Results Reporting

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How to see and analyse calculation results

Introduction

PowerFactory offers a diverse range of calculation functions, from load flow and short-circuit analysis through to many optional, specialist modules, such as Protection or RMS Simulation. But however good the calculations are, it is also important to users that they have the best tools to access and analyse those results efficiently. Sometimes an overview is needed; on other occasions it will be necessary to look closely at every detail. That's why *PowerFactory* allows access to calculation results in a number of different ways:

Output window	Shows the progress of the calculation, any errors and warnings, and in some cases a summary of the key results.
Diagram colouring	Offers a visual overview of calculation outcomes.
Diagram results boxes	Enable the user to look at precise calculation results in any specific part of the network.
Network Model Manager	For every active network element, all relevant results can be seen, in a spreadsheet format.
Plots	Many different types of plot, such as time-series, R-X, eigenvalue, vector plots. . .
Tabular reports	Flexible reports with filtering options, enabling the user to look at all results and easily find the main items of interest.
PDF reports	Easy-to-read presentation of results. Reports can also be exported from PowerFactory and shared with colleagues and clients.
User-defined reports	Options for users to access the raw results and generate their own customised reports.

In this paper, we present a number of different examples, to show how selected options might be employed, according to the task at hand. Other reporting options are also of course available in each case.

Example 1: Load Flow Analysis

Calculation purpose and typical reporting options

Load flow analysis is fundamental to the modelling and assessment of a network and underpins many other calculation functions. When a load flow calculation is run in *PowerFactory*, the results are held in memory and can immediately be viewed graphically and in the Network Model Manager without the need to run a report.

Selected Options:

- > Output Window
- > Diagram colouring
- > Diagram results boxes
- > Network Model Manager

Output window

The Output Window is an essential source of information, as it shows the progress of the calculation, with a level of detail that can be selected by the user. Importantly, it shows any warnings or errors. In general, the information in the Output Window can be filtered and searched, or copied to be used outside *PowerFactory*.

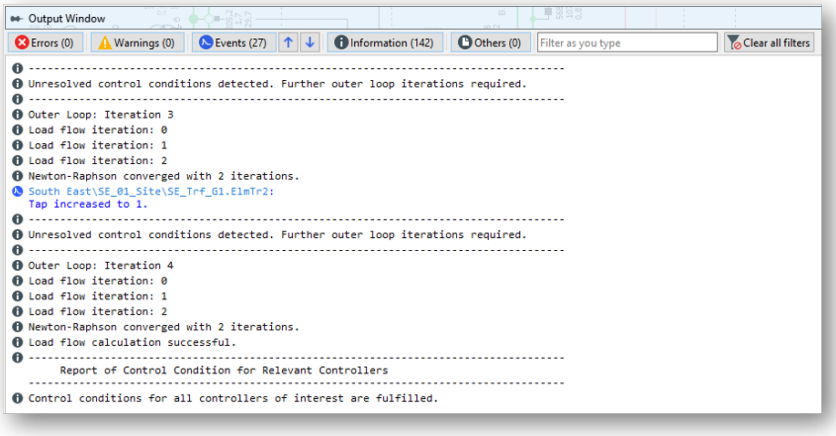
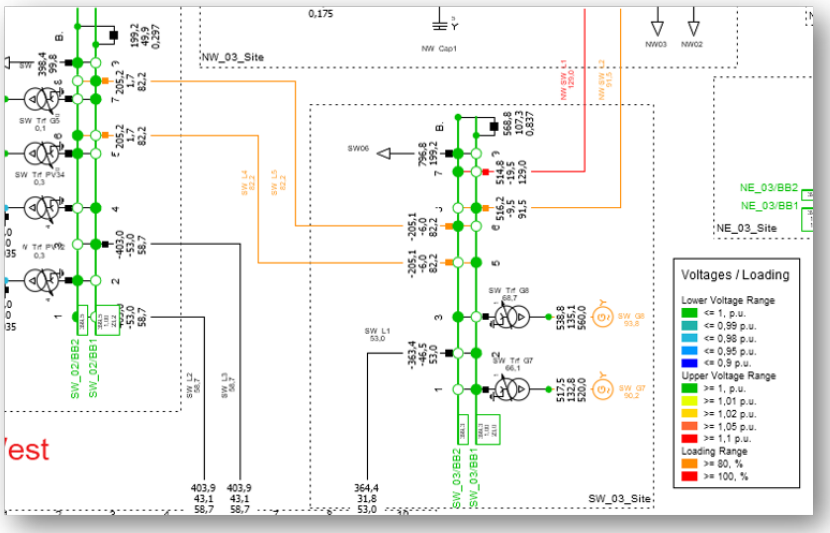


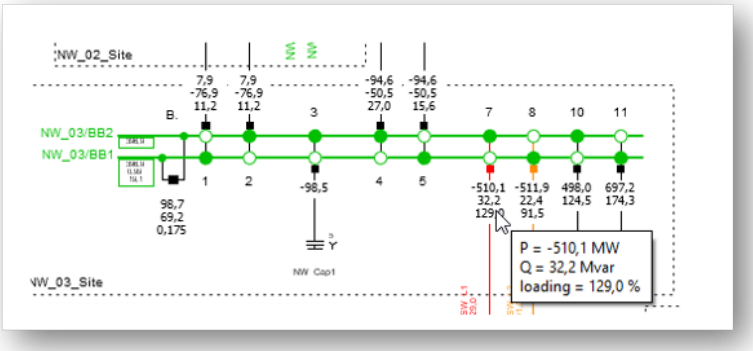
Diagram colouring



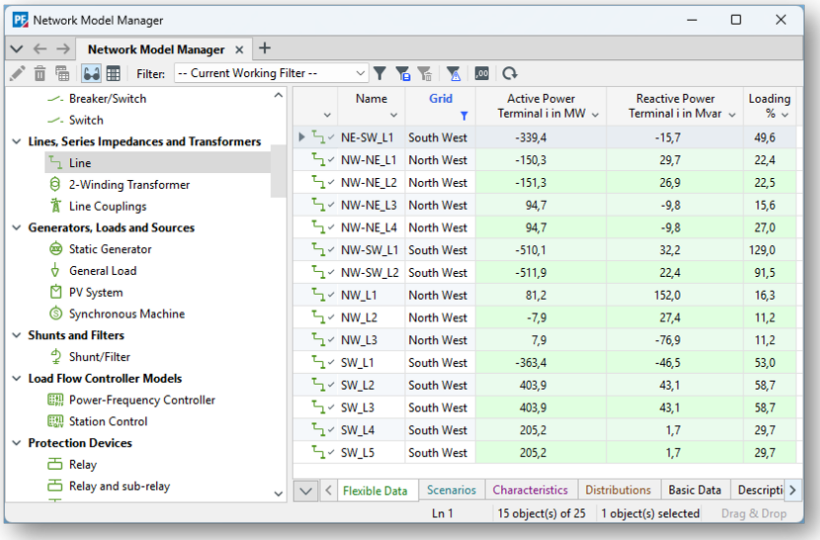
The default diagram colouring for load flow calculations gives a quick overview of the state of the network, highlighting any problems such as circuit overloading or voltages outside limits. The colour selection and thresholds are of course fully configurable. A heat-map option can be used to enhance the colouring.

Diagram results boxes

To see what is really going on in the network in detail, it can be useful to see power flows, currents etc. in a particular part of the network. The results boxes show calculation results for the various elements of the network, and are configurable in terms of content and format. Users can also create their own results boxes to show detailed or summary results.



Network Model Manager



The Network Model Manager enables the user to see attribute details and calculation results for each class of network element in the model. The information is presented in a tabular format, with sorting and filtering options. As well as standard tabs, a Flexible data page allows users to select exactly what they want to see. Data can also be copied and pasted into external tools such as MS Excel.

The ways of accessing calculation results that have been shown in this example for the load flow calculation are widely applicable *PowerFactory*, with many options for adapting them according to the analysis being carried out.

In the following examples, two other results reporting options are also explored: plots, which are an essential visualisation tool, and reports, which come in tabular or text format according to the requirements of the particular calculation function.

Example 2: Contingency Analysis

Calculation purpose and typical reporting options

Contingency Analysis, also referred to as n-1, is a load-flow assessment of the effect of fault outages on a network. As with many other calculation functions, the quantity of result variables and the fact that multiple results are recorded for each network element means that the results are held not in memory but in a results file.

Selected Options:

- Output Window
- Diagram colouring
- Tabular reports

Output Window

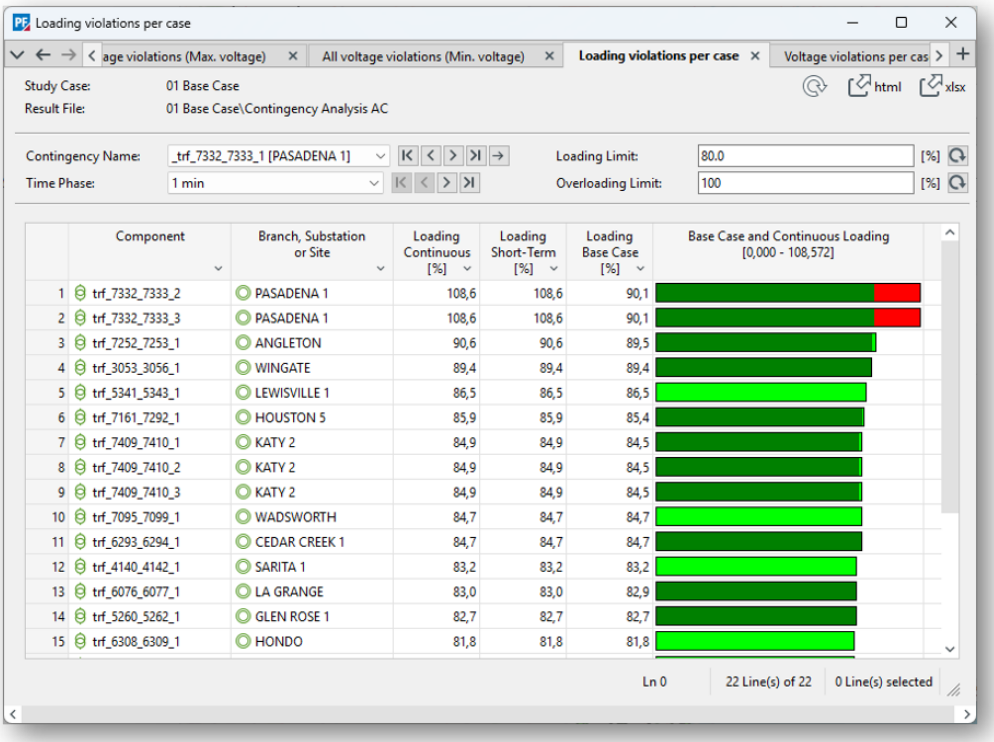
In the Output Window, the user can see the progress of the calculation, with options to show convergence details. Additional information such as remedial action scheme triggering (if used) will be provided.

Diagram colouring

Results shown on the diagram will just be those of the last-executed load flow, but the colouring indicates the worst limit violations out of all the contingencies.

Tabular reports

For functions such contingency analysis, which potentially generate a great deal of calculation output, tabular reports are the main tool for assessing the results. As well as summary report options, there are a range of different inbuilt reports that allow the user to easily assess the outcome of the contingency analysis. The reports include options to look at specific contingencies and specific time-phases, if used, and colouring to allow quick visual assessments.



Contingency Analysis tabular reports

Example 3: Time-Domain Simulations

Calculation purpose and typical reporting options

RMS and EMT simulations are used to assess the dynamic stability of a network, and look in detail at the transient effects of system disturbances. A typical case would be the use of an RMS simulation to study the dynamic response of the network when a short-circuit event occurs. The information in the output window is important, because events in the simulation are reported, together with any relevant warnings, but the main tool is the use of plots, which access the results in the results file and allow variables of interest to be seen over the simulation time period.

Selected Options:

> Output Window

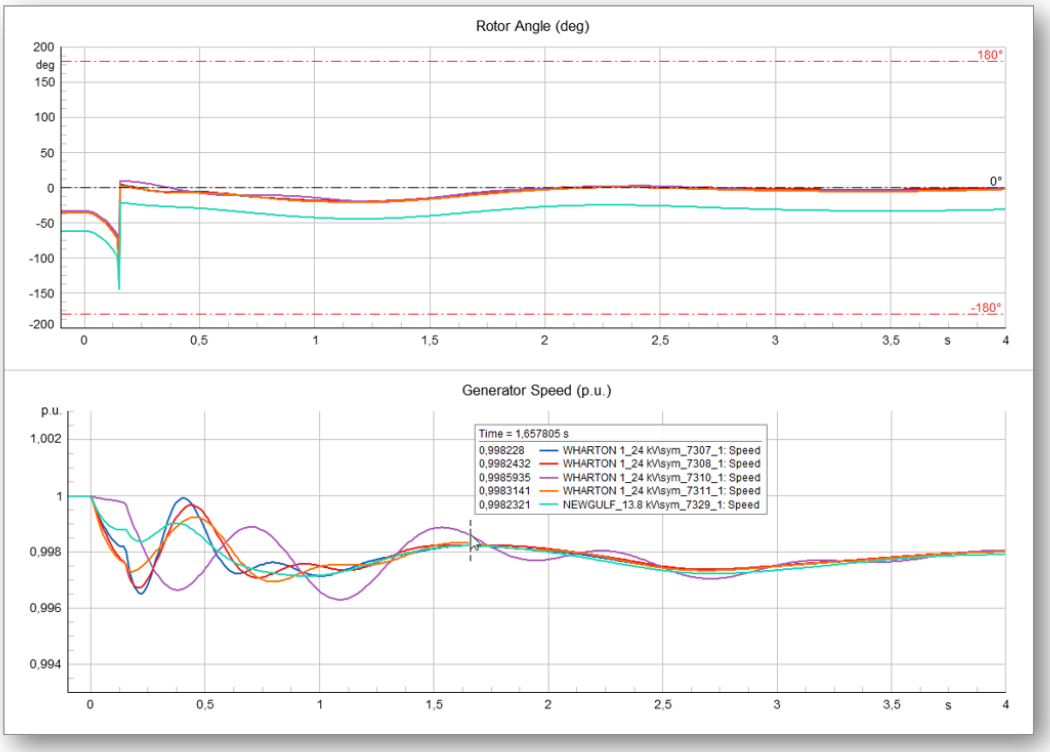
> Plots

Output Window

The progess of the simulation is shown in the output window, with information about simulation events, modelling warnings and other details being shown; the user has options to control how much information is displayed.

Plots

Plots are essential for the evaluation of any simulation. As part of the simulation set-up, the user can select which element variables should be recorded, and then easily configure plots to show the results, once the simulation has run.



RMS simulation plots

Of course, this is just one example; other calculations such as EMT Simulations, Quasi-Dynamic Simulations and Unit Commitment and Dispatch Optimisation also make use of time-based plots.

Example 4: Protection Functions

Calculation purpose and typical reporting options

The Time-Overcurrent Protection and Distance Protection modules functions in *PowerFactory* offer a great range of different features to support the protection engineer or system planner, including the Protection Coordination and Protection Audit. For some types of assessment, the diagrammatic information may be the most important output, but in other cases it is the detailed tabular output of results that is required.

Selected Options:

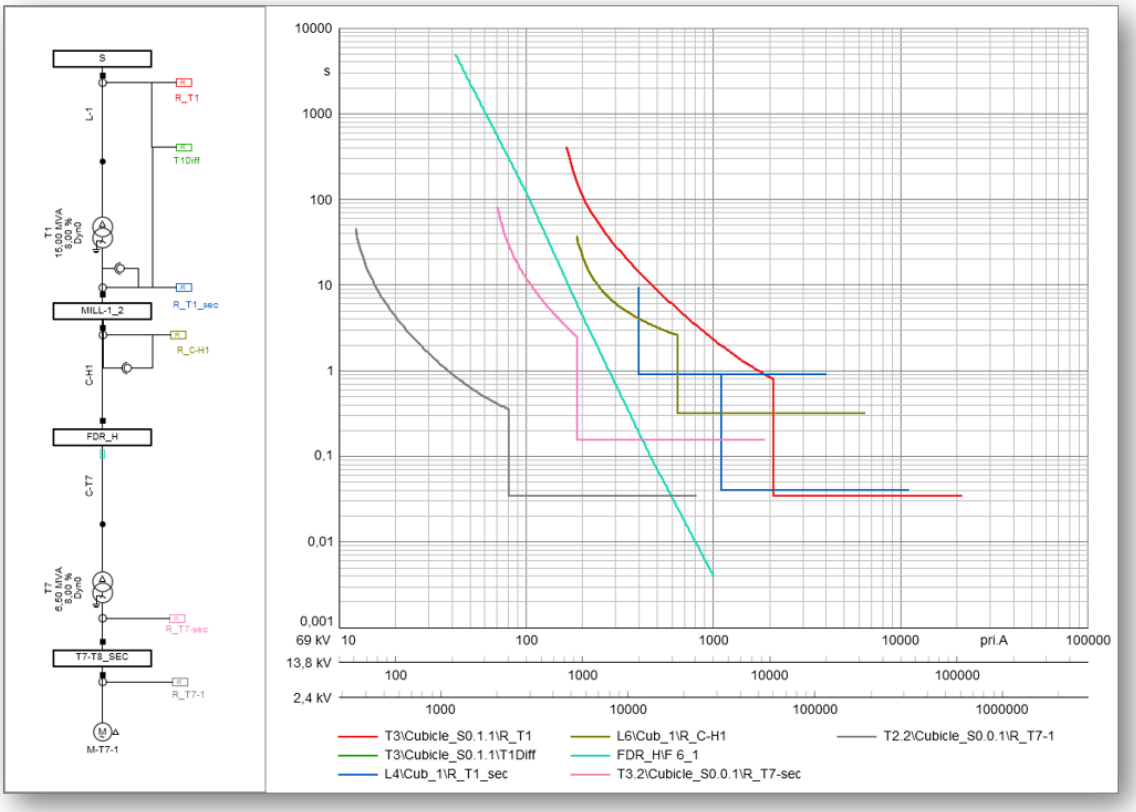
> Plots

> Tabular reports

Plots

Diagrams or plots are essential for the evaluation of protection schemes, as is evidenced by the number of different plot types available in *PowerFactory*:

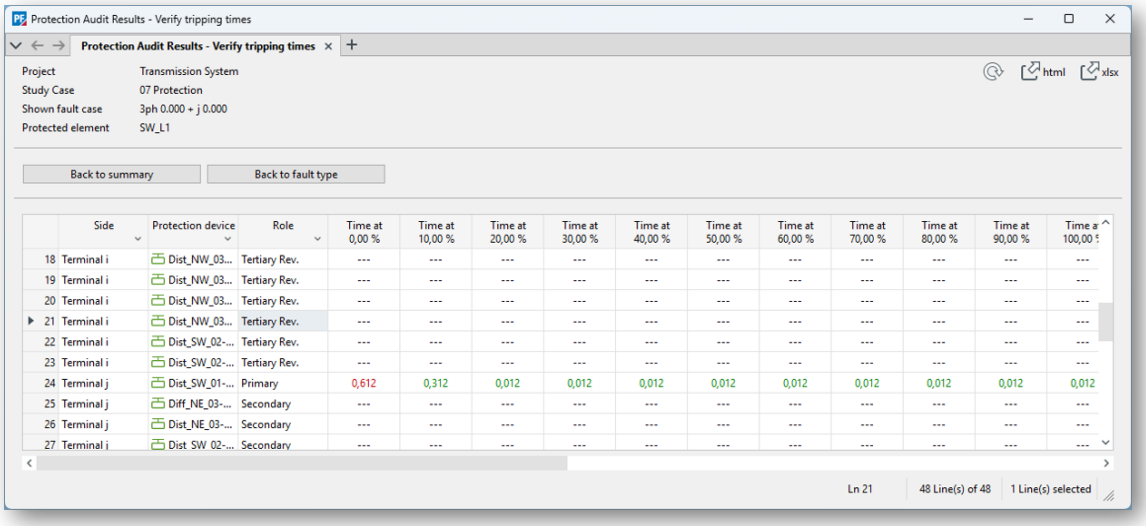
- Time-distance
- Time-overcurrent
- Short-circuit sweep
- Relay operational limits
- R-X
- Phase comparison differential
- Current comparison differential
- Curve-input



Time-overcurrent plot

Tabular reports

Tabular reports are used to output the results of *PowerFactory* functions such as the Protection Audit or the Protection Coordination assistant. These reports don't just present results in a table; they include features such as options for further analysis or the transfer of calculated settings back to the protection devices.



Protection Audit results

Example 5: Connection Request Assessment

Calculation purpose and typical reporting options

Connection Request Assessment function in *PowerFactory* is just one of many calculation functions that make use of PDF reports for presenting results. The function assesses potential connections against industry guidelines and the reports show results such as voltage changes, flicker and harmonics, as well as an evaluation of the acceptability of the proposed connection.

Selected Option:
> PDF reports

PDF reports

Once a Connection Request Assessment calculation has been executed, it is very straightforward to execute the report command, which will by default generate the PDF report in the inbuilt PDF viewer within *PowerFactory*. The reports are structured in such a way as to provide all the necessary calculation outputs together with a clear assessment outcome. The advantage of this type of reporting is that it can simply be exported from *PowerFactory* and forwarded to managers or clients without any further work, although there are also options for exporting in other formats such as MS Word, to enable further editing outside *PowerFactory*. The reporting framework enables users to introduce some customisation, such as the inclusion of company logos and suitable headers and footers.

Report: Connection Request according to VDE-AR-N 4105 06.05.2025

Connection Request Assessment VDE 4100/4105

1 Overall Assessment Summary

Number of connection requests: 1

Connection Request	Overall Assessment
HA_133\PV new	Approved

2 HA_133\PV new

2.1 Power Plant Definition

Installation						
Point of Connection (PoC)	Supply	SrT kVA	Plant Pmax (PEmax + PBmax) kW	Plant Qmax (QEmax + QBmax) kvar	Minimum power factor, cos(phi) -	Total connectible power, Sgesamt kVA
HA_133\ND_1190	TRFSTA09_1\TRF_19	630,	12,	0,	1,000	630,00

2.1.1 Generating units

Name	Type	Qty.	Out of service	Ur kV	SrE kVA	PEmax kW
PV new	Generator with converter	1	No	0,4	15,00	12,00

2.2 Point of Connection (PoC) Data

Point of Connection (PoC)	PoC Nominal Voltage kV	Short-Circuit Power MVA	Impedance Angle deg
HA_133\ND_1190	0,4	1,18	21,4

2.3 Assessment Summary

Calculation	Assessment
Overall Assessment	Approved
Loading of Network Components	Approved
Permissible Voltage Change	Approved
Sudden Voltage Change	Approved

2.4 Loading of Network Components

Assessment: Approved		
Branch	Loading %	Loading limit %
TRFSTA09_1\TRF_19	32,6	100,0

DIgSILENT PowerFactory Page 3 of 5

Extract from sample PDF report

User-defined reports

Although all the options described above give a great deal of flexibility in results reporting, we recognise that sometimes customers have some very specific requirements regarding how results are presented to the user. It is therefore possible for users to have their own customised reports, and two different approaches are possible.

Customised reporting scripts

Most calculation functions produce results files, and these are readily accessible. Scripts written in Python or DPL (the *DIgSILENT* scripting language) can be used to access the data in the results files and report it in ASCII or tabular format. Such scripts can be written by users themselves or commissioned from *DIgSILENT*.

Report Designer

The PDF reports described above can also be modified or written from scratch by users. This is done via the Report Designer, which makes use of third-party software that has been integrated into *PowerFactory*.

Executive Summary

PowerFactory's many calculation functions are complemented by a range of different options for reviewing and assessing the results, ranging from results boxes that are readily viewed in a network diagram to sophisticated and customised reports. In this paper, we have presented some examples of typical applications and shown how the users can easily find the information that they need.

All reporting functions described in this paper are part of the *PowerFactory Base Package*.

For more information, visit
www.digsilent.de

DIgSILENT GmbH
Heinrich-Hertz-Straße 9
72810 Gomaringen (Germany)
T: +49 7072 9168-0
mail@digsilent.de

DIgSILENT GmbH is certified
to the ISO 9001:2015 standard.
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