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Dynamics

PSS®SINCAL

Simulation of Dynamic Phenomena in Electrical Power Systems

These calculation methods enable investigations of different dynamic processes in electrical power systems.

The following modules are available:

- Motor Starting
- Stability (RMS)
- Electromagnetic Transients (EMT)
- Eigenvalue Analysis (NEVA)

Motor Starting

By means of a simplified procedure the maximum effects (drops in voltage, equipment overload) of accelerating motors can be determined. PSS®SINCAL simplifies starting motors by simulating R/X and I_a/I_n input data, which are given for asynchronous machines.

Moreover, this calculation method allows the determination of the required power for starting motors, taking the terminal voltages into account.

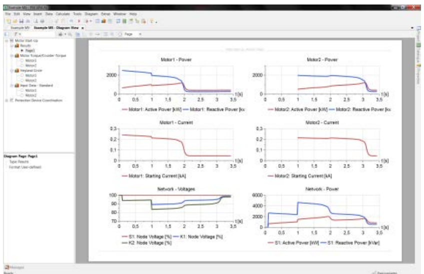

Figure 1: Diagrams for motor starting calculations

PSS®SINCAL calculates different network parameters (voltages, currents and power) for individual time steps during start-up.

This means, PSS®SINCAL motor starting calculations evaluate load-flow and determine motor performance. The voltages from load-flow calculations are used to determine motor performance. Different motors can be started at different times.

The results are available both in the network and in the result diagrams.

Stability (RMS)

PSS®SINCAL stability calculations analyze the dynamic behavior of power systems with the focus on electromechanical transients and the associated stability aspects. A power system is then stable, if it returns to a steady-state or equilibrium operation condition following a disturbance or malfunction in components.

The following criteria can be checked in detail, in order to assure a stable power system operation:

- Voltage stability
- Rotor angle stability
- Frequency stability

PSS®SINCAL's calculation module for stability has been developed precisely to check these criteria in different time and disturbance ranges. This calculation module is based on the PSS®NETOMAC program package, one of the world's leading programs for simulating all kinds of dynamic phenomena in electrical networks.

In stability calculations, the electrical network is modeled by complex impedances. Controllers, machines and modern technologies, however, are taken into account by differential equations. The examined system can be investigated symmetrically as well as asymmetrically.

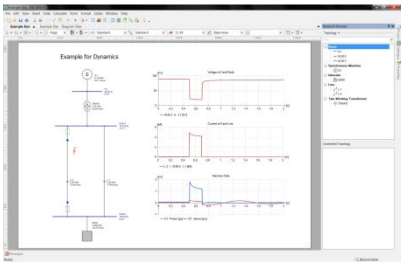

Figure 2: Results of a stability calculation

In order to consider asymmetrical faults, PSS®SINCAL uses symmetrical components (positive-, zero- and negative-phase sequence) to create a universal disturbance scenario. Different fault conditions can be modeled in detail.

This calculation module is used for those investigations, where the envelope curves of the characteristic values are sufficient results. The model complexity of networks and machines under investigation can be as high as intended, i.e. even networks with thousands of nodes and hundreds of machines can be investigated without any problems. Furthermore, all kinds of the appropriate equipment controllers can be efficiently modeled.

PSS®SINCAL provides you with a controller database containing the various predefined controllers:

- IEEE standard models
- CIM for dynamics (CGMES) models
- PSS®E controller models

- Excitation systems and limiters
- Turbine governors
- Power system stabilizer (PSS)
- Generic wind models
- FACTS models

"Block-Orientated Simulation Language" (BOSL) or a "Graphical Model Builder" (GMB) can be used to include user-defined control structures or to adapt standard models. For detailed information on GMB, please see the appropriate informative brochure.

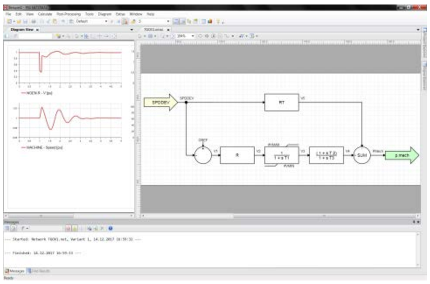

Figure 3: Graphical Model Builder (GMB)

Additional functions in this module as the stability limits calculation or the min/max evaluation facilitate the user various efficient analysis options.

Electromagnetic Transients (EMT)

The EMT module enables the user to study numerous physical phenomena in a wide frequency range using differential equations for networks, machines and controllers as well as complex models for frequency dependent equipment.

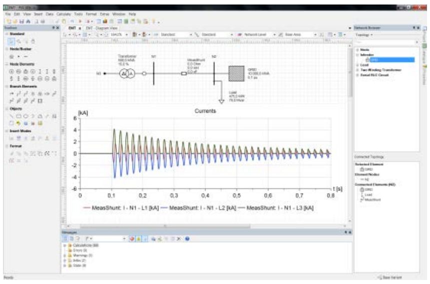

Figure 4: Results of a transformer energization

It offers a complete solution for all electromechanical and electromagnetic transients, including asymmetrical and non-linear processes with a very efficient model initialization. The typical application cases for this module are:

- Energization of transformers, lines and induction loads
- Sub-synchronous oscillations and torsional interactions
- Impact of converters or intermediate harmonics for HVDC transmission
- Switching studies
- Determination of valve stress for a static compensator during and after network short circuits

The main field of module's application is, therefore, in designing power system equipment taking significant electromagnetic phenomena into account.

Eigenvalue Analysis (NEVA)

The Eigenvalue Analysis module (NEVA) provides an extension of the classical methods in the time-domain with small-signal methods by linearization as well as by a frequency-domain approach in order to examine these critical oscillations.

The Eigenvalue Analysis module (NEVA)

- provides methods to investigate small-signal and long-term stability,
- allows a deeper view into eigenvectors, participations and residues,
- enables the determination of the best damping locations, and
- allows the evaluation of planned damping strategies.

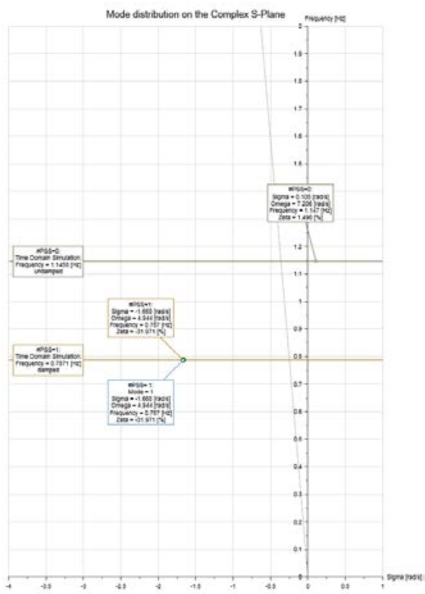

Figure 5: Results of an eigenvalue analysis

Eigenvalue and modal analysis is able to describe the small-signal behavior of the system – the behavior linearized around an operating point – but not the non-linear behavior of, for instance, controllers during large perturbations. Therefore, time-domain simulation (stability) and the valuable possibilities of the modal analysis in the frequency domain complement each other in the analysis of power systems.

Omega/VFd Residuum Magnitude	Omega/VFd Residuum Phase [°]	Machine Y(s)	Mode - Fre... [Hz]	Mode - Rel... [%]
1.000	0.000	3018G1	1.549	-13.210
0.406	290.622	206G1	1.549	-13.210
0.044	324.927	211G1	1.549	-13.210
0.024	27.006	3011G1	1.549	-13.210
0.006	331.907	102G1	1.549	-13.210
0.006	331.907	101G1	1.549	-13.210

Figure 6: Eigenvectors of an inter-area mode

The Eigenvalue Analysis module (NEVA) can be used in all products of the PSS® product suite, such as PSS®E, PSS®SINCAL and PSS®NETOMAC.

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