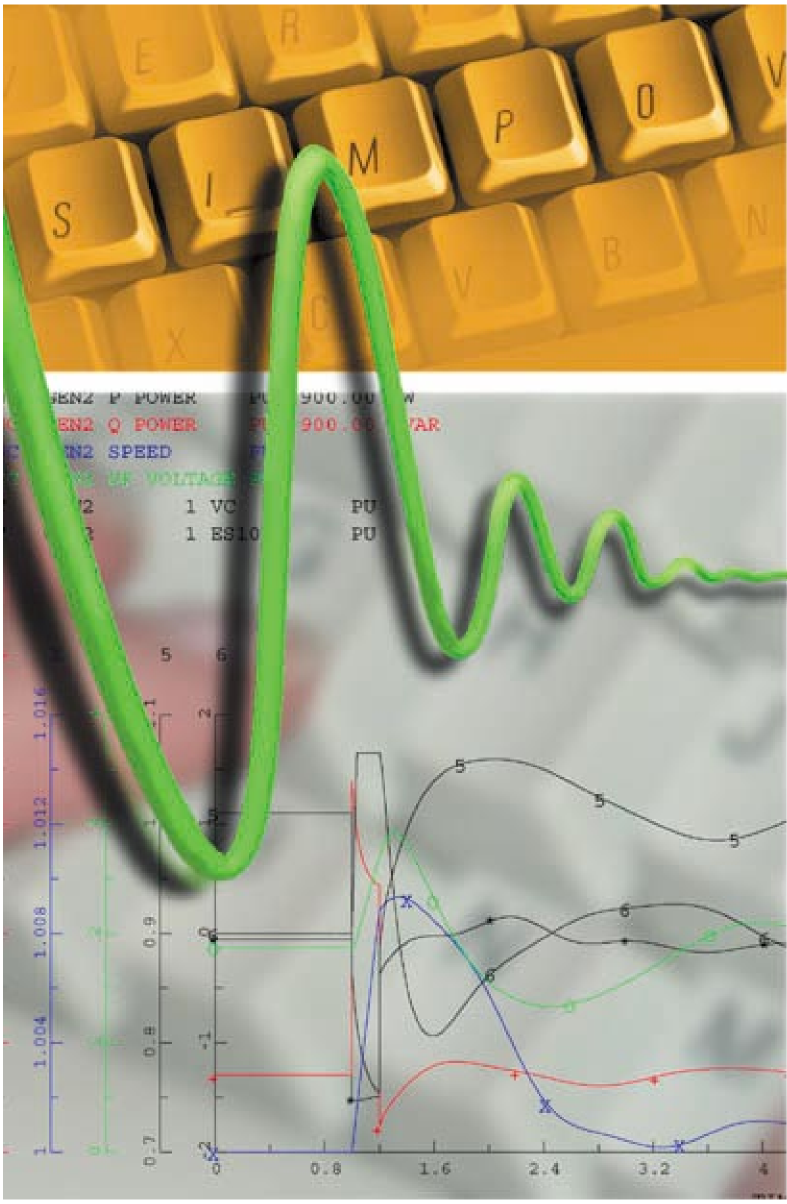
SIMPOW®

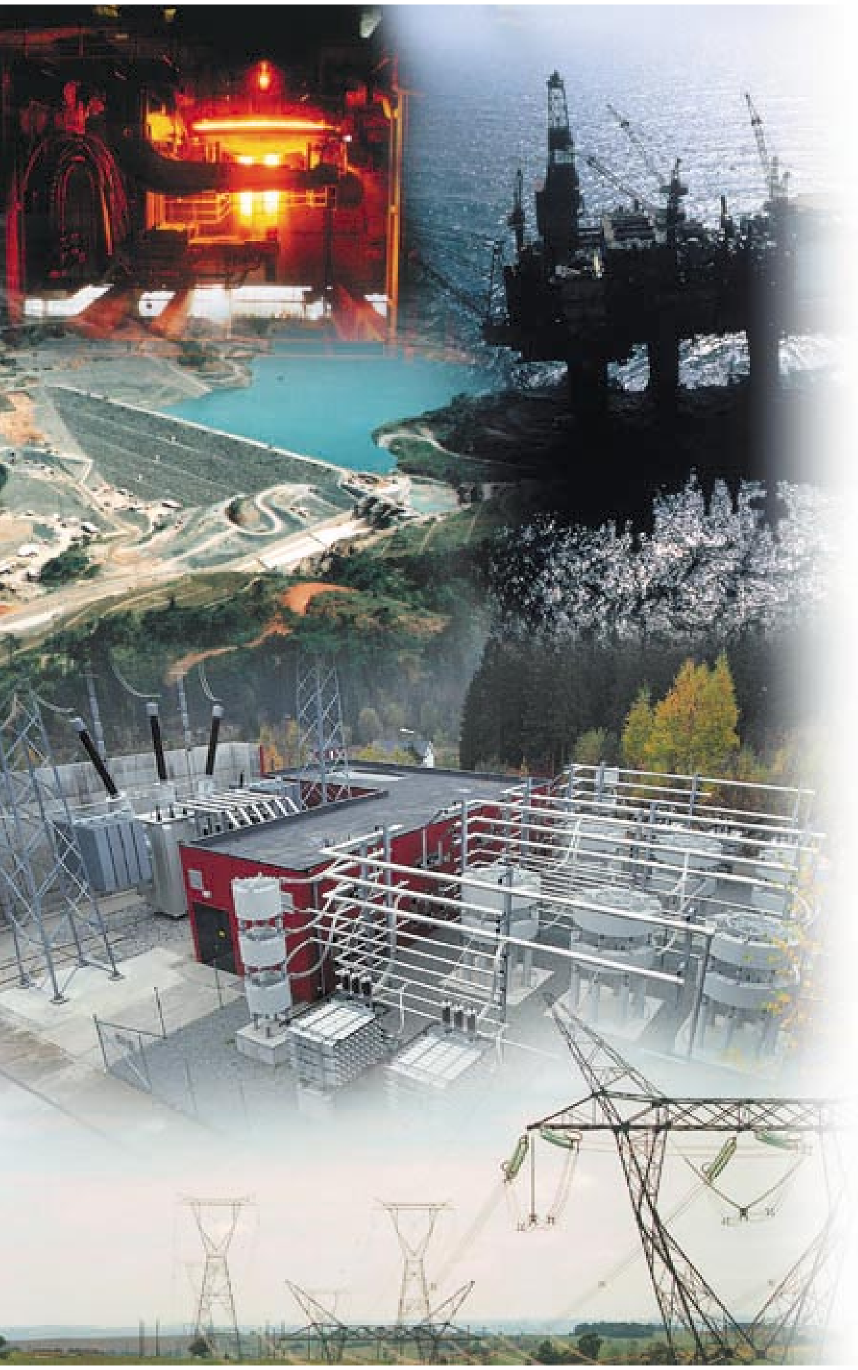
Power system simulation software



ABB

SIMPOW® is a highly integrated software for simulation of power systems. It covers a wide field of network applications focusing on dynamic simulation in the time domain and analysis in the frequency domain.

SIMPOW® is developed by the Power Systems Analysis Department of ABB Sweden. It is used by power utilities and consultant engineers and is also very suitable for research within universities and research institutes.



SIMPOW® can be used wherever an electric network needs to be analysed

SIMPOW's unique simulation and analysis features ensure an efficient planning, upgrading and utilisation of electrical power networks. By pre-simulation of projects or network upgrades, time spent on planning and pre-testing will be significantly reduced.

Calculations performed with SIMPOW®

Power-flow for calculation of power-flow balance, transformer tap settings, initial state for dynamic runs, etc.

Short Circuits for determining the fault level of e.g. industrial networks in order to check the thermal and electromechanical strength of switchgears, cables, and for setting of protective relays.

Transient Stability (TRANSTA mode) by employing phasor models for feasibility check and tuning of regulators in order to increase the power transmission capability and improve transient stability.

Machine Stability (MASTA mode) for simulation of the detailed dynamic performance of induction and synchronous machines during start and load switching conditions, e.g. in industrial power plants with different types, sizes and design of diesel generator and gas-turbine sets.

Linear analysis for determining eigenvalues for resonance analysis, sensitivity analysis, and modal analysis for displaying the eigenvectors. The linear analysis functions also comprise harmonic distribution calculations and frequency scanning. The latter can be applied over a selected range of frequencies.

SIMPOW® features and benefits

Flexibility for unlimited inputs into the system details.

A robust numerical technique characterized by high accuracy, efficient event handling, variable and/or fixed time step.

A graphical user interface.

Multi Load Flow calculations can be executed using the "execution command file".

Ability to execute in interactive and in background mode (semi batch).

A programming language, DSL, for user defined modelling of network elements, regulators, FACTS etc.

Graphical modelling capability with the tool DSL Code Generator.

Result presentation graphics comprising ASCII tables; time diagrams, variable versus variable diagrams, frequency diagrams and single-line diagrams. All graphics are furnished with menu buttons for selection of scaling factors, grids, time scales, result saving, paper printing, displaying on the single-line diagram, etc.

Calculation of Fast Fourier Transform, FFT.

Capability to switch between phasor- and instantaneous value models.

Capability to employ instantaneous value models for minor parts of a network, e.g. series compensators, and phasor models for the major part of the network.

Capability to conduct simulations of both electromechanical and electromagnetic transients.

A model library comprising standard and most utilised networks elements.

Input data editable in free field format. The data defines the model types and parameter values.

A conversion routine is available that transcripts input data from the network simulation software PSS/E™ to SIMPOW® data format.

Transformer tap changer, continuous regulator with steps and the function to control the voltage on the nearest as well as on the more remote bus.

Two and three winding transformers with phase shift for control of the load flow.

Shunt impedances, e.g. reactors and capacitors.

SVC, STATCOM, UPFC, CSC etc.

SVC Light.

Series compensation.

HVDC, two terminal and multi-terminal with latest technology on the controllers.

HVDC Light model.

Possibility to control the node voltages in nearby and remote buses.

Region Area Control.

Tie line control.

The requested node types; slack bus, PQ and PV are modelled.

SIMPOW® basic functions:

Power Flow OPTPOW

Fault Analysis STAPOW

Dynamic Simulation DYNPOW

The Load Flow program OPTPOW and the Fault Analysis program STAPOW are integrated parts of DYNPOW. This integration enables user defined modelling also in Load Flow.

Models in OPTPOW
Nodes
Lines
Transformers
Series Reactors
Series Capacitors
Shunt Impedances
Loads
Asynchronous Machines, Mechanical Loads
Rotary Converters
HVDC Converters
PWM Converters
Cyclo Converters
etc.

Models in STAPOW
Three-phase fault to ground
Two-phase fault to ground
Single-phase fault to ground
Two-phase fault
General fault
Phase interruption
General phase interruption
Travelling shunt faults
etc.

Power-flow – OPTPOW

The OPTPOW function is a static simulation of a power system under steady-state symmetrical conditions, considering the power-frequency voltages and currents.

Basically, the power system is represented by a single-phase model using positive-sequence quantities only. A large variety of constraints (variables to be at fixed values or within limits) can be pre-specified. The state of the system is given by the node voltages in the form of phasors, injected active and reactive powers, and some other variables.

The numerical technique employed to solve the power-flow problem is optionally either a “dynamic” method or the usual Newton-Raphson method.

The OPTPOW function is used for usual power-flow simulations.

To enable multi power-flow runs, the “Command File” facility is made available to accomodate the run instructions.

User oriented modelling in power-flow is now possible employing the inherent models programming language DSL.

Fault Analysis – STAPOW

STAPOW is a static simulation of a power system under steady-state symmetrical or asymmetrical conditions, considering power-frequency voltages and currents.

STAPOW processes a linearized “frozen” state from a TRANSTA simulation (see DYNPOW, page 5), at an arbitrary point of time after the occurrence of an event; normally at zero time.

STAPOW is, in the first place, used for calculations of power-frequency short-circuit currents. The extent of such a calculation can be specified to include the short circuit currents, their distribution, their positive, negative and zero sequence components, as well as the corresponding short circuit impedances seen from the faulty nodes.

Short-circuit current calculation according to IEC 909

SIMPOW® also includes a function by which short-circuit currents can be calculated according to the procedure and rules of the Standard IEC 909, which is aimed to produce conservative results. Maximum and minimum values of initial, peak, breaking and steady-state short-circuit currents on arbitrary nodes can be calculated.

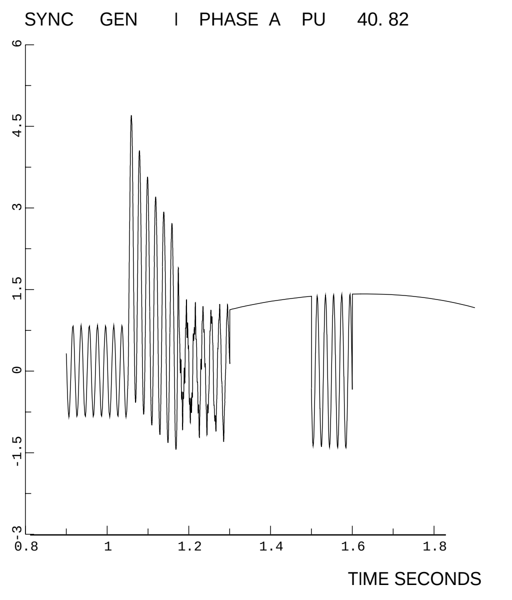
Dynamic Simulation
DYNPOW

Models in DYNPOW
- Nodes
- Lines
- Ideal Transformers
- Transformer with magnetizing characteristics
- Series Reactors
- Series Capacitors
- Varistors
- Shunt Impedances
- Loads
- Synchronous Machines
- Asynchronous Machines
- Mechanical Loads
- Rotary Converters
- HVDC Converters
- PWM Converters
- Cyclo Converters
- Exciters and Voltage Regulators
- Stator Current Limiter, Field Current Limiter
- Over Current Limiter
- Under Excitation Limiter
- PSS Power system stabilizers
- SVC Regulators
- HVDC Regulators
- Transformer Regulators
- Series Capacitor Regulators
- Turbines
- Turbine Governors
- Relay Protections
- Faults
- Breakers and Inertia

Dynamic simulations in SIMPOW® are performed in DYNPOW. There are two simulation modes; Transient Stability (TRANSTA) and Machine Stability (MASTA). Each simulation mode can be characterized as a dynamic simulation of a power system under steady-state or disturbed symmetrical or asymmetrical conditions.

TRANSTA simulates the power frequency components of a.c. system voltages and currents (phasors) and the average values of d.c. system voltages and currents while MASTA simulates the instantaneous values of voltages and currents.

Switchings between the TRANSTA mode and the MASTA mode of operation can be made during the course of a simulation. See fig.



In TRANSTA, the primary components are represented as symmetrical quantities. In MASTA, the primary components are represented as dq0 quantities.

DYNPOW has a comprehensive set of models available, including those of HVDC and SVC systems. DYNPOW uses an implicit predictor-corrector method of integration for simultaneous solution of all algebraic and differential equations. The default method is a combination of Gear's integration method and the trapezoidal integration method, with automatically controlled variable time step. The solution method assures retained accuracy and numerical stability also for long-term simulations.

DYNPOW is useful for a wide spectrum of study types, TRANSTA particularly in cases of large power systems, e.g. for traditional stability studies, and MASTA particularly in cases of small power systems but with requirement of detailed time resolution.

DYNPOW Linear Analysis

DYNPOW includes functions for linear analysis of power systems: Eigenvalue and frequency response techniques. In the general study case, these techniques include linearization of the power system equations at the actual operating point and consider only incremental changes of the state variables around the operating point.

The Eigenvalue techniques available are:

- Calculation of Eigenvalues and corresponding eigenvectors.

• Sensitivity analysis of an Eigenvalue with respect to parameters.
• Providing an Eigenvalue locus diagram, in the complex plane, for varying a parameter value.
• Providing a single-line diagram of the power system with "vector" visualization of the generator speed components of the Eigenvectors related to a selected pair of complex Eigenvalues (corresponding to a particular mode of generator electromechanical oscillations).

The Eigenvalue techniques can be applied at any time during a simulation. These techniques are excellent tools for the study of the small-signal behaviour and stability of generators and automatic control systems.

The frequency response technique available:
• Providing calculation (in the frequency domain) of the response of selected variables to a sinusoidal perturbation, either in the form of a current injected to a selected node or by adding a signal to a selected variable. Frequency scanning is performed for a specified range of frequencies. This technique is valuable, not least for treating harmonic matters.
• Calculating the frequency dependant impedance of the network at any perturbed bus.

DYNPOW-DSL

DYNPOW includes a programming language, the "dynamic simulation language" (DSL) by which the user can introduce models of any type of power system components, not only of automatic control systems (regulators) but also of primary components , for example of FACTS devices, drive systems and special machines.

Among the properties of DSL, mention can be made of the ability to handle dead-time delays and the ability to handle DSL-model equations written in implicit form. Furthermore, the DSL equations are solved simultaneously with all other equations of the total system simulated.

SIMPOW® is furnished with a graphical modelling tool, the DSL Code Generator, by which the user can generate the code used in dynamic simulation. The user can model exciters, voltage regulators, power system stabilizers, turbines, turbine governors, protective relays, etc, by selecting and connecting pre-defined block diagrams.

Validation of models

Validation of the existing models has been done in various ways.

The simplest models such as: transformers, lines, nodes, faults, etc have been validated in accordance with; text books, plausibility of results and comparison with theory.

Advanced SVC and HVDC components and regulators as well as associated synchronous machines, have been validated against analogue simulator and also against test results from existing SVC plants and HVDC links, e.g. the Gotland Link.

The validation has also been done by comparison of results from other computer programs similar to SIMPOW®.

SIMPOW® training courses and seminars

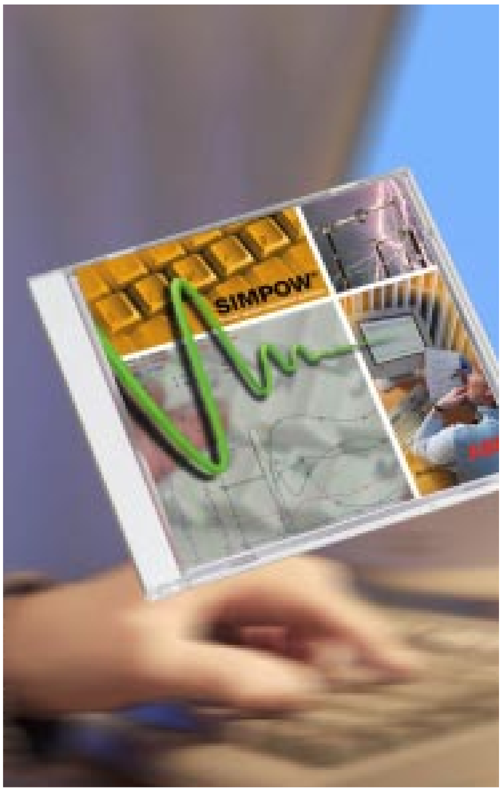
Training and support is a high priority to us. We want to make sure you get the most value from SIMPOW®. We offer a full spectrum of training courses, seminars and user group meetings. We want SIMPOW® to be an effective tool to meet your requirements. We welcome your input and will design a course to fit your needs.

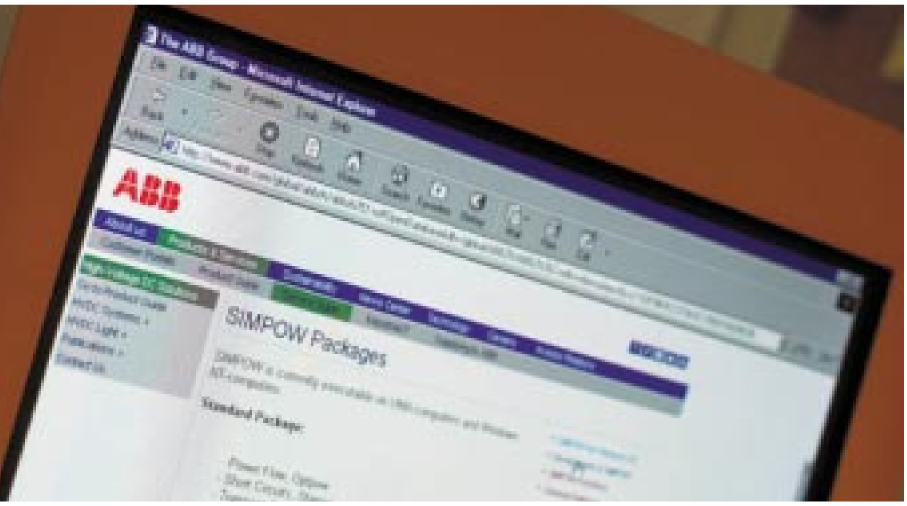
To get full value from SIMPOW®, training classes and seminars are available on a variety of topics.

Training Courses
Basic Course
Advanced Course
Modelling Course

Seminars
Advanced DSL programming
SIMPOW® application on HVDC in power networks
SIMPOW® application on Reactive Compensation in power networks
SIMPOW® application on industrial power networks
SIMPOW® application on railway power supply networks
etc.

Internet services
The presumtive users will have access to general information, news letters, reference lists, test versions and testimonials.
The regular users will have access to the same information and in addition updates of software and documentation, replies to frequently asked questions and training course registration.





SIMPOW® Packages

Two packages of SIMPOW® is made available for licensing, a standard package and an advanced package. The advanced package contains all the functions, see the list of package content below.

Standard Package include
Power Flow (OPTPOW)
Fault Analysis (STAPOW)
Stability Analysis (TRANSTA)
High level language, DSL, for implementation of control functions
Linear Analysis comprising calculation of Eigenvalues, sensitivity on Eigenvalues, modal analysis, frequency and data scanning

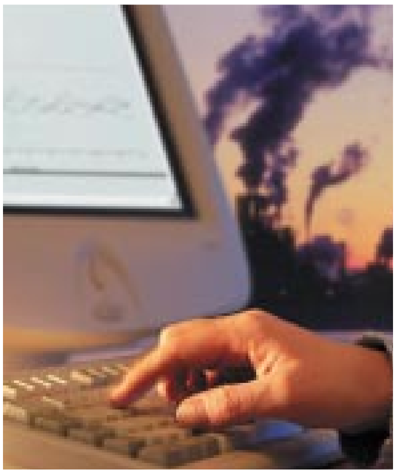
Advanced Package include
Standard package
Instantaneous value models (MASTA)
Harmonic calculations

Optional Functions
High level language, DSL, for implementation of primary components.

Documentation
User manual
Model description manual
Training course documentation
Internet on-line User manual and FAQ

Computer platforms

SIMPOW® is presently executable on Windows NT and Windows 2000 platforms.



Windows NT and Windows 2000 computers
Min 200 MHz Intel or compatible CPU
Min 64 MB primary memory
Min 2 GB hard disk
19-20 Inch high resolution colour monitor
Microsoft Window NT4.0 or higher order
CD drive
Adobe Postscript printer/plotters

Integration with other software products

The functionality and the excellent numerical capability enables integration with other network analysis softwares, e.g.

SIMTRAC, a railway simulation software for feasibility and design studies and for operators training. SIMTRAC employs dynamic models of the railway power supply systems and trains including the traffic time table.

ABB
Power Systems Analysis
Phone +46 21 32 40 00
Fax +46 21 14 92 60
E-mail simpow-inform.sepow@se.abb.com
Internet www.abb.com/ProductGuide/PowerTransmission/PowerSystemSimulation/SIMPOW

A02-0050E 2001.04 REKLAMCENTER 00490