Release Information for PSS®SINCAL Suite 9.0

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

1.1 Licensing

To operate PSS SINCAL 9.0, 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 Changes to Names

Load Profile Calculations

The name for the **Load Curve** procedure has been changed to **Load Profile**. This new name describes the actual functions more clearly and displays the connection to the corresponding Load Profile input data more clearly.

Load Assignment

The name for the **Load Trim** procedure has been changed to **Load Assignment**.

1.3 Modified Sample Networks

During installation, PSS SINCAL provides sample networks that represent the basic functions of the different calculation methods. The names of the sample networks have been changed to make it easier to allocate the networks to the calculation methods. The following is a list of the available sample networks and simulation methods, which can be used.

Electrical Networks

Name	Old name	Calculation methods
Example Ele1	Example Ele	PF, SC, DN, CA
Example Ele2	**new**	PF, SC, OB, MF
Example Ele3	Example HV	PF, SC
Example Ele4	Example Unsym	PF, SC
Example CO	Example Comp	PF, CO
Example Dyn	Example Stab	ST, EMT, EVA
Example LA	Example Trim	PF, LA
Example LD	Example Inc	PF, LD
Example LP	Example LC	PF, LP
Example MA	Example MS	PF. MA
Example OC	Example OC	PF, SC, ÜZ, AFH
Example Prot	Example Prot	PF, SC, ÜZ, SZ, DI
Example RC	Example RC	PF, SC, OB, RC
Example Route	Example Route	PF, ON
Example ZU	Example Rel	PF, ZU

Pipe Networks

Name	Old name	Calculation methods
Example Water	Example Water	WS, WCA, WH, WL
Example Gas	Example Gas	GS, GCA, GL
Example Heat	Example Heat	FS, FCA, FL

1.4 Improved SQL Server and SQL Server Express Connections

Previously, the performance of Microsoft SQL Server and Microsoft SQL Server Express in PSS SINCAL was not as high as that of ORACLE or Microsoft Access.

Analyses of very large networks showed that the limitation placed on the requests per second at the SQL Server was the main reason for differences in performance. Both SQL Server and SQL Server Express limit the number of requests per connection to approx. 3,000/second. This limit can, however, be a big problem for PSS SINCAL, since the DB connection sends a lot of requests.

To resolve these performance problems, two changes were made in PSS SINCAL: a bulk cursor is used for Select and Update and the insert strategy was changed. This assures that the performance is just as good on all database systems.

General Comment on Performance

PSS SINCAL performs best with Microsoft Access, assuming the size of the database does not exceed 150 MB. In this case the simple and normally available Access database in the main memory is much faster than the RDBMS systems. This changes significantly, however, when larger amounts of data are processed. In this case, real RDBMS systems such as ORACLE, SQL Server or SQL Server Express are much more appropriate.

1.5 Master Database

The administrative functions for the Master Database have been clearly arranged. Now a single central page in the Master Database view contains all the significant information.

The new page contains general information on the active view (Preview). This displays any active publications and the functions for user administration. There is even a list of all the attached client databases.

An administrator can use this central page to perform all the required administrative tasks.

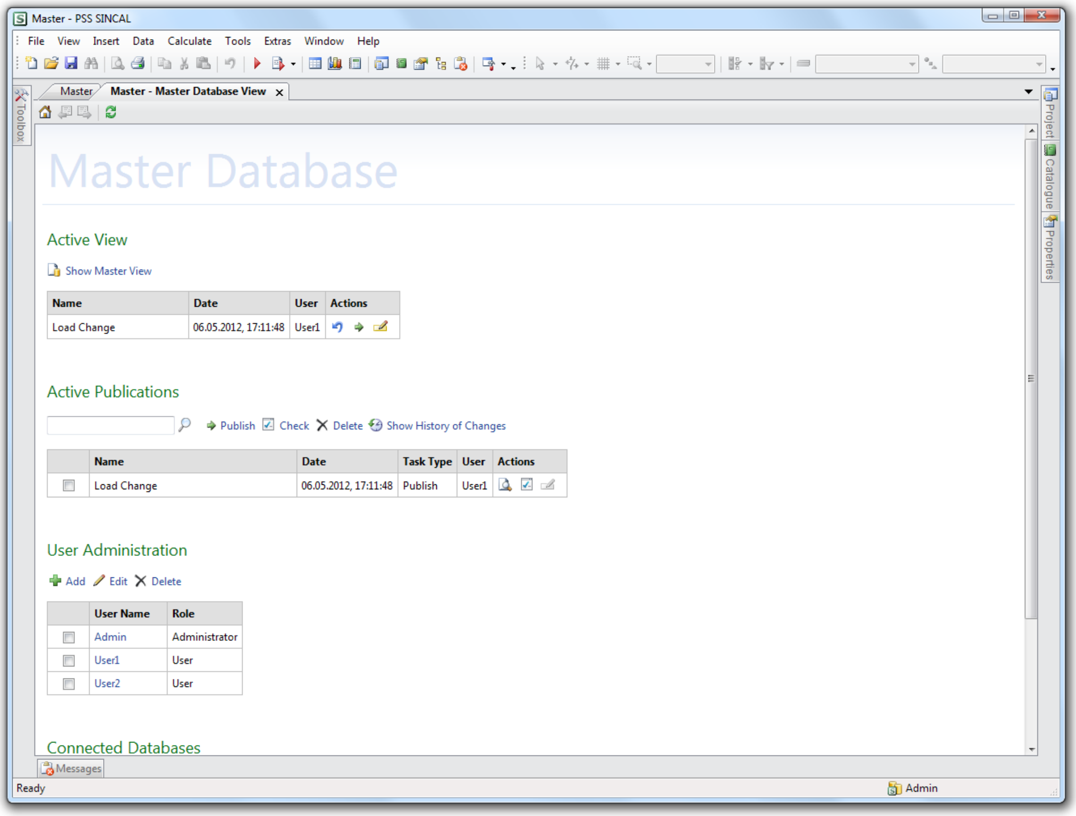


Illustration: The new Master Database View

Another new feature is the easy way to change between views. If the publication of a particular user is displayed, you can now switch back to the Master View at any time. This is done with **Show Master View**.

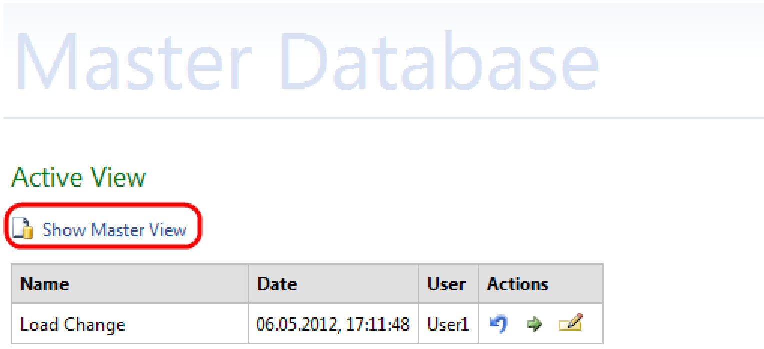


Illustration: Improved Changing between views

1.6 Help Programs

SinDBCreate

The **SinDBCreate** help program uses a console to create and manage PSS SINCAL databases. The program is particularly useful if you are working with SQL Server or ORACLE, since this is an easy way to manage the PSS SINCAL data structures in these database systems.

Up to now the help program could list, create and delete databases. Now there is a new function for updating databases.

If the program is started without any settings, information is supplied for use:

```
C:\> SinDBCreate.exe

Usage:
SinDBCreate /DBSYS:xxx /FILE:xxx /TYPE:xxx [Options]
    Create a new SINCAL-Database.

SinDBCreate /LIST /DBSYS:xxx /ADMIN:User/Password /SRV:xxx
    List all Databases on a server.

SinDBCreate /DELETE /DBSYS:xxx /FILE:xxx /ADMIN:User/Password /SRV:xxx
    Delete a SINCAL-Database on a database server.

SinDBCreate /UPDATE /DBSYS:xxx /FILE:xxx /USER:User/Password /SRV:xxx
    Updates the specified SINCAL-Database to the current version.

    /DBSYS:{ACCESS|ORACLE|SQLSERVER|SQLEXPRESS}
                            Database-System

    /FILE:{Database}
        MS Access:          Path and FileName of the MDB-File
        SQL Server Express: Path and Filename of the MDF-Datafile
        ORACLE:             User/Password@Instance
        SQL Server:         Database@Instance

    /ADMIN:User/Password    Administrator-Login for Database-Servers
    /USER:User/Password     Login Information for Database-Servers
    /SRV:Instance           Database Service Name/Server Name

    /TYPE:{E|W|G|H}         Network-Type (E)lectro|(W)ater|(G)as|(H)eating
    [/DB:{NET|STD|PROT}]    Database-Type (Network-Database is default]
    [/DATA]                 Fills STD-DB and Prot-DB with default data
    [/LANG:{ENG|GER}]       Language for database (default is ENG)
    [/SIN:Filename]         Path and filename of the SIN-file.
```

To update databases you have a new "/UPDATE" setting that lets you update the database to the current version.

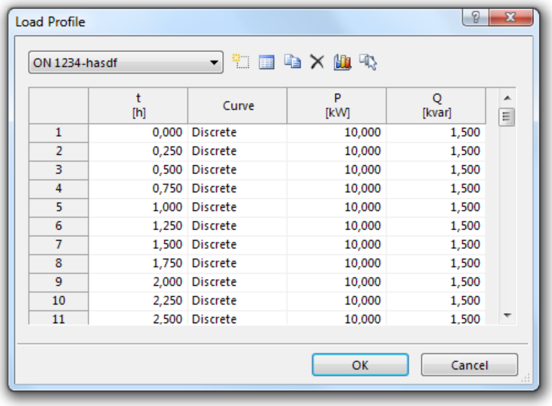
For a comprehensive description of these functions, see the chapter on **Help Program for Creating PSS SINCAL Databases** in **User Manual**.

2 PSS SINCAL

2.1 User Interface

New Dialog Box for Entering Characteristic Curves

The PSS SINCAL dialog box for entering characteristic curves has been completely revised. The new version makes it much easier to process characteristic curves with a large number of points (e.g. load profiles for a whole year). To achieve this, the table has been separated from the diagram.



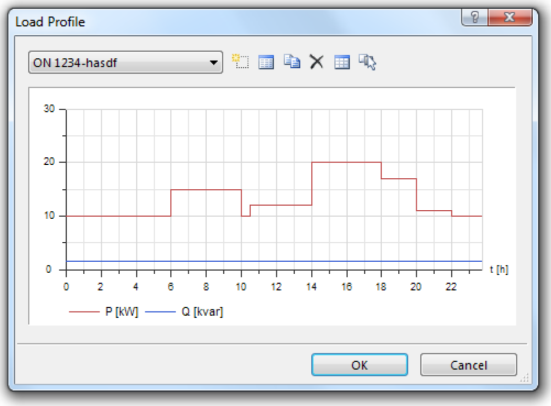


Illustration: New dialog box for entering characteristic curves

To select the different functions for editing the characteristic curve, use the integrated toolbar.

 Create a new characteristic curve

 Display basic data of the characteristic curve

 Copy characteristic curve

 Delete characteristic curve

 Switch to Diagram preview

 Switch to Table preview

 Select in graphics

The new type of display provides a lot more space for the diagram and the display quality is also much better. Simply click the control buttons in the toolbar to switch between table preview and diagram preview.

The characteristic curves in the diagram are now clearly labeled and only active characteristic curves are actually displayed. This is particularly important for profile data, since this lets you specify characteristic curves with different input values. Previously, all the possible values were displayed in the diagram and in the table, even if these would not be considered. The new version of

PSS SINCAL only displays characteristic curve values that are still active.

There is also a new **Select in graphics** function. Click this button to select all the network elements in the Graphics Editor assigned to the record in the screen form.

The functions for copying and inserting data in the dialog box have also been redesigned. Now it is easy to use Copy & Paste and Excel to fill the dialog box.

New Dialog Boxes for Editing General Data

The PSS SINCAL data model has a number of different data structures for defining the structural data (e.g. network level, network area, etc.) or supplementary data (main busbar, coupling data, etc.). These data structures are not directly connected to any network diagram, but are, nevertheless, still needed for network modeling.

To enable you to work more efficiently, the dialog boxes for editing these data structures have been reorganized. The dialog boxes now have a browser on the left listing all the records. The integrated filter field can be used interactively to immediately reduce the amount of data displayed. When you select a record in the browser, PSS SINCAL displays its data screen forms, making it easy for you to edit the data.

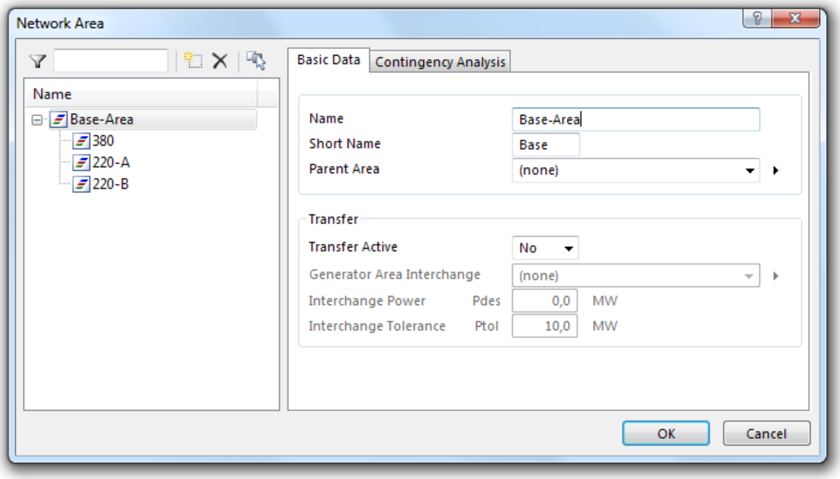


Illustration: New dialog box for editing network areas

Another very useful feature is the **Select** button in the integrated toolbar. This is used to select network elements in the Graphics Editor to which the record will be assigned.

New Menu for Data in Electrical Networks

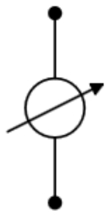
The PSS SINCAL menu structure for electrical networks has been reworked a bit. The **Insert** menu has been simplified by relocating the editing functions for general data to the new **Data** menu. In the new menu, the data are primarily structured with the help of the calculation methods.

Enhanced Dialog Box with Line Data

The dialog box for determining line data for electrical networks has been enhanced. The dialog box can now display the impedance of the route either as R and X, or Z and cosphi.

New Symbol for Two-Winding Transformer

For the two-winding transformer, there is a new predefined symbol type available to enable the display as a "Voltage Regulator":



The new symbol can be selected with the format dialog box.

Additional Information Field for Network Elements

All the network elements have an additional information field. The new field is intended only for documentation and as such can be used any way you want. The content of the field is not used by the calculation methods. The database has this field for electrical networks in the Element.Description table or for pipe networks in the FlowElement.Description table.

In the user interface, the new field is displayed in the **Element Data** tab in data screen forms. It can also be displayed in Tabular View under **Topology** – **Network Element**.

Sequence of Network Elements in Variants

PSS SINCAL has a special view option that lets you save the display sequence of the network elements and supplementary graphic objects in the .sin file. You need this particularly if you do not want to use the default sequence (supplementary graphics in the background, then above the network diagram). Before, this option could not, however, be used in connection with variants. When the variants were changed, the default sequence was always used for network elements. This problem has been repaired and now you can even use variants to save network elements in a sequence defined by the user.

Select by Type

The **Edit** – **Select** – **Select by Type…** function is used to select network elements, add symbols and supplementary graphic objects in the graphics view with the type. If you wish, you can use an additional filter restricting the selection and, for example, only selects loads assigned to a specific network level.

Up to now, this additional filter was only available for the network elements. Now the filter is also available for any add symbols. This is particularly useful when, for example, all protection devices assigned to a specific network level should be selected.

Loading Feeder Data from the Database

In PSS SINCAL, **Tools** – **Feeder…** determines the network feeders comfortably. Very complex routing algorithms are used in the calculations to analyze the network comprehensively and then determine the feeder data. This can take a lot of time – mainly in larger networks. For several PSS SINCAL versions now, the basic data of the determined feeders could also be saved in the network database. PSS SINCAL automatically loads these data when the network is opened. Since the data from the database only include the "basic information", feeders also need to be determined when you open the network to calculate the missing data. But, as we already mentioned, this can sometimes take a lot of time. For this reason, the document settings now have a new option to switch

OFF creating automatic feeder data when loading.

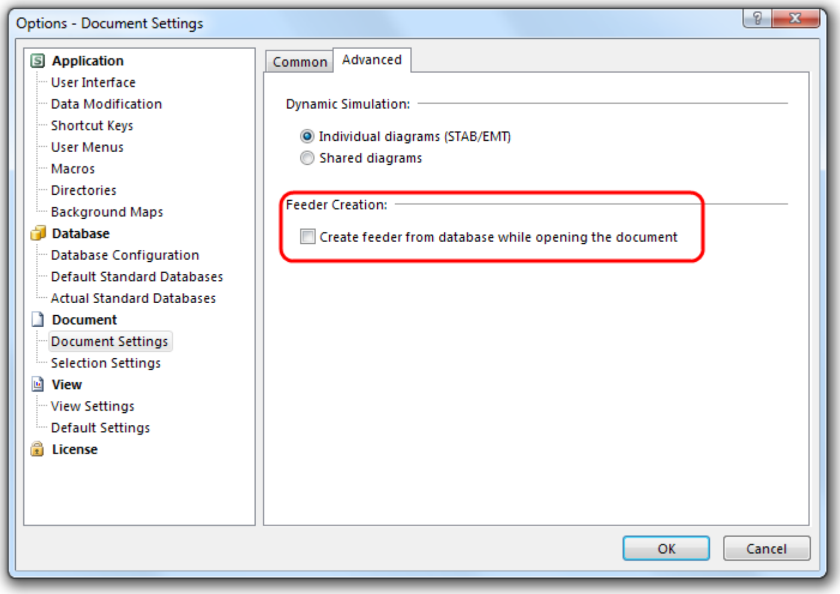


Illustration: Options dialog box with Document Settings

If the automatic creation is switched OFF, the feeder data can be updated manually at any time with the **Tools** – **Feeder…** function.

2.2 Reports

New Report System

PSS SINCAL has a completely new report system that replaces the previous one based on Crystal Reports. This step was unfortunately necessary, since Crystal Reports was taken over in 2008 by the company SAP and the local reporting function needed by PSS SINCAL is no longer being developed and not supported in new versions.

The new report system in PSS SINCAL is based on the product **List & Label**. This is a reporting tool of the German company combit GmbH.

How the report system has been integrated into PSS SINCAL user interface has basically remained the same. This means the user interface has a special Report View that can be opened in the menu **View** – **Report View**. The left side of the Report View has a browser where the opened compilations and the assigned reports are displayed. Simply select the report from the list to display it in the preview window.

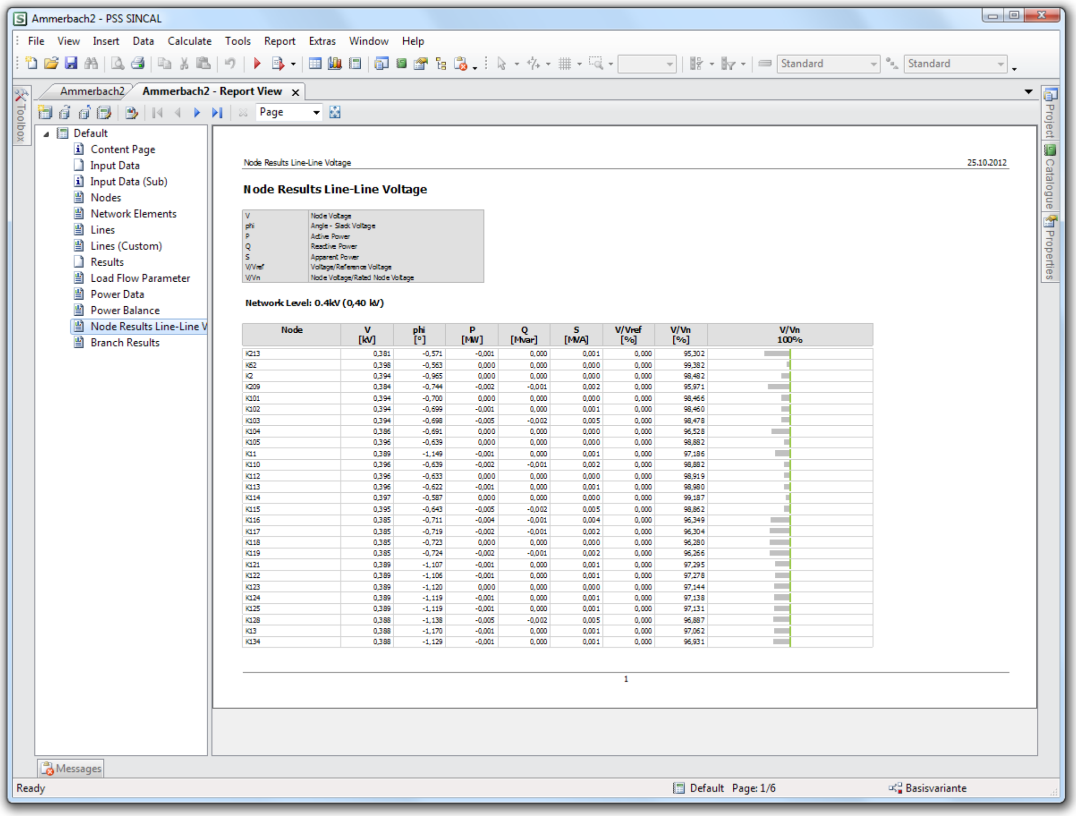


Illustration: New report system in PSS SINCAL

With the new report system also functions could be improved. The export functions are much more flexible to use. Complete compilations from different reports can be exported to an individual PDF file. This makes it much easier to pass on complete report compilations than in the old version.

The display of the reports has been optimized as well. The main idea was to display all the information more compactly, without it becoming difficult to read.

Report definitions created with Crystal Reports cannot be used in List & Label. Unfortunately, you need to generate all the report definitions again in List & Label. PSS SINCAL 9.0 does not contain all the reports that have been available up to now. PSS SINCAL only provides the basic original reports for Load Flow, Short Circuit, Protection and Pipe Network Calculations. This measure was completely deliberate, since reports are normally organized according to the requirements of individual customers, and this is now very easy to do with the new report system. A Report Designer can be started directly from PSS SINCAL user interface to generate one’s own reports.

Creating Your Own Reports

In Report View, you can open a Wizard by clicking **Report** – **Report** – **New Report** in the menu or using the browser’s pop-up menu.

The Wizard is used to select the basic data for a new report. To reduce the work involved in creating the reports as much as possible, new reports are normally created on the basis of already existing reports.

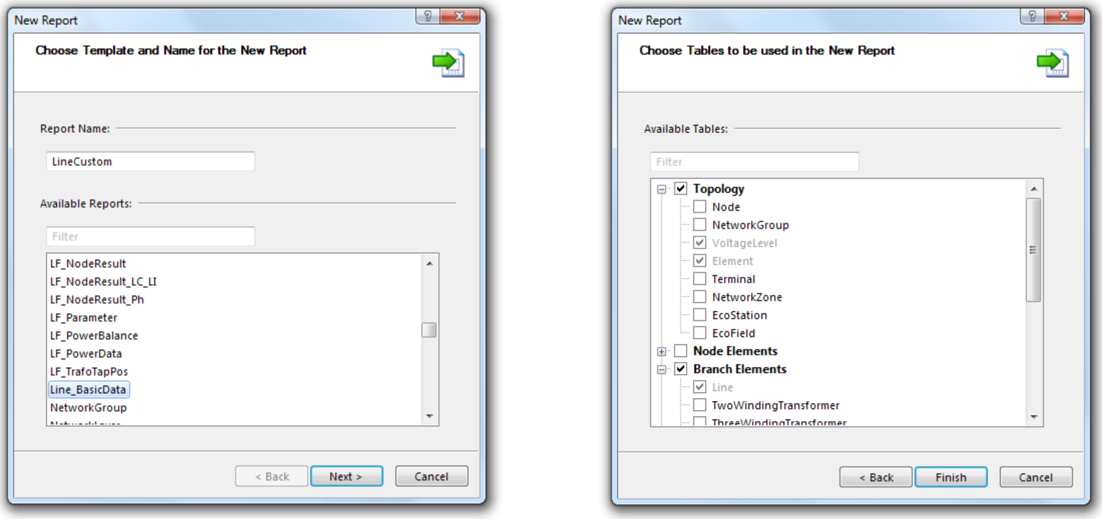


Illustration: Wizard for creating new reports

The current example shows how a custom report for line data is generated. A predefined report with the line data has been selected as a template. In addition to the template, you need to enter a name for the new report on of the first page in the Wizard. Click **Next** to open the second page of the Wizard. PSS SINCAL displays all the available data structures (precisely the tables from the network database) that can be displayed in the report. For new reports, first select which tables are to be used. When you are finished, click **Finish** to generate the new report.

This automatically opens the new Report Designer and displays the data structure of the new report.

The Designer is used to customize the report. The available tables and their attributes are displayed in the tool window **Variables/Field-List**. This data can be placed anywhere in the report and you can even add your own calculation formulas or create sub-groups. The Report Designer has an integrated comprehensive help function with a detailed description of all the Designer's functions.

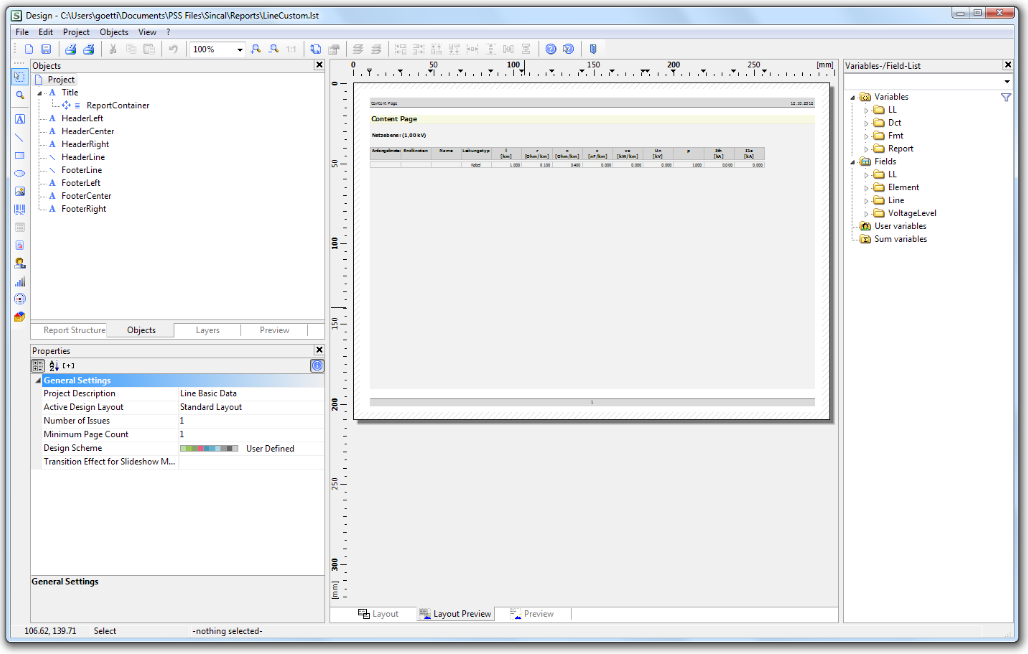


Illustration: Report Designer in PSS SINCAL

When you have finished defining your own report, simply close the Designer. The new report automatically becomes part of the current compilation. The report definition is stored in the user directory (Documents\PSS Files\Reports).

2.3 Load Flow

Changes to Implementation of Energy Storage

Since PSS SINCAL 8.5, energy storage is available that can be attached to synchronous machines and DC-elements. The original idea was to create a universal element for energy storage in the Load Profile Calculations. The problem of the previous implementation was that loading and unloading memory was done exclusively from the energy balance in the network. It turned out that this was not very useful in practical network modeling, so the way energy storage is implemented has been modified.

A BOSL model now controls energy storage behavior. The BOSL model has to be assigned to the network element supplying the energy storage device. The BOSL Model simulates whether power is removed from or fed into the network. The energy storage device is only required to manage the currently available energy and the corresponding minimum and maximum limits. The model lets you react appropriately to different network states (e.g. voltage at remote nodes or current at remote elements) and adjust the active and reactive power correspondingly. The direction the power flows is used to decide whether the energy storage device is being loaded or unloaded.

During PSS SINCAL installation, the BOSL model "EnergyStorage.mac" is placed in the global model directory. The model itself is organized very simply and, depending on the voltage at the target node, the memory is either loaded or unloaded. The following extract from the model shows how this basically works:

```
$1......12......23......3AA1....12....23....34....45....56....67...78...89...9ZZ
 Node     RVMAG    INPUT                         030000
$
 U = Node * 100.
 dP = 0.
 dQ = 0.
 Charge = 0       ! Charge: 1=load storage, -1=feed in power to the network
 RedFkt = 1
 dLowDiff = #Ufeed - #UFullL
 dUpDiff = #UFullU - #Ustore
$
$ Check Operation Area
 IF( U .GT. #Ustore ) THEN
    Charge = 1
 ELSE IF( U .LT. #Ufeed ) THEN
    Charge = -1
 ENDIF
$
$ Charging Battery
 IF( Charge .EQ. 1 ) THEN
   dP = #Pmin
   dQ = #Qmax
   IF( ( U .LT. #UFullU ) .AND. ( #UFullU .GT. #Ustore ) ) THEN
     RedFkt = 1 - ( ( #UFullU - U ) / dUpDiff )
     dP = #Pmin * RedFkt
     dQ = #Qmin * RedFkt
   ENDIF
$
$ Discharging Battery -> inject power to the net
```

```
   ELSE IF( Charge .EQ. -1 ) THEN
     dP = #Pmax
     dQ = #Qmin
     IF( ( U .GT. #UFullL ) .AND. ( #Ufeed .GT. #UFullL ) ) THEN
       RedFkt = 1 - ( ( U - #UFullL ) / dLowDiff )
       dP = #Pmax * RedFkt
       dQ = #Qmax * RedFkt
     ENDIF
   ENDIF
  $
   dP = dP / #Plf
   dQ = dQ / #Qlf

$1......12......23......3AA1....12....23....34....45....56....67...78...89...9ZZ
                 OUTPUT          dP     dQ
                 ENDE
```

Enhanced Functions for DC-Elements

PSS SINCAL DC-elements have been enhanced for more universal use. Previously, the DC-element had very special input data and was only used to feed or consume active power. The amount of reactive power was only determined by the reactive power demand of the inverter.

To make the element more useful, PSS SINCAL now has a new input variant where P and Q or P and cosphi can be entered directly. The corresponding manipulators (fP and fQ) are also provided.

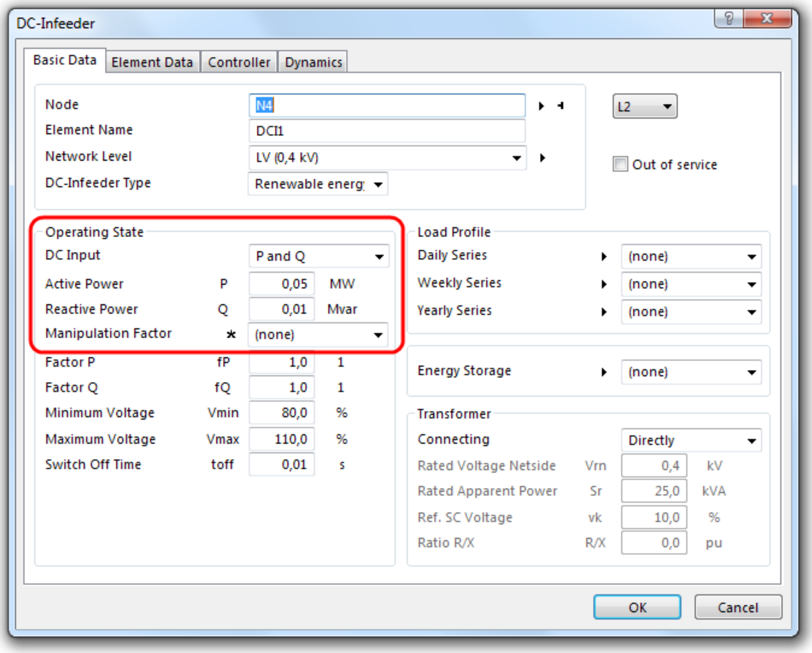


Illustration: Data input form for DC-Infeeder

Users have said they wanted to implement a special tap behavior, especially for DC-elements. The DC-element in PSS SINCAL is, however, a "container" and can be used for any kind of equipment: from a simple battery to a wind power station. The way these are regulated can vary greatly depending on network operator. For this reason, there is no way to create a generally valid control model for this element in the calculation algorithms. The solution is to use a BOSL model. With BOSL models, DC-elements can access to different network indices and then supply active and reactive power in the network. When BOSL models are used, regulation is universal: both in stationary simulation procedures and in dynamics. For the DC-elements, the global model directory has the predefined models "DCInfeeder .mac" or "DCInfeederU.mac" (1-phase). Or, of course, you can also generate your own models.

Enhanced Controlling for Transformers

The controlling of two-winding transformers has been reworked. Now you can set the basic controller type independent of whether the tap is identical in all three windings or done individually.

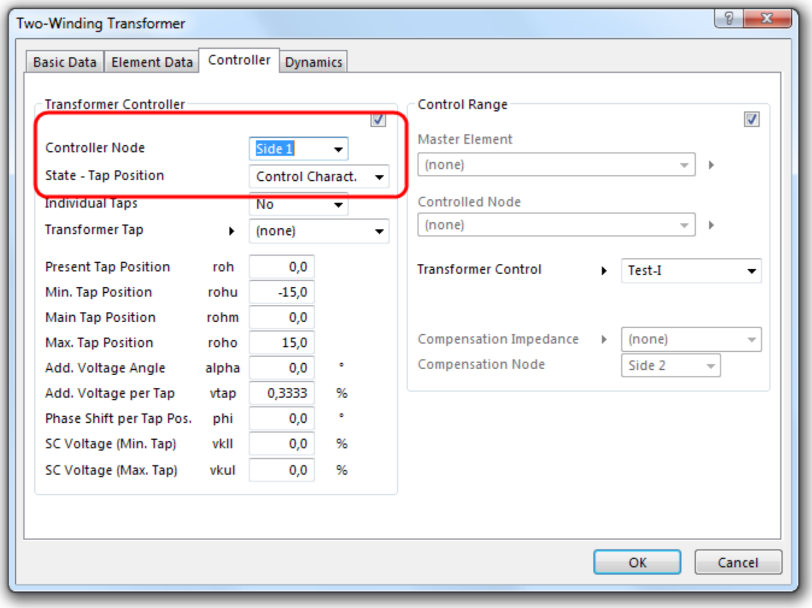


Illustration: Data screen form with controller data for a two-winding transformer

The new **Individual Taps** field selects whether the three windings are done individually.

State – Tap Position is used to select the type of control. The following options are available:

- Fixed
- Node
- Impedance
- Active power
- Reactive power
- Control characteristics
- Manual setting

There are also new options for **Control characteristics** and **Manual setting**.

If you select **Control characteristics**, you can choose the characteristics in the **Control Range** area. The control characteristics use either current or the power to define the target voltage u in %. The value for transformer controller adjustment can be taken either from the high- or low-voltage side of the transformer. This value is used with the characteristic curve to determine the proper voltage and an attempt is made with the control algorithm to attain this voltage by a corresponding change in the tap positions.

Manual setting is primarily for the short circuit current calculations in power blocks according to VDE 0102/2002 – IEC 909/2001. The option in the calculation methods works the same as in the **Fixed** option. But, when short circuit currents for the power unit are determined, you need to make a distinction to model a transformer with a manual setting correctly.

Smart Load Flow

The following illustration shows the basic architecture used to dynamically supply data for the calculation methods with the Smart-LF interface.

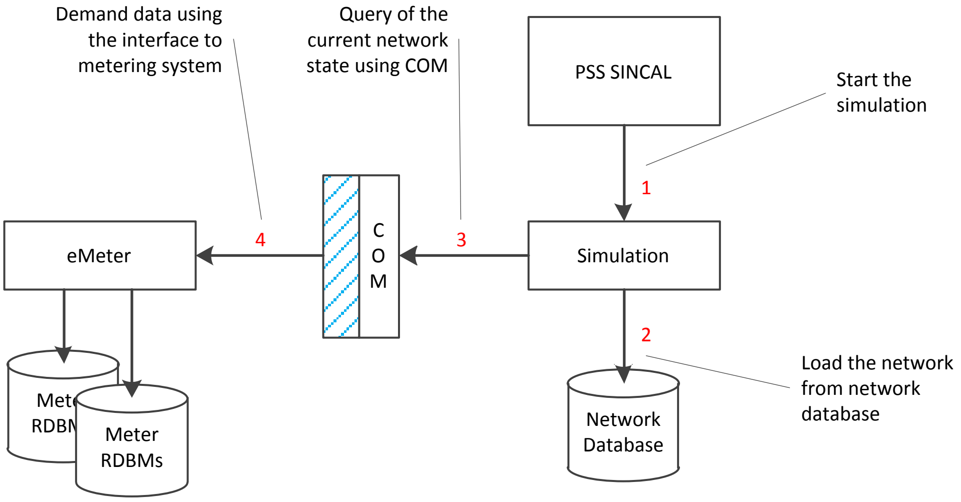


Illustration: PSS SINCAL dynamic data supply in Smart Load Flow

The sequence is basically as follows:

- **1:** PSS SINCAL starts the simulation to solve the load flow problem for a specific time t1.
- **2:** The simulation loads the entire network with all input data from the PSS SINCAL database. The network is analyzed and completely set up.
- **3:** Then a defined COM interface sends off a query to get the current network state for the time t1. All the network element UUIDs that need to be supplied with measured values are transferred to the COM interface.
- **4:** The data query is forwarded to the metering system, or the corresponding RDBMS server, and then the stored measured values are delivered for the time t1.

In the Smart Load Flow Calculations for a specific time interval (e.g. a day), the procedure repeats very often. Point 4 usually takes the most time, namely querying the data using the metering system. To improve performance, you should pre-select the required data in the run-up or save this at the Smart Server. To enable you to do this, PSS SINCAL now also transmits the starting and stopping times for the calculations to the Smart Server before the actual calculations start. This orders the data from the metering system and, if necessary, pre-stores them locally.

For detailed information on Smart Load Flow, see the PSS SINCAL Installation CD: "Doc\English\Misc\SINCAL Smart-Load Flow.pdf".

2.4 Electrical Networks with Different Frequencies

PSS SINCAL can now calculate electrical networks with different frequencies. To do this, network levels now also have definitions for frequency as in calculation settings. The frequency stored in the calculation settings is used as the basic frequency of the network. If the frequency at the network level deviates from this, elements assigned to this network level are used in the calculations separately.

Subnetworks with different frequencies cannot be connected directly. These can only be connected with a DC-line. To be sure, before the calculations actually start, an enhanced topology examination is executed to assure that the network topology is correct. If there are any errors, PSS SINCAL aborts the calculation procedure with a corresponding message.

Networks with multiple frequencies have been implemented in the following calculation methods:

- Load flow (symmetrical & unbalanced)
- Short circuit
- Multiple faults
- Protection simulation
- Contingency analysis
- Load profile
- Load development
- Harmonics
- Ripple control
- Dynamics

In Load Flow calculations and the Short Circuit calculations, subnetworks with different frequency are separated. The network interfaces need to then have the corresponding coupling by DC-elements.

The calculations for Multiple Faults, Protection, Contingency Analysis and Load Profile are based on the basic calculations for Load Flow and Short Circuit. There are no special treatments for different frequencies.

In Harmonic and Ripple Control Calculations, the calculations are carried out separately for all subnetworks of different frequencies and there are no interactions between them. This would not even be possible, since the subnetworks are only connected by DC-lines, which are always considered to be "blocking" in the harmonic calculations and ripple-control calculations.

In Dynamics Simulation the different frequencies are also supported. Network levels with different frequencies are exported as partitions to the .net file.

2.5 Contingency Analysis

New View for Evaluating Results

PSS SINCAL has a new view that allows you to visualize the results of calculation methods and even evaluate them interactively. This new Result View is currently only used in Contingency Analysis. In the future, however, evaluation and analysis functions will also be used for other calculation methods.

View – **Result View** in the menu switches ON the new Result View.

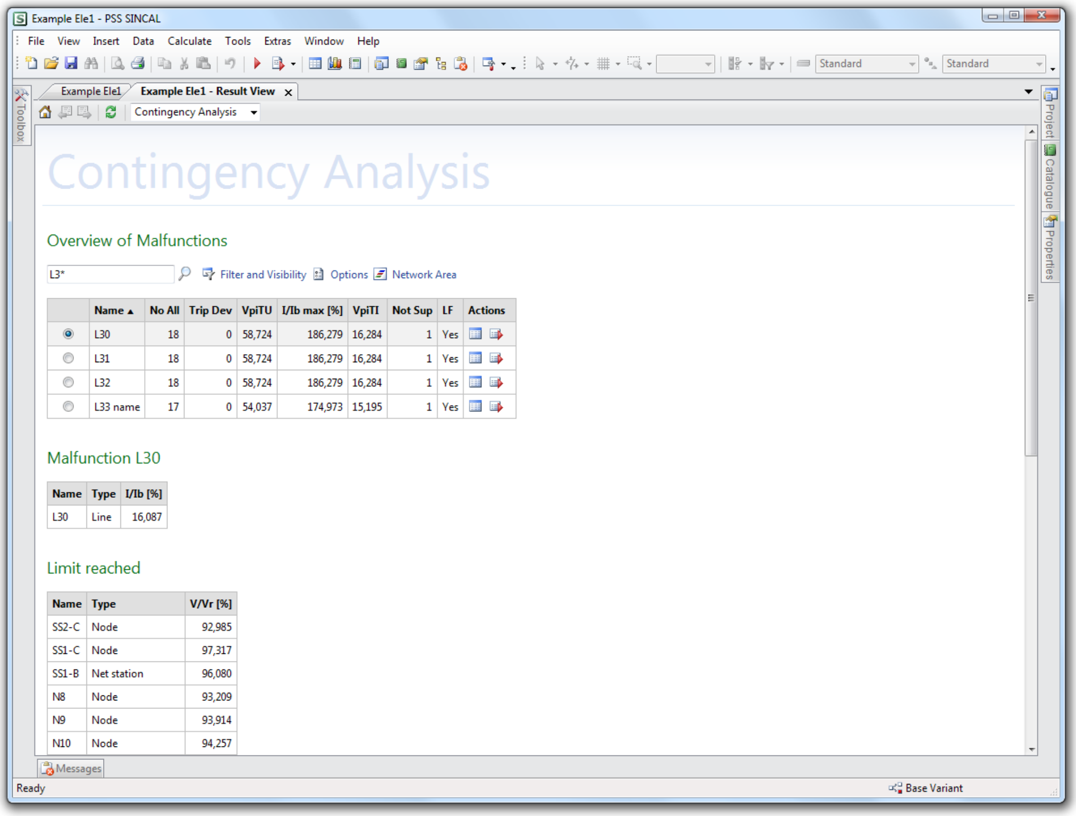


Illustration: New Result View with data for Contingency Analysis

The view has a toolbar with basic control functions. Here you can, for example, update the display or use a selection field to switch between different results.

The actual output data are visualized in the view. The results of contingency analysis are divided in two sections:

- Overview of malfunctions
- Details on the malfunction

Overview of malfunctions displays all the malfunctions. Filter functions can be set for the amount to be displayed and you can also sort the malfunctions according to significant criteria (not supplied consumers, limit violations, etc.).

When a malfunction is selected in the Overview of malfunctions, PSS SINCAL displays the **Details on the malfunction**. This includes the following information:

- **Malfunction:**
  Displays all the nodes and network elements that have malfunctioned (if function groups are used this can also be multiple nodes or network elements).
- **Limit reached:**
  Displays nodes where the voltage is above or below the predefined limit. PSS SINCAL also lists any network elements that exceed the limits (e.g. any elements that are overloaded).
- **Not fed:**
  Displays the nodes and network elements that are not supplied due to the malfunction.

- **Switching:**
  Displays all the network elements that have been switched ON.
- **Maximum:**
  Displays network elements with the maximum value (utilization or power) during the malfunction. These network elements do not have higher utilization or power in any other malfunction.

Enhanced Consideration of Network Elements in Contingency Analysis

Up to now, the following elements could malfunction in Contingency Analysis:

- Line
- Serial reactor
- Two-winding transformer
- Three-winding transformer
- Synchronous machine
- Asynchronous machine with load flow type DFIG
- Power unit
- Static compensator

To make it easier to use contingency analysis in modern distribution networks, PSS SINCAL now has malfunctions of the following elements:

- Serial capacitor
- Serial DC-element
- Variable serial element
- Shunt capacitor
- DC-infeeder

Improved Reporting Limit

The reporting limit for Contingency Analysis that has been available since PSS SINCAL 8.5 has been improved. This option in the **Load Flow extended** tab in the **Calculation Settings** sets how many limit violations are reported for each malfunction.

This option still works the same way, but now you are sure the reported limit violations are the critical ones; i.e. either the largest deviations from the prescribed voltage limit or the largest network element overloads.

2.6 Load Profile Calculations

New Diagrams for Results

PSS SINCAL Load Profile Calculations were originally developed for modeling real consumption behavior in symmetrical distribution networks. In recent years many new functions have been integrated in the calculation module, but the output diagrams for the results had up to now not been comprehensive reworked.

The new results diagrams for the Load Profile Calculations have been completely reorganized. These are now as flexible as the diagrams for dynamics simulation. All the results available for at time are prepared as signals that can be combined any way you want in the diagrams.

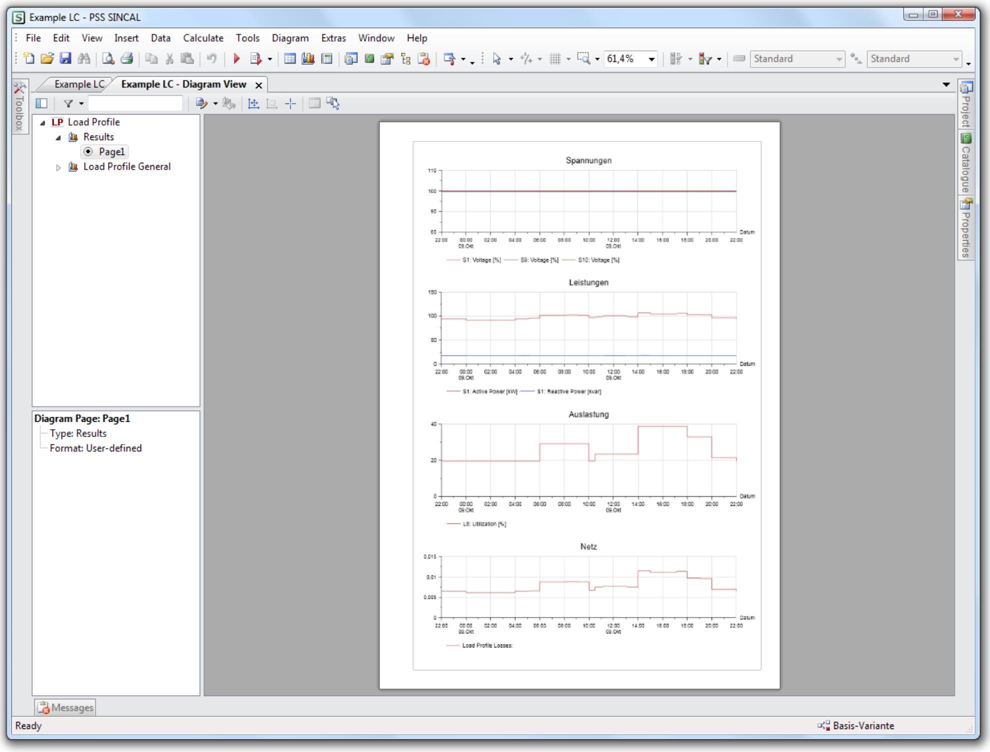


Illustration: Diagram view with new load profile diagrams

The illustration above shows the new results diagrams. One page combines the different signals. The voltages at some significant nodes are displayed both as total network losses and the utilization of different elements. This display can be defined any way you want – just like the results diagrams for dynamics simulation.

To customize diagrams, PSS SINCAL has a special dialog box to manage all the results signals from the Load Profile Calculations. You can use the toolbar in the diagram or the **Diagram – Customize Diagram Page…** menu to display the dialog box.

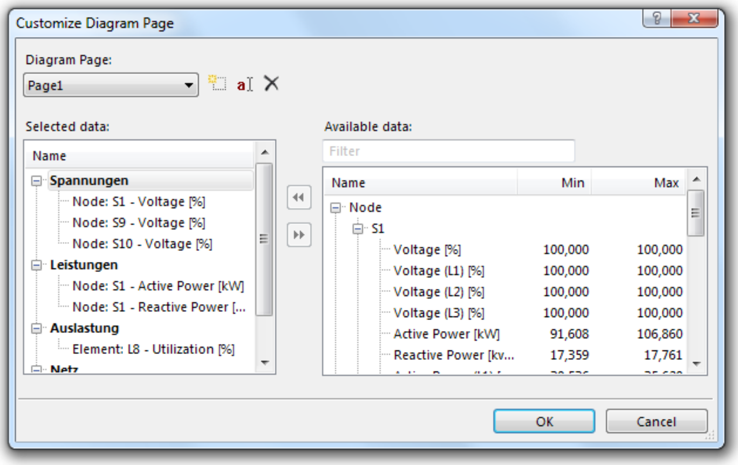


Illustration: Customizing load profile diagrams

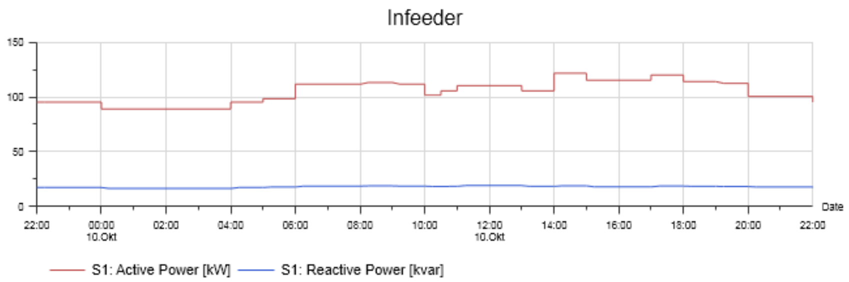
The list at the left of the dialog box contains the available diagrams and any assigned signals. The list at the right contains all the available signals. These are organized hierarchically according to type and element. To simplify finding the desired signals, PSS SINCAL has special filter functions. Filtering can be done according to names or according to limit violations (e.g. all nodes where the voltage is < 95 %).

Diagrams for Asymmetrical Networks

In asymmetrical networks, PSS SINCAL now has comprehensive diagrams to facilitate a detailed evaluation of the entire network. The node voltages are prepared per phase and, of course, also active and reactive power.

Date-Dependent Simulation

Surely the most important change in the Load Profile Calculations is the correct consideration of the date. Previously, the calculations were completely separated from the date, i.e. only load profiles were used. Now the calculations consider the date, i.e. the view date selected in the calculation settings. This date is the basis for actually creating the network; the Load Profile Calculations also start on this date. This means that you can now, for the first time, also do Load Profile Calculations in combination with future load increases.



This means that if there are any load increases in the network, the view date only has to be set to the desired future inspection time. Then the Load Profile Calculations are completely normal. The results are then calculated for the future time under correct consideration of the date-dependent network model and the load increases.

To enable you to properly visualize these date-dependent results, the diagrams have been enhanced. The annotation in the diagram is automatically customized for the selected time interval to assure that they are easily readable.

New Input Options for Profile Values

For load profile values, new input options are available. The definition for the **Series Type** has been separated from the input type. This simplifies the difference between daily, weekly and yearly profiles.

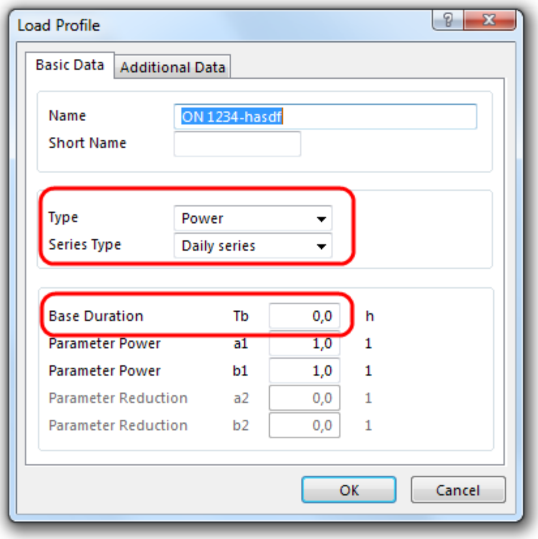


Illustration: Data screen form for Load Profile

Now the **Type** field can select from the following options for entering profile data:

- Factor
- Factor P and Q
- Power

There is a new option for **Factor P and Q**. The profile data are entered with an individual factor for active and reactive power. This makes it even easier to simulate individual load behavior, without having to enter the power absolutely.

Base Duration defines the time period in hours for the profile data. This is necessary, because in PSS SINCAL all the profiles can be entered for any period of time. Depending on simulation time, the values entered repeat cyclically (see the section on **Cyclical Treatment of Load Profiles** in the chapter on **Load Profile** in the **Load Flow Manual**). The Base Duration determines the time period used for repetition. If this field contains the value 0.0, PSS SINCAL uses the value 24 in the calculation methods for the daily profile. The value used for weekly profiles is 168 and the value for the yearly profiles is 8760.

Improved Data Management

During the Load Profile Calculations, many different load flows can be calculated. In earlier versions, the results of all the calculations were stored in the main memory and the data then written into the database at the end of the calculations.

This procedure is of course very easy to control from an implementation standpoint, but it causes problems in bigger networks. Networks of approximately 20,000 nodes can already have memory problems. The following calculation shows a load profile simulation for a four day period in fifteen minute intervals:

(20,000 nodes + 40,000 terminals) x 384 load flows = 23,040,000 results

As you can see, two different problems develop:

- Extreme main memory requirements, since the complete results are kept in the memory.
- Saving at the end is relatively difficult, since a lot of time is needed in the RDBMS.

Both problems can be controlled relatively well by asynchronously storing the results. The way results are stored and prepared for the calculation methods has changed completely. The actual calculations are done as before, but the results are stored in a queue. Each total load flow result is an element in the queue. An asynchronous continuous Worker-Thread reads and processes the queue. This means results can be stored asynchronously in the database while additional load flow calculations are being performed. This implementation can even greatly reduce the amount of memory required. As soon as the results are stored in the database, the results data can be released in the queue. Another advantage is improved performance in larger networks. Parallel storing of the results during the calculations means that additional time is not wasted storing data at the end.

2.7 Load Development

New Input Options for Load Increases

For load increases PSS SINCAL now has new options making modeling load increases in the network even more flexible.

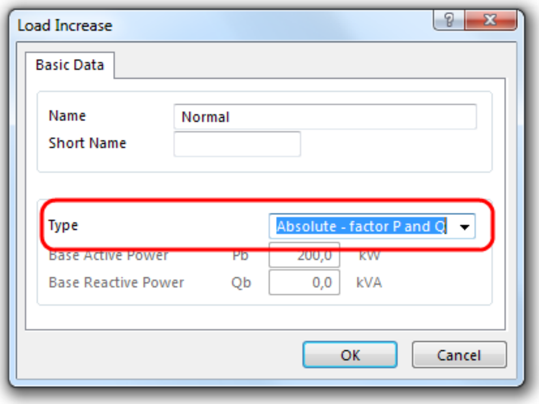


Illustration: Data screen form for Load Increase

Type defines how load increase values are entered. PSS SINCAL has the following options:

- **Relative – factor:**
  This type uses relative increase as a factor.
- **Relative – power:**
  This type also uses relative increase, but the factor is determined from the base active and base reactive power from the load increase record.
- **Absolute – power:**
  This type uses absolute active and reactive power.
- **Absolute – factor:**
  This option defines the factor by which the network element's base apparent power is multiplied.
- **Absolute – factor P and Q:**
  Here two factors are defined for active and reactive power. The network element's base active and reactive powers are multiplied by these factors.

The fields for **Base Active Power** and the **Base Reactive Power** are only required for the **Relative – power** option. Then two load-increase factors for active and reactive power are determined from the absolute power.

Improved Data Management

Exactly the same improvements have been implemented here as in the Load Profile Calculations. This makes it easier to use load development calculations in large networks. Of course, we should mention that normally far less data accrue in load development than in the load profile calculations. For comparison, a simple comparison of typical scenarios:

- Load development over 20 years with approximately 20 network changes per year = 20 x 20 = 400 load flows.
- Load profile calculations over a year in 15 minute intervals: 8760 h x 4 = 35,040 load flows.

2.8 Dynamics

Date Functions in BOSL Models

PSS SINCAL universal BOSL models can define individual behavior for almost all the network elements in steady-state load flow and short circuit calculations, and of course, also in dynamics simulation.

In the meantime, these BOSL models are also used for Load Profile Calculations, to control, for example, the loading and unloading of energy storage devices. Independent geo-stationary load flow calculations are done to calculate the network at two different times under different operating conditions. As this can also be used for enhanced procedures based on dates and times, the models need to have a simulation date and time.

PSS SINCAL provides the current time of the simulation as a **SIMDATE** variable:

```
#SIMDATE=41192.000000
```

The variable contains an exact date and time stamp based on **OleDateTime** (days since midnight, December 30th, 1899).

To enable you to also use the date in the BOSL models, there are a number of new functions for extracting the individual components from the date:

- YEAR(DateValue) Year
- MONTH(DateValue) Month: 1..12
- DAY(DateValue) Day in the month: 1..31
- YDAY(DateValue) Day in the year: 1..366
- HOUR(DateValue) Hour: 1..24
- MINUTE(DateValue) Minute: 1..60
- SECONDS(DateValue) Second: 1..60
- DSEC(DateValue) Second in the day: 1..86.400

Enhanced Control for Generating Unique Keys

Normally, more complex models with equivalent circuits need to have unique node and element keys for switching the corresponding elements in the model. Previously, PSS SINCAL always generated five predefined unique keys for elements and nodes for every model. In large networks with many models, however, this sometimes creates a number of unnecessary variables in the .net file. You can now directly control in the model how unique node and element keys are generated. You only need to define the two variables **MNCNT** and **MECNT** in the parameters:

```
[Data]
@DEFAULT@ #Node.N    = ' '   !  E: Network Node;
@DEFAULT@ #MNCNT     = 2     !! E: Number of unique MN keys to be generated
@DEFAULT@ #MECNT     = 5     !! E: Number of unique ME keys to be generated
```

PSS SINCAL reads both variables from the model and automatically generates the right number of variables when the model is connected in the .net file:

```
$ Model link
@ #MN1=             'MN0001'
@ #MN2=             'MN0002'
@ #ME1=             'ME0003'
@ #ME2=             'ME0004'
@ #ME3=             'ME0005'
@ #ME4=             'ME0006'
@ #ME5=             'ME0007'
@ #Node.N=          'X00006'
#.\Models\MODEL1.MAC
```

Enhanced Dialog Box for Plot Definition

The dialog box for plot definition has been redesigned to make it easier to select signals for dynamics simulation. Topology lists now have filter fields for reducing the amount displayed. This makes it easier to select the network elements to be used for plotting data.

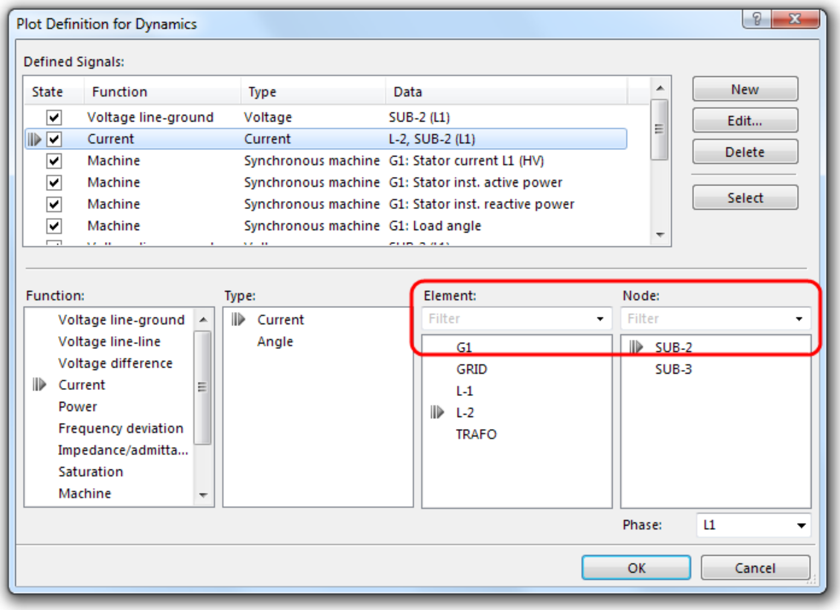


Illustration: Dialog box for Plot Definition for Dynamics

In large networks filter fields are particularly practical since the display in the respective list changes already while you are typing.

Forcing Asymmetrical Network Display

The Calculation Settings for Dynamics simulation has a new option to force asymmetrical network display.

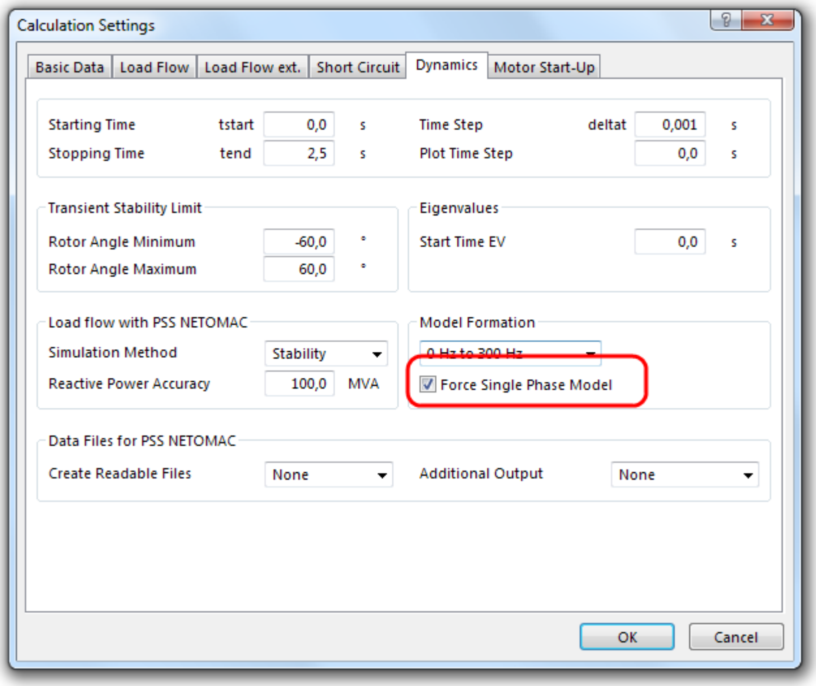


Illustration: Data screen form for Dynamics Calculation Settings

This is useful if you want to calculate a grounded asymmetrical fault in a symmetrical network. Previously, you needed to insert an asymmetrical network element into the network to ensure that the network also can be used asymmetrically in the dynamics simulation. With the new option this is no longer necessary.

2.9 Dynamic Network Reduction

This program module reduces an existing network so that only an equivalent network remains. For the most part, this module has same electric properties as the network that was not reduced.

To reduce the network, that area of the complete network is defined in PSS SINCAL graphically, which is to be reduced.

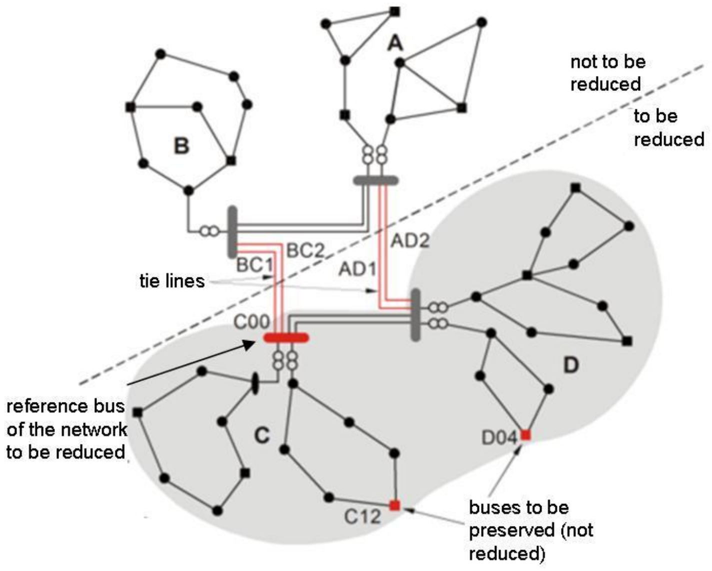
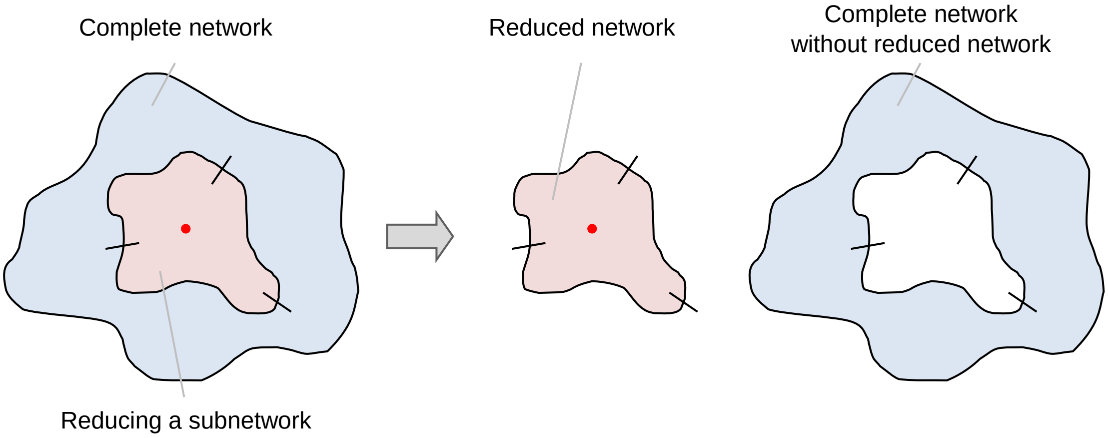


Illustration: Basic principle of network reduction

Click **Calculate** – **Dynamics** – **Dynamic Network Reduction…** in the menu to start the actual reduction. This opens a Wizard where the required control settings for network reduction can be entered.

Based on the graphic area defined, PSS SINCAL determines the topological structures for the network being reduced and the network that remains. The parameters selected in the Wizard are used to reduce the network.

The illustrations below show how this works:



For the whole network, you can select whether the subnetwork being reduced should actually be removed or whether the whole network will remain. Both the whole network and the reduced subnetwork will have connection definitions inserted at the end node points of the coupling lines. These connection definitions let you use the reduced subnetwork as an "include" network.

To reduce a network, the following prerequisites have to be met:

- The network being reduced has to be coherent. The network that is not reduced may be divided into subnetworks – and can even have isolated nodes.
- Only lines can be used to link the network being reduced with the one not being reduced.

The dynamic network reduction replaces all passive elements of the network being reduced with impedances. Generators and asynchronous machines are replaced by coherent equivalents.

Network Reduction

The network with the nodes which aren't (equivalent) generator nodes nor belong to the "not-to-be-reduced" network or any special nodes, are reduced as for static load flow calculation.

A reduced, equivalent transmission network results and consists of only:

- Generator nodes
- Coupling nodes for the "not-to-be-reduced" network
- Special nodes, special machines and special branches, which are in the "to-be-reduced" network but still have to be preserved.

This network would have been totally meshed. To reduce the number of the branches, only the low-ohm connections are selected, which, in a short circuit case, can transmit more than 10 MVA (user defined).

Load Modeling

The loads, which are given by the **load flow** reduction network at the remaining nodes, can be selectively modeled as impedance loads (I type) or as PQ loads.

The supply of the equivalent identified generators are added after the original load flow and considered as sum-supply for the equivalent generators (Coherence Generators).

For the equivalent loads the user can choose between two possibilities:

- The equivalent loads result from the **load flow** network reduction
- The equivalent loads received from the **load flow** network reduction are cancelled. Instead, a load is positioned at each equivalent generator node. This load has the same size as the generator's supply, but with a negative sign. It is provided that there are no large transmitted powers in the equivalent network, so that generation and consumption compensate each other regionally.

This produces a quasi-no-load equivalent network. There are no problems concerning the load flow convergence. The equivalent network can be connected to any external network with any voltages at the coupling nodes. The power delivered to the "not-to-be-reduced" network can be controlled by loads at the coupling nodes.

Dynamic loads, which are modeled by asynchronous machines, are reduced in the same way as the generators.

Coherent Generators

To recognize the coherent generators, all the coupling nodes as assigned a time-dependent voltage change with equal distribute random distribution. In order to excite active and blind power flows at the same time, the real and the imaginary part of the voltage must be changed.

Due to the voltage injection in all coupling nodes, the network reduction is almost independent of the excitation location, provided it appears in the "not-to-be-reduced" network as expected. Due to the random-formed character of the voltage the process is almost independent of the kind of the excitation. Since the level of the excitation also has no effect on the network reduction due to the correlation analysis, the process can be almost independent of place, kind and level of the excitation.

A further substantial effect arises as a result of the fact that the "to-be-reduced" network is completely decoupled from the "not-to-be-reduced" network (different network) due to the specification of the voltage on injecting the voltage changes at all of the coupling nodes. Thus no information about the "not-to-be-reduced" network is necessary; the network reduction can be only performed with the knowledge of the data of the "to-be-reduced" network (own network).

Selectable functions (e.g. speed deviations) of all generators are simulated by the user. The data set in it is still complete, i.e. the result of the simulation is exact and can be used later for the validation of the reduced, equivalent network.

The selected functions are subjected to a correlation analysis within the concerned time period (e.g. 8 s), which can discover and evaluate the similarity of the function curves among each other. Exact equally oscillating machines have the correlation coefficient 1, opposite phase oscillating ones the coefficient -1, all other values lie in between.

With the help of a standard routine for the cluster formation, generators are identified as coherent – build a cluster, when their correlation coefficient is 1. Investigations have shown that values of 0.8 give very good results; also correlation factors of 0.7 still give useful network equivalents.

In this cluster formation the number of the remaining machines must be given; the routine then decides the optimal group distribution. But in the network reduction, however, not the number of the remaining machines should be given, but the worst correlation coefficient within a group, which forms the measure of accuracy in the group formation.

Therefore the number of machines will be changed iteratively so that the worst given correlation coefficient can be kept. The middle correlation factor within a group, which is determined on the base of the portion of the rated outputs relative to the total's group rated output, serves for the comparison with the worst correlation factor. Thus the effect of small machines on the correlation factor is reduced.

Generators, which have been identified as members of a group, are connected in parallel to a single node with the voltage 1 pu by an "ideal" transformer (impedance near zero) with a complex transformation ratio. The original generator nodes will be removed later through the load flow network reduction and replaced with this single equivalent node.

The voltage 1 pu has been chosen because the generators in general run with this voltage. Deviated values affect only the main field saturation of the equivalent generator.

The complex transformation ratio, which is built from the voltage (magnitude and phase angle) of the "to-be-reduced" generator nodes and the voltage 1 pu, adapts the voltage magnitude and angle of the load flow at the common nodes of 1 pu. With this measure the load flow is exactly maintained – even in case of major angle differences.

If no complex transformation ratio is allowed, e.g. in a network reduction for a later use on an analogous network model, then the user can request real transformation ratios by inputting a suitable control. With that the load flow isn't maintained exactly.

The equivalent generator should react at once as a response to the voltage and frequency changes. This will be approximately achieved by parallel connection of the impedances of the direct and quadrature axis of the individual generators for specific oscillation frequencies.

The input impedances for the following frequencies (s) are calculated:

From 50 Hz (s = 1) the subtransient input impedances follow

$$Z'' = R'' + jX''$$

From 0.5 Hz (s = .01) the transient input impedances follow

$$Z' = R' + jX'$$

From 0.001 Hz (s ~ 0) the synchronous input impedances follow

$$Z = R + jX$$

The input impedances are connected parallel for the individual machines of a group:

$$Y''eq = Y1'' + Y2'' + \cdots + Yn''$$

$$Y'eq = Y1' + Y2' + \cdots + Yn'$$

$$Yeq = Y1 + Y2 + \cdots + Yn$$

From the three parallel-connected total admittances we can recalculate the single data of the equivalent generator. For example, this applies (index eq cancel in the following):

$$\frac{1}{Y} = Z = Ra + jXas + jXhd$$

Ra and Xhd, when Xas is known

$$\frac{1}{Y'} = Z' = Ra + jXas + \frac{jXhd * (Rfd + jXfd)}{Rfd + jXhd + jXfd}$$

Rfd and Xfd

The armature leakage reactance Xas is determined from the "to-be-reduced" machines through the rated power; the value affects only the distribution of the currents on the rotor side. Even if this value is a little inaccurate because of the middle-value formation, the dynamic behavior of the machine is affected insignificantly, and even the short circuit behavior is not affected at all.

With this method for determining the equivalent impedances, the subtransient, transient and synchronous short circuit injections of the equivalent machines are exactly maintained.

The equivalent starting-up time constant TAeq is calculated by the sum of inertial moment referred to the equivalent sum of apparent power:

$$TAeq = \frac{TAi}{Si} * Si$$

The injected power of the generators is added to a sum-supply. The injections can be selectively modeled in the load flow as PQ load, I load or PV load:

$$Peq + jQeq = Pi + jQi$$

To separate the generator's own oscillations from the controller effects, the coherent groups can – but mustn't – be first determined without controllers and later complemented with the controller's behavior.

Coherent Asynchronous Motors

Since asynchronous motors opposite to generators have substantially different data and an electromechanical behavior, the two kinds of machines must be distinguished. Thus, the clusters are produced separately for the generators, which are swinging together and asynchronous motors, which are swinging together.

The approach of the cluster formation is the same as described under Coherence Generators.

Properties of the Reduction Process

The dynamic network reduction can be performed only when the own network data and the tie lines to the external network are known. Data of the original network environment (external network) aren't required.

The **degree of the reduction** can be specified through the definition of a correlation factor or through the **number of the remaining machines** in the subnetwork.

The definition of a correlation factor is better because it leads to an optimal number of remaining machines. It has been noticed that by giving the worst correlation factor of 0.8 the results are great, but also with a correlation factor of 0.7 the results are quite good.

The given worst correlation factor can't be maintained because of the integer number of the machine groups; it can be only considered as a guide number. The correlation factor between two machine numbers closer to the given value is the one considered finally. The final number of the two machine numbers will be that number, whose correlation factor corresponds most closely to the given value.

The procedure gives the worst, as well as an averaged, correlation factor within a combined group of machines. Thus, the quality of the obtained reduction – compared with the correlation factor 0.8 – can be estimated.

The "to-be-reduced" network is defined through the specification of the tie lines between the "to-be-reduced" network and the "not-to-be-reduced" network.

The following elements of a "to-be-reduced" network can be kept not reduced (original):

- Nodes
- Machines
- Branches, e.g. lines, loads, transformers.

The short circuit behavior and also the load flow behavior of the equivalent network don't change by the load flow reduction.

Load flows into tie lines, which connect the "to-be-reduced" network with the "not-to-be-reduced" network, and also load flows within the "to-be-reduced" network remain exactly the same. Small deviations result due to the fact that the limited number of digits is possible for the output of the reduced network data and because the high-Ohmic connections are eliminated.

The short circuit currents in the reduced network are reproduced because the short circuit injections remain the same, due to the described method for the determination of the equivalent data of the machines.

The dynamic network reduction will only be done for a symmetrical network. Therefore only symmetrical faults can be simulated.

Physical data and parameter with elements usually found in stability programs are the results of the reduction.

Any models can be chosen as equivalent structures of controllers; the user should preferably use IEEE models.

A reduction of an already reduced network is possible but it may lead to less reduction accuracy.

The results of the network reduction are almost entirely independent on type, place and level of the excitation.

Voltage and frequency dependent loads are taken over directly, i.e. they will not be reduced.

Dynamic loads, which are modeled by asynchronous machines, are reduced in the same way as synchronous machines.

2.10 Coupled Multiple Lines

How PSS SINCAL processes coupled lines has been reworked. Previously, you could only define an individual line with a fully populated impedance matrix. This is, however, not enough for transmission networks. The new implementation lets you simulate any coupled multiple lines you want.

Coupling now involves a container to which existing lines can be assigned. This container administers the complete impedance matrix of all the lines assigned to it.

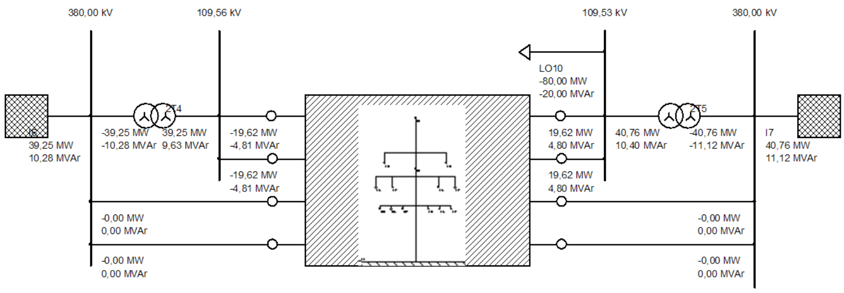


Illustration: Function principle for coupled multiple lines

This means networks are created as before with individual lines. If complete couplings for multiple lines need to be considered in more detailed observations, the container object with the coupling data is assigned to these lines.

This can be done easily in the data screen form of the line. Simply select the option for **Coupling data** in the **Line Type** field. Use the **Coupling Data** field to select the container object to which the line should be assigned. You also need to identify the line so that you can switch the connections with the admittance matrix of the coupling data. There is a **System** field to assign the line to the systems in the coupling data.

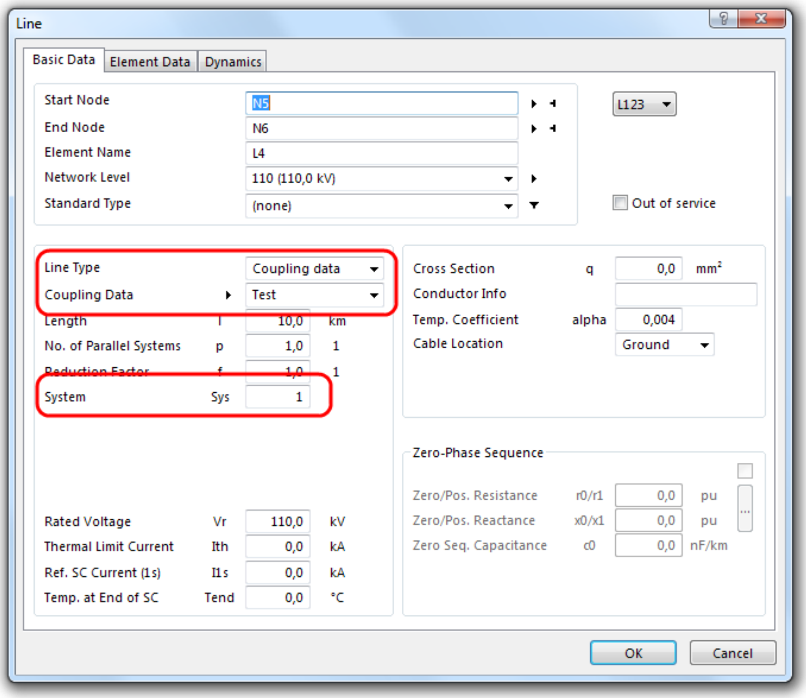


Illustration: Data screen form for Line

The program **Leika** calculates the coupling data. Leika is used to administer coupled systems, i.e. lines with the physical sequence of the phases at the tower or the ground in special project files. To simplify editing, such projects are stored directly in the PSS SINCAL network directory under "xxx_files\Leika". Leika can be started directly from the dialog box with the coupling data.

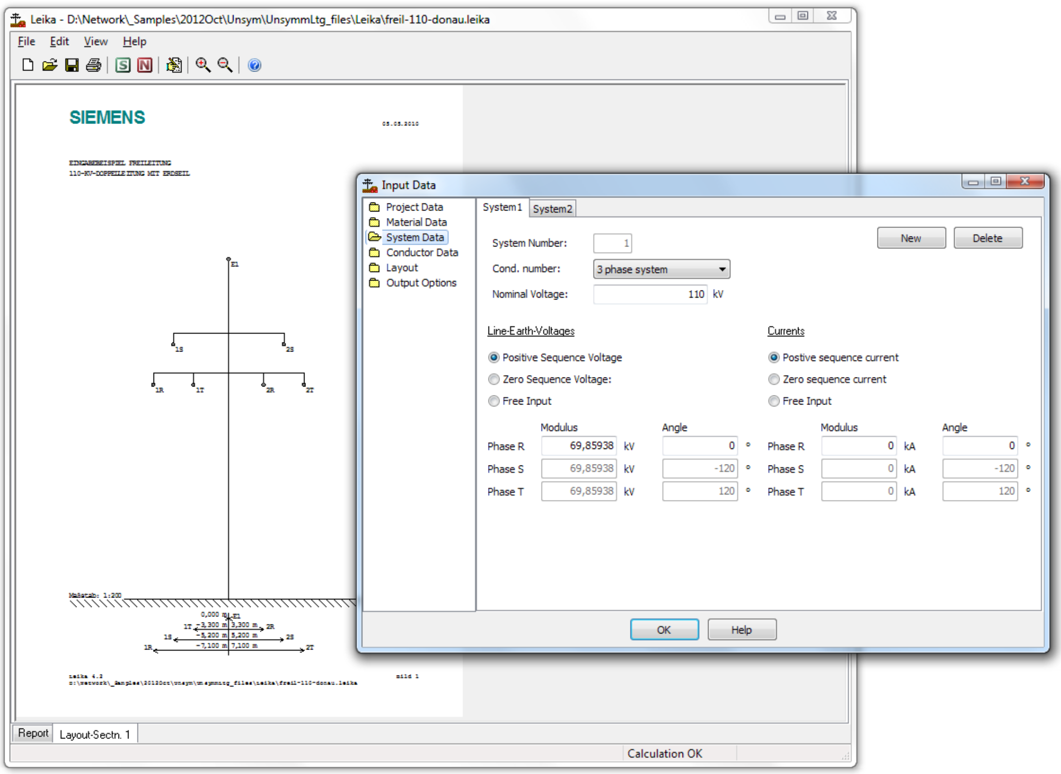


Illustration: Editing coupled multiple lines in Leika

Leika uses the data entered for coupled systems to calculate a complete impedance matrix precisely describing the transmission characteristics. Leika has a function for "Netomac Export" that stores the impedance matrix as a .mac file parallel to the Leika project file. PSS SINCAL uses this file in the calculations.

Connection in the Calculation Methods

In PSS SINCAL Load Flow and Short Circuit Calculations, the network data for lines assigned to the container object are ignored and the impedance matrix is integrated directly into the network's admittance matrix. This means the impedance matrix for the container object replaces the simulation of the individual lines. In PSS SINCAL Harmonic Calculations, the impedance matrix is converted to the frequency observed.

The line with coupling data represents an asymmetrical network element, so it cannot be used in symmetrical load flow calculations. If the network has coupling data, asymmetrical load flow calculations need to be carried out.

2.11 Reliability

The reliability calculations now have a new option to control whether the selected min. outage duration is considered when calculating the results. The option is found in the **Simulation Control** tab of the **Reliability Settings** screen form.

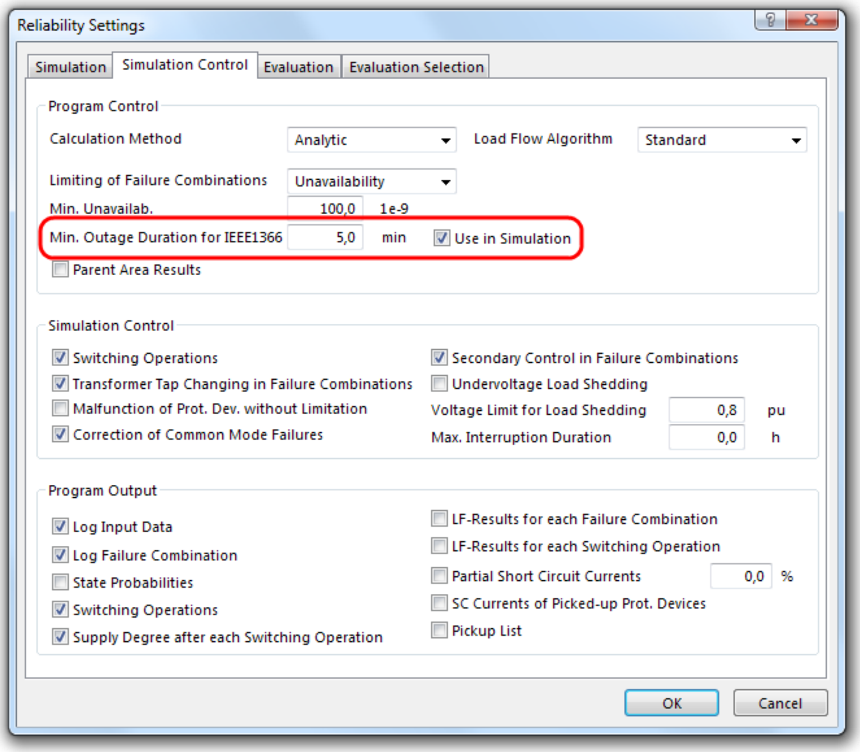


Illustration: Data screen form for Reliability Settings

When **Use in Simulation** is switched ON, PSS SINCAL only considers malfunctions when the results are calculated if the outage duration exceeds the minimum value selected.

2.12 Improved Convergence in Gas Network Calculations

Up to now, convergence for steady-state gas network calculations was not optimal when consumers with pressure-dependent consumption decrease were used. Sometimes a very large number of iterations were needed to solve the steady-state calculation problem. Changes in the calculation core have, however, greatly improved the convergence behavior for this type of consumer.

3 PSS NETOMAC

3.1 Enhanced Editing Functions in the GUI

Enhancements to Project Creation

The function for creating projects from existing net files has been enhanced.

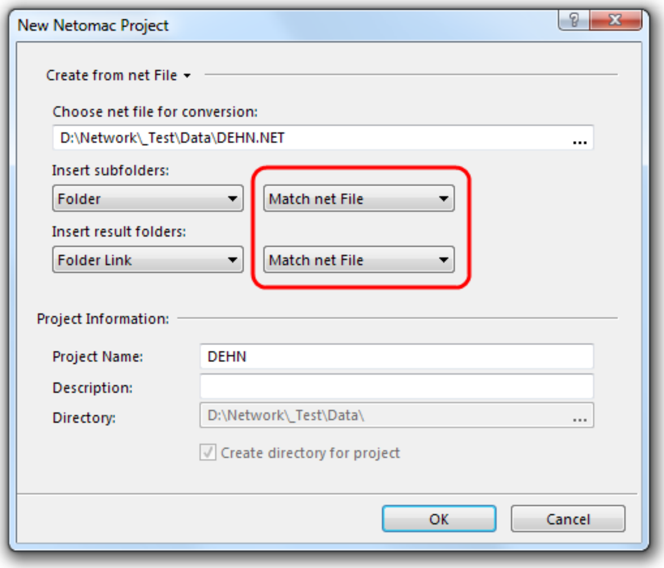


Illustration: Dialog box for creating a new project file

PSS NETOMAC has new options to insert subfolders and result folders, making it easier to use project files when net files are not organized as separate project folders.

In **Insert subfolders** and **Insert result folders**, select whether the directories or result directories parallel to the selected net file are added to the project.

- **None:**
  No directories are added to the project.
- **Folder:**
  The directories are added to the project as folders.
- **Folder Link:**
  The directories are added to the project as folder links.

These fields have the following additional options:

- **All:**
  All directories parallel to the selected net file are used.
- **Recursive:**
  All the subordinate folders are used in addition to the parallel folders.
- **Match net File:**
  Files are only used if they have the same file names as the net file.

Now you have the option of automatically extracting the control file (.ctl) from the network file (.net). PSS NETOMAC displays a corresponding dialog box when the project file is created, if it determines that the appropriate control file for the project does not already exist.

Enhanced Find Function

The function for searching in files has been improved to make it more useful, particularly in structured input files. The following illustration should help you understand how this works:

```
 89 $1......12......23......3AA1....12....23....34....45....56....67...78...89...9ZZ
 90 $
 91 $ Error-branch for error connection:  (X00016) in Fault (X00016)
 92 RX00016  SX00016 PX00016  1     1   1e8                     150
 93 RSX00016         KX00016  3     1   1e8                     150
 94 $
 95 $1......12......23......3AA1....12....23....34....45....56....67...78...89...9ZZ
 96 $
 97 $ 2W-Transformer: TRAFO (X0000a) from SUB-2 (X00006) to G1 (X00007)
 98 RX00006          UX0000a  1     1   1e8                     150
 99 RX00007          VX0000a  1     1   1e7                    11.5
100 TX00006  X0000aZ0X0000a  YY 157.5   150   375   0.3 13.02
101 TX00007  X0000aZS        0  11.5  11.5
102 M                X0000a      9999  9999
```

Illustration: Excerpt from net file in the Text Editor

As the illustration shows, the column structure of the input file becomes clear. In previous versions, searching for text or terms was difficult, because the words did not have any limits. This becomes clear if you look at line 100. The different keys in the Name2 and Name3 fields run into one another. But these keys are completely independent from one another.

To simplify searching in such cases, PSS NETOMAC has a function for "column-based" searching.

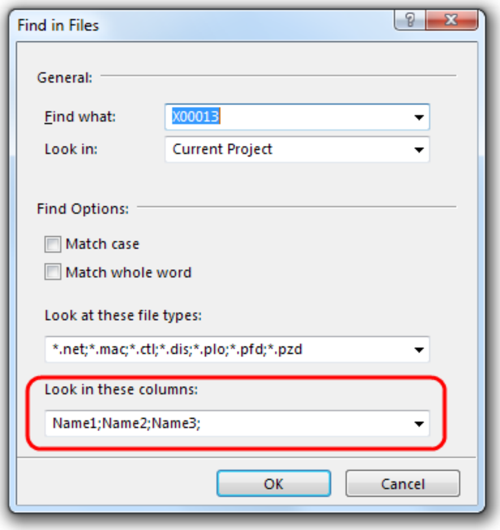
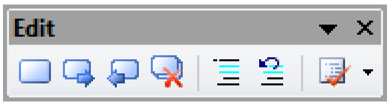


Illustration: Find in Files dialog box

The individual columns you want to search for can be pre-selected. In the dialog box above the first three columns with the name fields have been pre-selected. The search is done precisely in these fields. The following names can be specified for searching in columns: T, NAME1, NAME2, NAME3, AA, HZ1, HZ2, HZ3, HZ4, HZ5, HZ6, HZ7, HZ8, HZ9 or ZZ. Any number of columns can be entered. These are separated by semicolons ";".

Toolbar for the Text Editor

The text editor now has its own toolbar, making it easier to access important functions.



 Toggle bookmark

 Go to next bookmark

 Go to previous bookmark

 Clear all bookmarks

 Comment selection

 Uncomment selection

 Editor options

A particularly practical new feature is the **Editor options** button. This makes it easy to switch syntax highlighting, advanced column colors, column information and line number display ON or OFF.

Dialog Box for Editing the Plot Definition

The GUI has a new dialog box specifically for editing the plot definition (.plt file). The **Calculate – Plot Definition…** menu or in the Project Explorer the pop-up menu can be used to open the dialog box with a .plt file.

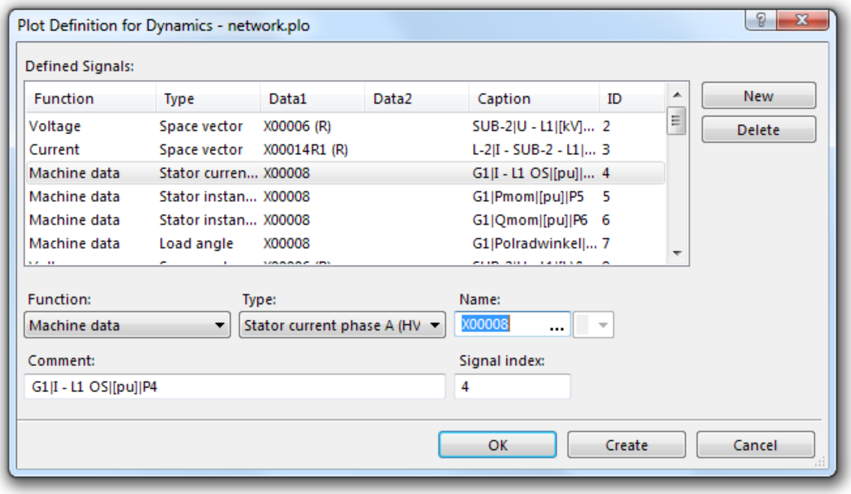


Illustration: Dialog box for Plot Definition for Dynamics

The list of options for **Defined Signals** contains all available signals. You can rearrange these signals in the list of options any way you wish. Simply select an entry in the list, hold down the shift key and move it with the cursor buttons up or down.

Click **New** to define a new signal. **Delete** deletes the signal selected in the dialog box.

The section at the bottom of the dialog box is used for a detailed description of the signal. The selected signal can be edited directly.

Function lists all possible signal functions for pre-selection. After you select the function you want, you can specify the signal with **Type**.

The following lists define the signal in more detail. The contents of these can vary depending on the function selected. For example, the voltage function also displays the Node and the Phase.

The smart topology selection fields in the dialog box are particularly practical. The "**...**" button opens a dialog box where you can select the appropriate nodes or network elements. PSS NETOMAC automatically customizes the amount of information in the dialog box according to the signal and the function that has been selected.

In the **Comment** field, additional information can be stored about the signal. **Signal index** identifies the signal. This index must be unique.

Another feature in the dialog box is the **Create** button. When this is selected, PSS NETOMAC automatically generates an empty results file (.res) containing all the signals defined in the dialog box – of course still without any data. These signals are, however, immediately available in the Signal Explorer from where they can be transferred into the diagrams.

3.2 Improved Simulation Integration

Asynchronous Calculations

All the calculation functions are now carried out asynchronously in the GUI. This means the actual calculations are an external process and do not block the GUI. You can continue working completely normally. The calculation procedure going on is displayed in the status bar as a progress bar and any information on the status are also shown here.

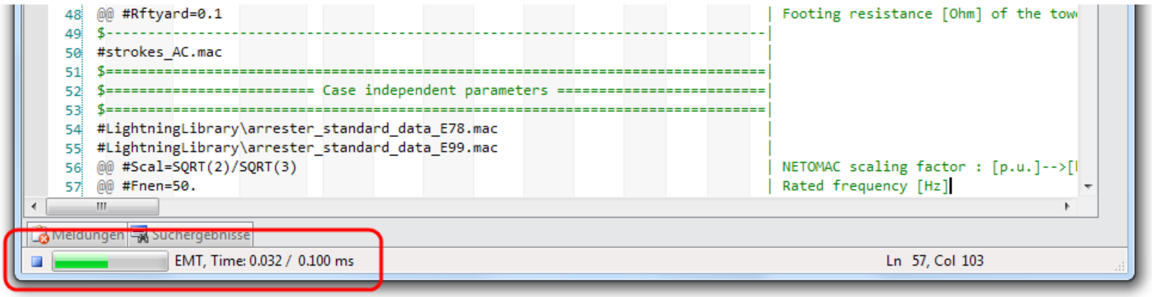


Illustration: Status bar in the GUI

The active calculation procedure can be stopped either with the **Stop** button in the status line or with **Calculation** – **Stop Calculation** in the menu.

Plotting Procedure during the Simulation

For asynchronous calculations, PSS NETOMAC also provides a plotting procedure during EMT and Stability Simulation. If you open a diagram page before the simulation starts, the signals displayed there are also updated during the simulation. This is very useful in simulations that go on for a long time since the signals in progress help you evaluate whether the calculation result will meet the expectations and, if they do not, you can abort the simulation.

3.3 New Functions in the Signal Explorer

PDZ Display

Now the Signal Explorer can display the signals in the RES file in two different ways – as they exist in the RES file or as PZD defines them.

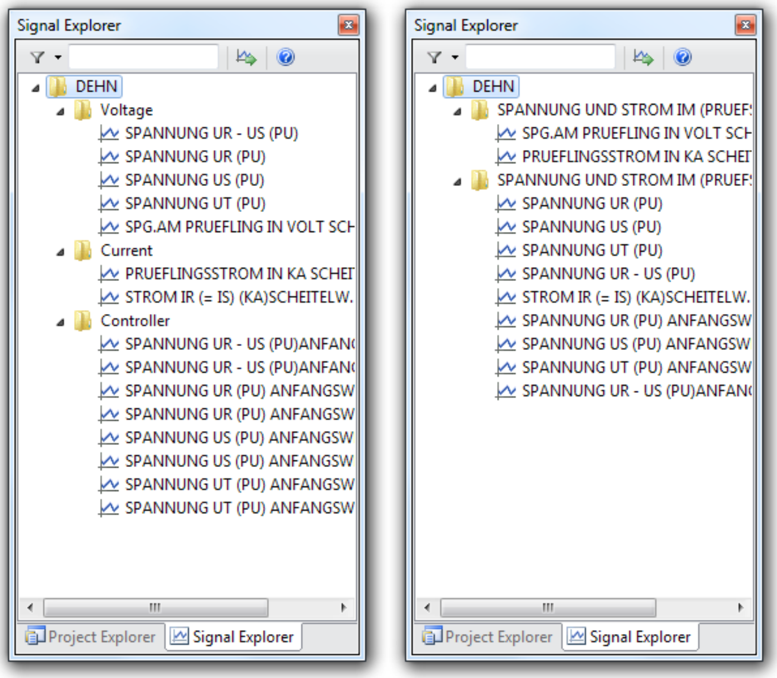


Illustration: Signal Explorer with different display options

The filter button in the toolbar of the Signal Explorer switches between the two display variants. PSS NETOMAC has the following options:

- **Signals:**
  This option displays the signals in the RES file. The signals are grouped thematically (voltages, currents, controllers, etc.) in the Signal Explorer.
- **PZD signals:**
  This display option displays the signals like the PZD file places them on the diagram pages. The scaling defined in the PZD file is also considered in the signals.

In both these display variants, the signals can be dragged into the diagram or even exported.

Export Function

The Signal Explorer has a user-friendly export function that you can simply switch ON with the corresponding button in the toolbar:

 Export signals

The Export dialog box is used to export the signals in the RES file either to the clipboard, into certain export formats such as XLS, ASCII, COMTRADE, or to an XRES file.

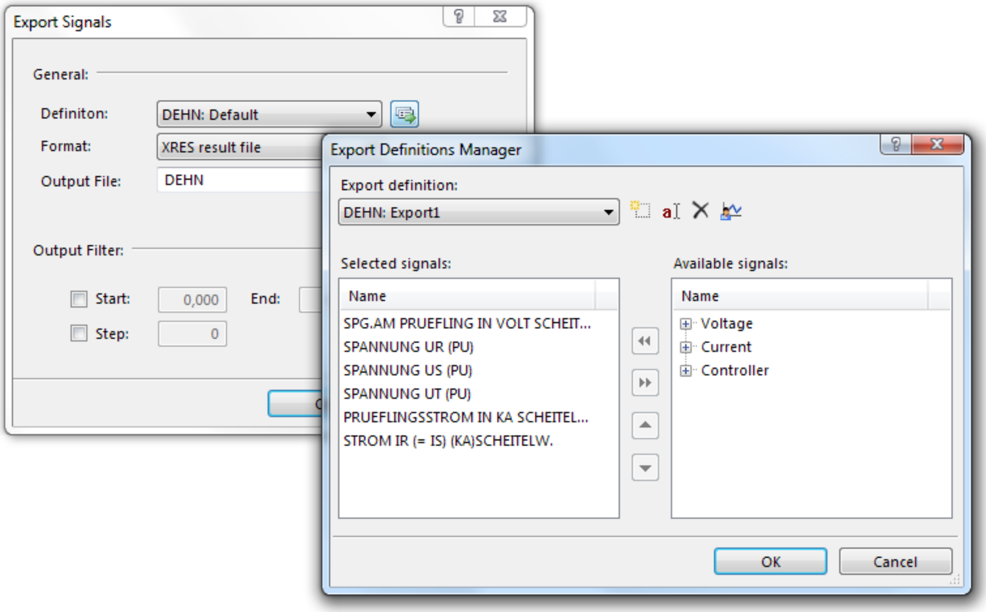


Illustration: Export definition in the Signal Explorer

Exporting to an XRES file is particularly practical. This is a special kind of XML file that can contain any data you want. The XRES file can be displayed directly in Tabular View. This is done entirely automatically analogous to the RES file. As soon as there is an XRES file in the **Results** directory for the project, this is also displayed in Tabular View.

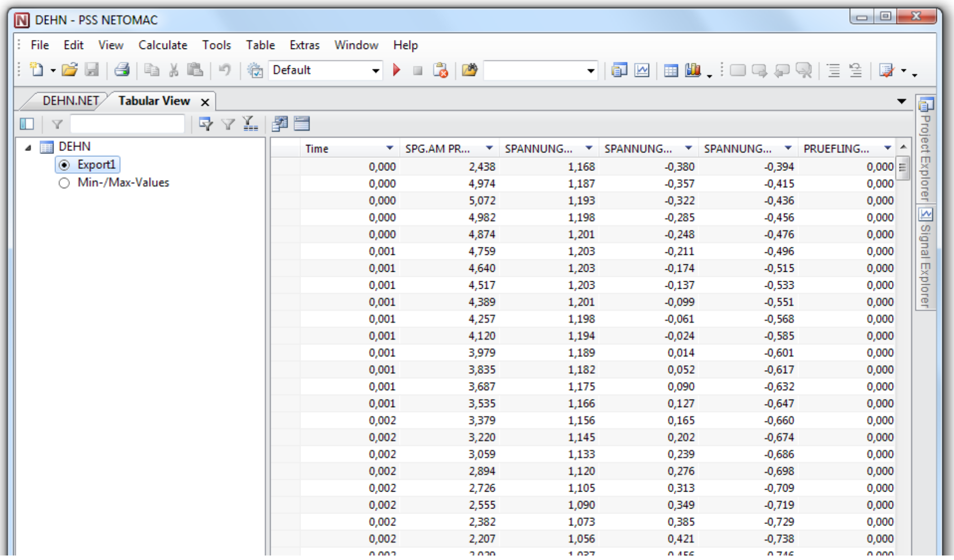


Illustration: Tabular View with exported signals

When you export in XRES format, a simple table is created with the minimum and maximum values in addition to the signal values.

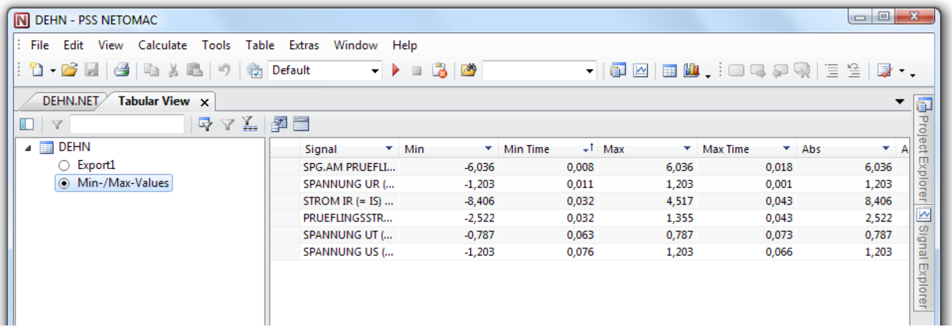


Illustration: Min/Max Values for exported signals in Tabular View

3.4 Diagram View

Enhanced Editing Functions in the Diagrams

The diagrams now have a data cursor similar to the one in PSS SINCAL to make it easier to read signal values precisely in the diagram. Turn the data cursor ON with the toolbar or the pop-up menu in the diagram. When this function is switched ON, PSS NETOMAC displays the coordinates of the data cursor in the status bar. An unusual feature of the data cursor is that it can be attached to a signal in the diagram. To do so, double-click on the desired signal in the diagram. Hold down the mouse button to position the data cursor anywhere in the diagram. If it is attached to the signal, PSS NETOMAC will display the appropriate Y value in the signal for the respective X value of the data cursor. To detach the cursor from the signal, double-click in a free area of the diagram.

Also new in the diagrams are the **enhanced pop-up menu functions**. You can select the signal used to open the pop-up menu in the Signal Explorer and thus open the dialog box for editing signal attributes.

Improved Generation of Diagram Pages

The functions for generating new diagram pages have been comprehensively reworked. To create diagram pages, PSS NETOMAC has the following functions:

- Create empty diagram page
- Create diagram page from PZD
- Create all diagram pages from PZD (new function)
- Combine diagram pages (new function)
- Compare diagram pages (new function)

These functions are still available in the pop-up menu in the diagram browser or the **Diagram – Create** menu.

The **Create diagram page from PZD** makes it easy to create new diagram pages that already contain the signals, scales and limits defined in the pdz file.

Combine diagram pages can be used to combine two existing diagram pages. This is useful, for example, if you want to compare two variants.

Compare diagram pages is used to compare diagram pages in the .res file with those in another .res file. This function is primarily intended to display the results of two different calculation variants in a diagram. Of course, the signals in both the .res files have to match. If they do, this is an easy way to make comparisons.

The illustration below shows part of a diagram generated with the comparison function.

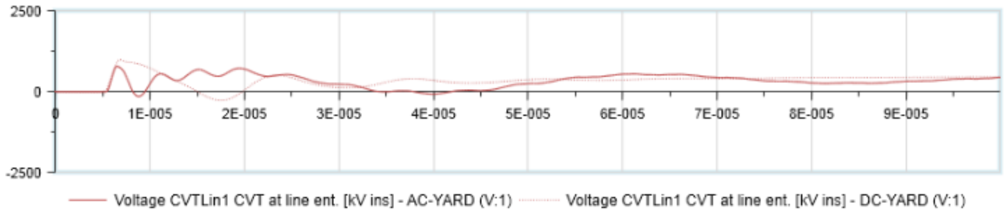


Illustration: Diagram comparison

The signals of the original .res file are displayed in the diagram. The signals from the file being compared are visualized as well. These signals are displayed with the attributes from the original file, but they do have points. In the legends, the names of the .res files are attached to the signal names.

3.5 Tabular View

New Field Chooser Dialog Box

Tabular View has a new dialog box to individually organize the amount to be displayed in the table. Simply click the **Field Chooser** button in the Tabular View toolbar to open the dialog box:

Field chooser

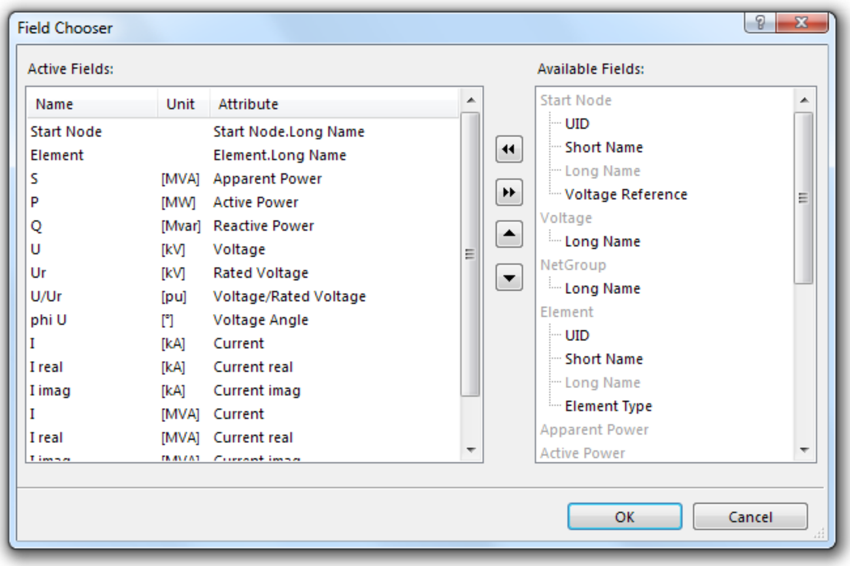


Illustration: Field Chooser dialog box

The list of **Active Fields** is divided into columns for Name, Unit and Attribute. Simply click on the name to change it. PSS NETOMAC will then display this name in the table as column legend.

PSS NETOMAC displays all **Available Fields** of the table in the list to the right. These fields can be individually added to the list of **Active Fields** by clicking the **Left Arrow**. Click the **Right Arrow** to remove them. **Up** and **Down Arrows** move the active fields to the top or to the bottom.

Enhanced Filter Functions

In addition to simple filters with the filter field directly in Tabular View, PSS NETOMAC now also has an enhanced filter function like the one in PSS SINCAL. Click the **Filter and Sort** button in Tabular View to switch ON the enhanced filter functions.

 Filter and Sort

The **Filter and Sort** dialog box is used to define different filters for the individual fields. You can even specify multi-stage data sorting.

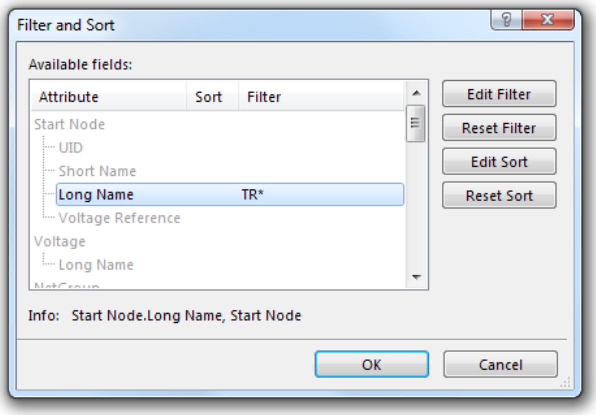


Illustration: Filter and Sort dialog box

The Available field list shows the current settings and is divided in three columns.

- **Attribute:**
  This column lists the names of all the available fields for the table.
- **Sort:**
  This column sets the sorting. Select the attribute you want in the list and click **Edit Sort**. Now the sequence of the sorting can be defined. Positive numbers are sorted in ascending order, negative numbers in descending order. This makes multi-stage sorting possible.
- **Filter:**
  This column defines filter rules for an attribute. Select the attribute you want in the list and click **Edit Filter**. Now you can define the filter by entering an operator (=, <>, >, >=, <, <=) and a filter value. In text queries, wildcards can be used.

Filtering and sorting can also be defined for fields that are not displayed in the table at all. This means the amount to be displayed can, for example, be limited to a specific category without actually displaying the field of the category in the table. To make it easier to differentiate between visible and non-visible fields, non-visible fields have gray lettering.

Enhanced Input Data and Load Flow Results in Tabular View

The way the input data and the load flow results are displayed in Tabular View has been comprehensively redesigned.

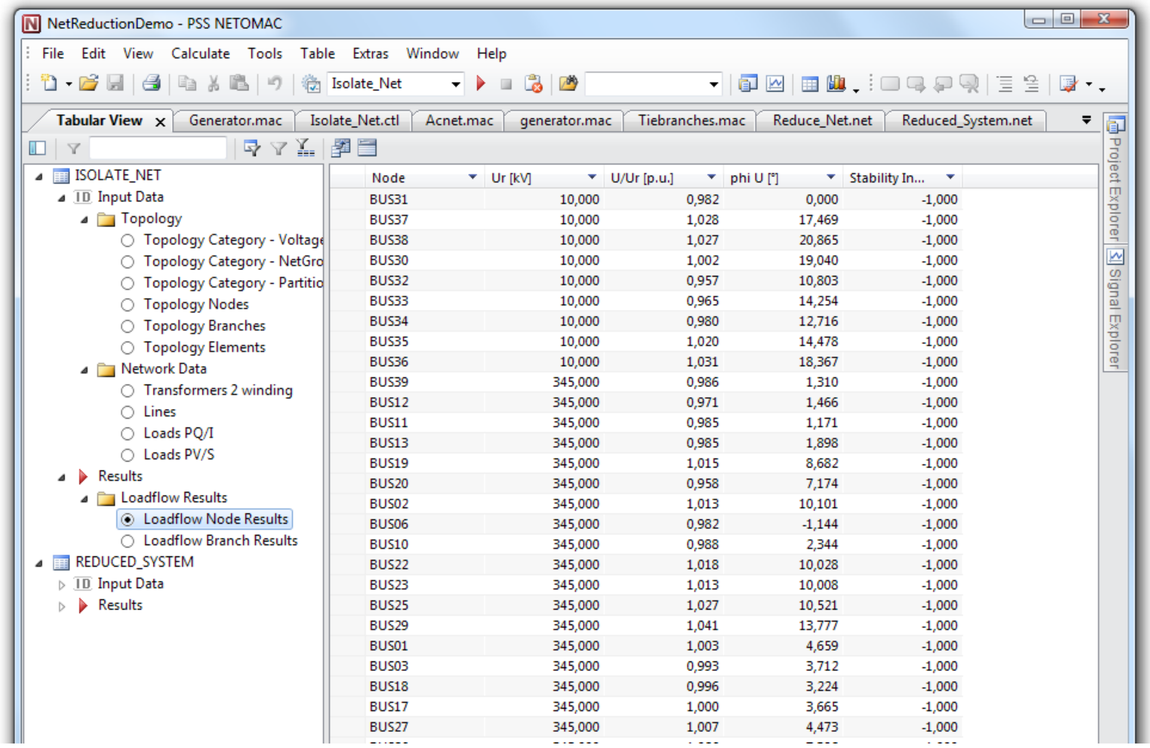


Illustration: Tabular View with load flow results

The Load Flow Calculations display comprehensive information in the XRES results file. These can, of course, also be displayed in Tabular View.

There are special **topology data** that describe the basic network structure. The most important topological components are the tables for nodes, branches and elements. All the categories (predefined and user-defined) are listed in the topology section as well.

The network's **input data** can also be displayed in the table for control or documentation purposes. The **Output** – **Result File** tab of the calculation settings dialog box can be used to configure the data to be displayed.

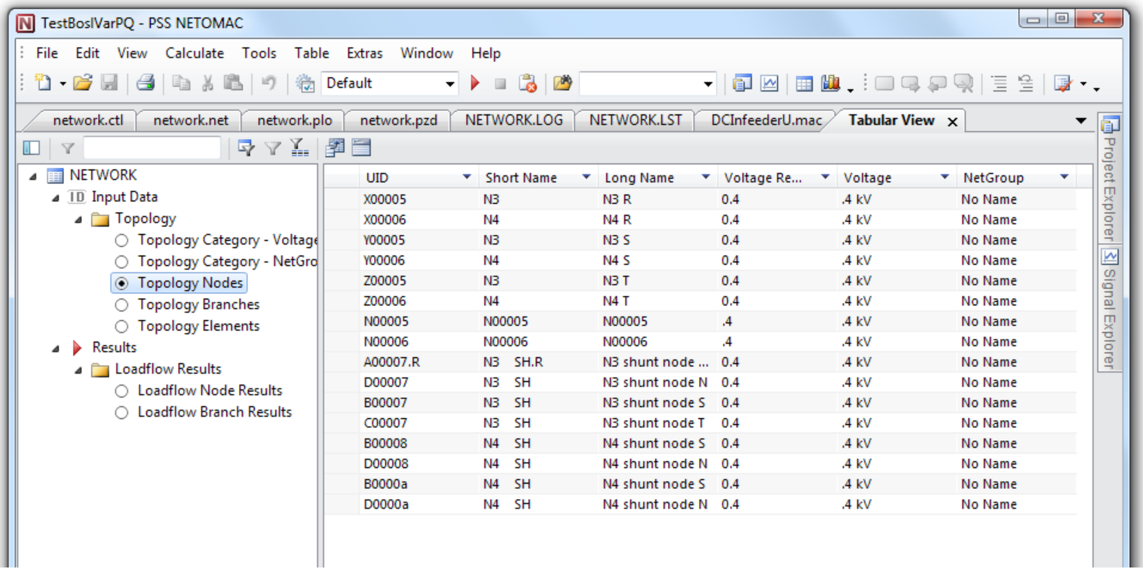
Of course, the table also contains the **load flow results**. These results can be either for nodes or branches. The scope of the branch results has been enhanced. All the branches have powers and currents (in MVA and in kA). And all the available topological information can also be displayed.

3.6 Results and Automation

Universal XRES-File

The XRES file is a special XML file that can contain any data you want. This is similar to the RES file in the diagrams. PSS NETOMAC automatically displays all the XRES files contained in the **Results** directory of the project in Tabular View. The structure of the XRES file is both simple and easy to understand. This structure lets you display the data in Tabular View, but also allows you to read the data using external applications.

XRES files can be used, for example, to store input data and load flow results. The following illustration shows the table with the data from the XRES file.



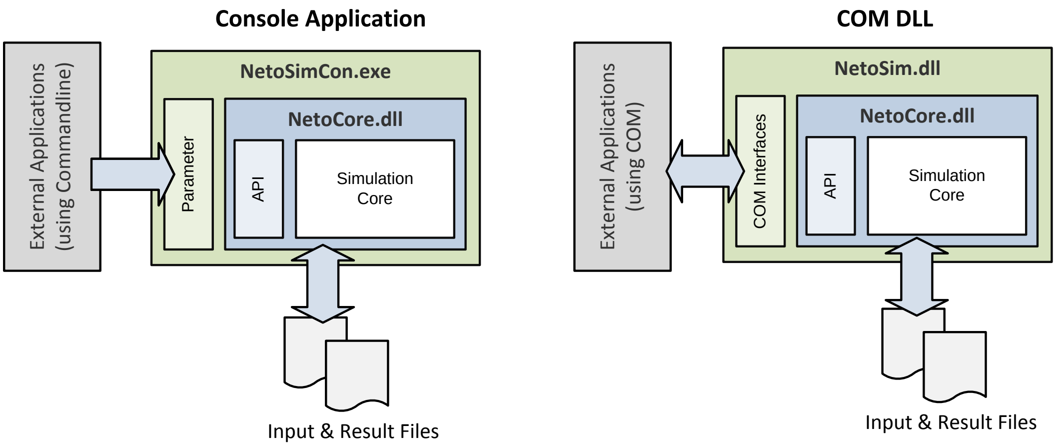
The following extract shows the XRES file for this:

```xml
<?xml version="1.0" encoding="UTF-8"?>
<!-- Created by PSS NETOMAC 9.0 (11.10.12 07:51)-->
<XML>
  <Table ID="Topology.Category.1" Name="Topology Category - Voltage">
    <Schema>
      <Column ID="ID" ShortName="" Name="ID" Type="long,primarykey" />
      <Column ID="UID" ShortName="" Name="UID" Type="string" />
      <Column ID="ShortName" ShortName="" Name="Short Name" Type="string" />
      <Column ID="Name" ShortName="" Name="Long Name" Type="string" />
    </Schema>
    <Data>
      <Row ID="1" UID=".4" ShortName="" Name=".4 kV" />
    </Data>
  </Table>
  <Table ID="Topology.Category.2" Name="Topology Category - NetGroup">
    <Schema>
      <Column ID="ID" ShortName="" Name="ID" Type="long,primarykey" />
      <Column ID="UID" ShortName="" Name="UID" Type="string" />
      <Column ID="ShortName" ShortName="" Name="Short Name" Type="string" />
      <Column ID="Name" ShortName="" Name="Long Name" Type="string" />
    </Schema>
    <Data>
      <Row ID="1" UID="No Name" ShortName="" Name="No Name" />
    </Data>
  </Table>

   …

</XML>
```

All the data in the XRES file are organized as tables. A table itself has a **Schema** that defines the individual attributes. The actual data follow in the section on **Data**. Each **Row** in this section represents a record in the table.

Automation Functions

The new PSS NETOMAC calculation modules are organized modularly. These have a central simulation core, the NetoCore.dll, which is embedded in a framework application. There are two variants: a simple Console Application and a COM DLL:



You can start the **Console Application NetoSimCon.exe** with a prompt. The command parameters that are transmitted at the start are used to control the procedure:

```
C:\> NetoSimCon.exe

Usage: NetoSimCon.exe -NET [-CALC [-EXP] | -GRD | -CMD] [-PARAM]

Parameter Description
---------------------

-NET <Network.net>     ... Network File

-CALC <CalcType>       ... Do a calculation
       SC              ... Short Circuit
       LF              ... Load Flow
       HAR             ... Harmonics
       VPRO            ... Voltage Profile
       FREQ            ... Frequency Response
       SIM             ... Simulation
       EV              ... Eigenvalues
       STABL           ... Stability Limit
       SNR             ... Static Net Reduction
       DNR             ... Dynamic Net Reduction
       OPT             ... Optimization
       IDF             ... Identification

-EXP <ExportType>      ... Export Results
      PLT              ... PLT-File
      CSV              ... CSV-File
      CTRA             ... Comtrade ASCII
      CTRB             ... Comtrade Binary

-GRD <Batch.grd>       ... Batch File

-CMD <CommandID>       ... Execute Command in NetoCore

-PARAM <ParameterList> ... Various Parameters for NetoCore

-INI <Command.ini>     ... Execute commands from INI file
```

The Console Application performs smaller automations simply and without any problems in Batch Scripts (.bat).

For enhanced automation tasks, PSS NETOMAC has the **COM DLL NetoSim.dll**. This DLL uses a COM interface for applications for these functions. The COM DLL can be used in scripting languages (e.g. Windows Scripting Host, Python), in programming languages (that support COM) and of course also in applications (Word, Excel, etc.).

The following excerpt from the file "SimTest.vbs" shows how the COM automation functions are used:

```
Dim SimulateObj

' Create an internal In-Pocess server
Set SimulateObj = WScript.CreateObject( "Netomac.Simulation" )
If  SimulateObj is Nothing Then
    WScript.Echo "Error: CreateObject Netomac.Simulation failed!"
    WScript.Quit
End If

' Initializing the simulation
SimulateObj.Init
SimulateObj.Language = "US"
SimulateObj.AddDataFile 0, strNetwork

' Start load flow simulatiopn
SimulateObj.Run siCalcLoadFlow

If SimulateObj.Status <> siStatusFinished And _
   SimulateObj.Status <> siStatusFinishedWithVariants Then
    WScript.Echo "simulation failed!" & vbCrLf
    Call WriteMessages()
Else
    WScript.Echo "successfully finished!" & vbCrLf
    Call WriteMessages()
    Call OutputLFResults()
End If

' Release used objects
Set SimulateObj = Nothing
```

For the entire example of automation "SimTest.vbs", see the folder "Netomac\Batch\Samples".

3.7 Dynamic Network Reduction

PSS NETOMAC's user interface now also has integrated dynamic network reduction. The functions are available in the **Tools** – **Network Reduction** menu. Separation, excitation and actual reduction can be performed.

To define the control data for network reduction, the **Calculation Settings** dialog box has been completely enhanced. **Tools** – **Dyn. Netreduction** now contains different tab data that can be used to edit the necessary control data.

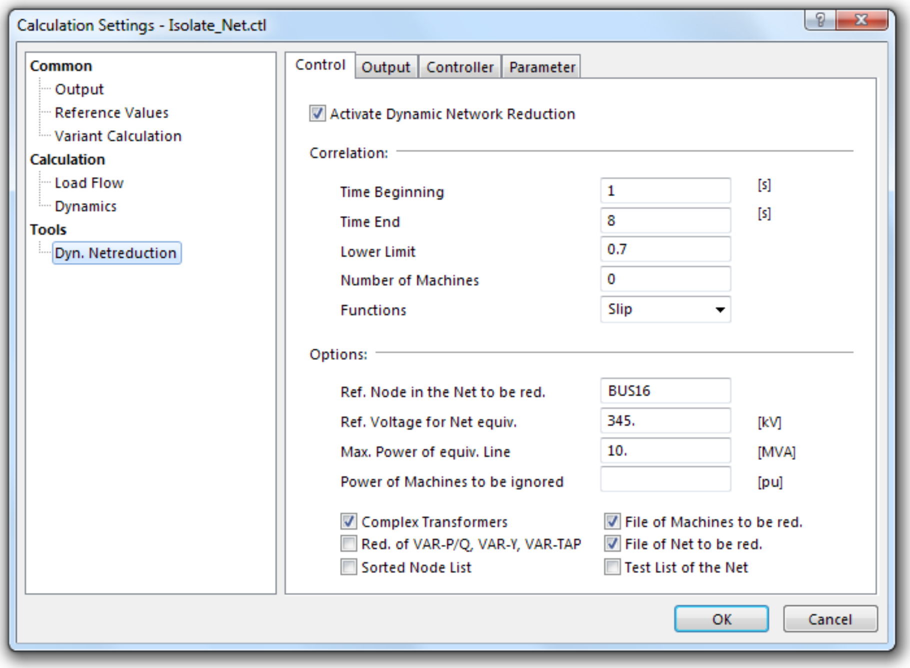


Illustration: Network reduction calculation settings

For a detailed description of the structure of the required input data, the procedure and also the network reduction procedure, see the chapter on **Network Reduction** in the Online Help.

3.8 PSS®E Import

The user interface now also has the PSS E Import. This is used to convert PSS E data from the Versions 29, 30, 31, 32 and 33 to the corresponding PSS NETOMAC networks.

File – **Import** – **PSS E** starts the importing procedure by opening a wizard where the required import settings can be defined.

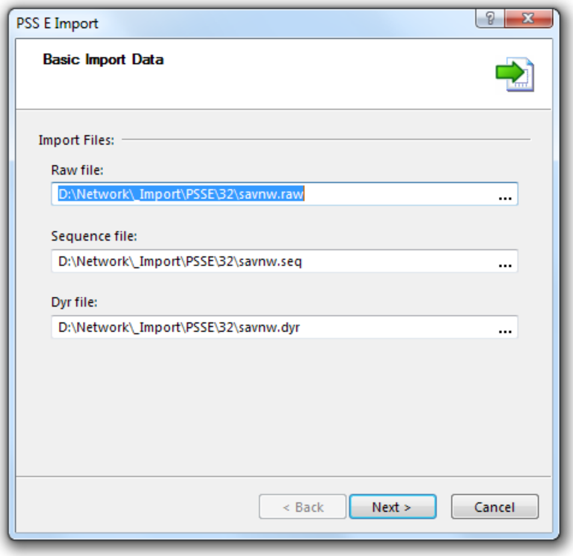


Illustration: Wizard for PSS E import

PSS E import can import static network data from the RAW and SEQ file as well as dynamic data from the DYR file.

3.9 Enhancements in the Calculation Modules

Current Calculation

A new method for the determination of element currents is implemented in the load flow module. The calculation is done now for the "terminals" of the element. A terminal has to be understood as connection of the element external to a boundary node. In order to determine the flow through the terminal, the currant at all branches of same boundary node name and element name are summed up.