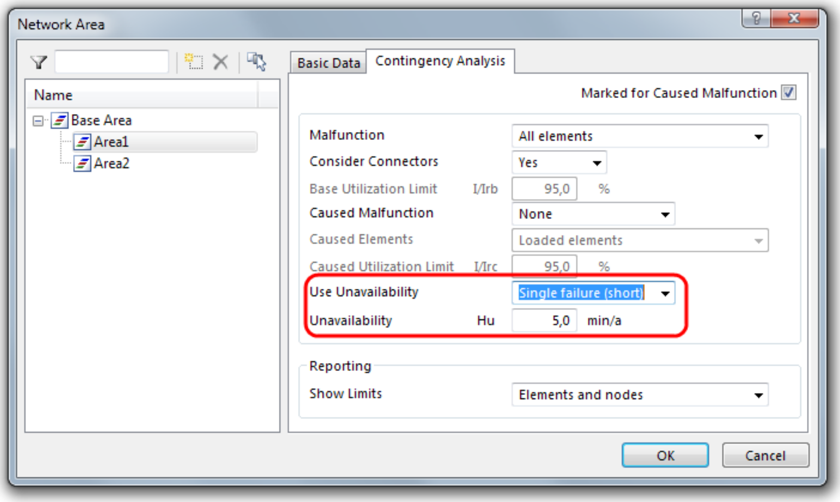


Illustration: Network area dialog box with control data for contingency analysis

Another useful innovation for contingency analysis is the display of **results in the network diagram**. However, a direct display of different results for all malfunctions is not possible since every malfunction here would be a complete load flow result. The maximum values are therefore visualized for the network elements and nodes. The maximum utilization present and the malfunction responsible for it are therefore displayed at the network elements. The minimum voltage and the malfunction responsible for it are shown at the nodes. The following illustration shows an extract of the results of the contingency analysis in the network diagram.

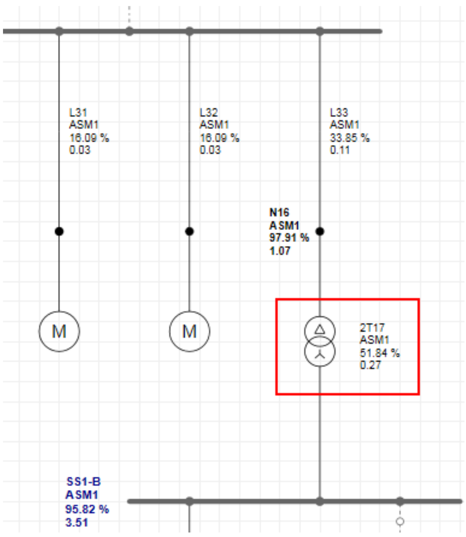


Illustration: Contingency analysis result in the network diagram

In the example the greatest utilization of 51.54 % on transformer 2T17 is reached when there is a malfunction at ASM1.

Another new feature is the **report for contingency analysis results**. This enables the output of all the relevant data, i.e. the malfunctioning elements, the unsupplied elements and the elements/nodes with limit violations. The generation of the report is controlled in the Result View of the contingency analysis. The results of the selected malfunction, those of all displayed malfunctions or all malfunctions can be exported as a report in a PDF file.

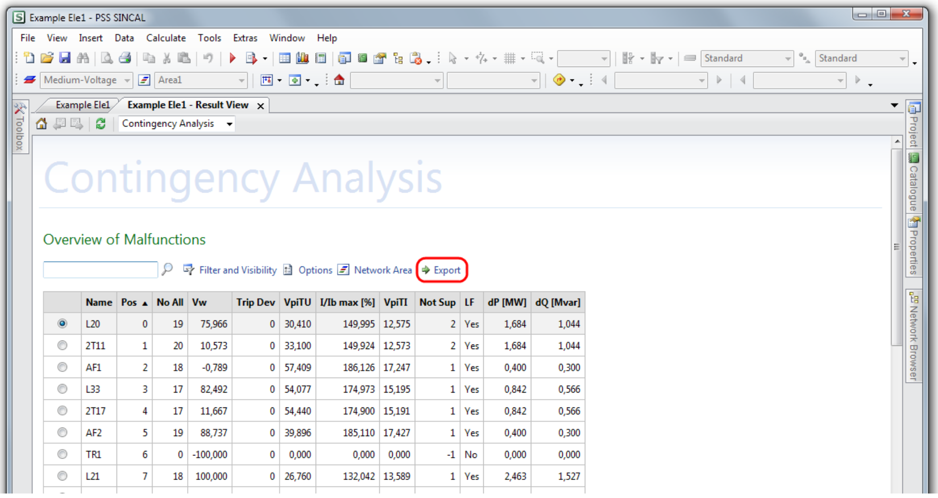


Illustration: Result View of the contingency analysis

Enhanced Load Profile Calculation

The profile definitions in the electrical networks were somewhat simplified and adapted to match the pipe networks. This was done to allow a more flexible and clearer input and also to enable an operating point calculation in the electrical networks (available in April 2014).

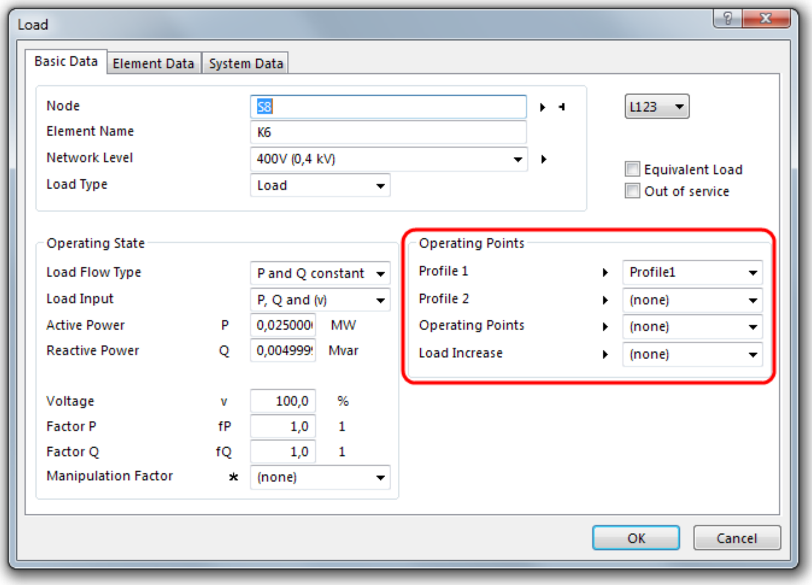


Illustration: Load input data

The network elements have the following standard data with which the variable operating points can be defined:

- Profile 1 and Profile 2:
  Any time-dependent profiles can be stored here that define the behavior of the network element when the power or the voltage is changed. Either daily, yearly or weekly series can be assigned to both Profile 1 as well as Profile 2. If more than one profile is assigned, the profiles are combined (i.e. multiplied) if the data input does not contain absolute values. This provides a very convenient way of simulating seasonal changes.

- Operating Points:
  This is where individual operating points as with the pipe networks are defined and assigned to the network element. This enables the calculation and comparison of different operating states of the network in the operating point calculation.
- Load Increase:
  This defines the increases over time which are used for the load development calculation.

A **profile dependent voltage change** is now also supported specially for generators and infeeders. For this the profile definition was enhanced so that the factor for the voltage change at the defined time can be stored as well as the power data.

Enhanced Protection Coordination

The protection coordination of PSS SINCAL provides some **new protection devices**:

- Distance protection devices:
  SEL-321, SEL-311A, SEL-311B, SEL-311C-1, SEL-311C-2, SEL-311C-3 und 7SA64
- Overcurrent protection devices:
  SEL-387, SEL-751, SEL-751A, SEL-311A, SEL-311B, SEL-311C-A, SEL-311C-B, SEL-311C-C, SEL-351A, SEL-351-5, SEL-351-6, SEL-351-7, SEL-351A, SEL-351S, SEL-387, SEL-387A, SEL-487A, SEL-487E, SEL-501, SEL-501-2, SEL-551, SEL-551C und SEL-587Z

The new DI devices are supported both in the settings calculation as well as in the protection coordination. The new OC protection devices are provided in the global protection device database and are likewise supported in the protection coordination. The functions for the tripping characteristics were extended specially for the OC devices. The following functions are also available:

- IEC Inverse (Curve C1): $t = 0.14 / ((I/In)^{0.02} – 1.0)$
- IEC Very Inverse (Curve C2): $t = 13.5 / ((I/In) – 1.0)$
- IEC Extremely Inverse (Curve C3): $t = 80.0 / ((I/In)^{2.0} – 1.0)$
- IEC Long Time Inverse (Curve C4): $t = 120.0 / ((I/In) – 1.0)$
- IEC Short Time Inverse (Curve C5): $t = 0.05 / ((I/In)^{0.04} – 1.0)$
- ANSI Moderately Inverse (Curve U1): $t = (0.0104 / ((I/In)^{0.02} – 1.0) + 0.0256)$
- ANSI Inverse (Curve U2): $t = (5.95 / ((I/In)^{2} – 1.0) + 0.18)$
- ANSI Very Inverse (Curve U3): $t = (3.88 / ((I/In)^{2} – 1.0) + 0..0963)$
- ANSI Extremely Inverse (Curve U4): $t = (5.67 / ((I/In)^{2} – 1.0) + 0..0352)$
- ANSI Short Time Inverse (Curve U5): $t = (0.00342 / ((I/In)^{0.02} – 1.0) + 0.00262$

Three additional tripping zones are provided for the distance protection devices. This means that there are now 6 zones that can be defined either forward, reverse or non-directional. The data for the auto-reclosure and the tele protection can also be entered. The following illustration shows the new data screen form for DI protection devices. The display of zones 1-4 and 4-… can be activated for the setting values.

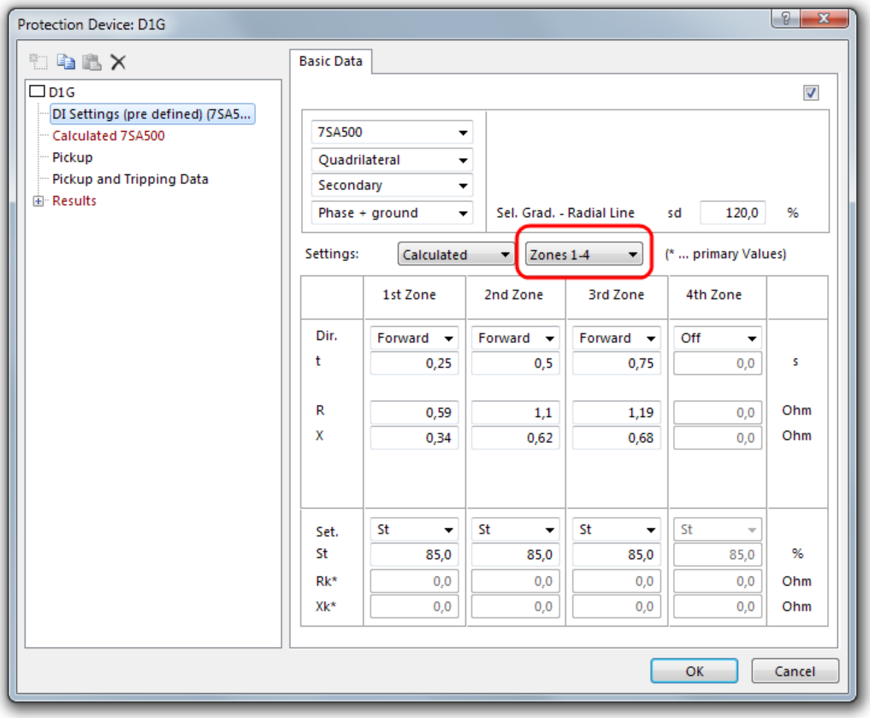


Illustration: Data screen form with input data of a DI protection device

The additional zones are also included in the settings calculation and these can be output in the diagrams and in the reports.

New **results reports for the protection coordination** are also provided:

- States of the protection coordination:
  This report contains a concise overview of the defined fault observations in the network as well as the status of the protection coordination. This makes it possible to immediately assess whether a defined fault could be isolated.
- Selective tripping times:
  This report shows the individual fault observations in the same way as the states, and outputs the relevant protection devices that have picked up.

It is possible to define the reference voltage for the currents for the I/t diagrams of the protection coordination. This is defined via the input data of the network level. If a voltage is specified here for the I/t diagram, the currents in the diagrams are referenced to the corresponding voltage. If 0.0 is set, the current is referenced to the network level voltage.

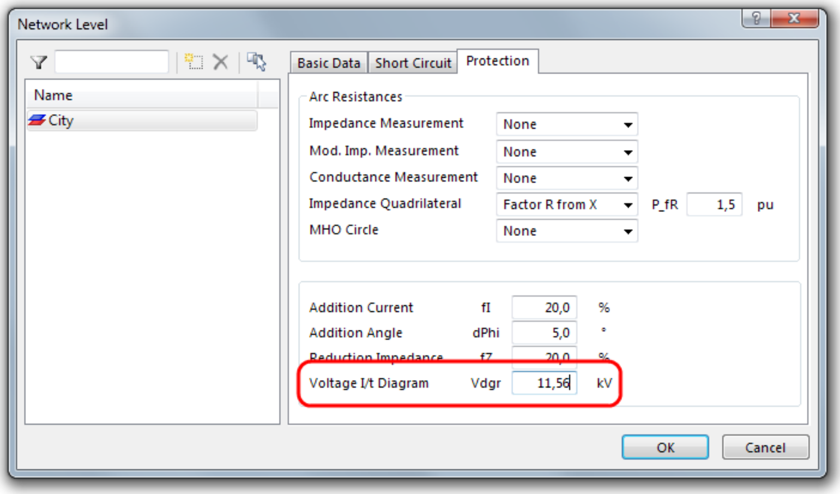


Illustration: Protection data definition in the network level

Some new **automation functions in the calculation methods** have been provided specially for protection coordination. This enables direct access to the fault locations and protection devices in the calculation methods.

This is particularly useful, for example, when the automation of protection calculations with possibly varying fault locations in the network is required. Previously this was not possible or only with considerable effort using some less effective changes to the database. The topology of the fault observation can now be changed directly:

```
'Change Topology at PROTOCFAULT

Dim ProtOb
Set ProtObj = SimulateObj.GetObj( "PROTOCFAULT", ProtID )

Dim NodeID
NodeID = ProtObj.Item( "Node_ID" )
ProtObj.Item( "Node_ID" ) = NewNodeID
```

It is also possible to access the protection devices. This is carried out using the protection location (ProtLocation). However, only read access to this object is possible. Changing the parameters of the protection devices would be too complex here and is normally not necessary since protection is fully provided in the network and is set accordingly. However, the protection location also enables access to the protection coordination results which are available within scripting (automation). This means that you can easily access the results of the protection devices directly in the virtual tables of the calculation methods.

```
'Get Results directly from PROTLOCATION

Dim ProtOb, ProtOCResult
Set ProtObj = SimulateObj.GetObj( "PROTLOCATION", ProtID )
Set ProtOCResult = ProtObj.Result( "PROTCORESULT" , 0 )

ProtOCResult.MoveFirst()
s_zeit = ProtOCResult.Item( "s_zeit" )
a_zeit1 = ProtOCResult.Item( "a_zeit1" )
phi_i = ProtOCResult.Item( "phi_i" )
```

VoltVar Optimization

With this procedure the voltage and the power factor can be controlled in radial medium- and low-voltage feeders, which can be symmetrical or unsymmetrical, with the result that all consumer nodes are located in the defined voltage range and that the transferred reactive power is as low as possible.

The optimization of the voltage is required to ensure acceptable network operation on the basis of the prescribed limits for all consumers at the feeder. The optimization of the power factor reduces the transfer of reactive power (and hence the losses) at the feeder.

In a typical feeder the voltage will usually decrease from the supply point (the substation) to the most distant consumer. The decrease is dependent to the load situation. The voltage drop will be larger at high load conditions and smaller at low load conditions. The power factor in the feeder mainly depends on the power factor of the individual consumer. The more inductive consumers are present (but the cable capacities counter slightly) the power factor it is getting smaller.

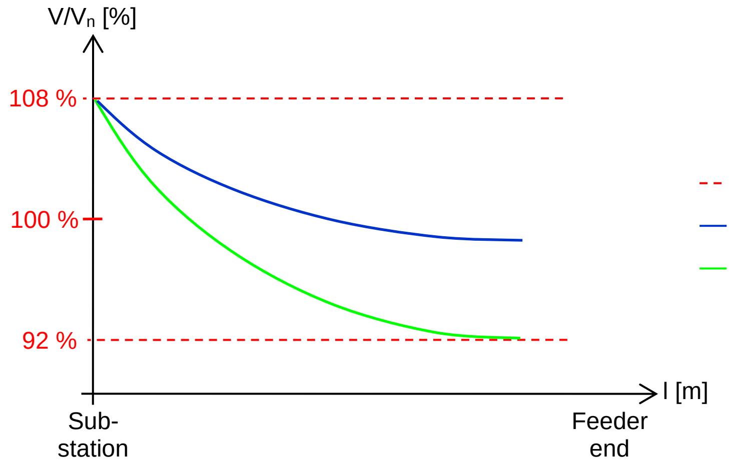


Illustration: Voltage curve in the feeder

The aim of the VoltVar optimization is to determine at what point of the feeder a capacitor should be installed and how the transformer must be set at the beginning of the feeder. This will ensure that the consumer nodes of the feeder are within the permissible range under high load and under low load.

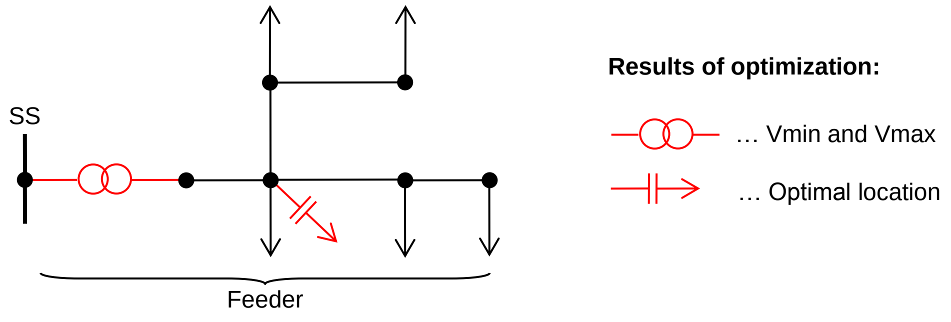


Illustration: Concept of VoltVar optimization

The results of the VoltVar optimization are available in both the Result View and in the Diagram View.

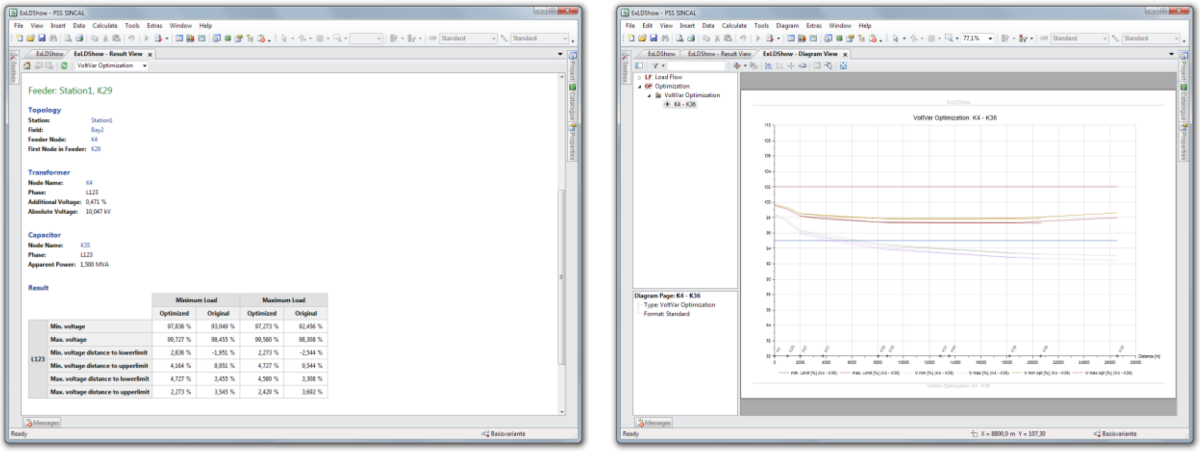


Illustration: Results of VoltVar Optimization

Network Reduction

PSS SINCAL 9.5 provided for the first time a method for correct dynamic network reduction. Although this can correctly simulate a reduced network for dynamic simulation, it places considerable requirements on the original network. This must be modeled to suit the dynamic simulation and the generators and machines in particular must be correctly simulated with all dynamic data.

However, it is this correct dynamic simulation in particular that is not possible in many cases, and so a **static network reduction** has been provided as well. This enables a network to be reduced for stationary analyses, i.e. for load flow and short circuit calculations. Either Ward or Extended-Ward procedures are used for the reduction. Both procedures simulate the impedance ratios of the reduced network area. The network reduced in this way supplies the same results with load flow and short circuit calculations as the non-reduced network.

The network reduction is now integrated via the **Tools** – **Network Reduction**. The menu provides either static or dynamic network reduction as selection options. The additional definition is made as before via a Wizard in which all the necessary control settings can be entered. The functionality was enhanced here in order to increase usability. The new **Reduction mode** is particularly useful, in which the following options can be selected:

- Single network:
  This generation variant modifies the entire network. In other words, all nodes and network elements to be reduced are removed from the whole network. Only the boundary nodes are kept. Boundary injections and boundary branches are connected to these boundary nodes.
- Separated network:
  This generation variant produces a 2nd network which contains all reduction elements. The reduced network is linked here to the whole network. Connection definitions are inserted here both in the whole network and also in the reduced subnetwork at the boundary nodes.

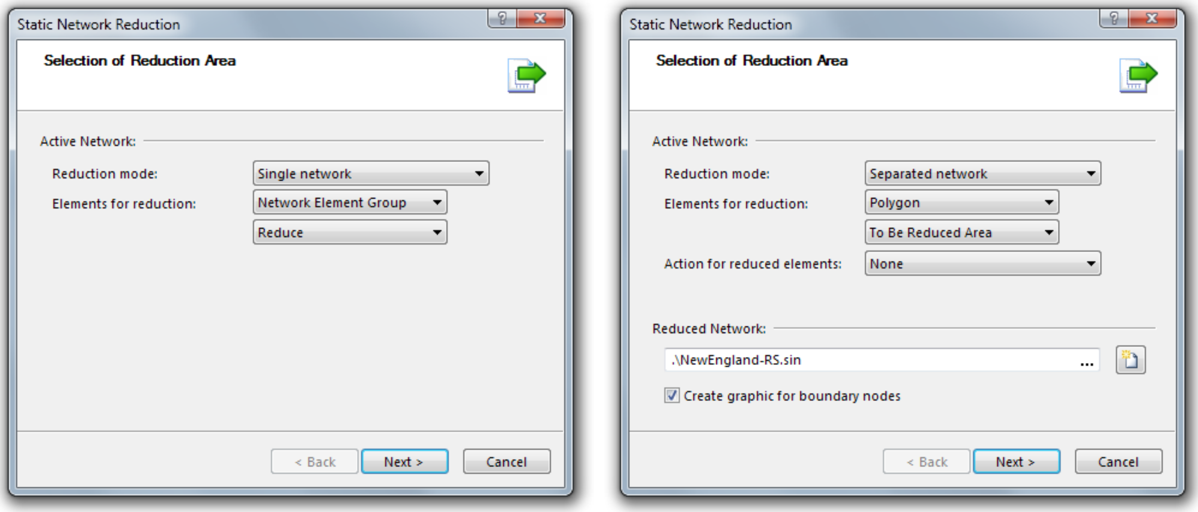


Illustration: Control dialog box for network reduction with different reduction modes

The selection of the **Elements for reduction** is also new. Previously it was only possible to select a graphic polygon which surrounded the elements to be reduced. It is now also possible to select a network element group which contains all the elements to be reduced.

The new input type **Boundary injection** is provided at the **Variable Shunt Element** specially for network reduction.

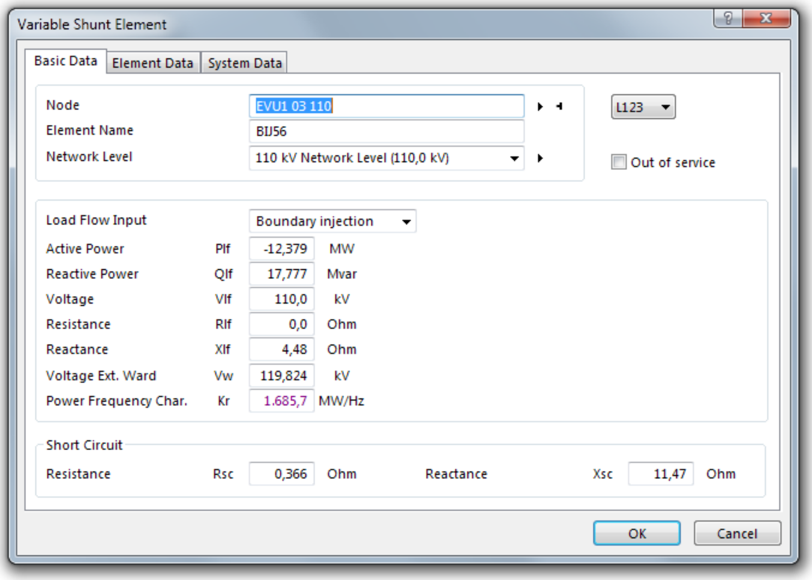
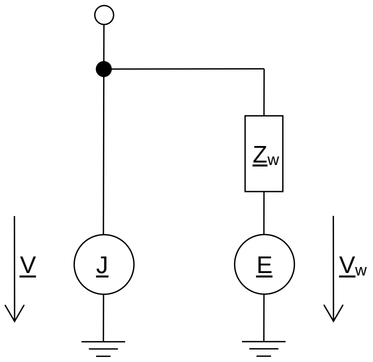


Illustration: Data screen form for Variable Shunt Element

This input type enables the modeling of a typical equivalent boundary injection resulting from the network reduction. The behavior of the network element is considerably different to the other simulations provided. Technically speaking, the network element in the load flow is simulated by a combination of several elements.



$$\underline{J} = \left(\frac{P_{LF} + jQ_{LF}}{\sqrt{3} * \underline{V}} \right)^{*}$$

$$\left| \underline{E} \right| = \underline{V}_{W}$$

$$\underline{Z}_{W} = R_{LF} + jX_{LF}$$

$$\underline{S}_{W} = \frac{\left(\underline{V}_{W} - \underline{V} \right) * \underline{V}_{W}}{\underline{Z}_{W}}$$

As shown in the circuit diagram, the network element in the load flow is simulated by a supply source with a constant power $\underline{J}$ and an additional voltage source $\underline{E}$. The voltage source is connected via an impedance $\underline{Z}_w$, with which the voltage-dependent reactive power supply source of the equivalent network is modeled. Due to the impedance, the voltage source behaves like a "soft" PV node for which the supplied active power is always zero. This type of modeling is called "Extended Ward" in network reduction.

The fields P_{LF} and Q_{LF} define the power of the supply source $\underline{J}$.

The source voltage $\underline{U}_w$ of the voltage source $\underline{E}$ is entered in the **Voltage Ex. Ward** field.

The impedance $\underline{Z}_w$ downstream of the voltage source is defined with the fields R_{LF} and X_{LF}. Normally here R_{LF} = 0.0 Ohm.

The primary power number indicates the rigidity of the supply source in relation to the network. This is required for the reliability calculations as well as for extended power distribution.

Verify Connection Conditions

This new calculation procedure is used to verify the connection conditions for a generating plant using the bdew guideline "Technical guideline generating plants connected to the medium-voltage network – Guideline for the connection to and parallel operation with medium-voltage distribution networks."

For this the new generating plant that is normally simulated by a synchronous machine is connected in the network at the required connection point. This is then selected and the pop-up menu is opened. Choose **Calculation at Element** – **Verify Connection Conditions** in the pop-up menu. This will open a dialog box in which all the required input data and control data for the verification can be defined.

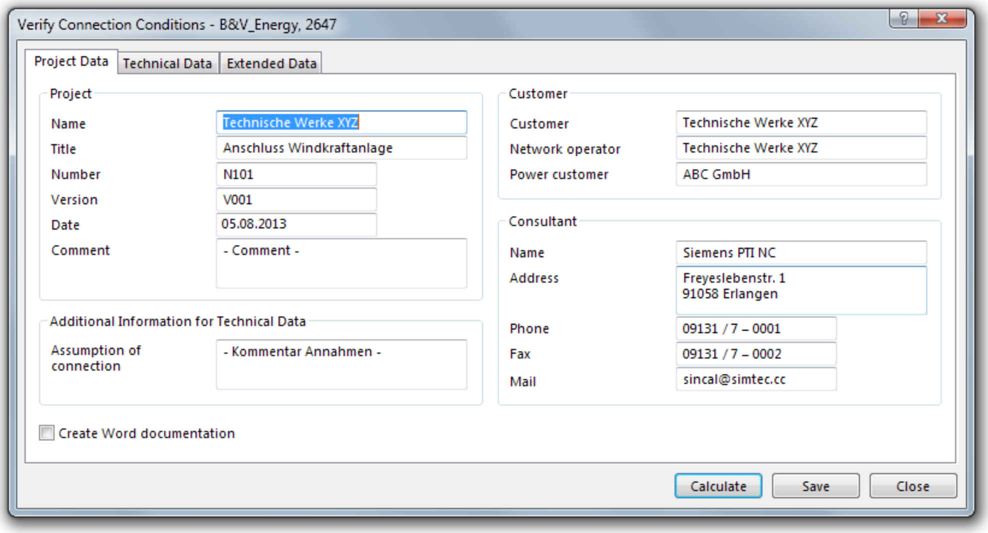


Illustration: Verify Connection Conditions control dialog box

The following checks are completed during the calculation procedure:

- Utilization of the network elements
- Voltage change
- Fast voltage change
- Long-term flicker
- Harmonics

The connection conditions are verified by combining the calculation procedures for load flow, short circuit and harmonics, as well as various temporary changes to the network configuration. This means that the appropriate calculation licenses are required in order to verify the connection conditions.

The results of the check are both visualized clearly in the result view as well as made available in the form of a comprehensive Word document.

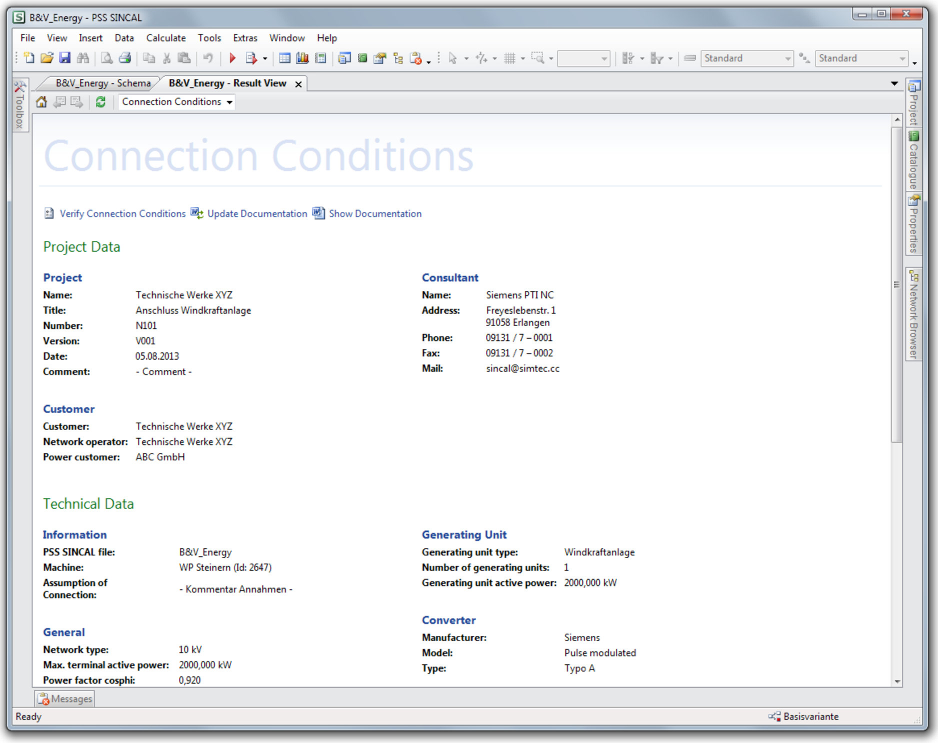


Illustration: Verify connection conditions – result view

The result view contains the most important input data and shows in the **Results** area whether the completed verifications succeeded or failed. This enables a fast evaluation of the permissibility of connecting the generating plant.

Control buttons are also provided directly in the result view.

Verify Connection Conditions

The **Verify Connection Conditions** button opens the dialog box with the control data and enables these data to be edited and the calculation to be restarted.

Update Documentation

The **Update Documentation** button enables the updating or creation of the Word documentation.

Show Documentation

The **Show Documentation** button opens the Word document containing a detailed summary of the completed verification tests as well as the corresponding results.

Enhanced Coupling Connection

PSS SINCAL 9.0 made it possible to simulate fully coupled multi-conductor systems. The multi-conductor system is simulated here with a completely filled admittance matrix with serial and shunt data. LEIKA is normally used for this, in order to calculate this admittance matrix on the basis of the tower profiles and the conductor and cable configuration etc. This data is then stored in the PSS SINCAL network and used for further calculations (load flow, short circuit etc.).

However, this method is not satisfactory if the coupling data was already determined with another program. In this case, this data cannot be processed directly with LEIKA as then no information is provided about the tower profile or the cable arrangement. The PSS SINCAL user interface was therefore provided with a new dialog box in which the data can be edited ergonomically. The data are entered in a table, separated for the serial data (R and X) and shunt data (G and C).

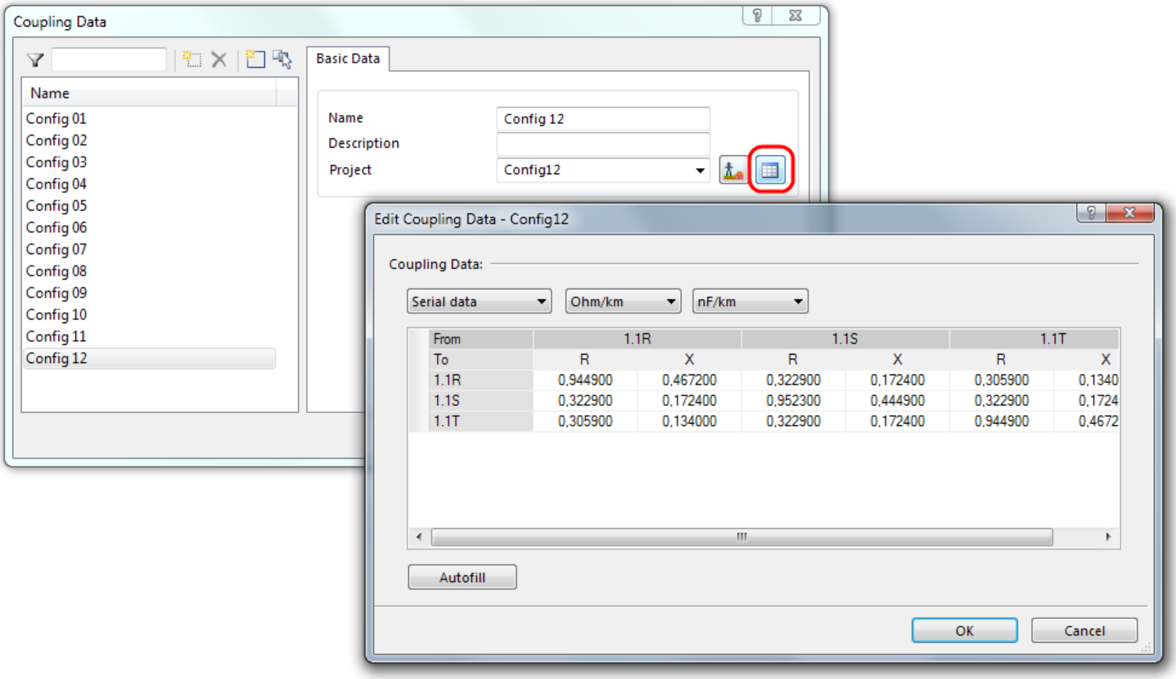


Illustration: New dialog box for editing the coupling data in the GUI

To simplify entry, it is possible to switch between different entry formats in the dialog box. These include: Ohm/km, Ohm/Mile, Siemens/Mile for impedances or nF/km, nF/Mile, Siemens/Mile for capacitances. In most cases, this enables entries to be made directly in the format in which the coupling data is available.

ISO Evaluation for Harmonics Results

An ISO evaluation is provided for the results of the harmonics calculations. This enables the node levels (uny in % and ua in %) to be visualized for the currently shown frequency in the network diagram. This is integrated in the user interface in the same way as the evaluations already provided in the **ISO Area** dialog box which can be opened with **Tools** – **ISO Area**.

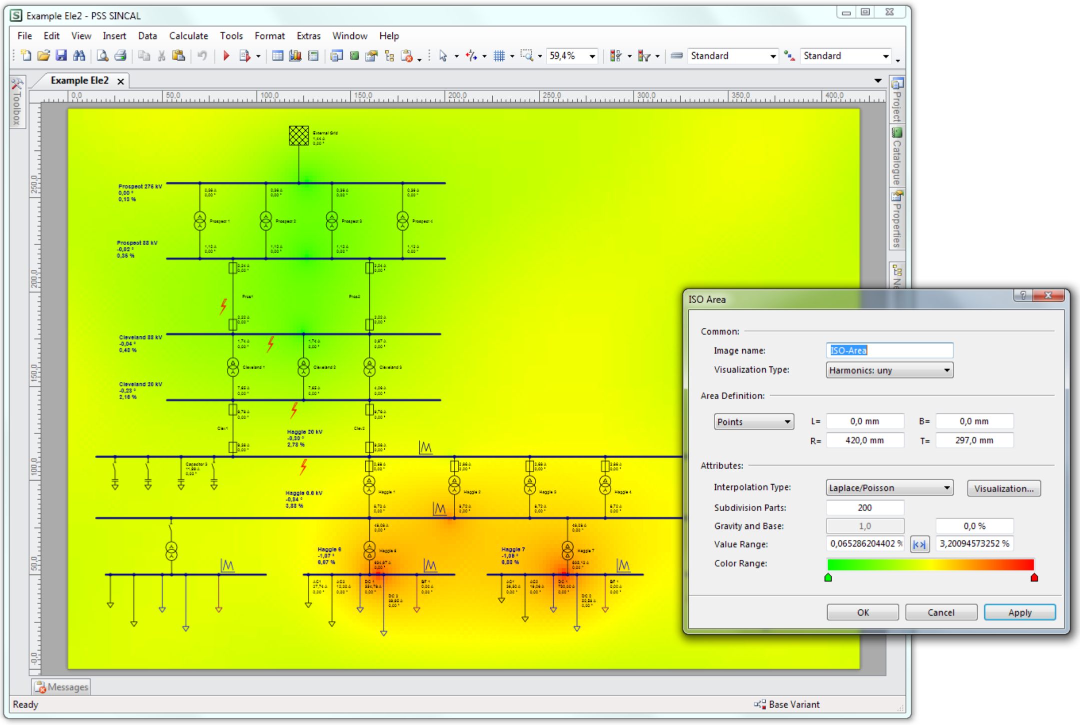


Illustration: ISO evaluation for harmonics results

Result Diagrams for the Reliability Calculation

Diagrams are now also provided for the node results (consumers) of the reliability calculation. These can be arranged interactively as required in the diagram window following the calculation. All reliability indices (Hu, Qu, Tu, Pu, Wu, Ku, Au) for the determined malfunction types can be displayed.

The following diagram shows the refund costs Au [€/a] for seven different nodes with different types of malfunction:

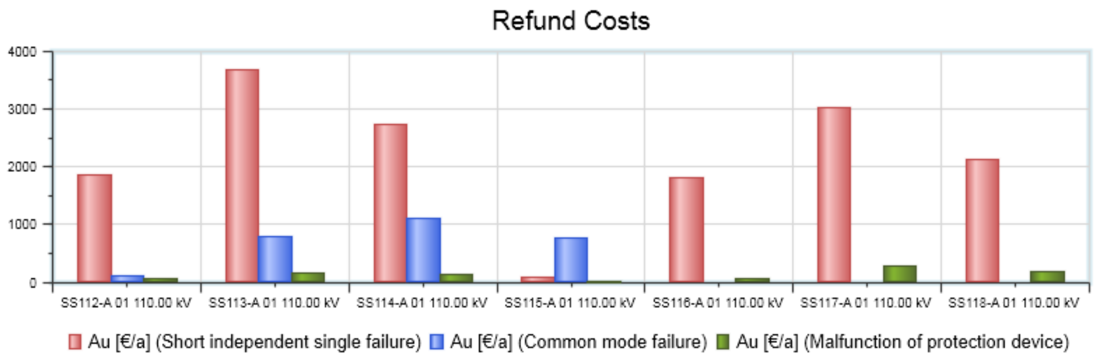


Illustration: New results diagrams for the reliability calculation

Enhanced BOSL Model Connection

The BOSL connection in PSS SINCAL was enhanced. GNE-V models can now be connected for synchronous machines, infeeders and for variable shunt elements. These modes are used for specifying the voltage amount and the angle in the load flow. In other words, these elements function like a slack. In order to use the GNE-V models the appropriate operating state must also be selected for the respective network element:

- Infeeder and synchronous machine: "|Vq| and Delta" or "|Vk| and Delta"
- Variable shunt element: "Model voltage"

Enhanced Model for Power Unit

The power unit in PSS SINCAL combines a generator and a transformer. The element was originally only provided to enable the correct simulation of power units in the short circuit calculation according to VDE. The data of the transformer was therefore not at all included for the load flow calculation up to now.

It can now be selected at the network element whether a simple simulation is carried out in the load flow calculation as before, or whether the network element is correctly simulated, i.e. through a combination of a generator with a downstream transformer including the corresponding losses.

Standard Type for Infeeder

A standard type is now also provided for the infeeder network element. This makes it possible to conveniently modify the data of the network simulated with the infeeder at a central point and to then transfer these changes to all networks which use the corresponding standard type.

Standard Models for Dynamic Simulation

The standard models for the dynamic simulation which are provided during of the PSS SINCAL installation were updated. The new models contain improvements and various adaptions so that the behavior is as identical as possible to the standard controllers available in PSS E.

Enhanced Import and Export Functions

The import and export functions provided in PSS SINCAL were improved at different points.

At **RAW export** the ratings assigned to the conductors and transformers are now also exported. The automatic version recognition was improved for RAW Import.

With **DVG export** many elements were exported up until now as "serial filters (LF1)" and "shunt filters (QF1)". Although this provides a correct electrical image of the network, this makes the further use of the generated export files more difficult. Therefore suitable network elements are now generated in DVG when possible. Both the import and the export of boundary injections (BI1, BI2) and boundary branches (EQ1, EQ2) have also been improved. These elements are now modeled in PSS SINCAL by a variable shunt element, which can reproduce the Extended Ward behavior of these network elements. The correct version number "0002" for DVG Export and also DVG Import is now used in PSS SINCAL.

DGS import and export have been provided with improved support for shunt reactors and for shunt RLC circuits.

The import of loads from **HUB files** was improved. If a load is defined in the HUB file with P1, P2, P3 and Q1, Q2, Q3 and all P and Q values are identical, these are totalized and a symmetrical load is imported. When importing switches from the HUB file, PSS SINCAL enters a minimum impedance for the connection generated in PSS SINCAL.

Improved CIM Import and Export

The CIM import and CIM export provided in PSS SINCAL were extensively revised in order to achieve improved compatibility with the different CIM versions. With the original implementation, it was assumed that CIM is a standard that has no major changes and for which every new version only contains additions to the previous version. Over the course of further development of CIM, it has been found that this was unfortunately not the case. The basic structures and derivations – even the available basic attributes – were fully changed several times in the different versions. This means that the structure of a CIM 10 file is completely different to a CIM 14 file.

With the previous implementation, this multitude of versions could not be correctly represented, and so the CIM connection in PSS SINCAL was revised so that individual import and export implementations are available for each CIM version, which are completely independent of each other. This also included a streamlining of versions and profiles. In PSS SINCAL 10.0 the following CIM versions are supported:

- CIM 10
- CIM 12, Profile CIM for Planning
- CIM 14, Profile CIM for ENTSO-E
- CIM 16, Profile CIM for ENTSO-E

Note: The CIM version 16 is not yet finally standardized. The implementation provided in PSS SINCAL is based on the results of the last interoperability tests carried out in Brussels in the summer of 2013. The final CIM version 16 standardization is expected to be completed at the end of 2013. The implementation in PSS SINCAL 10.0 is expected to be adapted accordingly with a product update.

2.3 Pipe Networks

Contingency Analysis

The contingency analysis for the pipe networks was enhanced in the same way as for the electrical networks. The **results in the network diagram** as well as the new **report** are now provided here with the complete data of the selected malfunctions.

Improvements for District Heating Calculation

The simulation of consumers with small consumption in heating calculations has been improved. The small consumptions can lead to a high hold time and in combination with this to a cooling down of the transport medium. This causes problems if the amount of consumption should be determined during solving the mesh equations. To resolve the problem, the cooling down is prevented by forcing a flow as long as a valid supply line temperature and the amount of the consumption power can exactly be determined.

3 PSS NETOMAC

3.1 User Interface

Enhanced Calculation Settings

The dialog box for defining the calculation settings was enhanced and also structured differently in some places in order to make the editing of the various control settings for the different calculation methods simpler and clearer.

New options are provided to **control load flow results** in the XRES result file to enable the faster processing in the calculation and in the GUI with particularly large networks.

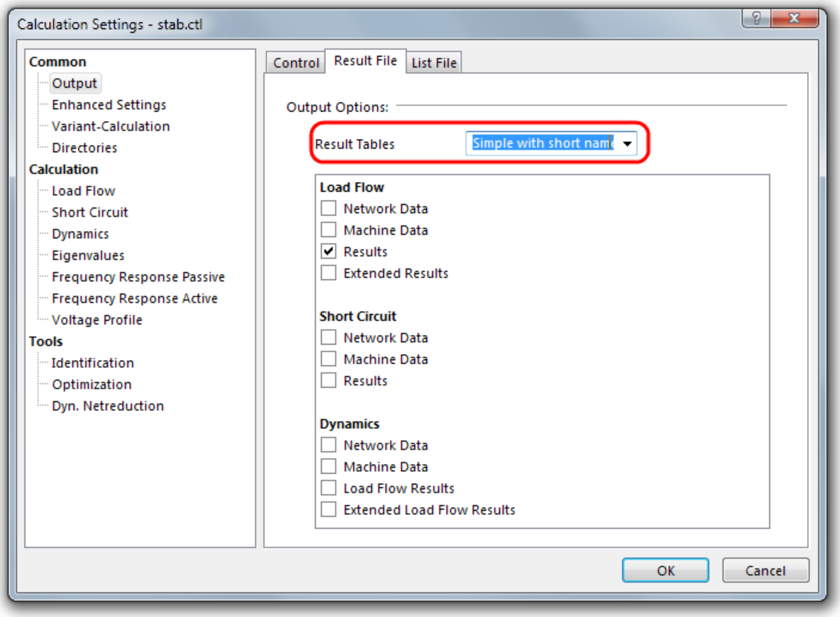


Illustration: Calculation Settings dialog box

The Result Tables selection field is used to define the scope of the results in the Tabular View.

- Extended:
  All tables are generated with foreign keys. This makes it possible to display additional data in the individual tables for the linked tables.
- Simple with short names:
  Instead of the foreign key references, the short names of the linked data are stored in the result file.
- Simple with long names:
  Instead of the foreign key references, the long names of the linked data are stored in the result file.

New global control options are also provided in the **Enhanced Settings** tab. This makes it possible to enter settings for the processing of partition data, the load flow and also for the BOSL models.

Enhancements in the Diagram System

The diagram system in PSS NETOMAC was enhanced and improved in many places in order to make the display and evaluation of the simulation results even more efficient. Improvements were also made in the dialog boxes for generating and parameter setting the diagrams in order to allow more user-friendly operation.

The settings for the **configuration of global diagram functions** are still provided in the Options dialog box.

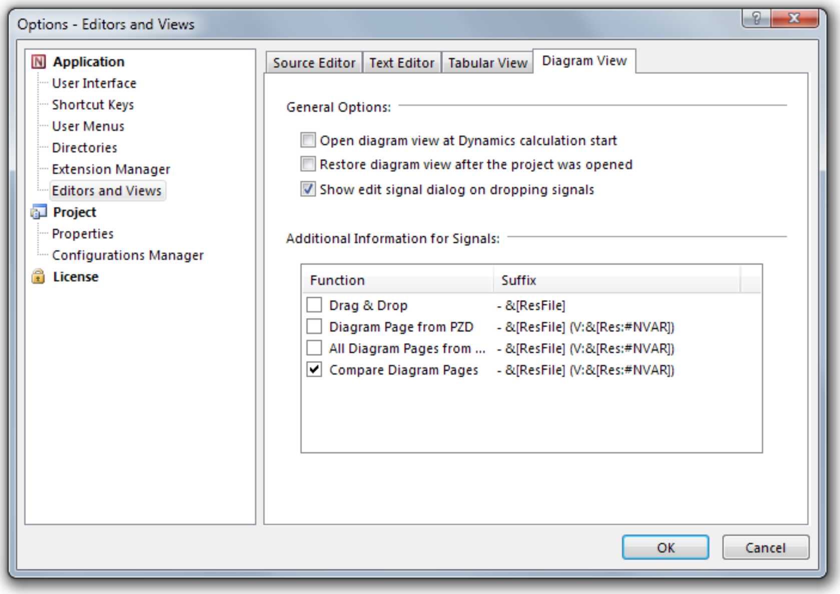


Illustration: New Options dialog box for diagrams

It is now also possible to configure whether the diagram window is to be reopened when a project is opened. Another useful new function is one that allows the dialog box for editing signal data to be opened automatically when a signal is dragged into the diagram by the Signal Explorer.

The diagram system also now supports the display of the signals recorded by the **sample controllers**. The following illustrations show the same signal. The top one shows the recording with a set sample rate and the bottom one shows the signals recorded in the simulation time step.

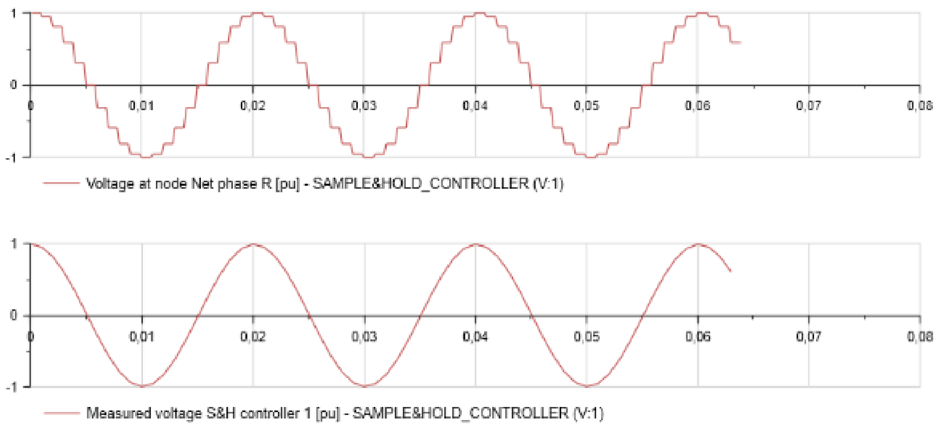


Illustration: Signals of the dynamic simulation

Both signals are stored with all the required information in the RES file. The Signal Explorer only displays a signal that can be dragged into the diagram as before. If a recording with different sample rates is available, the signal itself is provided with an option to select the sample rate.

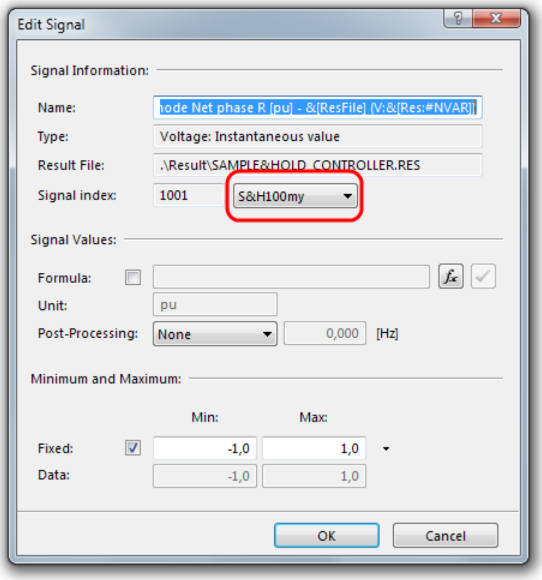


Illustration: Dialog box for editing signal data in the diagram

Another new feature of the diagrams is the optional display of a second Y axis. This enables signals with different data to be combined better in a single diagram. The similar display of diagram pages such as in the "old" version of PSS NETOMAC is thus also improved. The data series in the diagrams as well as the user-defined objects can be assigned either to the primary or secondary Y axis. This can be done in a simple way with the Format dialog box and can be changed any time.

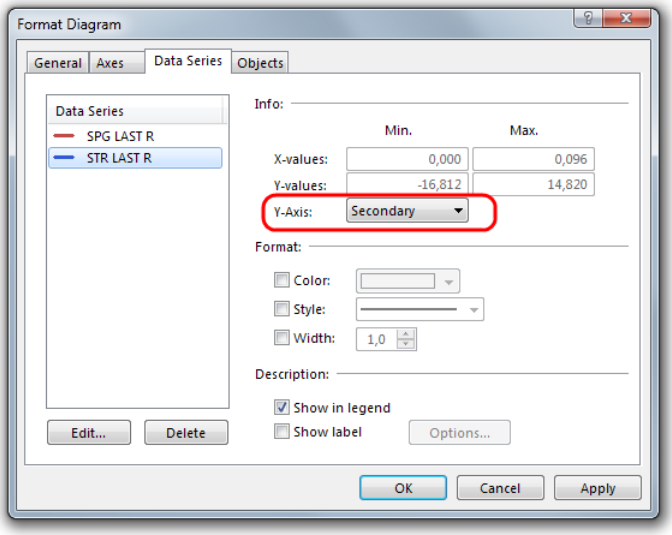


Illustration: Dialog box for editing data series

When generating diagram pages base on the PDZ data, it now also can be controlled, if the signals should automatically be assigned the primary and secondary Y axis, to achieve a similar display like in the "old" version of PSS NETOMAC.

Diagrams can now also be provided with a **user-definable page number**. This is assigned to the diagram page and can be shown at any position, i.e. in the header line, the footer line and also in the diagram itself. The page number of the diagram page can be defined in the **Comment** dialog box. When diagram pages are generated on the basis of PZD data, the page number is automatically taken from the PZD information.

Enhanced DLL Connection

The external DLL makes it possible to use an external program code directly in the PSS NETOMAC calculation. For this there was previously a permanent predefined EXTERN.DLL that could be called with the EXTERN block.

As the use of external DLLs is becoming increasingly more important for many users, the connection here was made more flexible. It is now possible to use any number of different external DLLs. The following example shows the previous application and also the new more flexible implementation:

```
$1......12......23......3AA1....12....23....34....45....56....67...78...89...9ZZ
 AUSWERT         DEMO     N
 X1=#X1
 X2=#X2
$                          II12    I22    I32    I42    I52    I62    I72   I82   I92
 MYBLOCK1        EXTERN    IX1     X2   !  I31    I41    I51    I61    I71   I81   I91
                 BLOCK_1   OY1B1   Y2B1
 DLL=ExternSalf.DLL
                           E
 MYBLOCK2        EXTERN    I#X1    #X2
                 BLOCK_2   OY1B2   Y2B2
                           E
                 ENDE
$1......12......23......3AA1....12....23....34....45....56....67...78...89...9ZZ
```

The new "DLL" parameter enables an external DLL to be loaded with a user-defined name. This is shown in the example MYBLOCK1. On loading, the PSS NETOMAC search paths are used (based on the definition in the CFG file). The previous use of the fixed "EXTERN.DLL" is of course still available. For this the definition is used as shown in the example MYBLOCK2. The small example project "ExternDemo" which shows the use of external DLLs, is also provided during the installation.

The loading of DLLs that required in turn other DLLs often causes problems, as in certain circumstances the required DLLs could not be found depending on the system configuration. The only solution to rectify these kinds of problems is to extend the system PATH variable. However, this is more likely to be problematic if different projects with different DLLs are to be used. A [DLLPath] section was therefore added to the CTL file from PSS NETOMAC. The additional search paths can be entered here. When the CTL file is loaded, the PATH variable is then automatically extended with these paths. In order to edit the DLL paths the Calculation Settings dialog box was also enhanced. The new **Directories** tab can be used to conveniently edit the search paths for DLLs.

Conversion Functions

The PSS NETOMAC user interface now features some conversion functions that were not previously available. These can be found in **Tools** – **Conversions**.

- Combined input file:
  The combined input file replaces all file references (e.g. macros) in the NET file with the content of the respective file.
- Convert to binary format:
  This function can be used to convert different PSS NETOMAC databases (controller and machines) that are in ASCII format into binary files for quicker access. The binary forms of the

files have been specially optimized for the direct access of Fortran.

- Simulink DLL:
  This function generates a proper PSS NETOMAC macro for an existing Simulink DLL, which then lets you use the Simulink DLL in a PSS NETOMAC file. Simply select the corresponding Simulink DLL with the file selection dialog box. PSS NETOMAC automatically creates a corresponding MAC file, parallel to the DLL.
- Convert block names:
  This function enables the block names of controllers to be converted between German and English.

Signal Export

The exporting of signals has now been simplified even more. The export function has been integrated directly in the Signal Explorer toolbar and enables all signals present in an RES file to be exported in different formats. For this the new **Export Signals** Wizard is opened for creating export definitions as required.

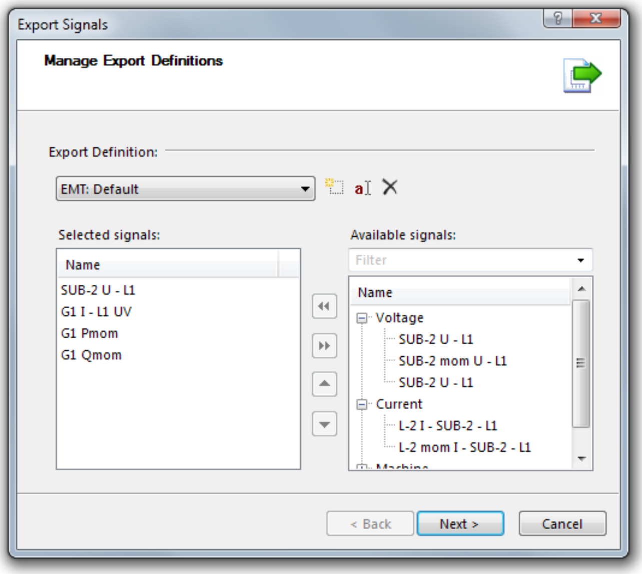


Illustration: Export Signals Wizard – Manage Export Definitions

An export definition contains any signals from an RES file that are to be exported. These signals can also be converted with formulas. The signal definitions can also be used according to the PZD file. Any number of different export definitions can be created. These definitions are all stored in the project file and are thus available immediately the next time the Wizard is opened.

After selecting or composing the export definition, it is possible to set the form in which the data is exported and also the amount of data to be exported.

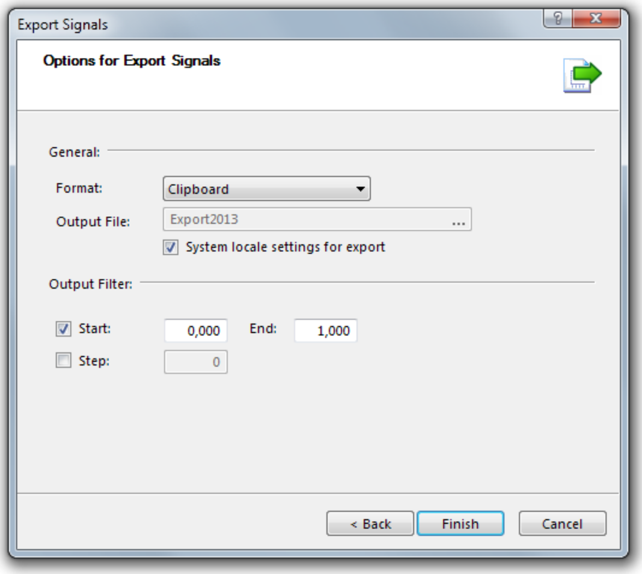


Illustration: Export Signals Wizard – Options for Export Signals

The following export formats are provided:

- Clipboard
- XRES result file (the signals' minimum and maximum values are exported along with the signals)
- CSV file
- PLT file
- COMTRADE ASCII file
- COMTRADE binary file
- Level 4 MatLab file

3.2 Calculation Methods

Result Comparison for "Old" vs. "New" Product Version

In order to validate the new PSS NETOMAC version and ensure that the results are correct, extensive comparison calculations were made with the "old" PSS NETOMAC version 40.x. The comparison calculation produces very good matches (slight numerical deviations depend on the system as the new version is created with a new compiler). Improvements have furthermore been made in the new version and errors have been corrected which then produce again different results at some understandable places.

Performance Improvements in the Load Flow

The performance when processing large records was considerably improved. The reading in and creation of the network model in the calculation methods is particularly very complex and therefore requires a lot of time. However, extensive internal optimizations have significantly improved the processing speed. The possible performance gain in the load flow calculation of larger records is over 50 percent (total computation time for large records without optimizations in the calculation methods 78 seconds, with optimizations < 35 seconds).

General Improvements in the Load Flow

The convergence behavior in the load flow could be improved through various changes and optimizations in the algorithms. The convergence of "problematic" networks is considerably faster.

With the generators (specifically with the PV types) an improved utilization of the reactive power limits was implemented. This should ensure that the reactive power is fully utilized in order to achieve the target voltage. The new function can be activated using an option in the CTL file. This control option is also provided in the Extended Settings of the Calculation Settings dialog box.

The treatment of several generators on the same node is also improved. Here the power values are distributed proportionally on all generators connected to the node.

Enhanced Integration for Models

Recursive folding was implemented for the VZ1, DIFF and PD blocks for numerical integration. This type of integration is particularly more precise with large time constants in relation to the time step. As old results change, the Extended Settings tab in the Calculation Settings dialog box was provided with an option for On/Off switching.

Extended Transformer Controlling

It is now possible to define a controller characteristic for transformers and use this to individually control the additional voltage, the angle of the additional voltage as well as uk and ur for the respective tap position. For this the new "t" line is provided for the transformer, with which the controller characteristic can be defined. The following extract shows a small example:

```
$--- Transformers
$1......12......23......3AA1....12....23....34....45....56....67...78...89...9ZZ
TN1             T1      YY110   110   66     .008  8.
TN2                     0022    22
$1......12......23......3AA1....12....23....34....45....56....67...78...89...9ZZ
tN2      1.03   T1      F  1.0   1.03 1.     3
t                         1     -8.   0.     .002  -2.
t                         2     -2.   0.     .001  -1.
t                         3      0.   0.     .0     0.
t                         4      2.   0.     .002   1.
t                         5      8.   0.     .001   2.
$1......12......23......3AA1....12....23....34....45....56....67...78...89...9ZZ
```

A detailed description of the "t" lines is provided in the PSS NETOMAC Procedure Manual under "Network Elements – Line T – Transformer with Transformer Ratio".

The new controller characteristic is also used if transformers are imported from PSS E RAW files containing impedance correction tables. On actuation by PSS SINCAL the new controller characteristic is also used.