

DigSILENT Technical  
Documentation

**What's New in**  
***PowerFactory* Version 14.1**



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**PowerFactory Version 14.1**

**What's New 14.1**

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# 1 Introduction

The following sections in this document look at the new features and enhancements that are available in *PowerFactory* **Version 14.1**.

The descriptions presented here are intentionally brief, meaning that only a summary of the new *PowerFactory* features is given. However, in order to achieve a better understanding, differences between the new and previous versions are discussed and explained with the use of examples.

While going through the document, the reader will come across a series of images that highlight part of the text. The interpretations of these images are as follows:



Indicate hints or the new feature/enhancement available in **version 14.1**.



**Important Note!** It emphasises a certain *PowerFactory* characteristic.



The **Questions and Answers** section. Some of the chapters will have a Q&A section to make the concept clearer.

Although the present document gives a general overview of the implemented features, we would like to encourage the user to refer to the User's Manual and/or technical references for further details.

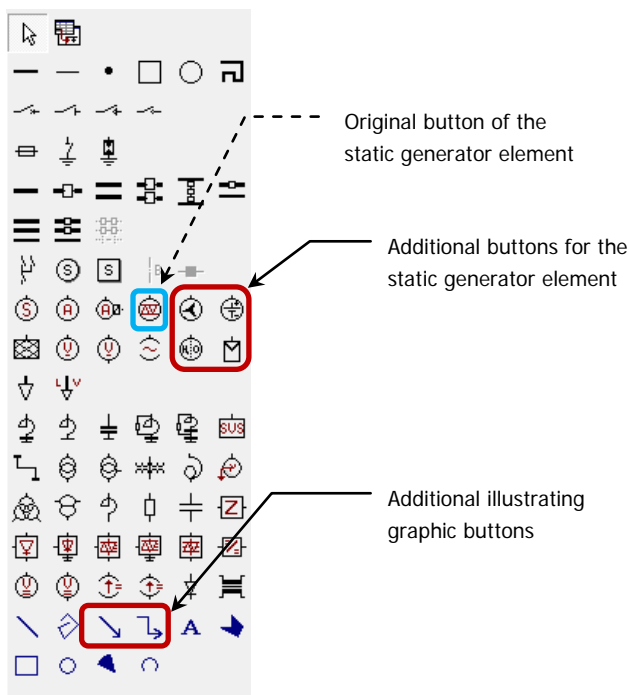
We would also like to express our sincere gratitude to all of our clients for their valuable feedback and suggestions, which allow us to continuously improve our software.

## 2 PowerFactory v14.1 Main Interface Window, the Data Model and Single Line Diagrams


### 2.1 New Features in the Main Interface Window







#### 2.1.1 What's New in the Drawing Toolbox?



In **version 14.1** four additional buttons related to the static generator element and two additional buttons related to the illustrating graphic are introduced (see Figure 2.1).



**Figure 2.1 Additional Buttons in the Drawing Toolbox**

Besides the original *static generator* representation (  ), the user has now the option of choosing between the following symbols:

- **Wind Generator:**  or displayed as 
- **Fuel Cell:**  or displayed as 
- **Photovoltaic:**  or displayed as 

- **Storage:**  or displayed as 





The symbol of each category (Wind Generator, Fuel Cell, Photovoltaic and Storage) can be changed by selecting the element from the graphic (so it's marked), right mouse button → *Change Symbol*. A dialogue window is then opened, prompting the user to select a symbol from a list.

If a specific *static generator* has already been drawn and a different category is required (for example displaying Storage instead of Photovoltaic); edit the element by double clicking on it and change the *Category* field located in the *Basic Data* tab page.




Important to note here is that although the category of the static generator element (*ElmGenstat*) can be exchanged, the model being considered **remains the same** (generic Static Generator model). Depending on the type of simulation to be carried out by the user, an extension of the model would be required such as adding a DSL definition.

In addition to the static generator buttons, two illustrating graphic line buttons are introduced.

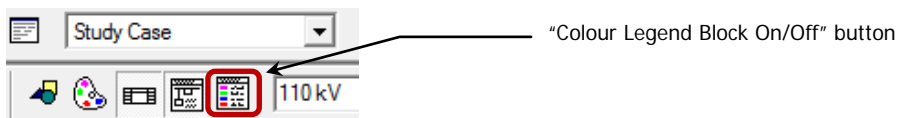
- **Arrow** 
- **Polyline arrow** 

The arrow style can be selected on either side of the line or polyline by editing the object after insertion.


On a further note, the user will notice a “wider” drawing toolbar. If required, the width (drawing toolbar) can be modified by clicking on the “User Settings” button (  ) and specifying the new value in the *Number of Columns in Drawing Tools Docker* option (Graphic Window tab page).

## 2.1.2 The “Colour Legend Block On/Off” Button


In **version 14.1** a “Colour Legend” button is made available in the main toolbar.



*Figure 2.2 Location of the “Colour Legend Block On/Off” button in the main toolbar*

In previous *PowerFactory* versions, the colour legend was accessed through an option defined in the “Colour Representation” dialogue window (  ); this basically meant that every time the user wanted to enable/disable the legend, the “Colour Representation” window had to be prompted.



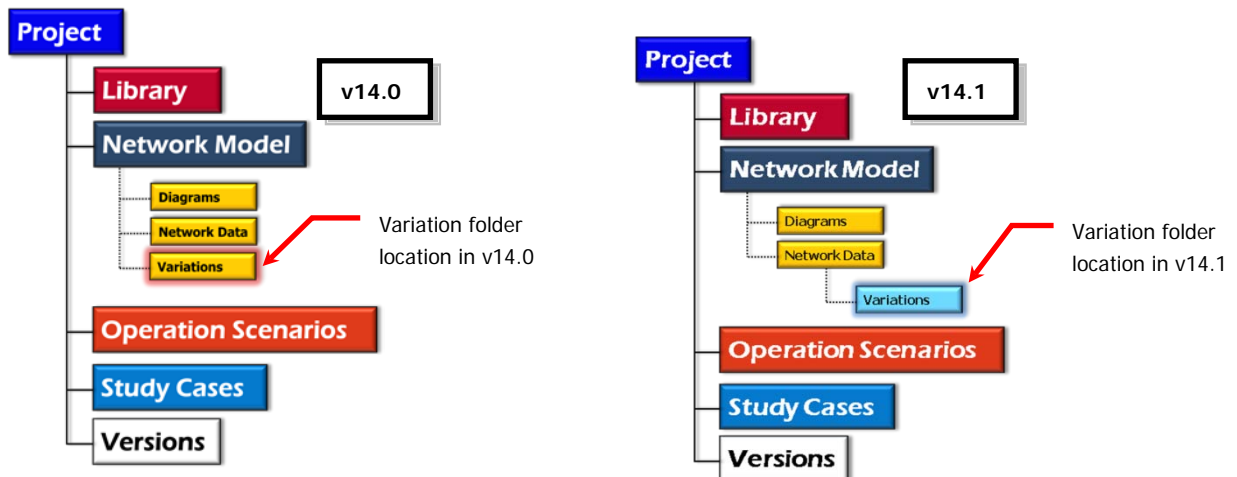
Now, the “Colour Legend” can be easily enabled/disabled by clicking on the “Colour Legend Block” button (  ), allowing a better handling.



## 2.2 Enhancements in the Data Model and Single Line Diagrams

### 2.2.1 Variations, Expansion Stages and what they Record

Whenever creating a new project in *PowerFactory* **version 14.0**, the user was taught to locate the variation folder directly inside the **Network Model** folder, as indicated on the left side of Figure 2.3.



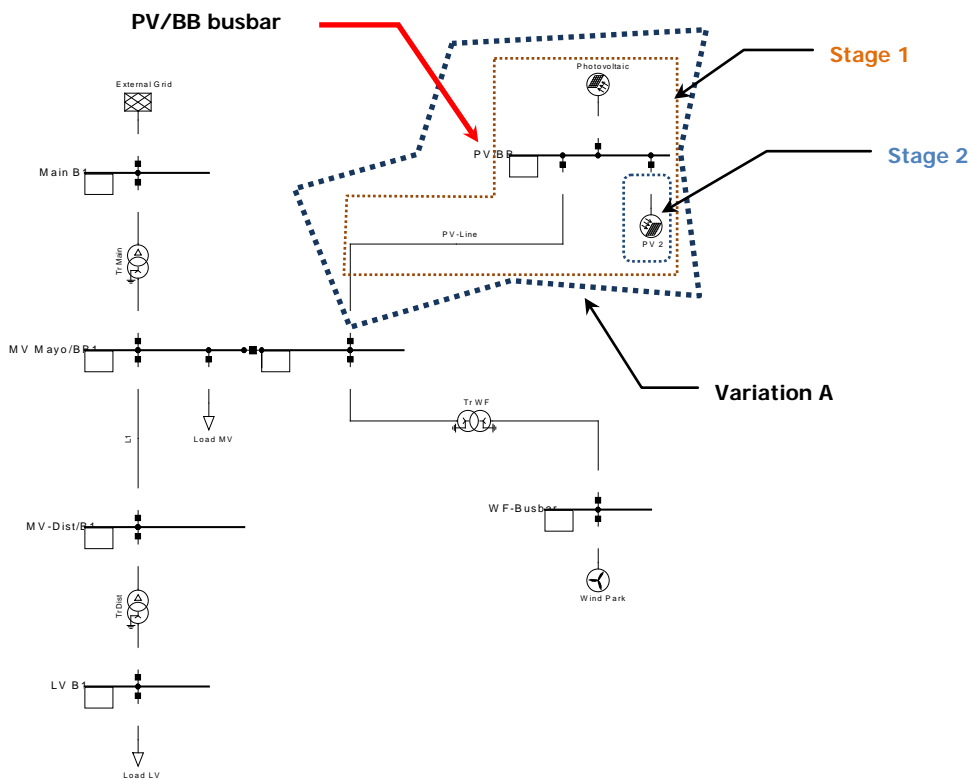
**Figure 2.3** Location of the Variations folder in versions 14.0 and 14.1

This changes however in **version 14.1**. Now, the location of the variation folder is defined by default within the **Network Data** folder, as indicated on the right side of Figure 2.3. The reader may be wondering the reason behind this change; well, it all had to do with the way graphics got handled when working with variations.

In **version 14.0**, whenever the user worked with variations (and a corresponding recording expansion stage), the common idea was that only model changes or topology changes got recorded (adding/deleting/modifying elements) which is actually true to some extent. The user may have noticed however that graphical changes were also being recorded. These graphical recordings in the expansion stage lead sometimes to confusion in the single line diagrams, depending on how and where the changes were made.

In order to prevent the recording of graphical information, the variation folder is created by default within the **Network Data** folder. This gives a sense of having a “Permanent” single line diagram.

To illustrate this concept better, let's take a look at the single line graphic shown in Figure 2.4. Here, a portion of the network has been defined with a variation (**Variation A**), which in this particular case consists of two expansion stages.



**Figure 2.4 Example Network**

Everything seems fine here, at least until now!

Now, let's suppose that we have this variation set up in **version 14.0**. Let's suppose also that we begin making some graphical modifications while stage 1 is recording (stage 2 is therefore not active). These graphical modifications (moving elements, rotating them, etc.) will be, as we know, recorded in this stage (stage 1). Consider that one of the graphical changes made was a new placement of the existing **PV/BB** busbar (moved to the left). If you now make stage 2 active (by changing the study time), the graphical representation will be altered because when stage 2 was initially defined, the graphical information of the Photovoltaic element of this stage was also stored. As a result the user would see an alteration in the single line graphic (Figure 2.5).



It should be pointed out to the reader that the element defined in stage 2 **doesn't get disconnected!** The previous is somewhat a simple example which illustrates one particular case. You can picture this issue in bigger systems, where a fair number of variations exist and which are correlated together. If not enough attention is paid on how and where graphical information gets recorded, well, the user could have at the end very confusing single line diagrams.



In **version 14.1** this is avoided because the graphical information is no longer recorded in the expansion stages. The variations (stages) are therefore only truly regarded as objects storing modifications related to the model. This basically means that any graphical modification, regardless if variations are active or not, are reflected directly in the single line graphic. Due to this new characteristic, the "Permanent Diagram" concept is introduced.

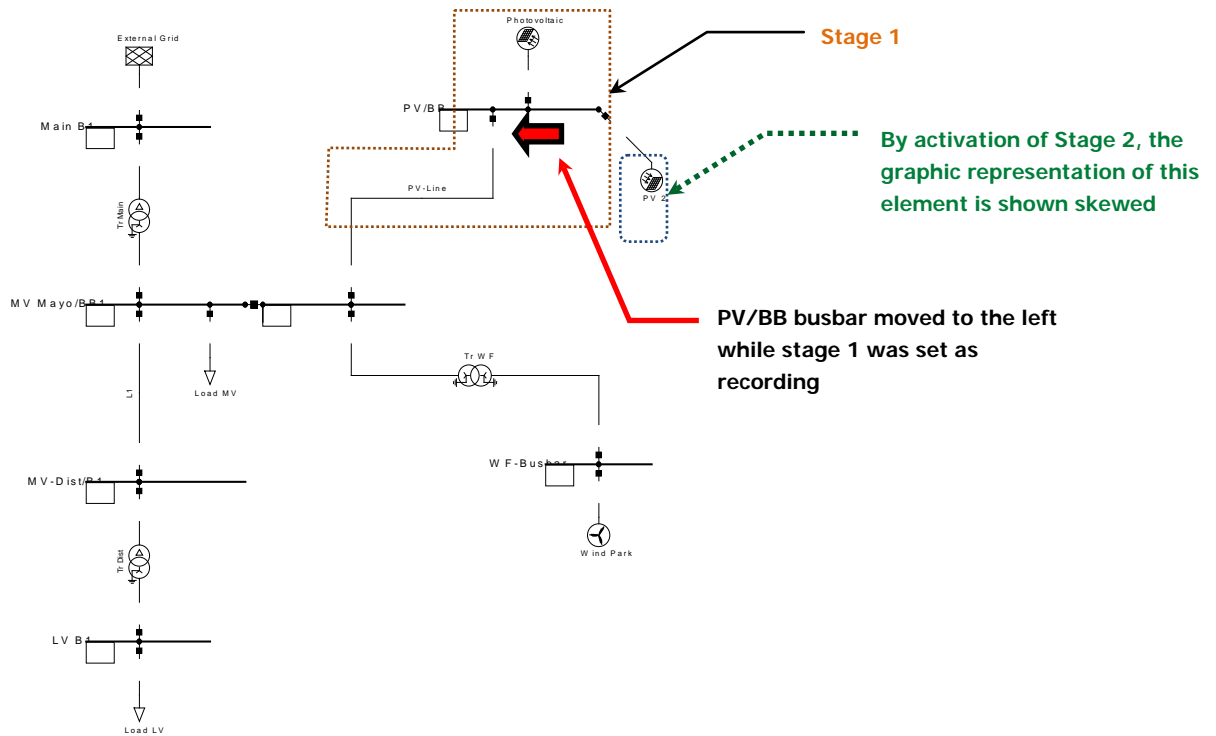


Figure 2.5 Example Network with graphical modifications reflected



Aside from this change (storing of graphical information), the remaining properties of the variation **stay unaltered** (Please refer to Chapter 17 of the User's Manual).

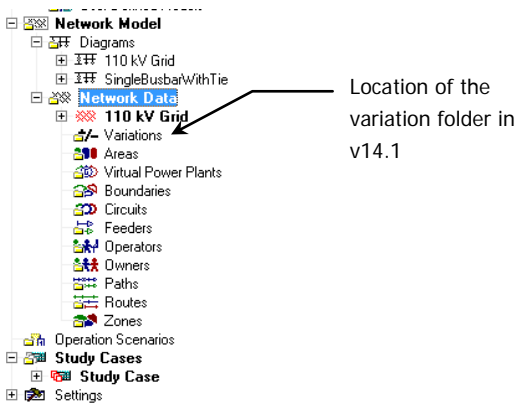


Figure 2.6 Location of the variation folder in version 14.1



Questions & Answers:

**Q1:** Will this new variation concept **not record any** type of graphical information? That is, what about graphic changes that are not directly related to elements, such as illustrating lines, texts, DPL buttons, etc?

**A1:** Actually the stage will **NOT RECORD ANY** type of graphical information, regardless if its element related or not; graphical changes in the texts, illustrating lines, DPL buttons, etc. are also not recorded.

**Q<sub>2</sub>:** Can I revert to the previous type of variation concept? That is, I want to allow the recording of graphical information in the stages of the variations.

**A<sub>2</sub>: YES.** There is no direct way of doing it however; meaning that if you're expecting to find an option somewhere in order to automatically change the variation concept, you won't find one. What should be done here is to manually (from the Data Manager) cut/paste the Variations folder to the Network Model folder (as in version 14.0). By doing so, the stages of the variations will record graphical information. Just keep in mind that before cutting/pasting the Variations folder, it should be empty (no variations inside). There is something here however related to the "Permanent Diagram" concept. So please refer to the next section (2.2.2).


**Q<sub>3</sub>:** Can I have in the same project the two types of variation concepts?

**A<sub>3</sub>: NO!** This is not possible. Once you have a variation folder in the Project, the creation of another variation folder (doesn't matter where) is not allowed.


**Q<sub>4</sub>:** If I import a Project that was created in version 14.0, will the variation folder be automatically moved?


**A<sub>4</sub>: NO,** the variation folder will not be moved, and therefore the variations will record the graphical changes (as in 14.0).

## 2.2.2 The "Permanent Diagram" Concept

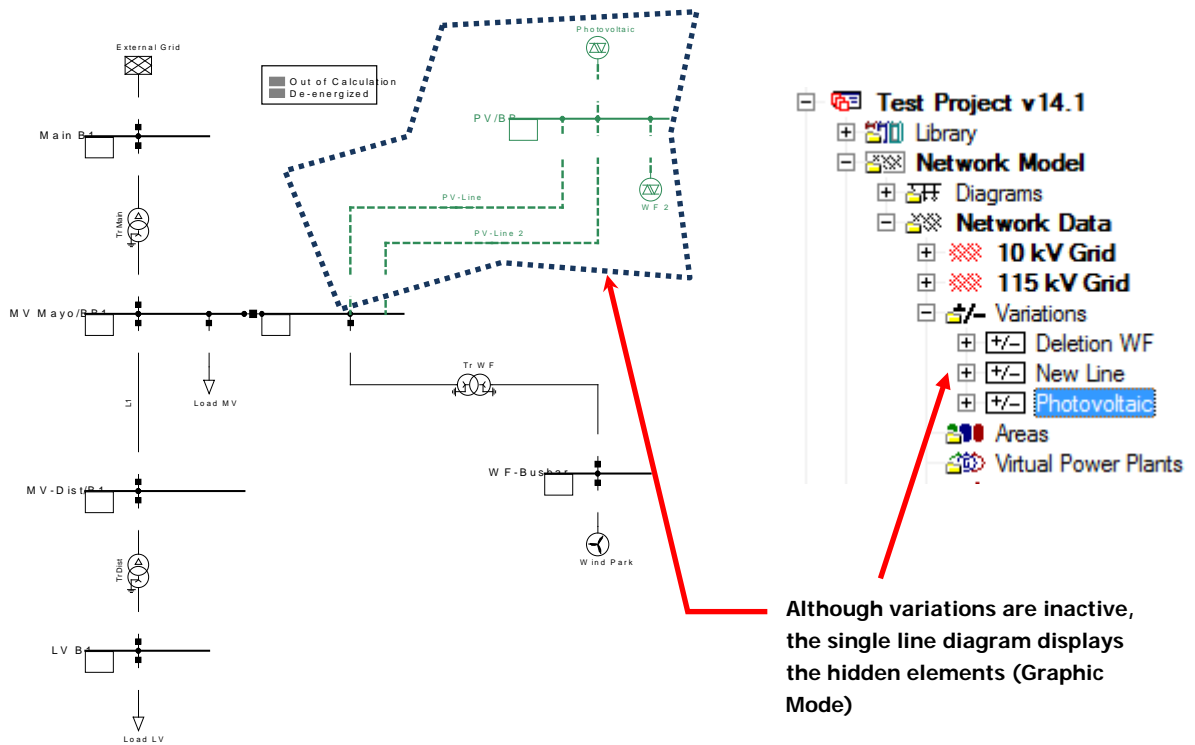
In **version 14.0**, obtaining a graphical representation of the variations included in the model was achievable by making sure that the selected group of variations were active (with their corresponding stages active) and then configuring the colouring mode (  ) to either "Recording Expansion Stage Modifications" or "Grids/Original Locations" so they could be easily traced in the single line diagram.



When working with **version 14.1**, if the diagram is in graphic mode (  ), any "inactive" variation is nonetheless shown in a light colour and dashed (provided that the variation folder is located inside the Network Data folder).

If the freeze mode (  ) is enabled, "inactive" variations will no longer be shown. Figure 2.7 illustrates a single line diagram in the "Graphic Mode". Notice that although the corresponding variations are inactive, the single line diagram still shows the variations/expansion stages ("hidden" elements).

For more information on the Freeze and Graphic mode, please refer to Chapter 11 (Network Graphics) of the User's Manual.



**Figure 2.7** Display of "Inactive" variations in the single line diagram (Graphic Mode)



Although the variations can be "inactive" (elements are considered as "hidden"), modifications in the single line diagram are still possible; this is achievable because of the "Permanent Diagram" concept. Of course, while the elements are hidden any other type of modification related the data model (e.g. length of the line, active power setting, etc.) is not allowed –**Read Only**-. If these type of changes are required, then the corresponding variation should be activated first.



#### Questions & Answers:

**Q<sub>1</sub>:** Can I delete "hidden" elements (of inactive variations/expansion stages) from the single line diagram?

**A<sub>1</sub>:** Nice try! The answer is **No!** Since "hidden" elements are **Read Only** objects, deletion is not possible. Of course, graphical changes (such as new placements) of the hidden elements are permitted.

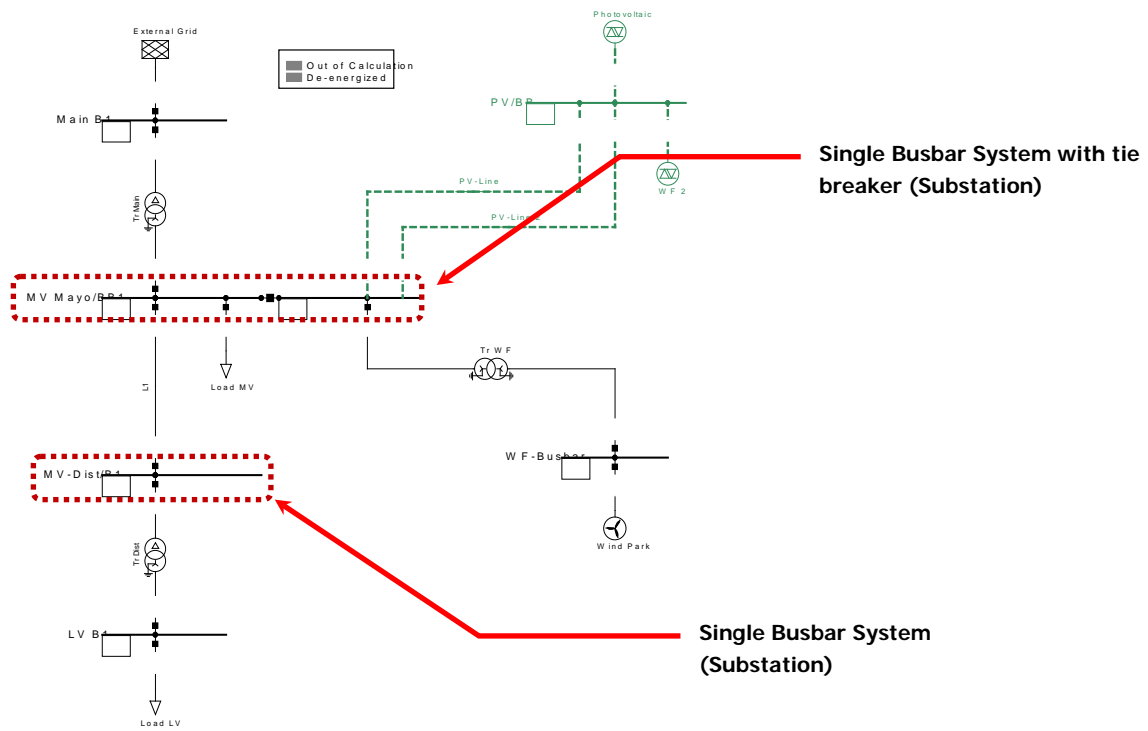
**Q<sub>2</sub>:** If I revert to the previous variation concept, will I still have the definition of "Permanent Diagram" and the display of inactive or "hidden" elements in the single line diagram?

**A<sub>2</sub>:** **NO!** Once you revert to the previous variation concept, the graphics will be shown as in v14.0. That is, there will be no definition of "Permanent Diagram" because graphical changes will be recorded in the stages. Inactive variations ("hidden" elements) will no longer be displayed in the single line diagram.

### 2.2.3 “Draw Existing Net Elements” Option: The “Show Elements of Drawn Composite Nodes” Button

Whenever the user worked with substations and wanted to represent them as composite nodes so to have an overview diagram, the graphical representation of “internal elements” (of the composite node) was not that straightforward.

Picture the following: You have defined a power system with the help of a couple of substation elements (ElmSubstat), such as indicated in Figure 2.8.



**Figure 2.8 Example Network; Substations**

As the reader is well aware of, the previous single line diagram can be represented as an overview diagram by creating a new graphic ( ) and using the “Draw Existing Net Elements” option ( ).

By doing so, the two substations can be drawn as “Composite Nodes” ( or ), which would result in the single line diagram shown in Figure 2.9. Once a “Composite node” has been drawn, the internal elements (terminals, switches, etc.) will not be available from the displayed list in the “Draw Existing Net Elements” window.

The reader maybe wondering, why do we need to draw the internal elements in the first place? Isn't this the whole idea when drawing an overview diagram?

This is actually correct; that's the basic idea of the overview diagram. In some cases however, the user may require drawing internal elements. To illustrate this better, let's take a look at Figure 2.10. Here the “Detailed Graphic” of substation **MV Mayo** is shown (this representation can be obtained by double clicking on the MV

Mayo composite node). Suppose that while in this diagram the user adds a new element. In this case for example, maybe it's required inserting a series reactor between the two main busbars in order to limit the short circuit current.

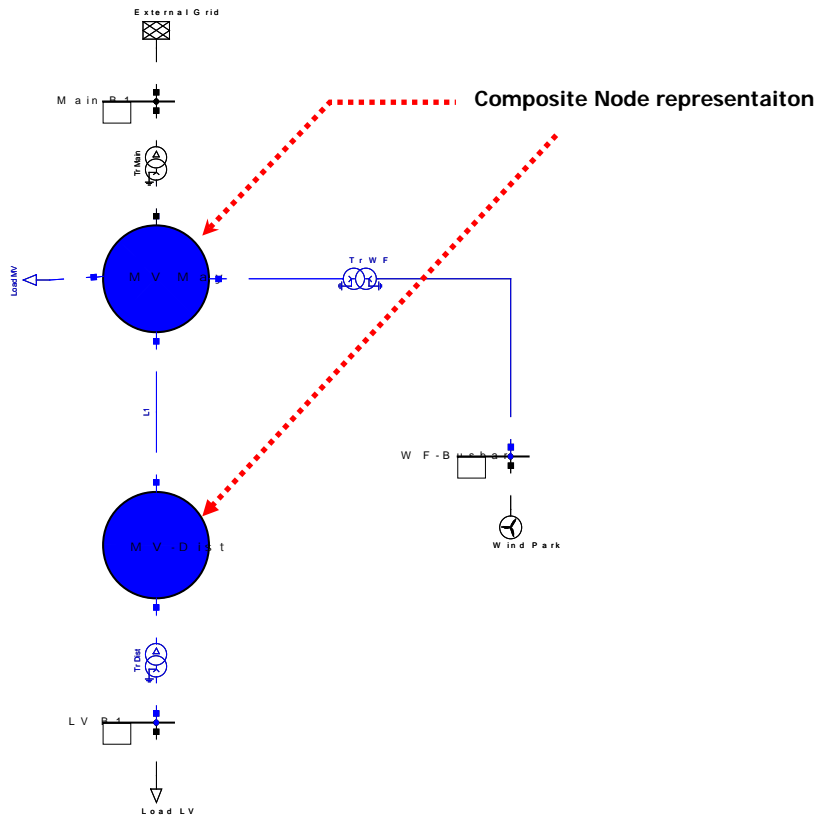


Figure 2.9 Example Network; Substations, Overview representation

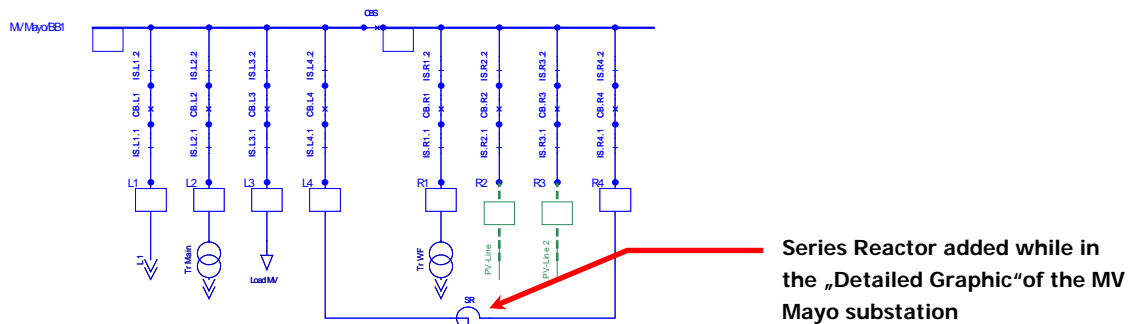


Figure 2.10 Detailed Graphic of MV Mayo Substation

Since the series reactor was added in the “Detailed Graphic” of the **MV Mayo** substation it will be defined as an internal element (of the substation). This basically means that once you create an “Overview Diagram”, the series reactor will not appear in the displayed list of the “Draw Existing Net Elements” window.

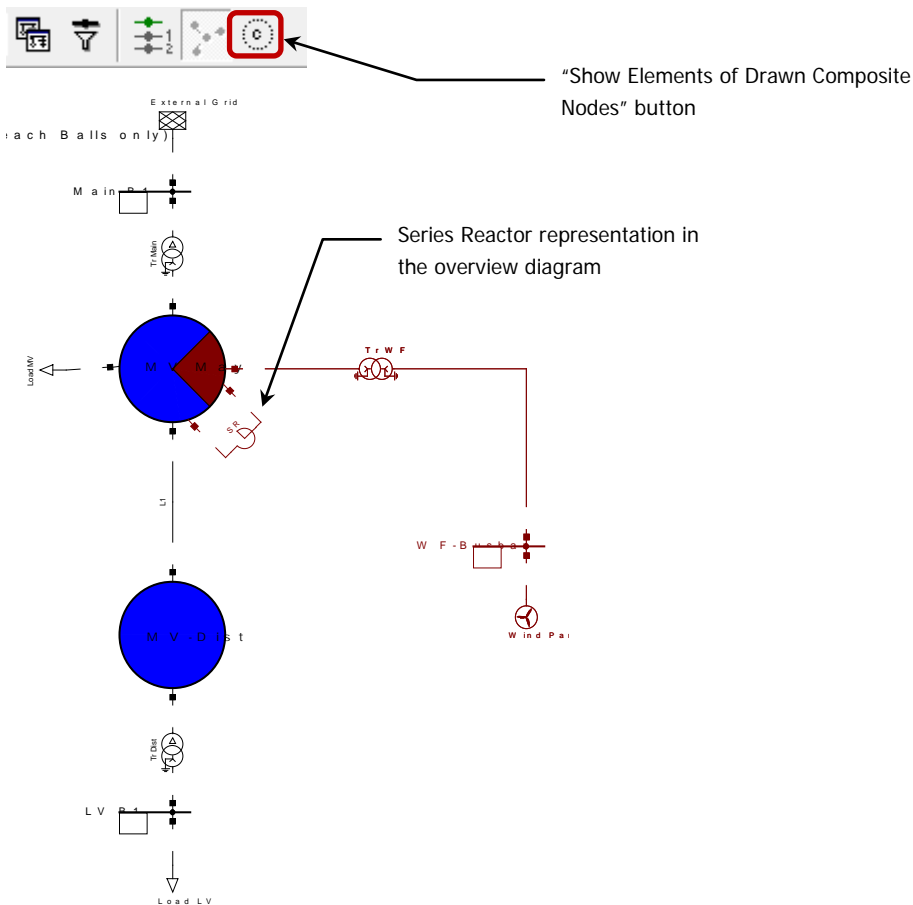
How to display graphically this element in the “Overview Diagram”?



In **version 14.0** this is achievable by copying the series reactor element (from the Data Manager) and then pasting it **graphically** in the overview diagram. By pasting the element graphically, the connections will be not completely shown (indicated with >>). To have this properly drawn the “Redraw” option must be used.



In **version 14.1** this is much easier! Once the user has drawn the composite nodes, the internal elements of every substation can be accessed by clicking on the “Show Elements of Drawn Composite Nodes” button, located in the “Draw Existing Net Elements” window.



**Figure 2.11 Overview Diagram showing the Series Reactor**

## 2.2.4 Working with Templates and the Template Library

The first thing we can ask ourselves is: Why use templates? Well, the answer is simple; templates are used to facilitate the further construction of network models.

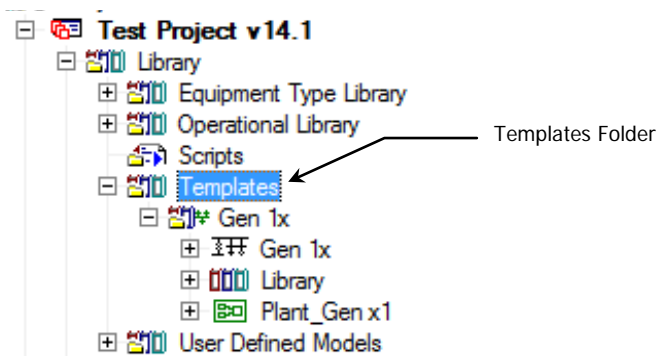
Let’s return to the example we have been using throughout this document. If you take a closer look at Figure 2.8 -particularly at the bottom right side of the single line diagram- you will notice a “Wind Park” element modelled with a “Static Generator”. Consider that this model represents a complete Wind Park (e.g. 50 MW). Now, because we need to carry out analysis in the Wind Park itself, a detail representation is then required, meaning that every wind turbine should be modelled independently. How to achieve this? Your answer could be: Very easy! I just



simply configure the “static generator” and the “type” being used so it represents a single wind turbine, and then **copy & paste** the static generator with its terminal several times until I have the complete wind park model.

This could be one way of doing it of course. The other option that you have is to create a template. But maybe you don't see the advantages of doing it with a **Template** compared to the **copy & paste** option.

However, what happens if the “Static Generator” representing a single wind turbine has a “Station Control” and a “Composite Model” assigned to it? Well, the **copy & paste** option will not create an additional “Station Control” and “Composite Model”. The user would have to create them separately for every “Static Generator”, which depending on the number of wind turbines can be time consuming. Here is where the templates come in handy.



**Figure 2.12** Location of the Template Folder

The template can be therefore defined not only for a single element but for a group of elements. Now, coming back to our example, how can we define a template for the “complete” (including the station control, composite model, etc.) wind turbine model?

In **version 14.0** when the user defined a template (achievable by marking the elements in the single line, right mouse button → *Define Template*), the template contained only the elements that were selected (marked) from the single line diagram. So I guess you're wondering now: But there is no graphical representation of the “Station Controller” or “Composite Model”. How to include them in the template? What the user needed to do then is to create a textbox for every additional element that is not graphically shown (such as the Station Controller). By doing so and by marking these additional text boxes together with the elements, the template included them. What about the types and frames? Do they get also stored in the template? The answer is: **NO!** If the user wanted also these objects, then they needed to be manually placed inside the template (by moving them). The complete procedure was therefore not that simple.

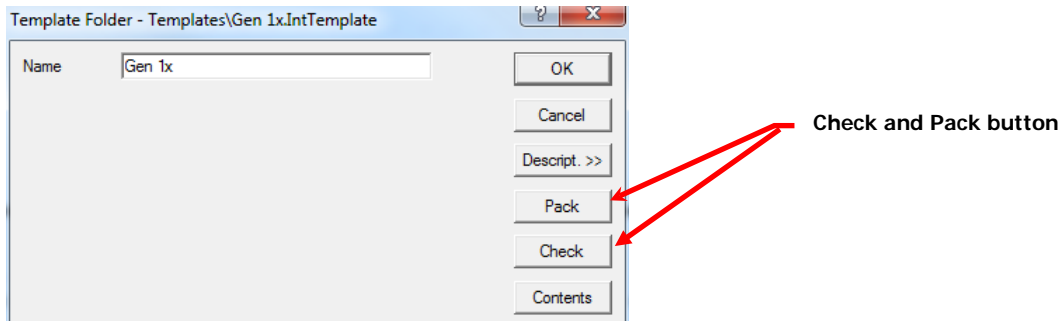


Enter **version 14.1**. Here there is no need to define additional text boxes and/or move types and frames. Once an element is marked from the graphic, and the “Define Template” option is selected, the user will have the choice of adding additional related models, such as:

- **Station Controllers** (ElmStactrl)
- **Secondary Controllers** (ElmSecctrl)
- **Tap and Shunt Controllers** (ElmTapctrl and ElmShntctrl)
- **Composite Models** (ElmComp)
- **Tower Couplings** (ElmTow)

How are here the types handled? Well, in this version new features for the template are available. Once a template has been created and afterwards edited (to edit a Template, open the Data Manager, right mouse

button on the corresponding template→*Edit*), the user will notice two additional buttons: The Check and Pack button.



**Figure 2.13** The Template window

If the user clicks on the “Check” button, the template is checked for external references. Independent if external references exist or not, a corresponding message is printed in the output window.

If the user clicks on the “Pack” button, all external references (Types, Block definitions, Capability Curves and Thermal Ratings) are copied into a “Library” folder inside the template.



Although the template concept here described was explained for a group of elements, it should be noted that this feature is also available for:

- Substation Templates (Composite node) and
- Branch Templates (Composite Branch)



### Questions & Answers:

**Q<sub>1</sub>:** When would I require copying the external references to the templates (Types, BlkDef, IntQlim and IntThrating)?

**A<sub>1</sub>:** If you're intending on using some of the templates in other Projects, then we recommend copying the external references so that everything is contained inside. If this is not performed, and you try to copy the template to other projects, *PowerFactory* will first run a “consistency check” to detect conflicts in assignments. If conflicts are detected (missing types) then you would have to choose between three options: 1 Cancel the copy of the Template, 2 Copy the Template and reset the missing references, or 3 Prompt the merge tool.

**Q<sub>2</sub>:** Once I have copied the Template to another Project (with references included), how can I rearrange the type data stored in the Template? In other words, I would like to have the type data of the template stored in the library folder of my Project.

**A<sub>2</sub>:** **Good Question!** Simply move (**not copy and paste**) the type information to the Project library folder. The references of the objects using the types will be automatically updated.


## 2.2.5 The New Global Template Library!

In **version 14.1** a new global “Templates” library is made available (\Library\Templates\). This global “Templates” library contains the following “ready for use” models:

- **Battery System with frequency control** (10 kV, 30 MVA)
- **Double Fed Induction Wind Turbine Generator**
  - o (0.69kV 1.0MW)
  - o (0.69kV 1.5MW)
  - o (0.69kV 2.0MW)
  - o (0.69kV 2.3MW)
  - o (0.69kV 2.5MW)
  - o (0.69kV 2.7MW)
  - o (0.69kV 3.6MW)
  - o (0.69kV 5.0MW)
  - o (0.69kV 6.0MW)
- **Fully Rated Converter Wind Turbine Generator**
  - o (0.4kV 1.0MW)
  - o (0.4kV 1.5MW)
  - o (0.4kV 2.0MW)
  - o (0.4kV 2.3MW)
  - o (0.4kV 2.5MW)
  - o (0.4kV 2.7MW)
  - o (0.4kV 3.6MW)
  - o (0.4kV 5.0MW)
  - o (0.4kV 6.0MW)
- **Variable Rotor Resistance Wind Turbine Generator** (0.69 kV, 0.66 MW)
- **Photovoltaic System** (0.4 kV, 0.5 MVA)




How to include one of these models in your current project? Easy, just follow these steps:

- While your project is active, click on the “General Templates” icon () located in the “Drawing Toolbox”.
- The resulting window will display the available “Substation Templates” as well as the templates in the global template library. Select one of them.
- Place it somewhere in your single line diagram.
- Viola! Besides having copied the model in the “grid” of your project, the template is also copied to the template library of your project (complete with types, block definitions, etc.)

## 2.2.6 The Renewed “Diagram Colouring” Option!

The colouring representation in **version 14.1** undergoes major improvements in its colouring criteria functionality.

First of all, the user will notice a name change of the colouring button () . In previous versions the button had the name “Colour Representation” while in **version 14.1** it’s renamed to “**Diagram Colouring**” (we think it better describes the functionality). By clicking on this button, the window displayed in Figure 2.14 will appear.

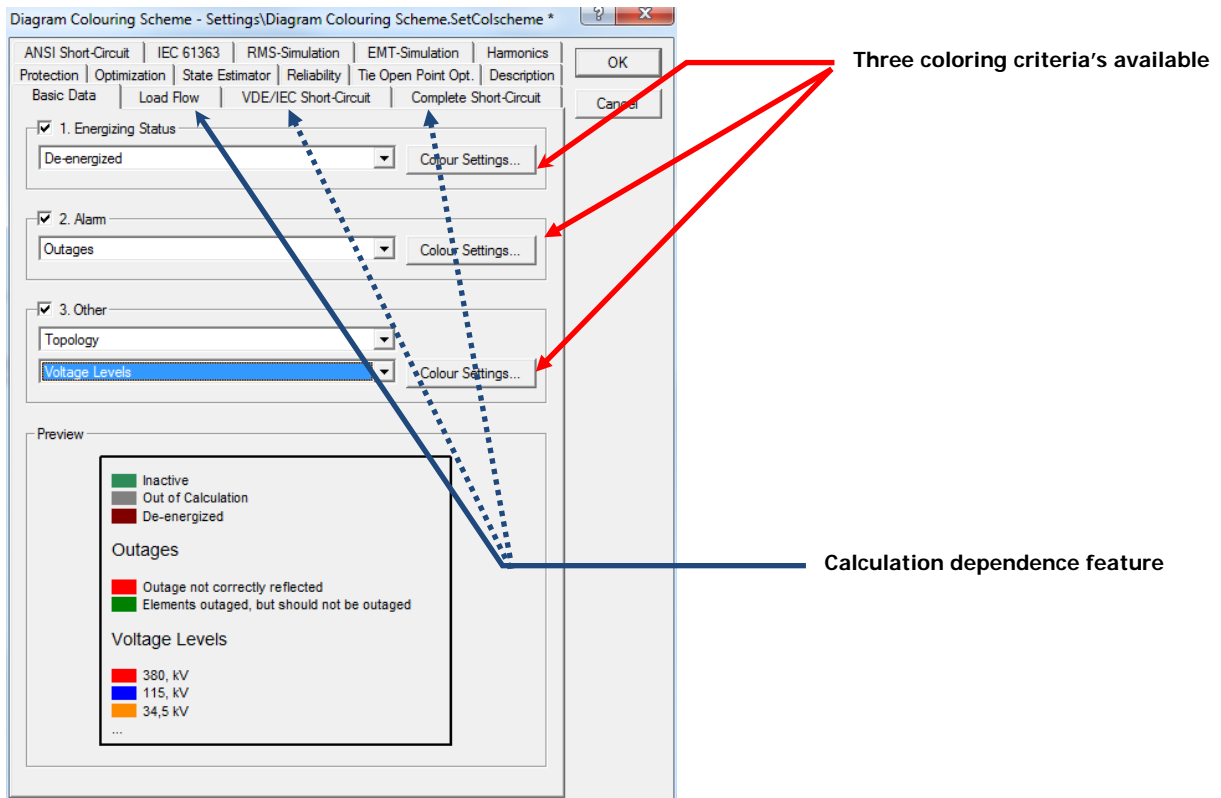


Figure 2.14 “Diagram Colouring Scheme” window

The user will notice major changes when compared to other versions.

Have you ever required having a “calculation dependence” colouring?

In previous versions, if different colouring modes were required for the same single line diagram, the user had to access every time the “Colouring Representation” in order to change the colouring mode; for example, if it was required to have the single line diagram coloured initially according to “Voltage Levels”, but once a load flow was calculated the colouring should be according to “Low and High Voltage/Loadings”, the user had to click every time on the “Colouring Representation” in order to change the colouring mode. The other option would be to have several copies of the single line diagram and assigning different colouring modes to each of the diagrams. The first option would require too many actions by the user and the second option would require having copies of the single line diagrams.



In **version 14.1** the above is avoided due to a new **calculation dependence** feature. The user has therefore the possibility of selecting different colouring modes per calculation method. If a specific calculation is valid, then the selected colouring for that calculation is represented. As an example, if the user selects the colouring mode “Zones” for “No Calculation” and “Low and High Voltage/Loadings” for the load flow calculation, then the initial colouring will be according to “Zones”. However, as soon as a load flow is calculated, the diagram would be coloured according to “Low and High Voltage/Loadings”. If the load flow calculation is reset (clearing of results), the colouring mode would switch back to “Zones”.

Furthermore, a 3-priority level colouring scheme is also implemented, allowing the colouring of elements according to the following criteria: 1<sup>st</sup> Energizing status, 2<sup>nd</sup> Alarm and 3<sup>rd</sup> “Normal” colouring.

### Energizing Status

If this option is enabled “De-energized” or “Out of Calculation” elements are coloured according to the settings in the “Colour Settings”.

### Alarm

If this option is enabled a dropdown list containing alarm modes will be available. It is important to note here that only alarm modes available for the current calculation page will be listed. If an alarm mode is selected, elements “exceeding” the corresponding limit are coloured. Limits and colours can be defined by clicking on the “Colour Settings” button.

### “Normal” Colouring

Here, two lists are displayed. The first list contains all available colouring modes. The second list contains all sub modes of the selected colouring mode. The settings of the different colouring modes can be edited by clicking on the “Colour Settings” button.

Every element can be coloured by one of the three previous criteria. Also, every criterion is optional and will be skipped if disabled. In relation to the priority, if the user enables all three criteria, the hierarchy taken in to account will be the following:

“Energizing Status” **overrules** the “Alarm” and “Normal Colouring” mode. The “Alarm” mode **overrules** the “Normal Colouring” mode.



Colouring modes and colours are no longer selected individually per diagram. Instead the colouring (modes and colours) are defined per project.


Summarizing the new colouring concept:

- **Better structure of the existing colouring modes**
- **Calculation dependence colouring**
- **Default settings per project instead of per graphic.**



### Questions & Answers:

**Q<sub>1</sub>:** If the settings of the new “Diagram Colouring” feature are project based, how can I have single line diagrams coloured differently?

**A<sub>1</sub>:** **This is still available!** Remember, the colouring settings are **by default** Project based. If you require having all or some diagrams coloured differently, then you should click on the “Graphic Options” button (  ) and change the diagram colouring to “Colouring Scheme”. This will allow you to define your own colour settings and to assign them to each single line diagram independently.

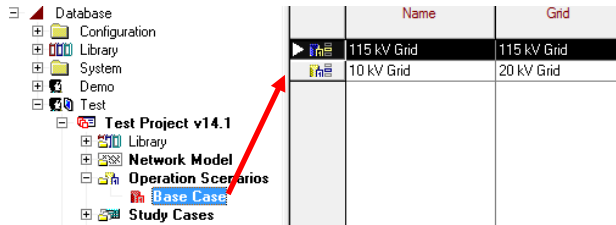
## 2.2.7 Operation Scenarios and the New “Scenario Scheduler” and “Scenario Configuration” Object

The functionality of the Operation Scenario has not changed in **version 14.1**.



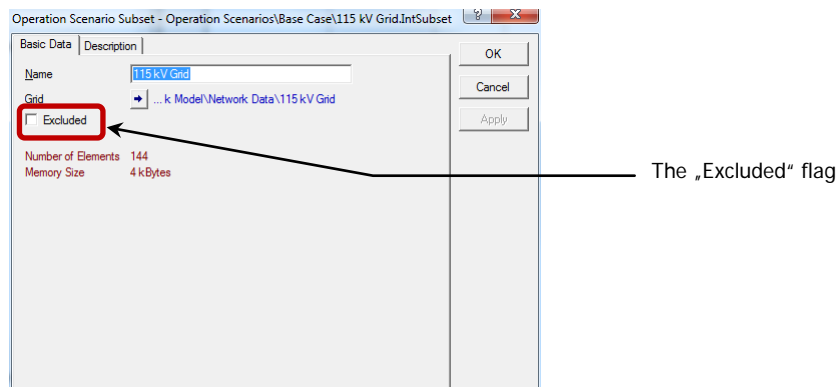
What has changed then? Well, several enhancements have been made. If we can recall correctly, in **version 14.0** the information stored in a scenario was divided into subsets (demand data, generation patterns, local

switch status, etc.). More often however, it is useful to have this information divided according to the grids. Because of this, in **version 14.1** the scenario subsets become grid based.



**Figure 2.15 Subsets of the Operation Scenario (Grid Based)**

Another enhancement is that in the scenario grid subset, an “exclude” flag is added. This will allow the user to temporarily disable a subset so that operational data doesn't get considered.



**Figure 2.16 The Operation Scenario subset dialog (Excluded flag)**

It's clear to the user that one of the properties of the scenario is that it's “date and time independent”. Wouldn't it be nice however to allow the activation/deactivation of a scenario based on the date and time of the study case? **Example:** Let's suppose that we have setup a project containing one single study case and several operational scenarios that reflect the load and generation profile according to certain hours of the day. As a rule, by changing the study time, the assignment of the scenario won't change.

In *PowerFactory v14.1* a “Scenario Scheduler” (IntScensched) object is introduced, so that by its activation, if the study time and date of the active Study Case is changed, the corresponding scenario will be activated.

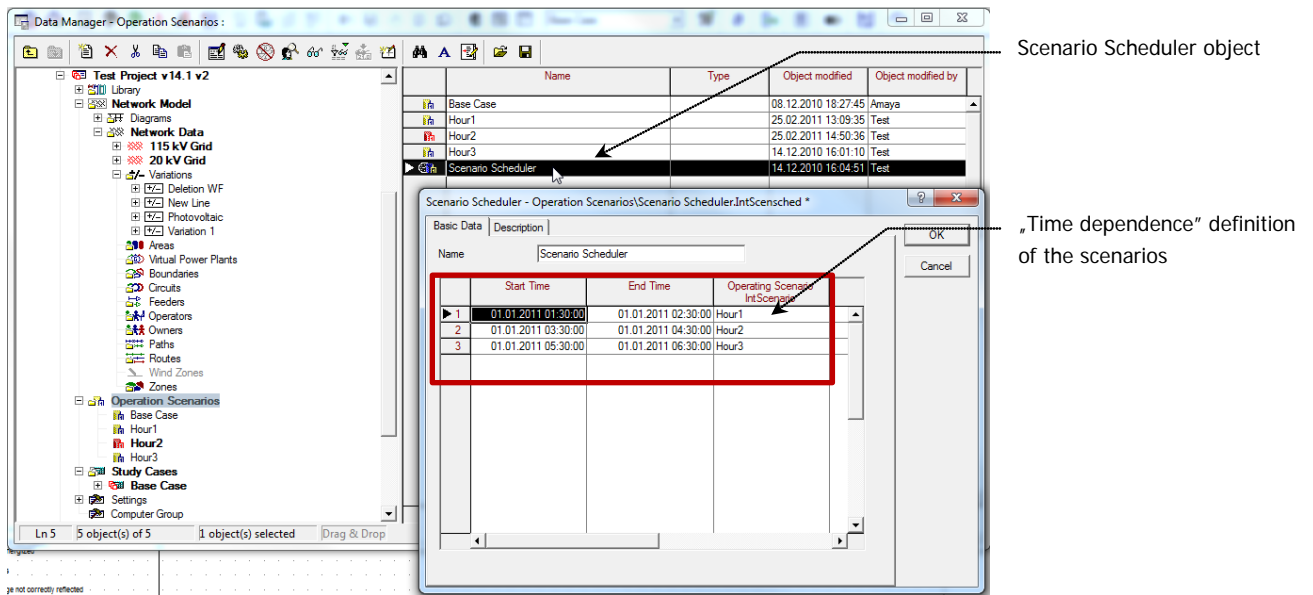


Figure 2.17 The Operation Scenario scheduler



Besides this, in **version 14.1** a “Scenario Configuration” feature is also implemented. This basically means that the user is able to define the operational data “relevant attributes” per class per project. Or in other words, the user will have the possibility of defining what information get’s stored in a scenario. For more information regarding the “Scenario Scheduler” and the “Scenario Configuration” objects please refer to Chapter 16 of the User’s Manual.

## 2.2.8 Substation Automation: Switching Rules (IntSwitching)



In **version 14.1** a new Switching Rule object is available. The Switching Rule is related to a substation and it basically defines switching actions for a selected group of switches that are defined inside a substation. The different switching actions (no change, open or close) are defined by the user considering different fault locations that can occur inside a substation. These switch actions will always be relative to the current switch positions of the breakers.

The selection of a Switching Scheme for a substation is independent of the selection of a running arrangement and if required, the assignment of switching schemes can be specified to be part of the operation data (provided the user uses the “Scenario Configuration” object).

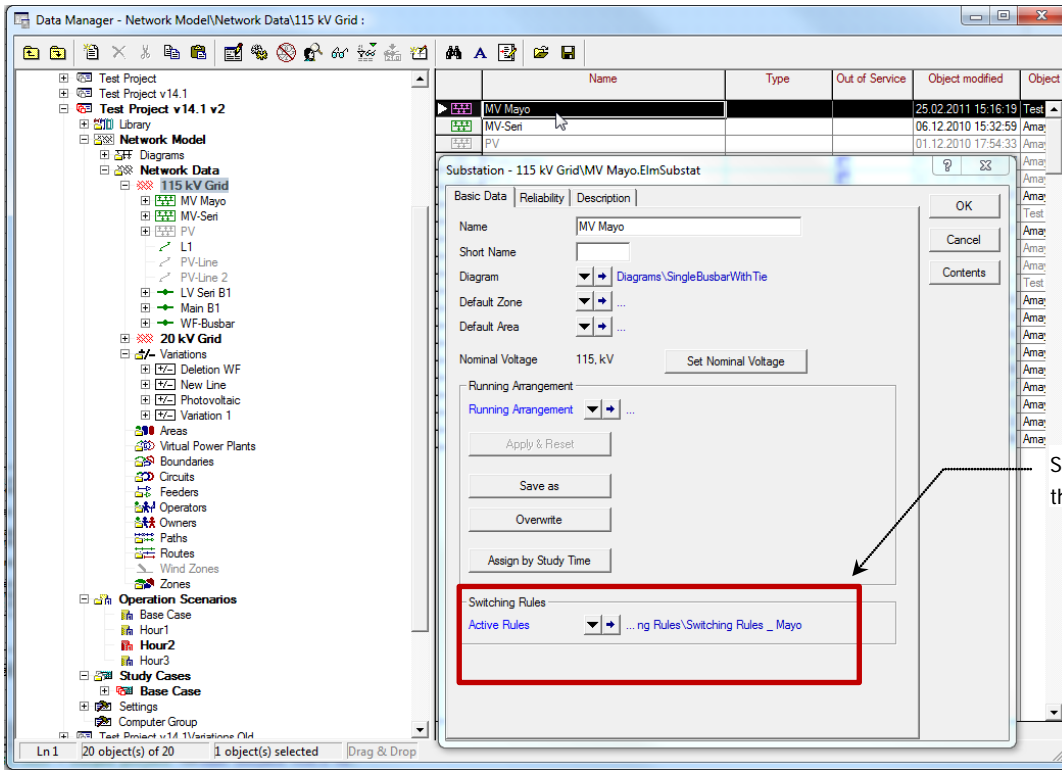


Figure 2.18 Switching Rule Definition

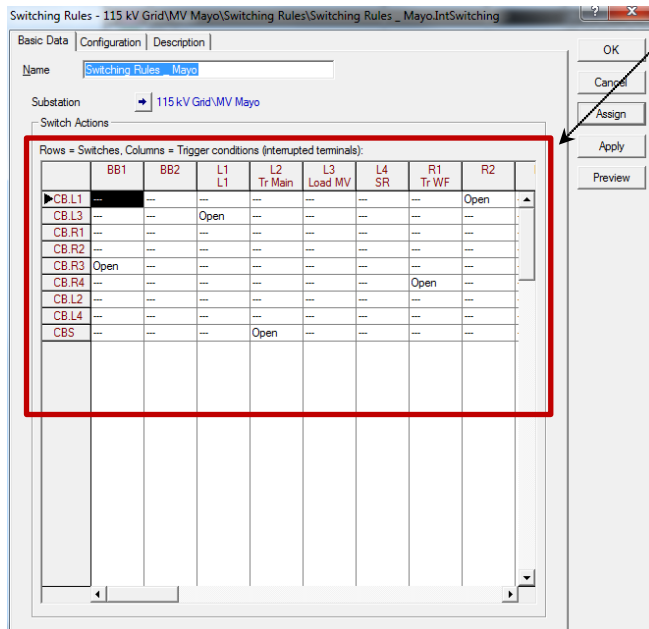


Figure 2.19 The Switching Rule Object

So, maybe after all this explanation the question would still be: When to use "Switching Rules"? Picture the following: While performing a "Contingency Analysis" you want to evaluate the results considering the "current" switch positions in a substation and compare them to the results considering a different substation configuration





(for the same outage). This can be easily done with “Switching Rules”. Please refer to chapter 5 of the User’s Manual for more information regarding how to create, select, apply and assign switching rules.

## 2.2.9 Some nice to know “Shortcuts” when Working with Single Line Diagrams

Here are some additional enhancements available in **version 14.1** that may come in handy when working with single line diagrams:



**The Hand Tool option:** Whenever the user “Zooms In” a diagram, the “Hand Tool” option can be quite useful in order to move around the graphic. This implied however that the user had to toggle between the “Hand Tool”  button and the “Graphic Mode”  button to allow other actions in the graphic (e.g. selection of elements). This is much more flexible in **version 14.1**. Any time a “Zoom In” has been performed in a diagram, the “Hand Tool” can be toggled ON by clicking and holding the tracking wheel of the mouse. Once the tracking wheel has been released, the “Hand Tool” is disabled.

**“Zooming In” and “Zooming Out” with the tracking wheel of the mouse:** In previous versions this was achieved by holding down the “Shift” key while scrolling up or down with the tracking wheel of the mouse. In **version 14.1** the “Ctrl” key is used instead. The reason behind this change is so it matches the same zooming functionality of other commercial software’s.

## 2.2.10 File Formats for Background, Company Logo, and Picture Box VI

In **version 14.1**, for the single line diagram background, Company Logo (Title Block), Picture Box VI and user defined graphic symbols (Symbol File) the following **additional** formats are now supported:

- **JPEG** (\*.jpg; \*.jpeg; \*.jpe; \*.jff)
- **PNG** (\*.png)
- **GIF** (\*.gif)
- **TIFF** (\*.tif; \*.tiff)

## 2.2.11 Plots: Additional Variable Description

Have you sometimes lost track of the definition of the variable you were selecting when plotting them in Virtual Instrument Panels? That is, until now when the user selected the variable to plot, only the name of the variable appeared in the list (such as u1, phiu, etc.).



In **version 14.1**, the description of the variable is now displayed.

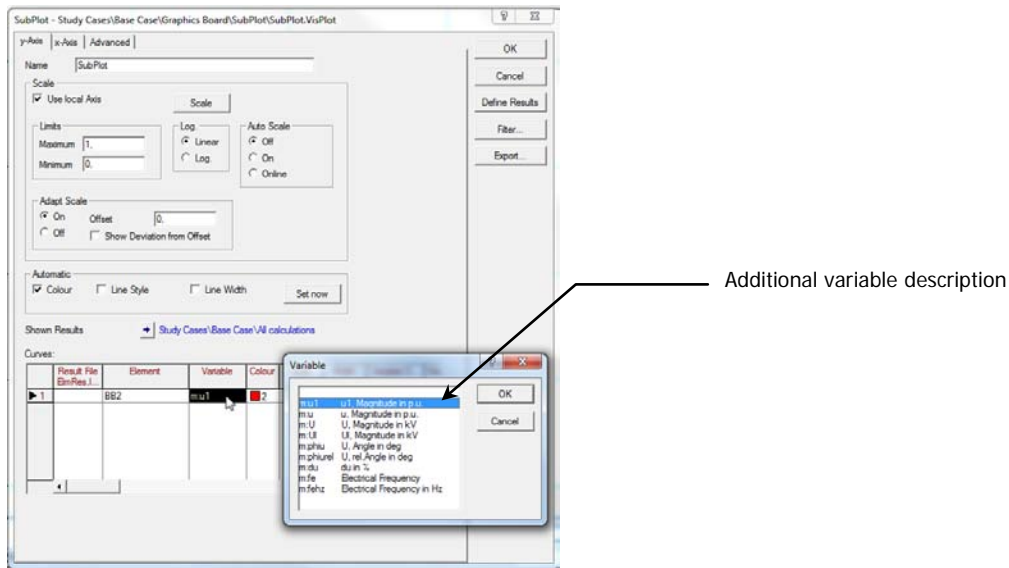


Figure 2.20 Additional Variable Description

## 2.2.12 Variable Set Definition: Additional Signal Description

In previous version, whenever selecting “Signal” variables, it was not clear to the user if the signal corresponded to a “State”, “Input” or “Output” variable.



In **version 14.1**, an extra column is added in the “Signal” variable set so that the signal “type” can be easily detected.

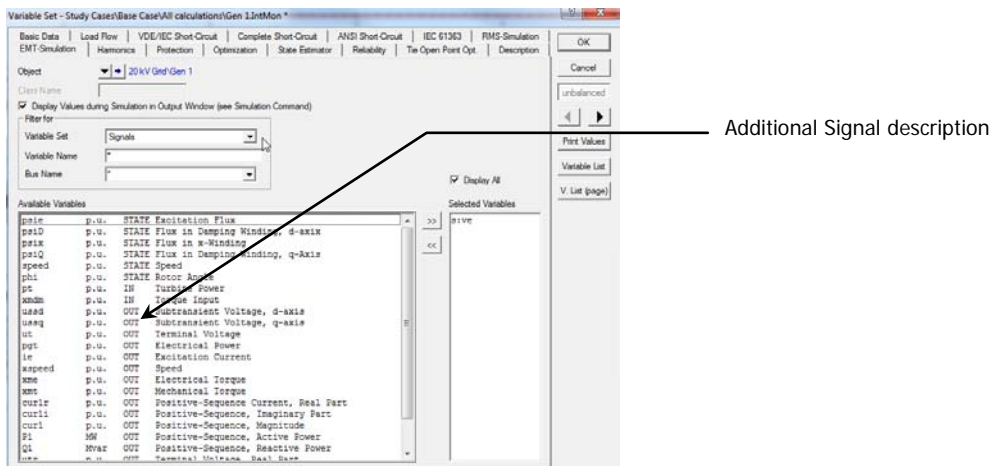


Figure 2.21 Additional Signal Description

## 3 PowerFactory v14.1 Power System Analysis Functions & Models

### 3.1 Enhancements in the Load Flow Calculation

#### 3.1.1 Consideration of Active and Reactive Power Limits in PQ Machines

Whenever the user specifies a machine as PQ (could be a synchronous machine, static generator, PWM converter or SVS), the **Active** and **Reactive Power** as well as their limits (Pmin, Pmax, Qmin, Qmax) are typically stated. Under such considerations, it could happen that the value of Active or Reactive Power entered is outside these limits.

In **version 14.0**, if the user had machines modelled as PQ, every time a load flow was executed the **Active** and **Reactive Power** stated (of PQ machines) were maintained fixed in the calculation, regardless if they were inside or outside the specified limits (Pmin, Pmax, Qmin, Qmax).



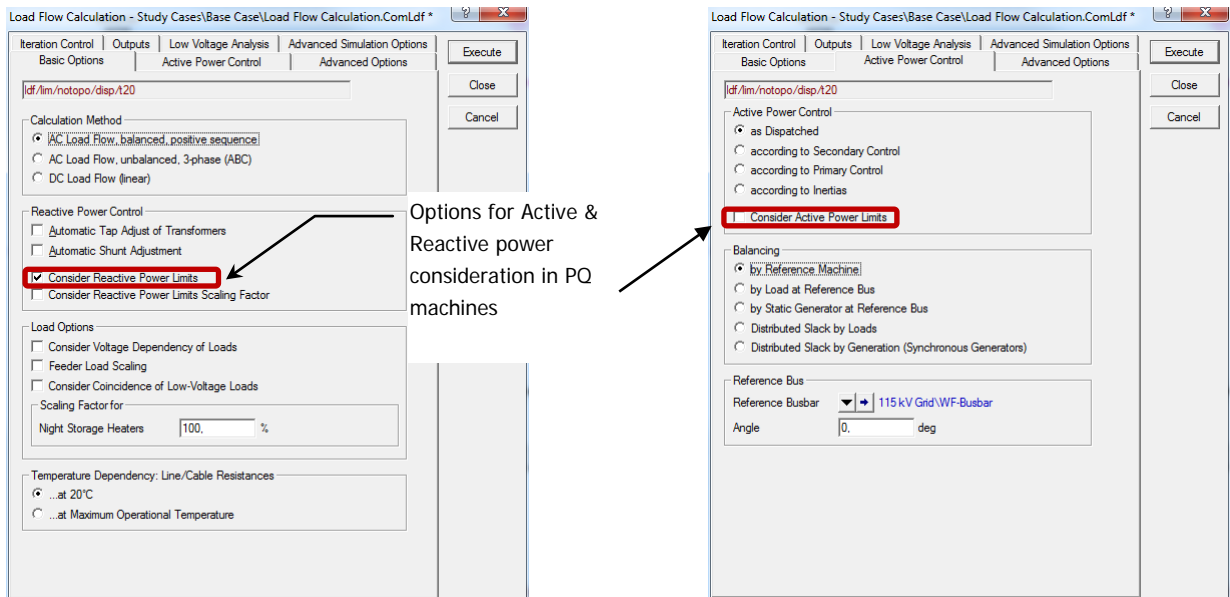
This can be handled differently in **Version 14.1**; here the user has the option of “forcing” PQ machines so that the P and Q resulting from the load flow are always within limits. That is, if required, the load flow algorithm will adjust the initial P and Q stated by the user so that limits are not exceeded.



**Remember:** Although the load flow algorithm can adjust the P and Q of the machine (load flow solution), the initial values of P and Q defined in the element remain unchanged; unless of course, the “Update Database” command is executed.

What options do you need to specify in order to consider the active and reactive power of PQ machines? You would need to specify the following options in the “Load Flow” command:

- **Consider Reactive Power Limits** (“Basic Options” tab page)
- **Consider Active Power Limits** (“Active Power Control” tab page)



**Figure 3.1** Options that should be stated in order to consider the active and reactive power of PQ machines.

## 3.2 Considering “Temperature Dependency” in your Analysis

It is well known that the resistance of a conductor varies in accordance to its temperature. Until now (v14.0), the resistance “Temperature Dependency” can be defined in a calculation by assigning a “characteristic” object to the resistance field of every line and conductor type.

### 3.2.1 Line, and Conductor Type (TypLne, TypCon): “Temperature Dependency” Extension



In **version 14.1**, the temperature dependency of the resistance can be now specified in the “Load Flow”, “RMS” and “EMT” tab pages of the line (TypLne) and conductor (TypCon) type. The user is then required to provide the following additional data:

- Max. Operational Temperature:** Maximum temperature in °C of the line/conductor for continuous operation.
- Temperature Dependency:** Defines how the resistance of the line/conductor changes according to temperature variation. The following options are available:
  - (a) Resistance at maximum operational temperature (Ohm/km)
  - (b) Temperature coefficient (1/K)
  - (c) Conductor material (*Aluminium, Copper or Aldrey*)

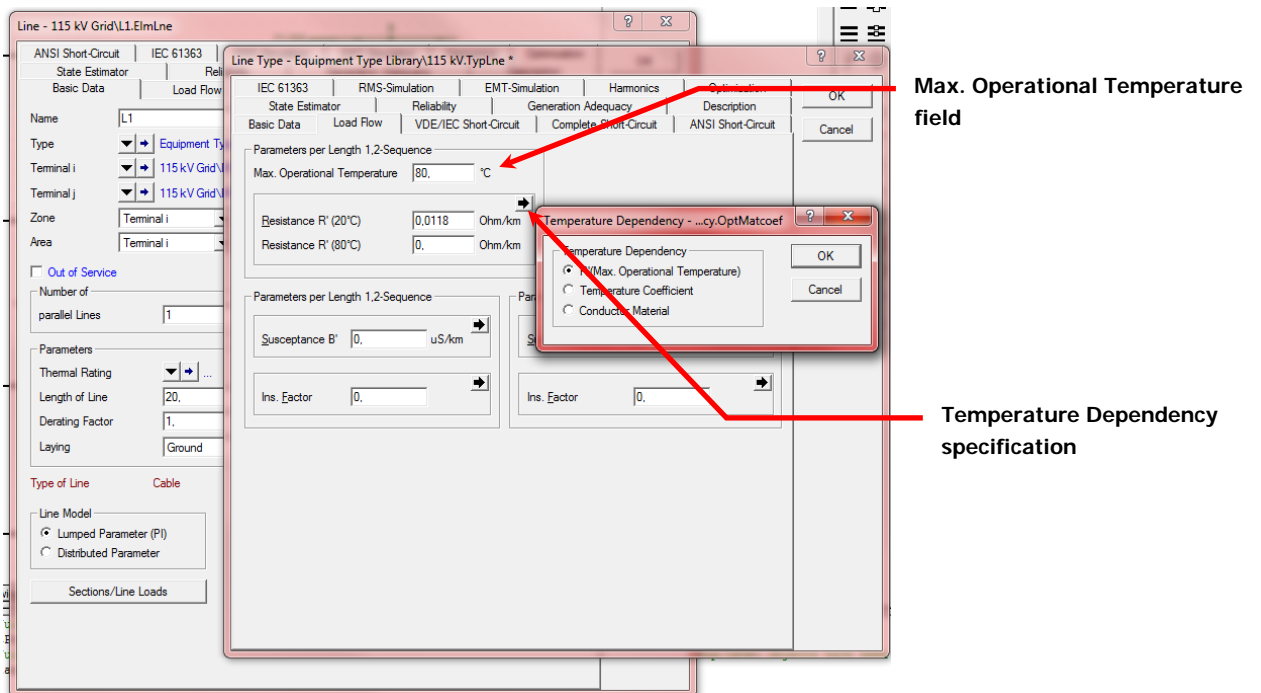


Figure 3.2 Temperature Dependency definition in the Line Type

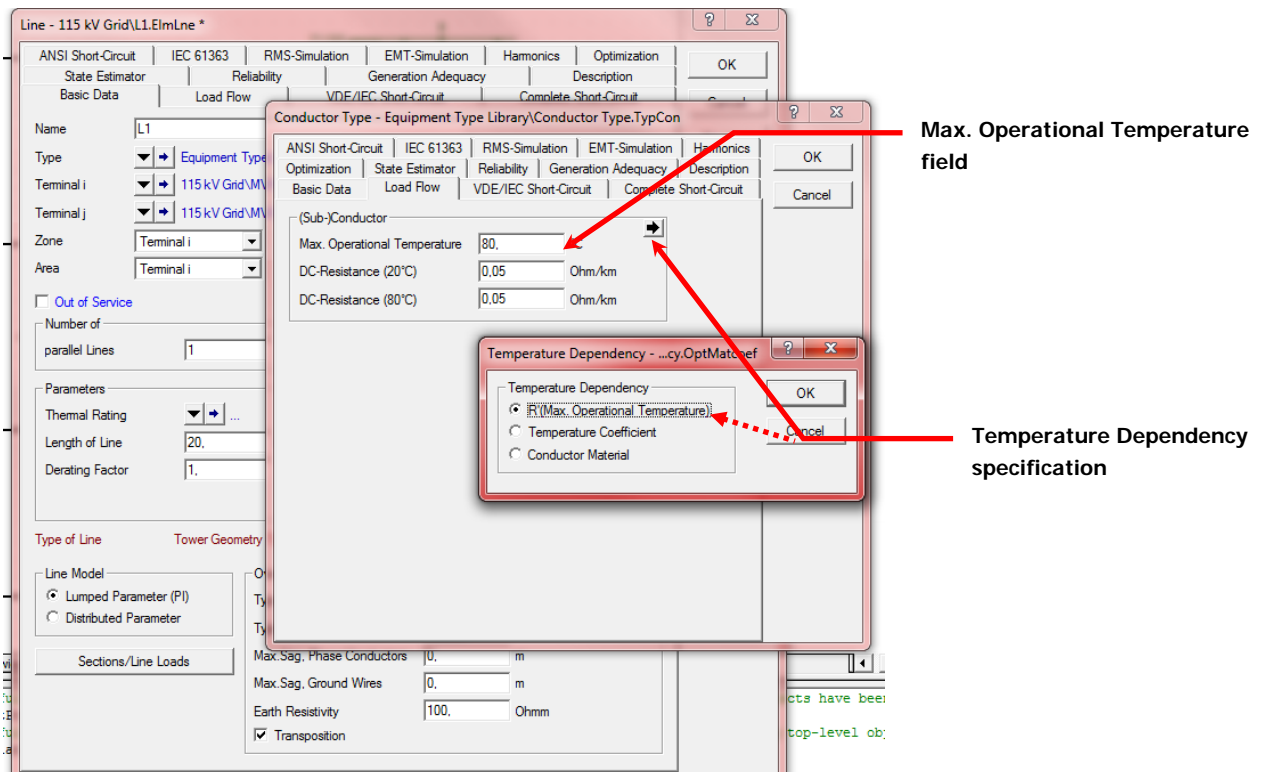


Figure 3.3 Temperature Dependency definition in the Conductor Type



Although not specified in the “Harmonic” tab page; performing a Harmonic Load Flow will also take into account the “Temperature Dependency”.



As in the previous paragraphs, the temperature dependency of the resistance can be also specified in the “Complete Short Circuit” tab page of the line (TypLne) and conductor (TypCon) type. The user is then required to provide the following additional data:

**Maximum End Temperature:** Maximum temperature in °C that the line/conductor can support for a short time period without changing its properties irreversibly.

**Temperature Dependency:** Defines how the resistance of the line/conductor changes according to temperature variation. In this case only two options are available:

(a) Temperature coefficient (1/K)

(b) Conductor material (*Aluminium, Copper or Aldrey*)



The “Temperature Dependency” setting of the “Complete Short Circuit” method is independent from the setting in the load flow (EMT&RMS) tab page.

### 3.2.2 Cable Type (TypCab): “Temperature Dependency” Extension



In **version 14.1**, the temperature dependency of the resistance for cables is specified by entering the temperature coefficient for each layer conductor/sheath/armor, as illustrated in Figure 3.4. The user will therefore notice a different way of entering the data when comparing it to the line and conductor type. Also, the temperature coefficients are the same for all calculations.

**Maximum Operational Temperature** and **Maximum End Temperature** are specified in the corresponding calculation tabs page (analogous to the line and conductor type).

The resistivity ( $\mu\text{Ohms}\cdot\text{cm}$ ) of each layer is corrected according to its corresponding temperature coefficient. Resistance is then corrected using the resistivity and the temperature entered in the calculation method.

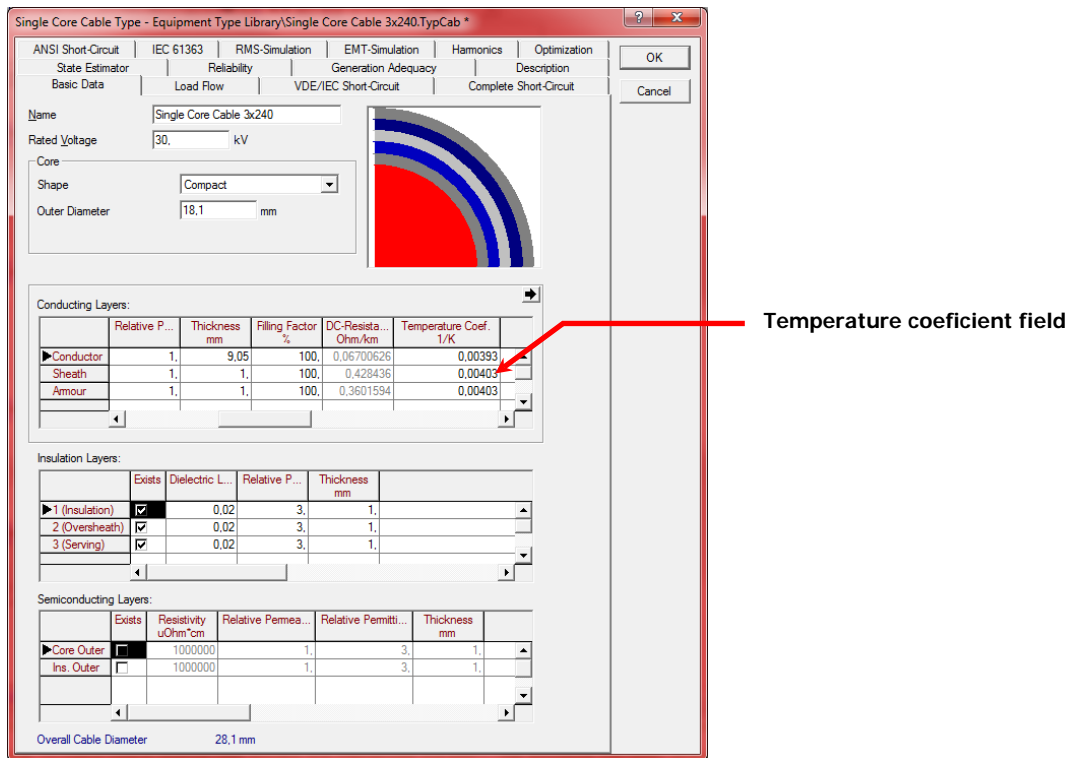
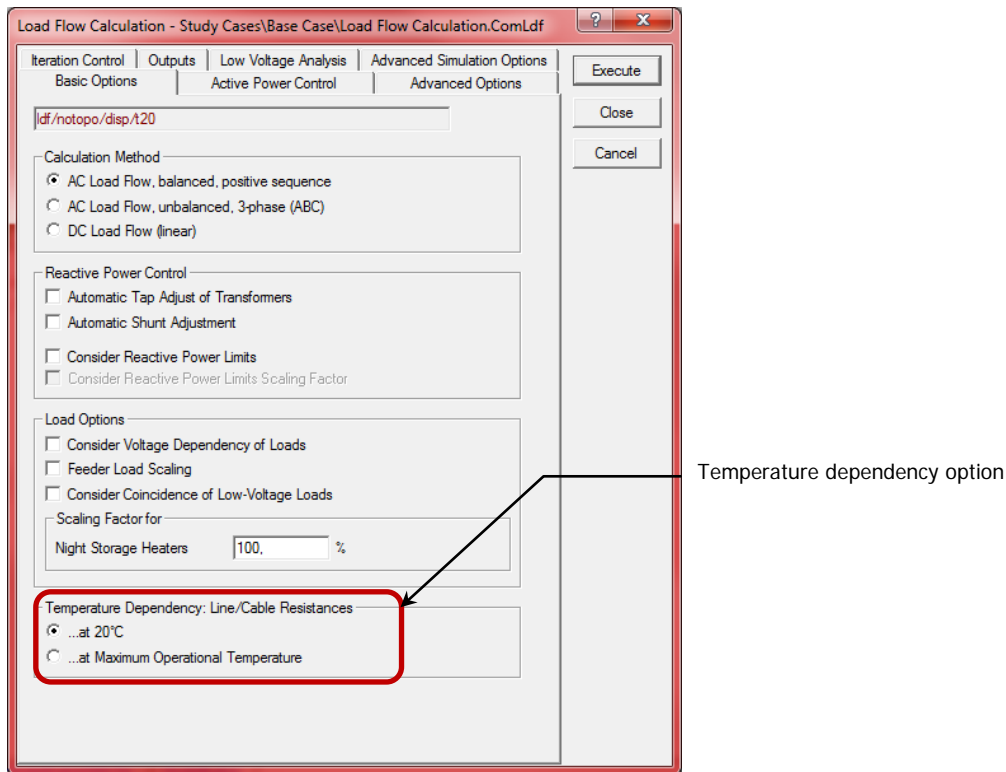


Figure 3.4 Temperature Dependency definition in the Cable Type

### 3.2.3 Load Flow Calculation



In **version 14.1** the “Temperature Dependency” of the resistance in lines, conductors and cables can be easily considered by using the new “Temperature Dependency” option located in the “Basic Options” tap page of the load flow command.



**Figure 3.5** Temperature Dependency option in the Load Flow Command

If option “**at Maximum Operational Temperature**” is selected; each conductor, cable or line will have its resistance adjusted according to the settings described in sections 3.2.1, 3.2.2.



As an extra note, the “Temperature Dependency” option is available for balanced (positive sequence) and unbalanced load flow calculations.

### 3.2.4 RMS and EMT Simulations

Whenever performing an RMS or EMT simulation, the user is required to calculate first the “Initial Conditions” of the system. Since the “Calculation of Initial Conditions” is based on the results of the load flow, the “Temperature Dependency” will be considered if the load flow command has this option enabled.



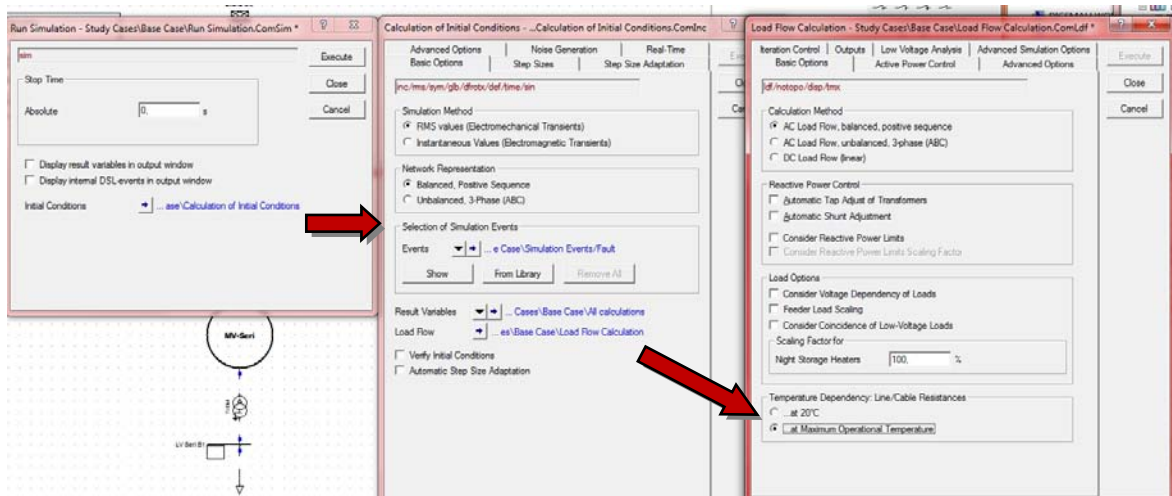


Figure 3.6 Links form the RMS/EMT Simulation Command to the Load Flow Command.

### 3.2.5 Short-Circuit Calculation: Complete Method

In case performing a Short Circuit calculation according to the “Complete Method”, two concepts have to be made clear: How the short circuit is **initialized** and how the short circuit is **calculated**.

**Short-Circuit initialization:** If the load flow initialization option is enabled (Advanced Option tab page) the “Temperature Dependence” of the resistance is done according to the settings in the load flow Command.

**Short-Circuit calculation:** If the calculate option is set to “Min. Short-Circuit Currents” then resistance values are corrected to maximum end temperature (**not maximum operation temperature**), otherwise resistance values referred to 20 °C.



**Important note:** If the load flow initialization is required for calculating pre-fault voltages/currents used by short-circuit calculation; the temperature value taken into account to perform resistance correction is the “Maximum operational temperature”. For short-circuit currents calculation however, the temperature value considered is “Maximum end temperature”.

### 3.2.6 Harmonic Load Flow Calculation

As in the previous short circuit section, the harmonic load flow calculation consists also of two concepts: How the harmonic load flow is **initialized** and how harmonic load flow is **calculated**.

**Harmonic Load Flow Initialization:** Resistance temperature correction option to be considered in Harmonic Load Flow Command (ComHldf) and Frequency Sweep Command (ComFsweep) is the same specified by the Load Flow Command pointed by these commands.

### 3.2.7 Updated “IEC Standard Cable” Global Library

As an additional note to the user, the “IEC Standard Cable” global library has been updated so that the available line types reflect correctly the following information:

- **Resistance at 20 °C** (“Basic Data” tab page)

- 
- **Maximum Operational Temperature** ("Load Flow" tab page)
  - **Conductor Material** ("Load Flow" tab page)
  - **Maximum End Temperature** ("Complete Short Circuit" tab page)

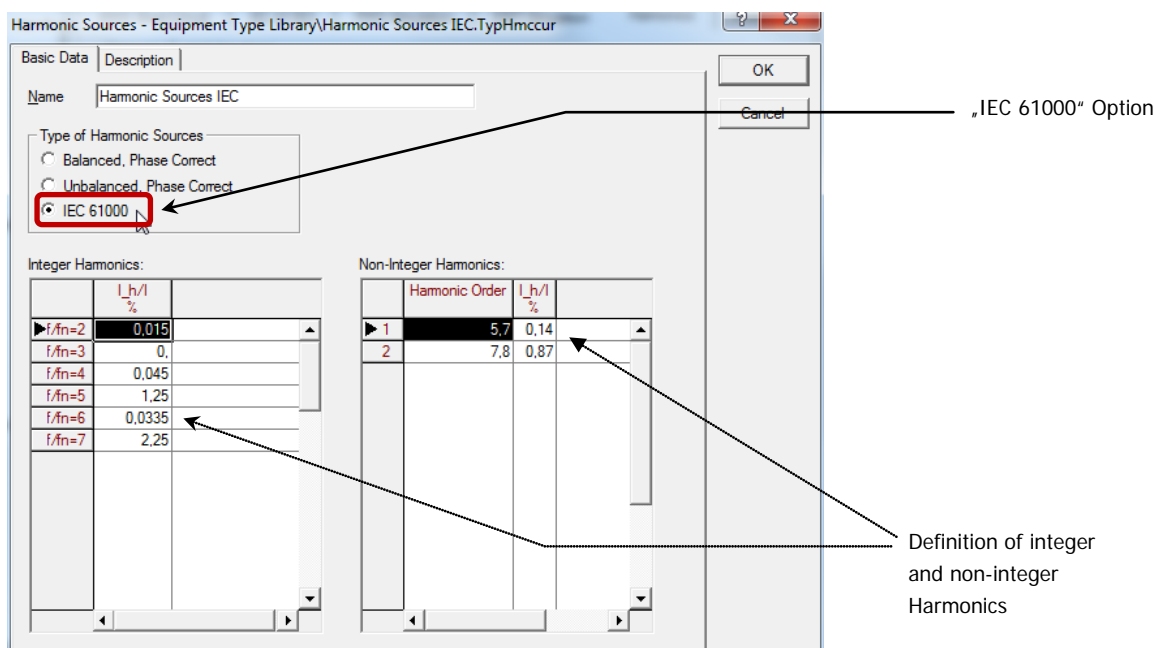
## 3.3 Harmonic Analysis according to IEC 61000-3-6

In previous *PowerFactory* versions, the harmonic load flow calculation according to IEC 61000-3-6 could be carried out via a DPL script. In any case, this involved the extra task of creating the DPL and setting it up every time the user wanted to apply it in other projects. In **version 14.1** this is now a “built in” function.

### 3.3.1 Harmonic Current Source Type (TypHmccur): “IEC 61000” Extension



In **version 14.1**, the ‘Basic Data’ page of the harmonic current source type (TypHmccur) contains a new option called ‘IEC 61000’ as shown in Figure 3.7. When selected, the user can enter the harmonic current injections for both integer and non-integer harmonic orders.



**Figure 3.7** New option for the Harmonic Current Source Type: ‘IEC 61000’

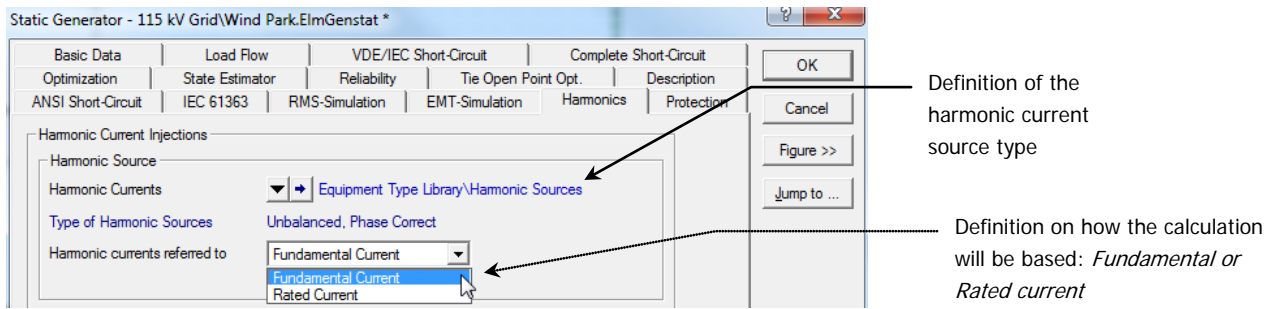
As in **version 14.0**, the following 3-phase models are capable of utilising the harmonic current source type:

- **Load** (ElmLod - ‘Type’ must be set to ‘Current Source’ on the ‘Harmonics’ page)
- **Static generator** (ElmGenstat)
- **AC current source** (ElmIac)
- **Static var system** (ElmSvs)
- **PWM converter** (ElmVsc, ElmVscmono)
- **Rectifier/Inverter** (ElmRec, ElmRecmono)

In all cases, the Harmonic Current Sources type is assigned on the element’s Harmonics tab page, under ‘Harmonic Currents’. This is illustrated in Figure 3.8 for the example of a Static Generator.



The option selected in the Harmonic Current Sources type dictates how the defined harmonic current injections will be treated by the Harmonic Load Flow algorithm.



**Figure 3.8** Harmonic current injections assignment to a static generator element



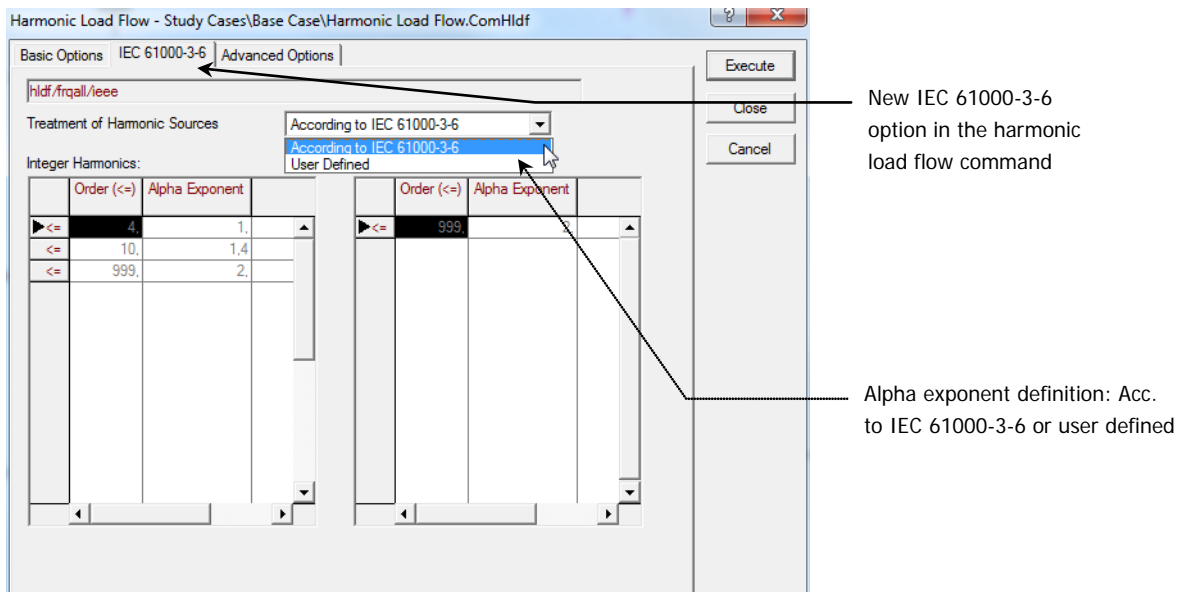
For phase-correct sources (balanced or unbalanced) a selection can be made between rated current and fundamental current. For IEC sources however, the calculation is always **based on rated current**.

### 3.3.2 Harmonic Load Flow Calculation

The harmonic load flow calculation in *PowerFactory* now supports the summation of harmonic currents and voltages according to the IEC 61000-3-6 standard (“second summation law”).



Due to this enhancement, the user will find a new page titled ‘IEC 61000-3-6’ in the Harmonic Load Flow command, as shown in Figure 3.9.



**Figure 3.9** Harmonic load flow option ‘According to IEC-61000-3-6’

Alternatively, the user can freely define the values for the alpha exponent for integer and non-integer harmonics, by instead selecting option ‘User Defined’.

Furthermore, the user has the option of calculating HD and THD based on rated current (for branches) and rated voltage (for buses), as shown on the ‘Advanced Options’ tab page in Figure 3.10.

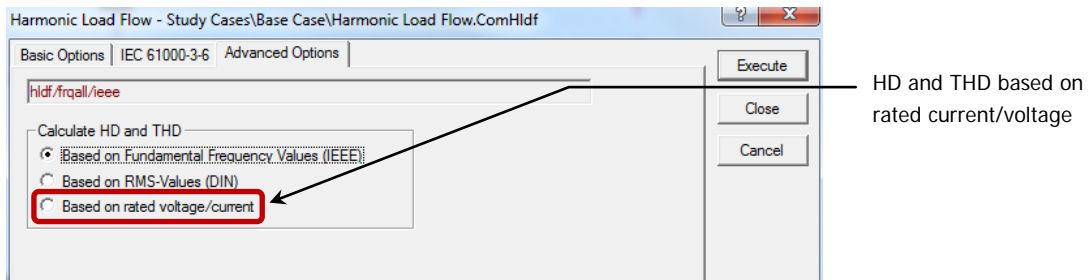


Figure 3.10 THD/HD calculation based on rated current/voltage

## 3.4 Flicker Assessment according to IEC 61400-21

As in the case of harmonic load flow calculation according to IEC 61000-3-6; in previous *PowerFactory* versions the Flicker assessment according to IEC 61400-21 could be carried out by means of a DPL script. In **version 14.1** this is also now a “built in” function.

### 3.4.1 Flicker Coefficient Type (TypFlicker)

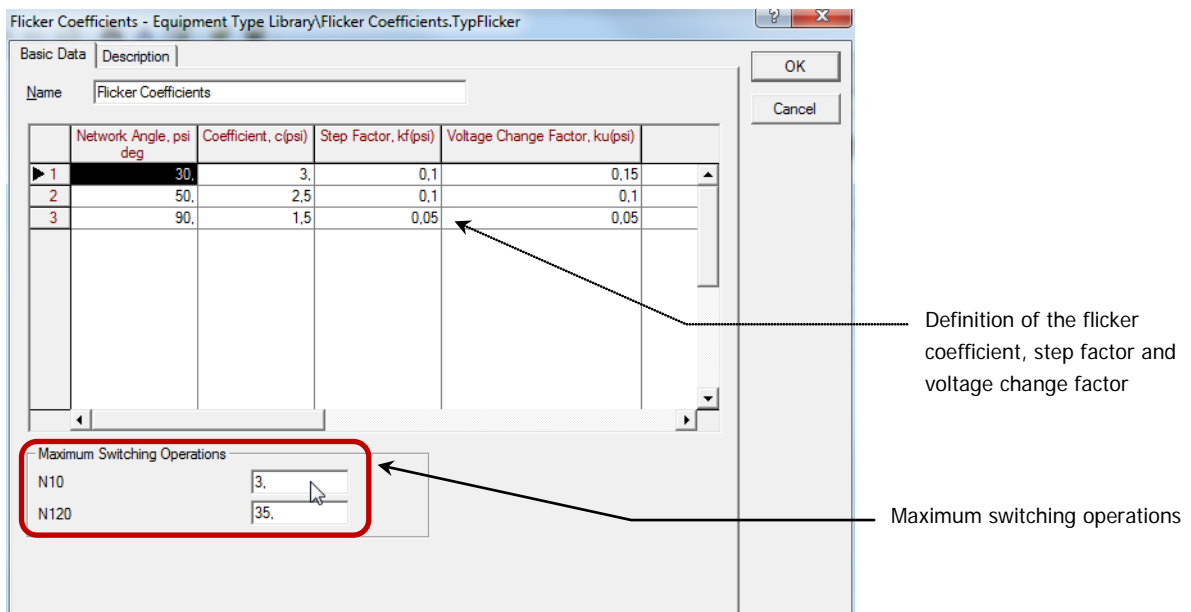


In **version 14.1**, a new Flicker Coefficient Type (TypFlicker) is available. Here the user is able to define for different network angles the following:

- **c(psi)** Flicker coefficient
- **kf(psi)** Flicker step factor
- **ku(psi)** Voltage change factor

also, the following maximum switching operations are defined:

- **N10** Max. no. of switching operations in a 10-minute period
- **N120** Max. no. of switching operations in a 120-minute period

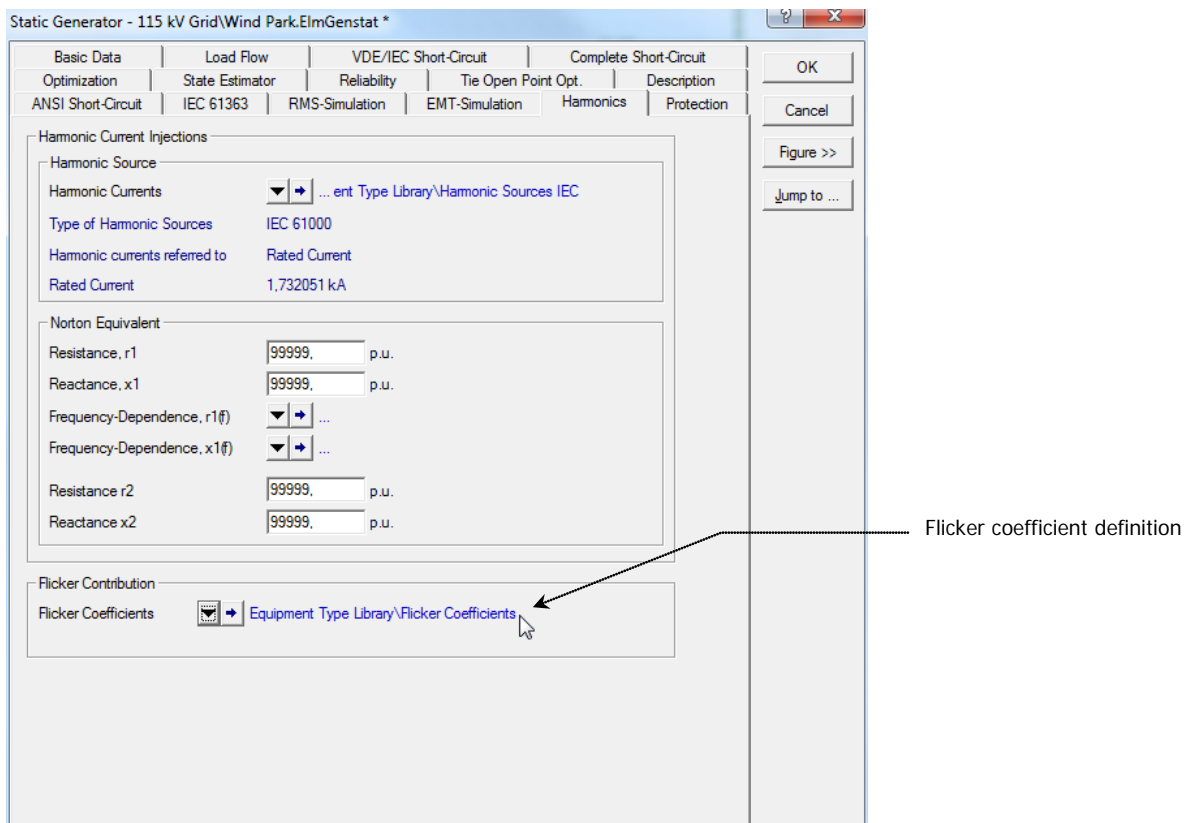


**Figure 3.11 Flicker Coefficient Type (TypFlicker)**

The following 3-phase models are capable of utilising the flicker type:

- **Static generator** (ElmGenstat)
- **Asynchronous machine** (ElmAsm)
- **Doubly-fed asynchronous machine** (ElmAsmsc)
- **PWM Converter** (ElmVscmono)

In all cases, the flicker coefficient type is assigned on the element's Harmonics tab page, under 'Flicker Contribution'. This is illustrated in Figure 3.12 for the example of a Static Generator.



**Figure 3.12 Flicker Coefficient assignments**

### 3.4.2 Flicker Assessment in the Harmonic Load Flow Calculation

The harmonic load flow calculation in *PowerFactory* now supports the calculation of Flicker according to the IEC 61400-21 standard.



Due to this enhancement, the user will find an additional option "Calculate Flicker" in the Harmonic Load Flow command, as shown in Figure 3.13.

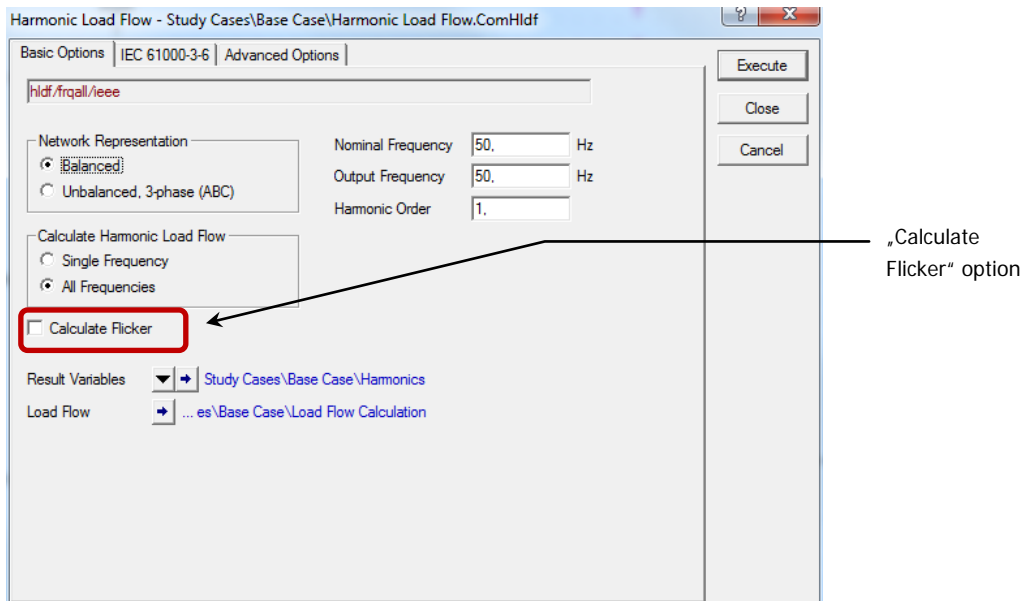


Figure 3.13 Calculate Flicker option in the Harmonic load flow command

## 3.5 The “Flickermeter” Tool (IEC 61000-4-15)



The IEC standard 61000-4-15 specifies the function and design of apparatus for the measurement of flicker. In **version 14.1** a user-interface for the calculation of the short-term and long-term flicker according to the IEC 61000-4-15 standard is now available.

### 3.5.1 Flickermeter Command (ComFlickermeter)

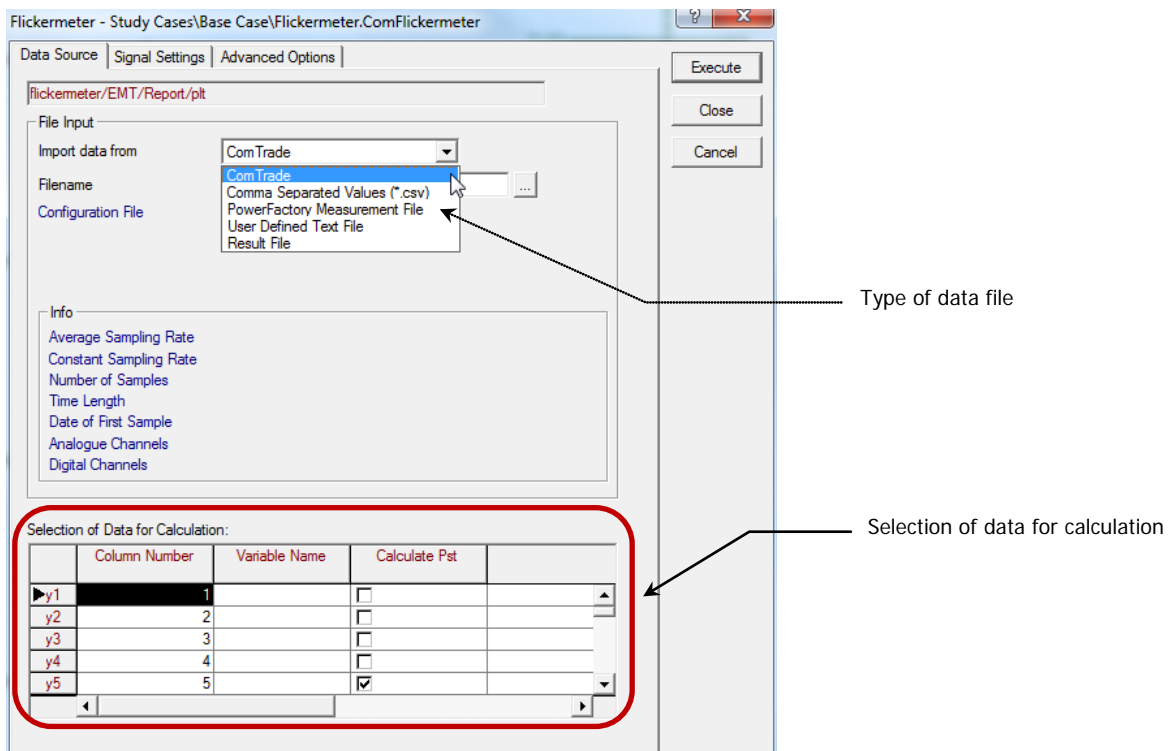
The user will find the Flickermeter button in the “Stability” toolbar definition.



By clicking on this button, the Flickermeter command window will open requesting the user to state the following data:

Parameter Name	Description
<b>Import data from</b>	Specifies the type of data file containing the input data (ComTrade, Comma Separated Values, PowerFactory measurement files, User defined text files)
<b>Filename</b>	The name of the input data file
<b>Configuration File</b>	The name of the corresponding configuration file (relevant for ComTrade input files only)
<b>Sampling Rate</b>	The sampling rate of the input data; either read from file or user-defined (dependent on input file type)
<b>Observation Period</b>	The time period over which the flicker should be analyzed
<b>Specify start time</b>	User-defined start time at which data should be read from file
<b>Calculate Plt</b>	Perform calculation of Plt (long-term) flicker contribution
<b>Number of Observation Periods</b>	The number of successive observation periods (or “time windows”) to analyze
<b>Selection of Data for</b>	This table allows the selection of which data to analyze from the input

Parameter Name	Description
Calculation	<p>file. The left-most column (y1,...,y24) provides a naming for the output of results of the Flickermeter calculation of which time-series signals were analyzed.</p> <p>The 'Column Number' refers to the column in the input file, of the time-series signal/s to be analyzed.</p> <p>For ComTrade files, the 'Variable Name' is automatically read from the input file and displayed. No variable name is provided for other file types.</p> <p>The 'Calculate Pst' column allows the user to select which signals are to be analyzed.</p>



**Figure 3.14 Flickermeter command window**

The Flickermeter command will write the results to a "result file" provided the option "Calculate Pst" has been selected. The results of the Flickermeter calculation can be also displayed in the output window if the user selects the option "Report" from the "Advanced Options" tab page.





### Questions & Answers:

**Q<sub>1</sub>:** Why is the “Flickermeter” button in the “Stability” toolbar? Shouldn’t it be located in the “Harmonics” tool bar instead?

**A<sub>1</sub>:** Since the files used by the Flickermeter tool are related to simulation type files (time) the idea is to have it also in the simulation (“Stability”) toolbar.

## 3.6 Generation Adequacy Assessment

The ability of the power system to be able to supply system load under all possible load conditions is known as 'System Adequacy'. Furthermore, the analysis can be extended so to determine the wind power capacity contribution to system adequacy.

In **version 14.1** a Generation Adequacy Tool is now available, allowing the user to examine the ability of the total system generation resources to cover the peak load, taking into account uncertainties in the generation availability and load level.



In **PowerFactory 14.1** the Generation Adequacy Assessment is carried out by means of the **Monte Carlo** method (probabilistic).

### 3.6.1 Stochastic Model for Generation Object (StoGen)



In **version 14.1**, a new Stochastic Model for Generation object (StoGen) is available. Here the user is able to define for different "generation states" the following:

- **Availability of Generation** (in %)
- **Probability of Occurrence** (in %)

State	Availability %	Probability %
1 State 1	100.	75.
2 State 2	75.	20.
3 State 3	20.	5.

*Figure 3.15 Stochastic Model for Generation Object (StoGen)*

### 3.6.2 Power Curve Type (TypPowercurve)



In **version 14.1**, a new Power Curve Type (TypPowercurve) is available. Here the user is able to define tabular input of wind speed (in m/s) vs. nominal power output (in p.u. or MW).

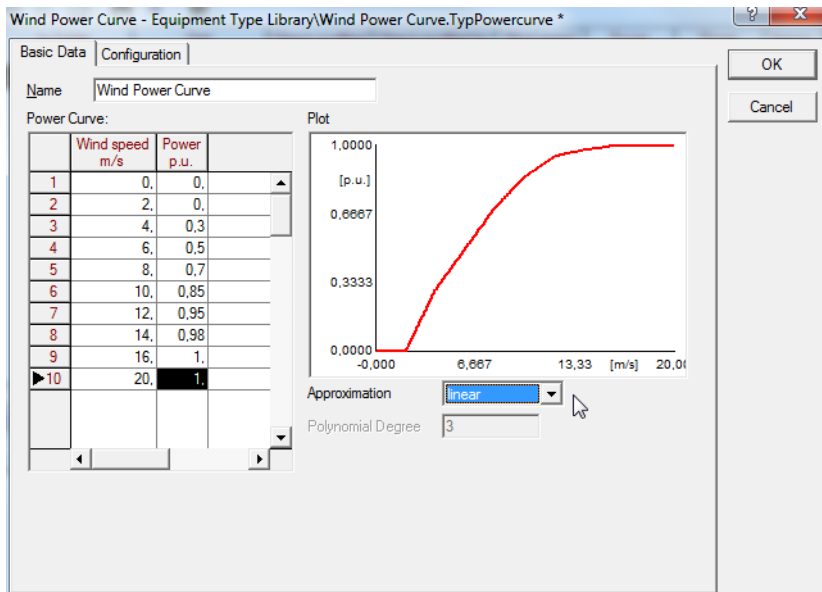


Figure 3.16 Power Curve Type (TypPowercurve)

### 3.6.3 Meteorological Station (ElmMeteostat)



In **version 14.1**, the user has the possibility of defining “groups” of wind generators according to their correlation. Several wind generators can refer to a single meteorological station, representing the case whereby several wind turbines may have identical or different average wind speeds, yet are correlated with one another. A new Meteorological Station Element (ElmMeteostat) is therefore available.

### 3.6.4 Definition of Dispatchable (Conventional) Generation



The following 3-phase models are capable of utilising the stochastic model object, **provided there defined as generators** and not as motors:

- **Synchronous machine** (ElmSym)
- **Static generator** (ElmGenstat) set as Fuel Cell, HVDC Terminal, Reactive Power Compensation, Storage, or other Static Generator
- **Asynchronous machine** (ElmAsm)
- **Doubly-fed asynchronous machine** (ElmAsmsc)

In all cases, the stochastic model object is assigned on the element’s “Generator Adequacy” tab page, under ‘Stochastic Model’. This is illustrated in Figure 3.17. Also, in order to consider the generation as “dispatchable”, the “Wind Generation” option in the “Basic Data” tab page of the synchronous, asynchronous, and doubly fed machine should be disabled. The static generator model in the other should be stated as Fuel Cell, HVDC Terminal, Reactive Power Compensation, Storage, or other Static Generator.

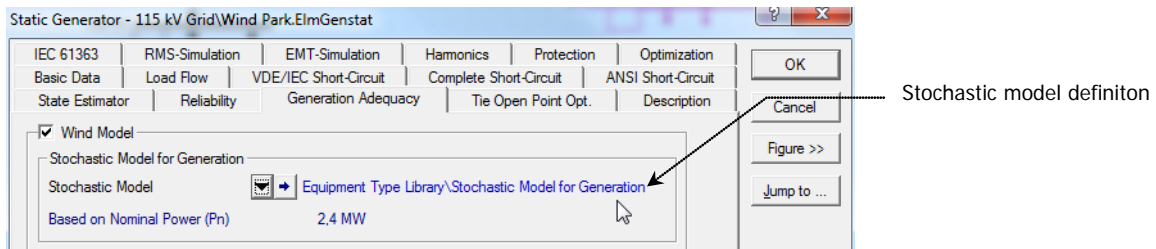


Figure 3.17 Stochastic Model for Generation Object (StoGen)

### 3.6.5 Definition of Non-Dispatchable (Wind and Renewable) Generation



As in the previous section, the following 3-phase models are capable of utilising the stochastic model object, **provided there defined as generators** and not as motors:

- **Synchronous machine** (ElmSym) set as "Wind Generator"
- **Static generator** (ElmGenstat) set as "Wind Generator", "Photovoltaic" or "Other Renewable"
- **Asynchronous machine** (ElmAsm) set as "Wind Generator"
- **Doubly-fed asynchronous machine** (ElmAsmsc) set as "Wind Generator"

In all cases, the stochastic model object is assigned on the element's "Generator Adequacy" tab page, under 'Stochastic Model'. As illustrated in Figure 3.17.

In addition to the stochastic model described above, a stochastic wind model may then be defined on the element's Adequacy page which provides:

- **Wind Model:**
  - Stochastic Wind Model (Weibull Model)
  - Time Series Characteristic of Active Power Contribution (MW)
  - Time Series Characteristic of Wind Speed (m/s)
- **Wind speed probability and mean wind speed** (via the definition of a Weibull curve)
- **Definition of wind generator power curve** (TyPowercurve)
- **Representation of correlation** (ElmWindzone)

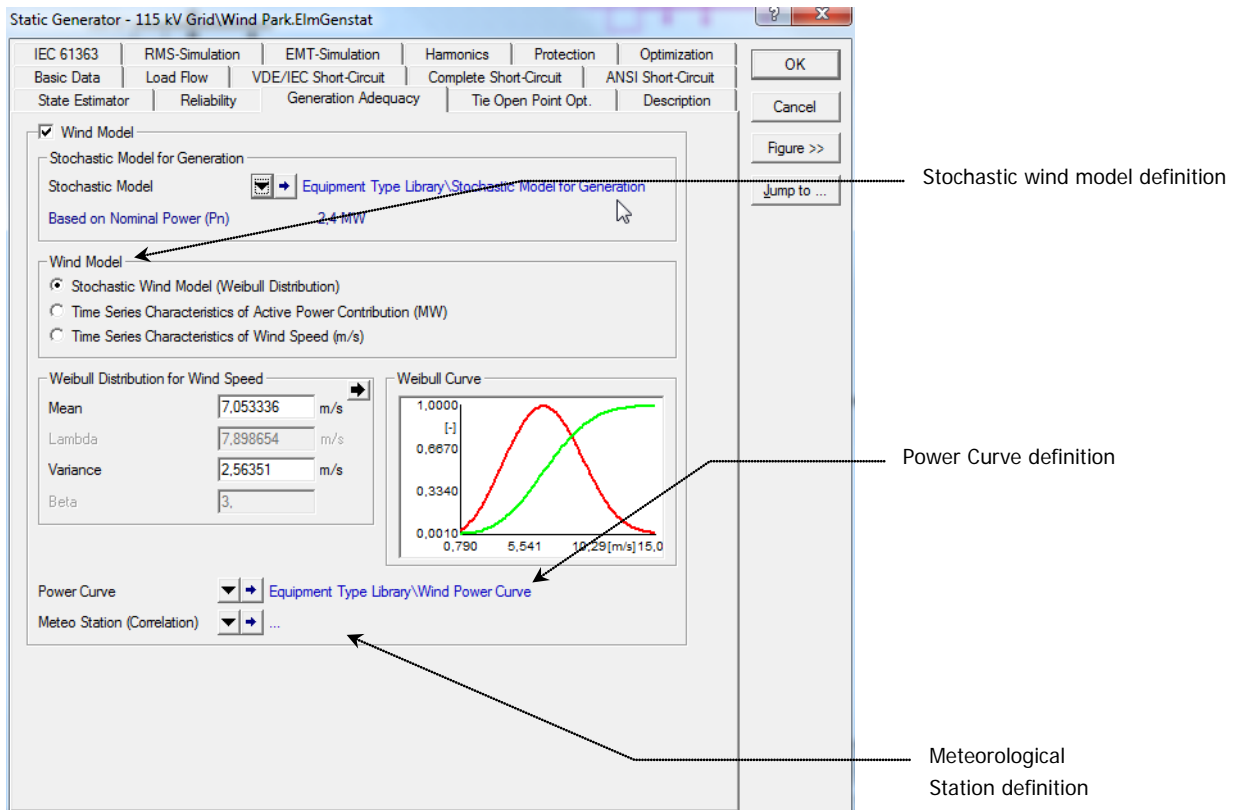


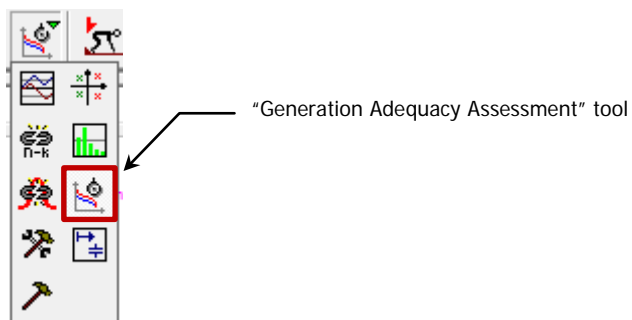
Figure 3.18 Specifying a stochastic wind model in a generator for Generation Adequacy

### 3.6.6 Definition of Demand

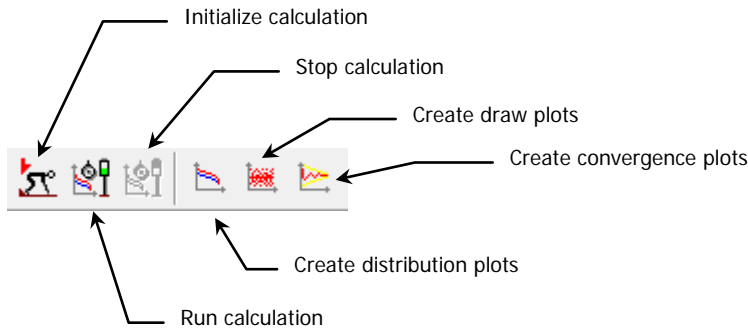
There are two alternatives to model the demand: **Fixed** and **Variable** demand. Fixed demand refers to a specific value of demand that does not change during the entire analysis. Variable demand means that the load varies on time. The demand elements do not have stochastic models attached. Instead, they may use time characteristics to model the time dependency.

### 3.6.7 Generation Adequacy Toolbar

The user will notice a new "Generator Adequacy Assessment" tool available.



where the available icons have the following functions:



### 3.6.8 Generation Adequacy Initialization Command

By clicking on the Initialize calculation button, the user can define the following data:

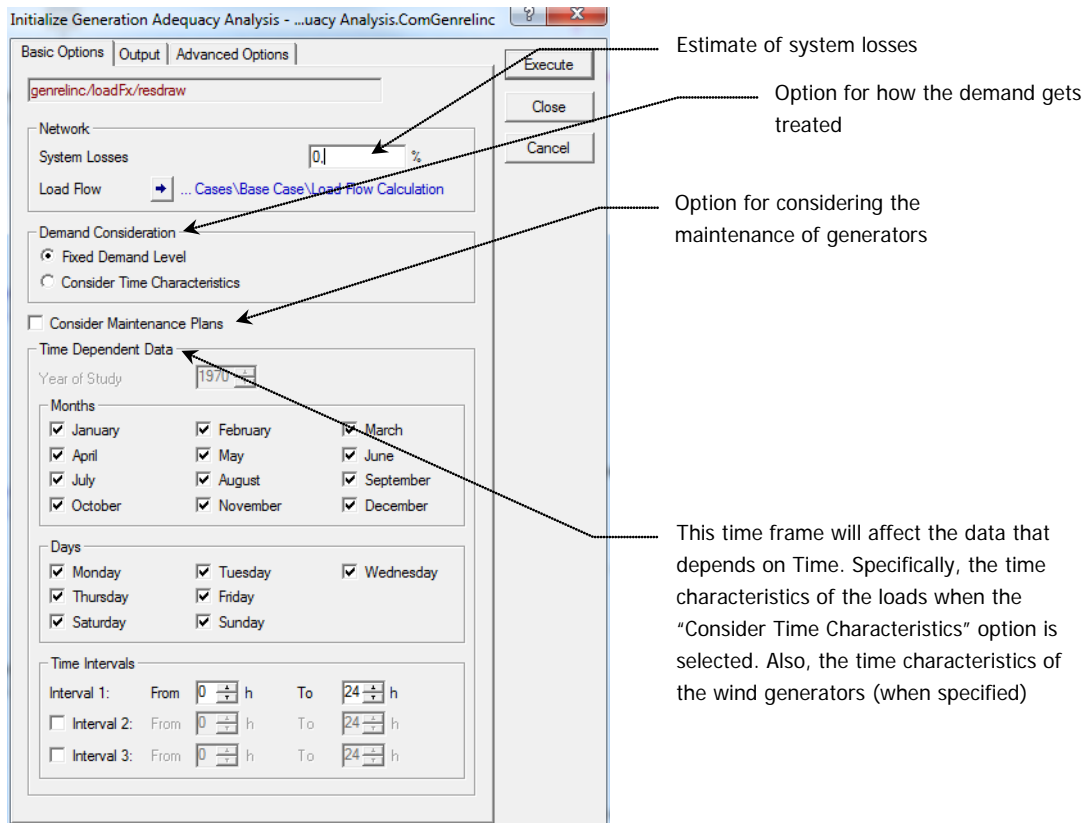


Figure 3.19 Generation Adequacy Initialization command

### 3.6.9 Generation Adequacy “Run Calculation” Command

By clicking on the “run calculation” button, the user can define the following data:

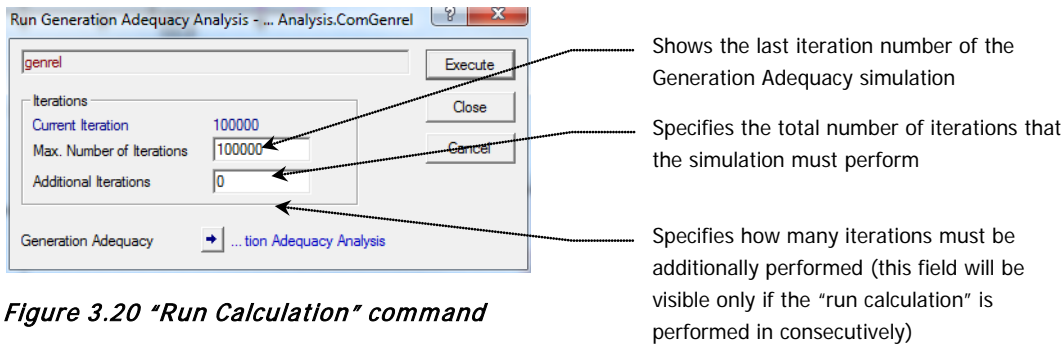


Figure 3.20 "Run Calculation" command

### 3.6.10 Results and Plots

After the generation adequacy has been performed, the following variables can be obtained:

- **Total Available Capacity**
- **Available Dispatchable Capacity**
- **Available Non-Dispatchable Capacity**
- **Total Generation (Unconstrained)**
- **Non-Dispatchable Generation (Unconstrained)**
- **Dispatchable Generation (Unconstrained)**
- **Total Reserve Generation (Unconstrained)**
- **Reserve Dispatchable Generation (Unconstrained)**
- **Reserve Non-Dispatchable Generation (Unconstrained)**
- **Total Demand (Unconstrained)**
- **Demand Supplied (Unconstrained)**
- **Demand Not Supplied (Unconstrained)**
- **Residual Demand (Unconstrained)**
- **Loss of Load Probability**
- **Incident indices**
- **Expected Demand Not Supplied**
- **Loss of Load Probability (LOLP) Average**
- **Variance**
- **Coefficient of Variation**

Also, three types of plots can be created automatically:

- **Distribution plots** (quantity value vs. aggregated probability in %)
- **Draw plots** (quantity value as calculated by the Monte Carlo analysis at each iteration)
- **Convergence plots**

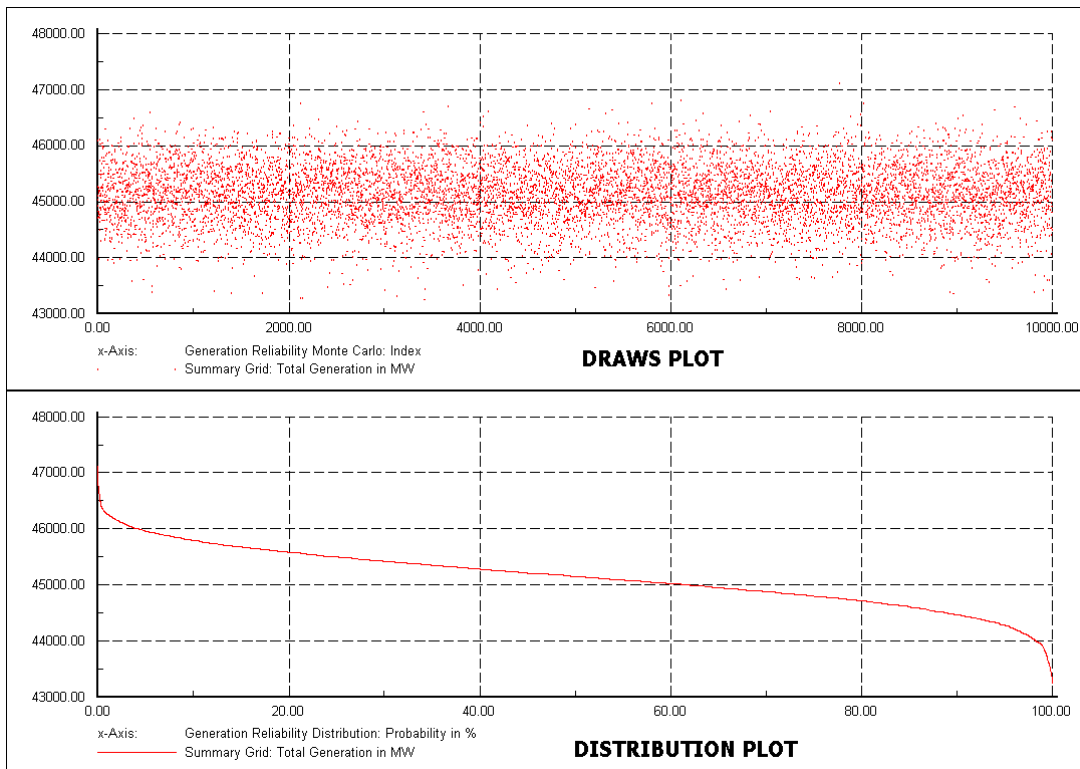


Figure 3.21 Distribution and Draw Plots



## 3.7 Enhancements in the Contingency Analysis

### 3.7.1 The “Parallel Computing” Option

Before going into detail with the “Parallel Computing” option, let’s review the Contingency Analysis definition: “to evaluate the violations in system operating states (if any) that certain contingencies can pose to the electrical power system”. If the reader has been involved with such type of analysis then it will be clear that the calculation time required mainly depend on two factors: 1) The size of the power system and 2) The Number of contingencies to be simulated. So it could happen that the simulation time required takes a couple of seconds (or less) or more than half an hour.



With the development of multi-core machines and also the well developed Ethernet network technology, the calculation of contingencies in parallel is now an option in **version 14.1**. This particular feature would allow reducing significantly the simulation time required depending on the amount of cores used.

#### Allowing “Parallel Computing”

There are two types of settings associated with the Parallel Computing option. The first and more general group of settings are the ones related to the management of the parallel computation function (computing method and the assignments of slaves). To access and modify these settings; log-on first as an administrator and afterwards open a Data Manager window. Locate and edit the Parallel Computing Manager (\System\Configuration\Parallel Computation\).

The users can however define their own settings by creating a system folder (with key "Parallel") under the folder "\\Configuration" and then creating the setting object "ComParalman". This can only be carried out when logged on as administrator.

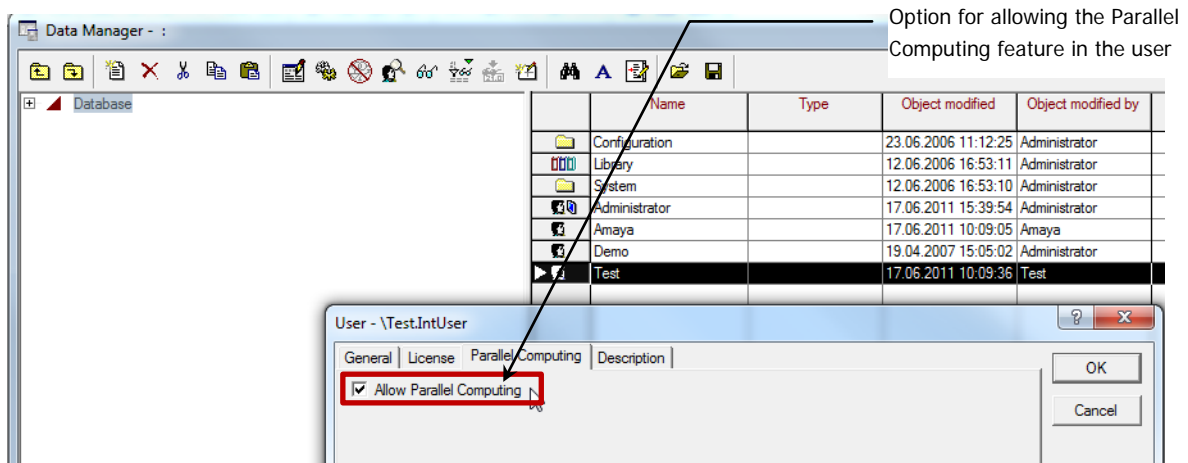


Figure 3.22 Allowing the Parallel Computing Feature

## “Parallel Computing” Main Settings

Once the user has logged on as an administrator, the settings (\Configuration\Parallel Computation\) of the “Parallel Computing” can be configured based on the following information:

- **Master host name or IP:** the machine name or IP address of the master host. If only the local multi-core machine is used, it could be filled up with “localhost”.
- **Parallel computing method:** 1) Multi-core local machine – all the slaves will be started in this machine. 2) Local machine plus remote machines – the slaves could be started in both the local machine and remote machines.
- **Number of slaves:** the number of slaves will be started in this local machine. This number should not be greater than the number of cores available in this machine.
- **Computer group:** the link to a computer group (number of remote machines) which will be used for parallel computing.

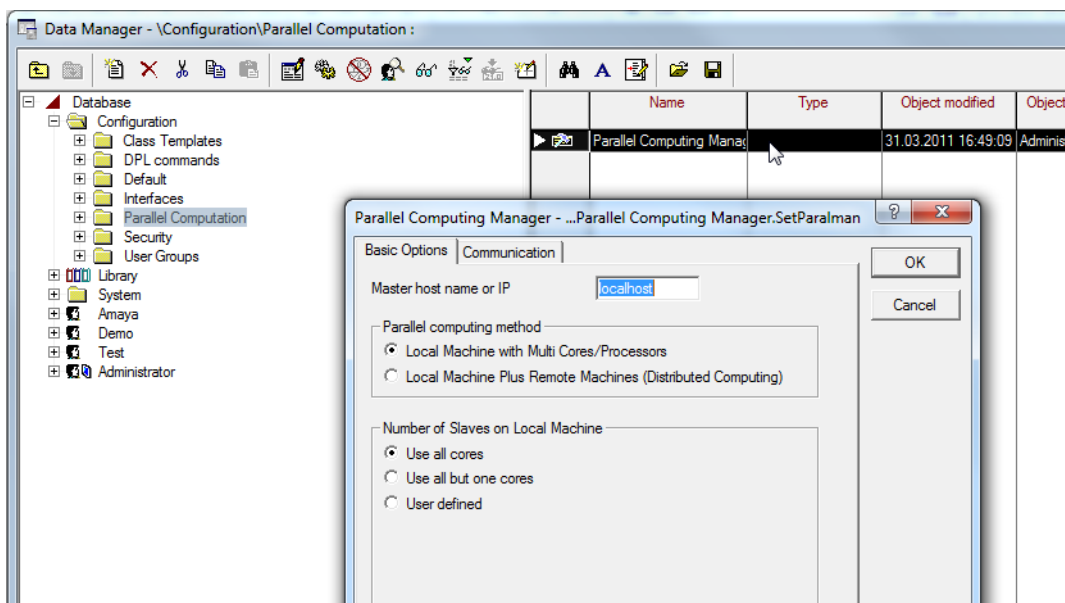


Figure 3.23 Parallel Computing settings

## Starting the “Parallel Contingency” Analysis

The user will notice a new page in the Contingency Analysis Command dialog – “Parallel Computing”:

- **Enable Parallel Contingency Analysis for AC, DC or Time Sweep** – If the corresponding option is not ticked, the contingency analysis works as default (sequential calculation). If the option is ticked, the contingencies will be calculated in parallel.
- **Minimum number of contingencies** – The parallel contingency analysis will be started only if the number of contingencies is greater than this setting. If there are only a few contingencies, it doesn’t make sense to calculate in parallel because it is time consuming to start slave engines and transfer network data.
- **Package size for optimized method and Package size for standard method** – The master distributes the contingencies to slaves per package. The package size means how many contingencies shall be calculated by a slave each time. The contingencies could be calculated using either optimized method or standard method. As the standard method is much slower than optimized method, the

package size of standard method should be smaller than optimized method to well balance the calculation.

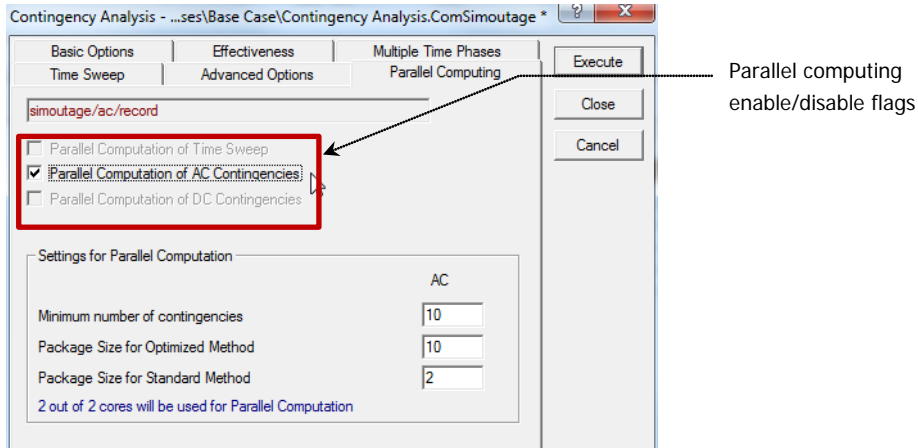


Figure 3.24 Contingency Analysis Command dialog – “Parallel Computing”



#### Questions & Answers:

**Q1:** Can I perform a contingency analysis with the “Parallel Computing” option on my “stand alone” computer?

**A1:** If your computer has more than one processing core then of course you can take advantage of this option. **Just remember**, if you have only a couple of contingencies defined, it doesn’t make that much sense to calculate them in parallel. You will even notice that the process is a little more time consuming because it needs to start slave engines and transfer data.

### 3.7.2 The “Time Sweep” Option

Consider having a Project set up with operational scenarios covering the 24 hours of the day and consisting also of variations. If the user wanted to calculate contingencies so to cover the 24 hours then this had to be accomplished with the use of a DPL.



In **version 14.1**, a new tab page is made available in the contingency analysis command - Time Sweep-. Here, by enabling the “Time Sweep” option, the user can define a number of study times. The execution of the “Time Sweep” will automatically then change the date and time of the active study case according to the list and run the contingency analysis. By having this option available, the user would be able to easily calculate the Contingencies over 24 hour span automatically.

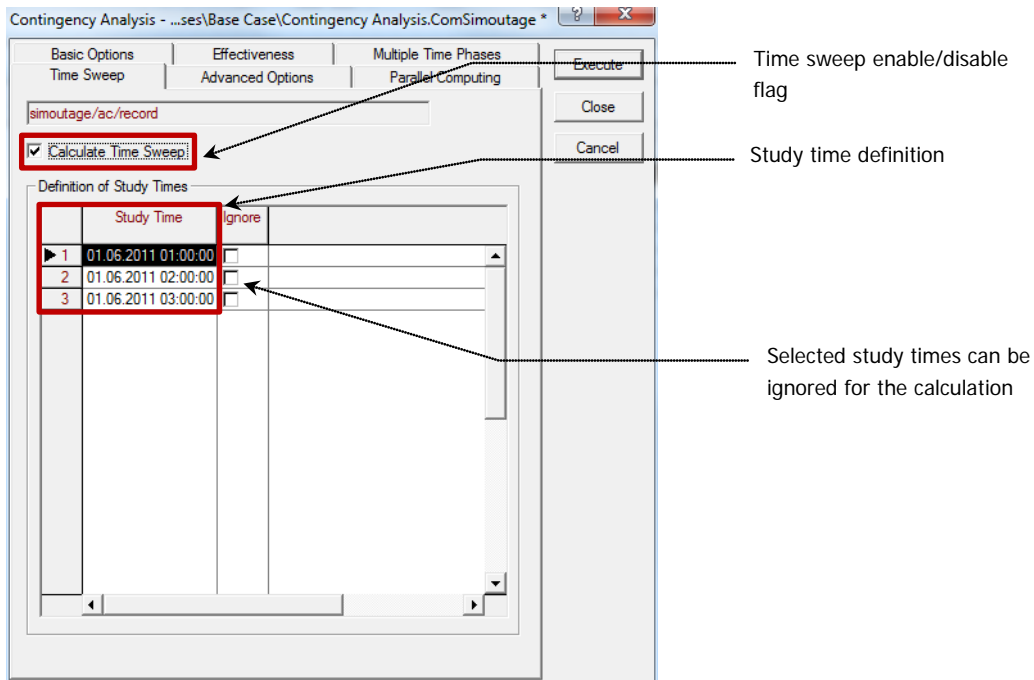


Figure 3.25 Contingency Analysis Command dialog – “Time Sweep”



As an important note, in order for the “Time Sweep” to activate the corresponding scenarios automatically, a “**Scenario Scheduler**” (IntScnsched) object needs to be created and activated (see chapter 2.2.7).

In addition, the user has the possibility of performing the “Time Sweep” with the option “Parallel Computing” enabled i.e. different study times are calculated simultaneously over several cores (or machines).



#### Questions & Answers:

**Q1:** Once the contingency “time sweep” analysis is finished, what would be the time and date of the study case? Will it be reset to its initial setting?

**A1:** **Yes!** At the end of the simulation, the “study case” date and time will be reset to its initial setting.

### 3.7.3 Considering Switching Rules

The Contingency Analysis can take into account the predefined Switching Rules. In order to specify, whether or not the Switching Rules shall be considered in the analysis the user will find an extra option in the “Advanced Options” tab page of the Contingency command.

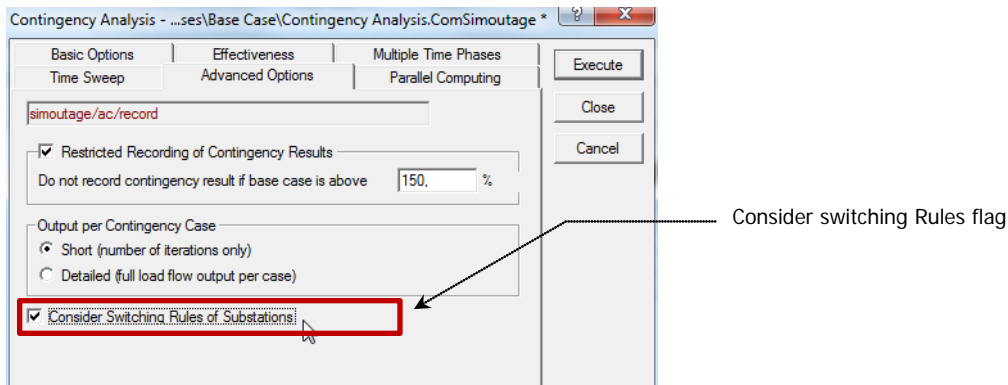


Figure 3.26 Contingency Analysis Command dialog – “Time Sweep”

### 3.7.4 New Tabular Standard Reports

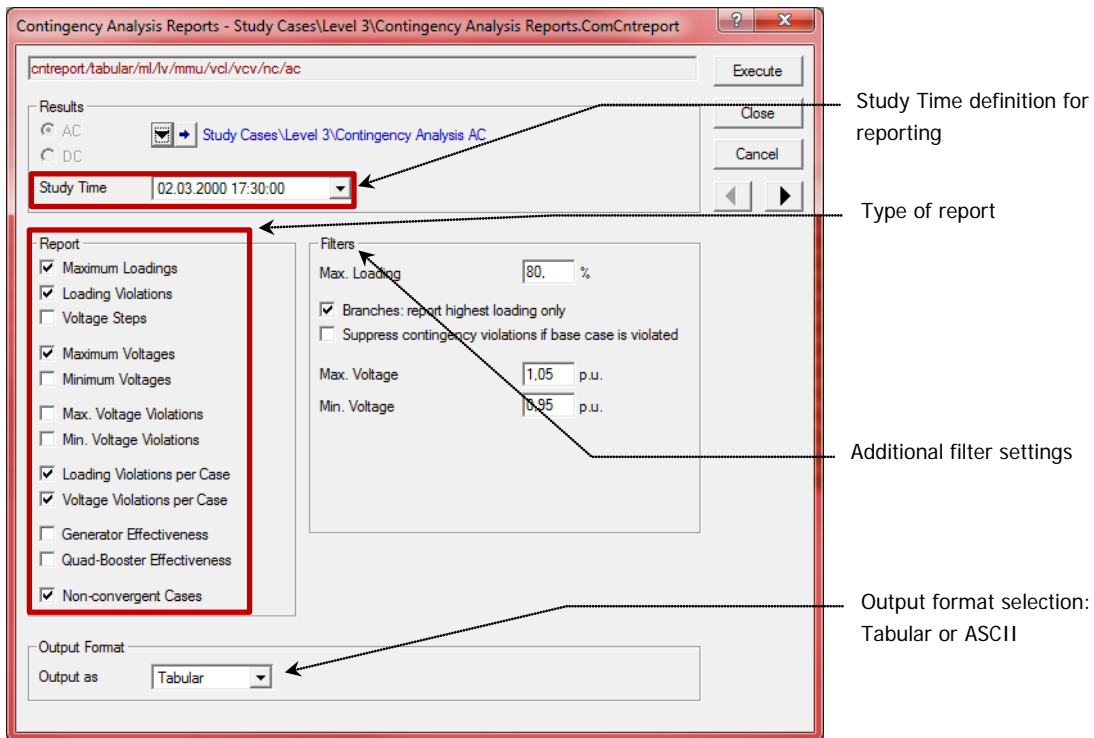


In **version 14.1**, once a “Contingency Analysis” has been performed, the user will have the option to choose between **ASCII** and **Tabular** formats for reporting. An extra “Report Contingency Analysis Results” button located in the “Contingency Analysis” toolbar will be therefore available.



By clicking on this button, the user will have the option of reporting the following:

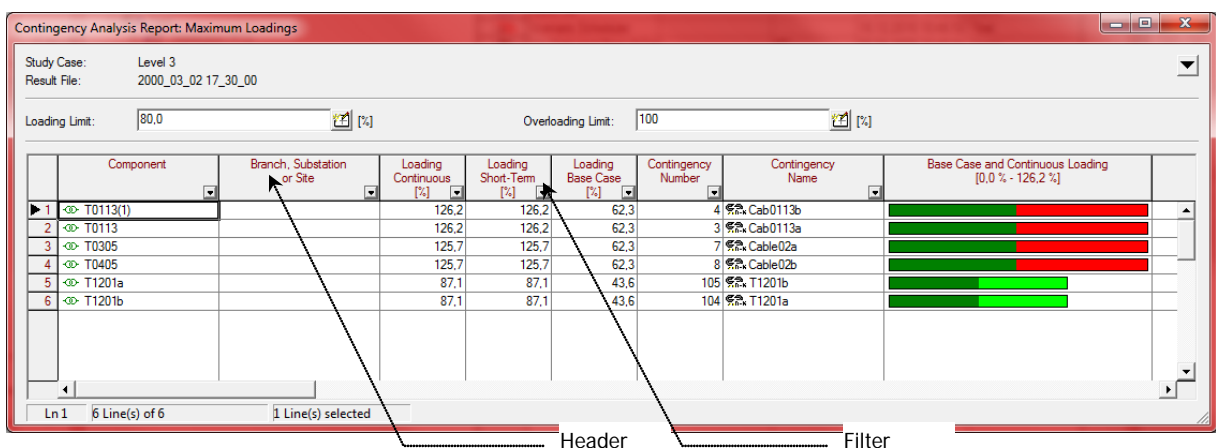
- **Maximum Loadings**
- **Loading Violations**
- **Voltage Steps**
- **Maximum Voltages**
- **Minimum Voltages**
- **Maximum Voltage Violations**
- **Minimum Voltage Violations**
- **Loading Violations per Case**
- **Voltage Violations per Case**
- **Generator Effectiveness**
- **Quad-Booster Effectiveness**
- **Non Converging Cases**



**Figure 3.27 Contingency Analysis Report dialog**

If the user selects a Tabular format for reporting, the tables displayed will be composed of the following sections:

- **Header:** Identifies the report and its data.
- **Filter:** Represented as drop-down lists, allowing the selection of one item at a time or as "Custom".
- **Table:** Matrix of rows and columns containing cells that can refer to an object and provide actions like "Edit", "Edit and Browse" and "Mark in Graphic". It also supports copy and paste, scroll features, page up and down keys as well as Ctrl+Pos1, Ctrl+End and HTML view.



**Figure 3.28 Tabular Report (Maximum Loadings)**



```

-----
|                               | DigSILENT | Project: |
|                               | PowerFactory |-----|
|                               | 14.1.0    | Date:    |
-----
| Contingency Analysis Report: Maximum Loadings | Loading Limit: 80,0 % |
-----
| Study Case: Level 3 | Annex: / 1 |
-----
| Component | Max. Loading [%] | Loading | Contingency |
|           | Cont. | Short-T. | Base | Number | Name | Interrupted Components |
-----
| T0113(1) | 126,2 | 126,2 | 62,3 | 4 | Cab0113b | Cab0113b |
| T0113 | 126,2 | 126,2 | 62,3 | 3 | Cab0113a | Cab0113a |
| T0305 | 125,7 | 125,7 | 62,3 | 7 | Cable02a | Cable02a |
| T0405 | 125,7 | 125,7 | 62,3 | 8 | Cable02b | Cable02b |
| T1201a | 87,1 | 87,1 | 43,6 | 105 | T1201b | T1201b |
| T1201b | 87,1 | 87,1 | 43,6 | 104 | T1201a | T1201a |
-----

```

**Figure 3.29 ASCII Report (Maximum Loadings)**

## 3.8 Enhancements in the Tie Open Point Optimization

### 3.8.1 New “Objective Function” option and the Consideration of Constraints

The basic objective of the “Tie Open Point Optimization” tool is to optimize an initially radial distribution network, such that it can continue its operation in a radial manner, while minimizing the system losses and respecting the specified thermal limits of the lines and the voltage constraints of the busbars.

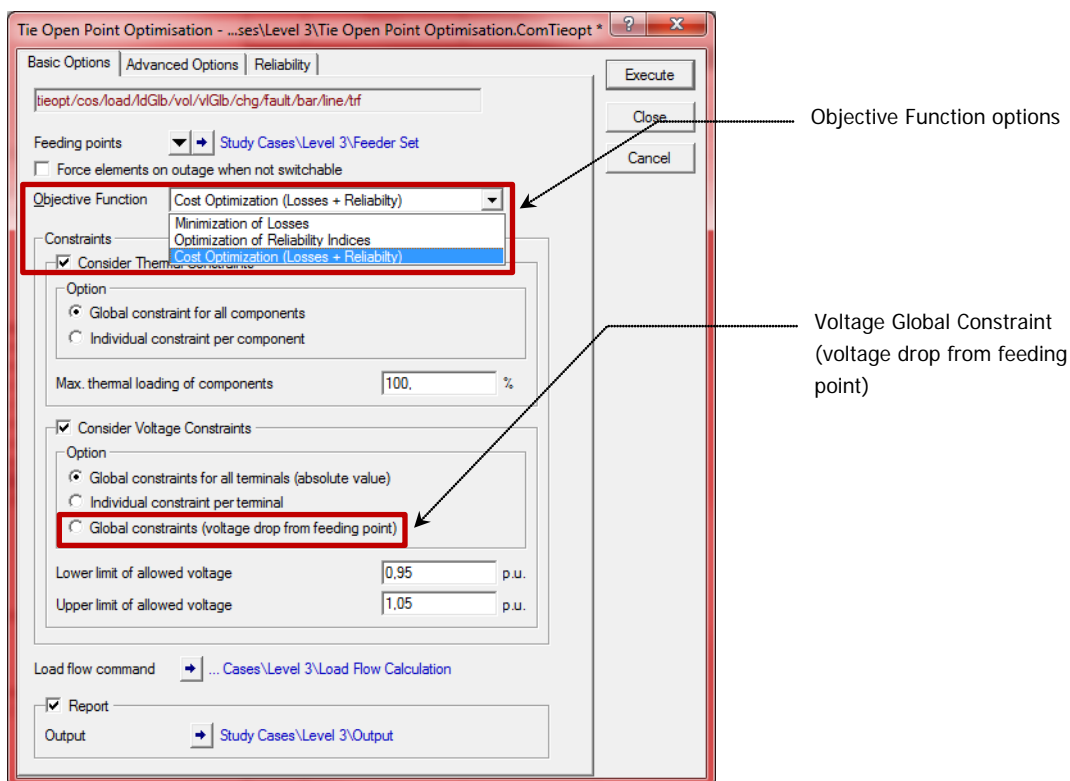


In **version 14.1** the algorithm is extended so besides “Minimizing System Losses”, two additional options are available to the user:

- **Optimization of Reliability Indices**
- **Cost Optimization** (Losses + Reliability)

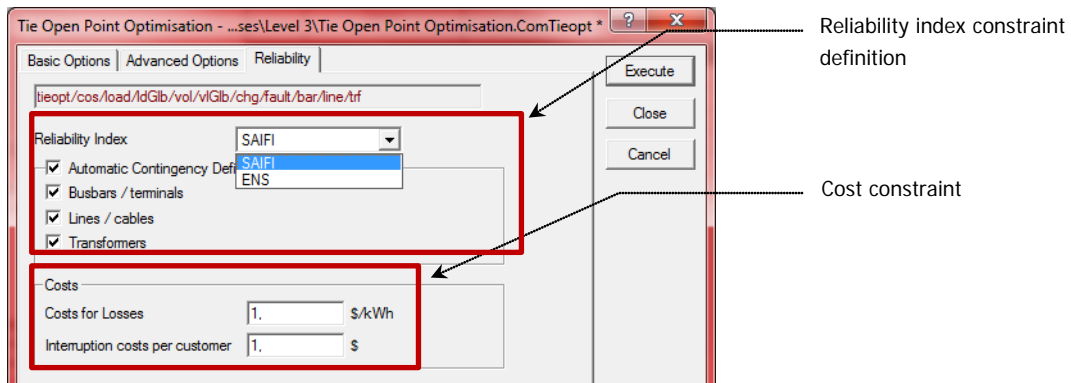
If the user selects one of the above, then the corresponding reliability indices (and costs) should be selected.

Another additional feature consists in the consideration of Global Constraints taking into account the voltage drop from the feeding point.



**Figure 3.30** Tie Open Point Optimization Command (Basic Options)





**Figure 3.31 Tie Open Point Optimization Command (Reliability)**

## 3.9 Enhancements in the Reliability Analysis

### 3.9.1 Optimal Power Restoration Strategies

In previous version, when the user performed reliability analysis, the fault restoration was achieved by closing the switches with smallest operation time. This however led sometimes to the overloading of elements and consequently reflected in load shedding.



In order to avoid unnecessary load shedding, the optimal power restoration strategies have been enhanced in **version 14.1**. Here the switching actions are found such that:

- **No constraint is violated** (thermal loading and voltage)
- **Number of switch actions is minimized**

Therefore, a combination of Reliability Analysis' simple Power Restoration algorithm with the Tie Open Point Optimization is defined.

## 3.10 Enhancements in Protection Models

### 3.10.1 Interlocking: Time-Overcurrent Diagram

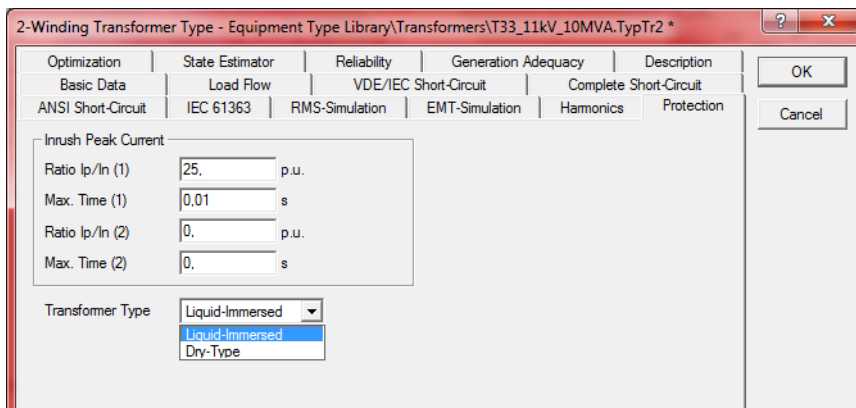
In cases where the user modeled protective devices with internal interlocking, the tripping time was not being correctly **plotted** in the time overcurrent diagram (the tripping time is correctly calculated).

In **version 14.1** the correct graphical representation of the internal interlocking is achieved.

### 3.10.2 IEEE C57.109: Transformer Damage Curve Extension

In **version 14.1** the IEEE C57.109 Transformer Damage Curve is extended so it considers the transformer as being:

- **Liquid Immersed** or
- **Dry-Type**

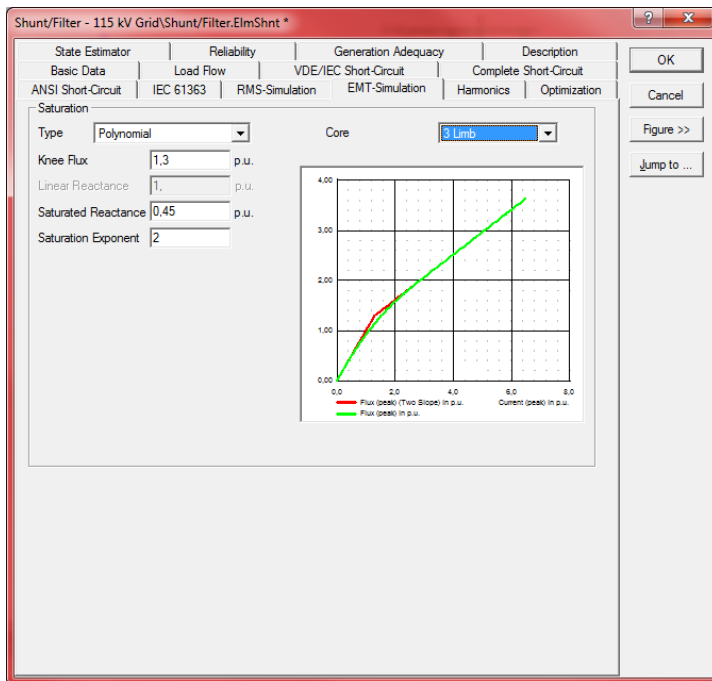


*Figure 3.32 Transformer Damage Curve (Transformer Type)*

## 3.11 Enhancement in the Shunt Element (ElmShnt)

### 3.11.1 Saturation Extension

Ever required modelling the saturation of a shunt reactor in an EMT simulation? In **version 14.1**, the shunt model is extended so that saturation can be now considered.



**Figure 3.33** EMT tab page of the Shunt Element

The saturation "Type" can be therefore defined as one of the following options:



- **Linear** No saturation considered
- **Two-Slope** Approximates the shunt saturation by two linear slopes
- **Polynomial** Saturation curve is represented by a polynomial of user-defined order
- **Current/Flux Values** Saturation curve is specified with user defined points



As an important note, the saturation model will be excluded (not considered) for C-Type shunts.

## 3.12 Enhancement in the Series Reactor Element (ElmSind)

### 3.12.1 Saturation Extension

As in the shunt reactor, in **version 14.1**, the series reactor model is extended so that saturation can be now considered.

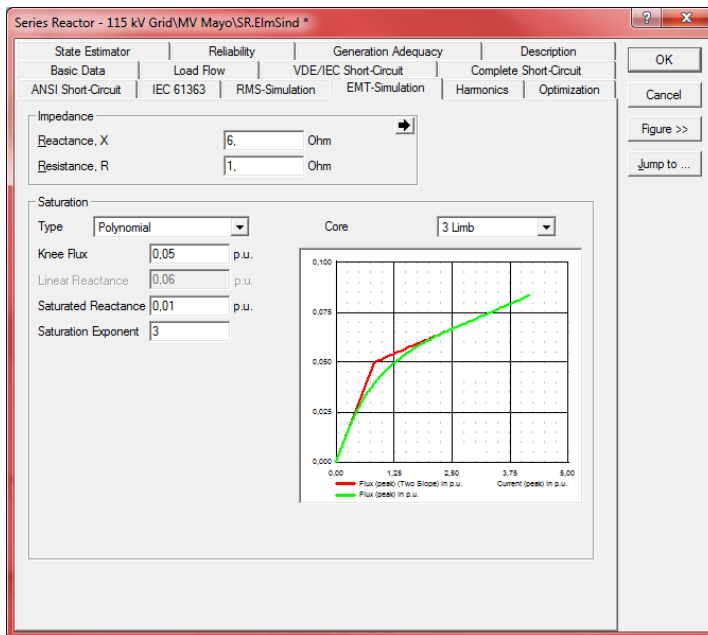


Figure 3.34 EMT tab page of the Series Reactor Element

The saturation “Type” can be therefore defined as one of the following options:



- **Linear** No saturation considered
- **Two-Slope** Approximates the shunt saturation by two linear slopes
- **Polynomial** Saturation curve is represented by a polynomial of user-defined order
- **Current/Flux Values** Saturation curve is specified with user defined points



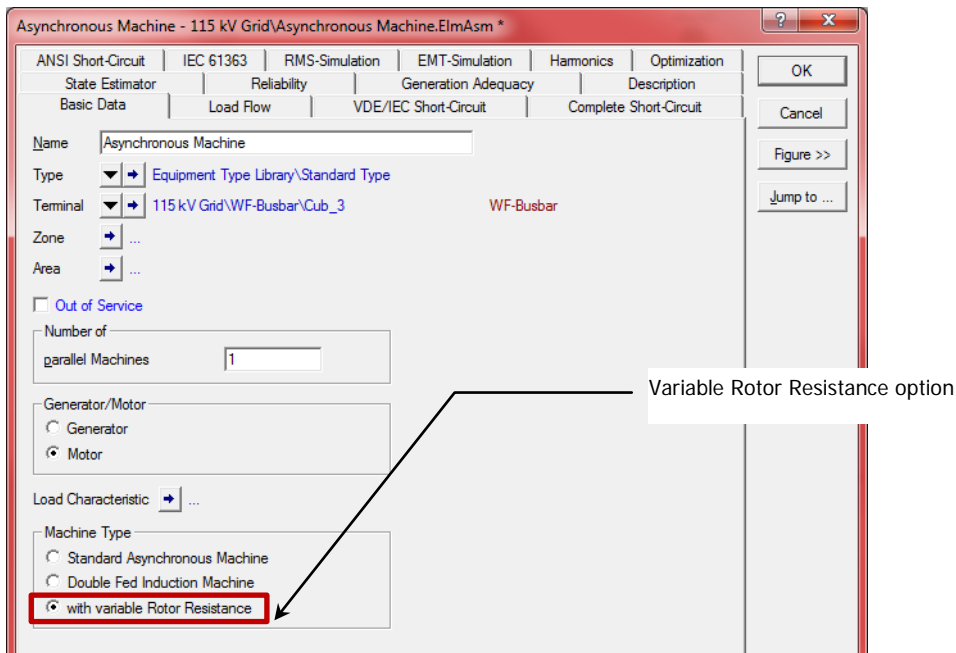
As an important note, the saturation model of the series reactor will be excluded (not considered) if:  
 the Reactance = 0, or  
 it's stated as a “DC series reactor”, or  
 if the input signal “Xin” is connected via a composite model

## 3.13 Enhancement in the Asynchronous Machine Element (ElmAsm)

### 3.13.1 Variable Rotor Resistance Extension

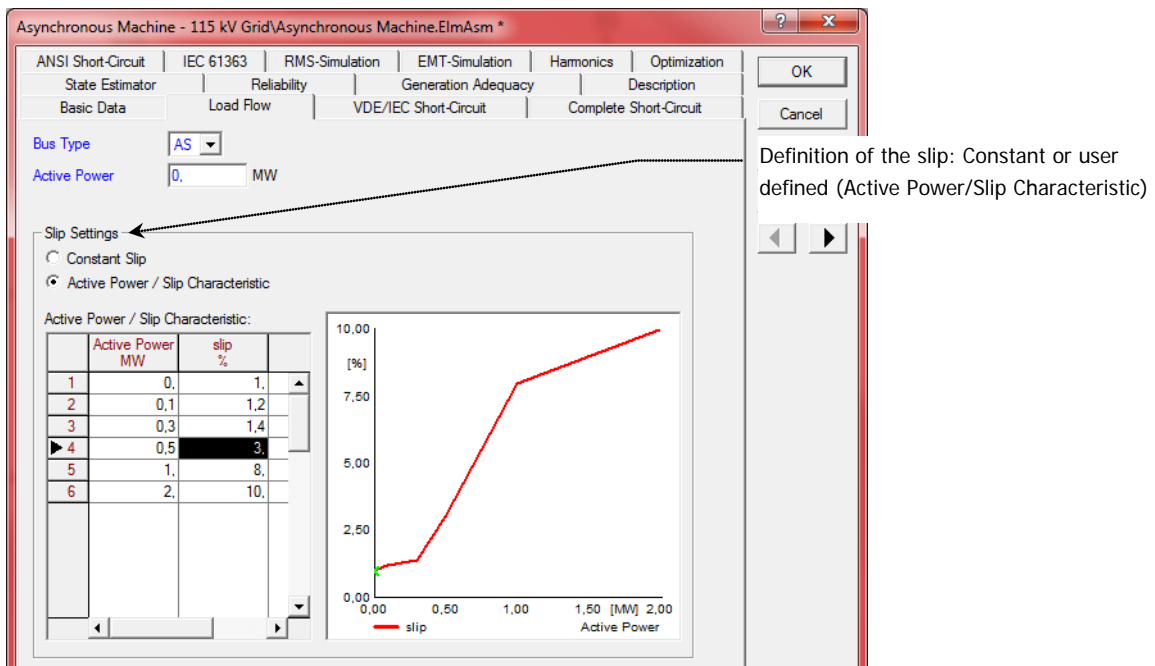


In **version 14.1**, the asynchronous machine model is extended so that a variable rotor resistance can be modelled in the load flow.



**Figure 3.35 Basic tab page of the Asynchronous Machine Element**

Once the option “with variable Rotor Resistance” is selected, the following additional settings will be available on the load flow page:



**Figure 3.36 Load Flow tab page of the Asynchronous Machine Element corresponding to a “Variable Rotor Resistance” selection**

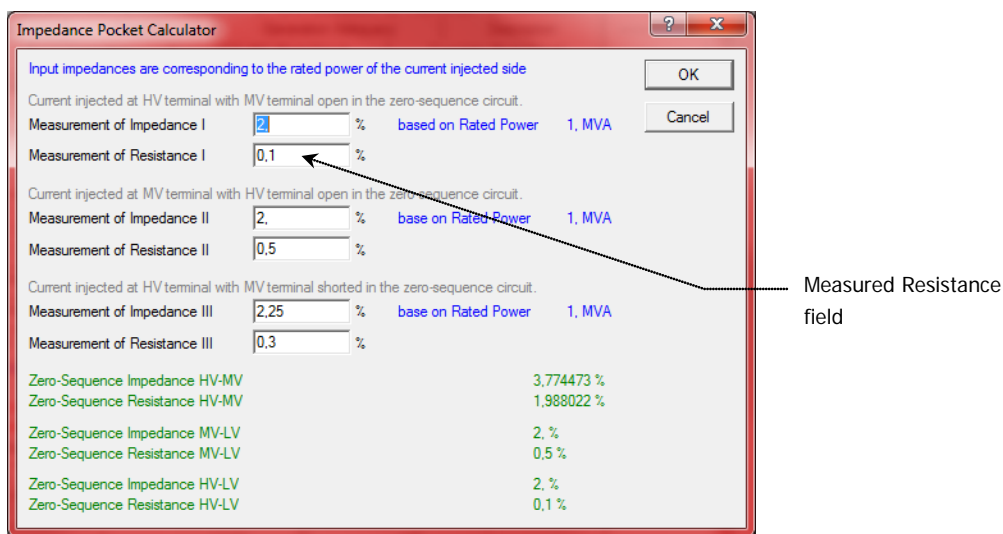
## 3.14 Enhancement in the 3-Winding Transformer Type (TypTr3)

### 3.14.1 Pocket Calculator Extension

The pocket calculator is a tool which transforms commonly measured impedance values of the 3-winding transformer into equivalent star-impedances in the zero sequence.



In **version 14.1**, the pocket calculator tool available in the 3-Winding Transformer Type is extended so that the measured resistances (not only impedances) are also considered.



Impedance Pocket Calculator

Input impedances are corresponding to the rated power of the current injected side

Current injected at HV terminal with MV terminal open in the zero-sequence circuit.

Measurement of Impedance I	2	%	based on Rated Power	1, MVA
Measurement of Resistance I	0,1	%		

Current injected at MV terminal with HV terminal open in the zero-sequence circuit.

Measurement of Impedance II	2,	%	base on Rated Power	1, MVA
Measurement of Resistance II	0,5	%		

Current injected at HV terminal with MV terminal shorted in the zero-sequence circuit.

Measurement of Impedance III	2,25	%	base on Rated Power	1, MVA
Measurement of Resistance III	0,3	%		

Zero-Sequence Impedance HV-MV	3,774473	%
Zero-Sequence Resistance HV-MV	1,988022	%
Zero-Sequence Impedance MV-LV	2,	%
Zero-Sequence Resistance MV-LV	0,5	%
Zero-Sequence Impedance HV-LV	2,	%
Zero-Sequence Resistance HV-LV	0,1	%

Measured Resistance field

Figure 3.37 The Pocket Calculator tool

## 3.15 Enhancement in the Voltage Measurement Device (StaVmea)

### 3.15.1 Simulation (Additional Output Signals)

In **version 14.1** additional zero sequence output signals are available:

- **u0r** Zero Sequence Voltage, Real Part
- **u0i** Zero Sequence Voltage, Imaginary Part
- **u0** Zero Sequence Voltage, Absolute

## 3.16 Enhancement in the Current Measurement Device (Stalmea)

### 3.16.1 Simulation (Additional Output Signals)

In **version 14.1** additional negative and zero sequence output signals are available:

- **i2r** Negative Sequence Current, Real Part
- **i2i** Negative Sequence Current, Imaginary Part

- **i2** Negative Sequence Current, Absolute
- **i0r** Zero Sequence Current, Real Part
- **i0i** Zero Sequence Current, Imaginary Part
- **i0** Zero Sequence Current, Absolute



## 4 Other Important Enhancements

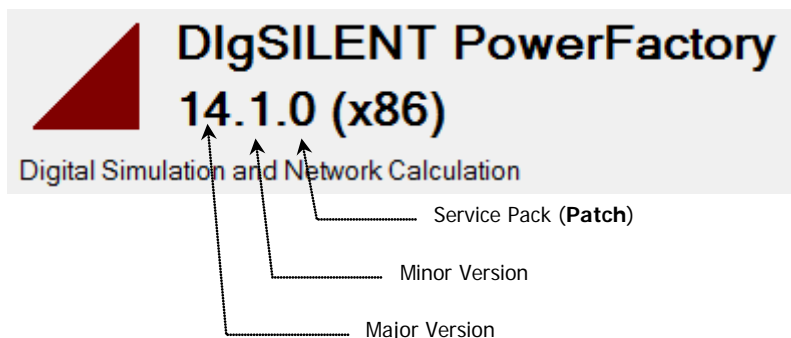
### 4.1 PowerFactory v14.1/ 32 & 64 Bit

*PowerFactory* **version 14.1** is now available in both 32 and 64 Bit architecture. One of the advantages that can be pointed out in a 64 Bit architecture is that it can handle more memory and larger files. Typically a 32 Bit architecture in windows based computers can handle up to 2GB in memory. In the case of a 64 Bit CPU, dependent on your computer system, it can handle much more.

### 4.2 PowerFactory Versioning

In order for the user to get a better understanding on the connotations used in the different *PowerFactory* releases, here are the following definitions:

- **Major Version:** In case of new "Major" versions, significant changes are carried out, e.g. changes in the data structure (13.2 →14.0), new and improved models and functions, and minor enhancements and fixes.
- **Minor Version:** In case of new "Minor" versions, minor changes are carried out, e.g. new and improved models and functions and minor enhancements and fixes.
- **Service Pack:** In case of new "service pack's" (**patch**), minor enhancements and fixes are performed.



As an important note, the database scheme is not changed when the Service Pack (patch) number is changed; **except for a BETA Version.**

### 4.3 CIM-ENTSO-E Profile

In **version 14.1**, both export and import of CIM (Common Information Model) is supported. The CIM interface is currently intended for importing/exporting the following profiles:

- UCTE May 2009
- ENTSO-E 2009

CIM is a standard of the International Electrotechnical Commission (IEC), and it's purpose is to allow the exchange of information related to the configuration and status of an electrical system.

## 4.4 Topological Processing: Breaker Reduction

Currently, there are several different ways to translate the original network to calculation network:

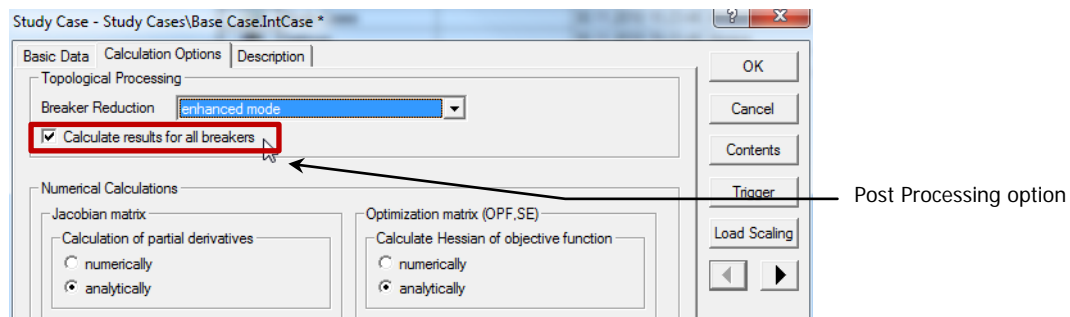
- **No reduction:** the network is one to one translated
- **Any suitable reduction:** the path composed of reducible elements between two bifurcations is reduced.
- **Fully enhanced reduction:** any reducible element will be reduced.

The last method (full enhanced reduction) has the best performance as it maximize the reduction. However, it has the following issue:

- **No results available for reduced elements**



In **version 14.1** a “Post Processing” option (Calculate results for all breakers) is available to retrieve the results for reduced elements. The option can be enabled from the “Calculation Options” of the study case.



*Figure 4.1 Study Case – Calculation Options – tab page*