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PSS®SINCAL

All-in-one Simulation Software for the Analysis and Planning of Power Networks

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PSS®SINCAL is an all-in-one analysis tool that supports planning engineers from electricity transmission and distribution to pipe networks (including Hybrid networks).

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PSS®SINCAL – Overview

PSS®SINCAL is a power system simulator for the planning, modeling, and analysis of all types of networks, including: transmission, distribution, industrial, rail, and renewables / distributed energy systems. It is used in over 90 countries around the world by transmission and distribution planning engineers, protection engineers, power system consultants, power quality engineers, power plant and industrial network operators, distributed energy resource field engineers, operations planning engineers, IT professionals, and researchers.

Its field of application enables the engineers to get answers to questions on power- and frequency stability, correct protection setup, restoration of supply or economic driven design decisions across all voltage levels. Due to its support for both balanced and unbalanced networks, PSS®SINCAL enables users to study the combined impacts on the low-medium-high voltage network simultaneously – a task that is becoming an increasingly important industry requirement as the transmission and distribution (T&D) worlds are becoming more integrated. This includes true to live modeling of elements such as PV, wind parks, e-cars, fuel cells, batteries and central control systems. As PSS®SINCAL combines the analytic capabilities of electrical and pipe networks, it is ready for studies of Hybrid networks (also called universal grid). The tool exchanges energy between electrical networks and gas or heating networks to decrease the high volatility of our future energy systems.

User-defined applications can be developed with its object-oriented data model. Furthermore, sophisticated case and data management facilitate the handling of complex multi-user projects. PSS®SINCAL can be integrated with other components of the utility IT landscape, including Geographic Information Systems (GIS), SCADA, Distribution Management Systems (DMS), and Meter Data Management Systems (MDMS).

Unique Advantages

As a single source solution, PSS®SINCAL is designed by power engineers to solve power engineering challenges. For over 50 years, Siemens PTI engineers have optimized the capabilities of PSS®SINCAL, offering the tools needed to meet evolving and future industry challenges (such as quantifying the technical and economic impacts of the increasing penetration of Distributed Energy Resources [DERs]). Due to its longevity and adaptability, PSS®SINCAL offers a number of distinct advantages:

- Proven high-performance, fast and accurate simulation engine
- Established highly versatile application with standardized interfaces for easy data import and export – allowing users to maintain a variety of data sets in a single system
- Numerous interfaces enabling simple integration into any IT environment – the use of open or commercial databases permits direct data exchange with other systems (e.g., GIS, SCADA, ERP, MDMS, Asset Management)
- Modern user interface with interactive internet visualizations of network models in schematic, geographic, or multilayer diagrams
- Tight integration with other applications in the PSS® Portfolio, such as PSS®E
- Equipped with a complete set of algorithms from load flow and short circuit up to advanced, such as: economic and strategic planning, and dynamics
- Programming can be done with standard scripting languages such as VBA, VBS, C++, .Net, Python™ and Java via COM.
- Interactive work-flow support with user-defined customizations
- Multi-dimensional network model including the ability to manage time-based model changes / variants / scenarios / projects

Where does PSS®SINCAL Fit?

Generation

Utilities, TSOs, and Independent Power Producers (IPPs) need to run a variety of different studies to plan for secure, reliable, and economically feasible power generation infrastructure investments. These generation interconnection studies include multiple types of analysis (e.g., load flow, short circuit, dynamics (stability and EMT) – including the support for control units such as automatic voltage regulators, governors, power system stabilizers, and protection). PSS®SINCAL provides the core analysis and automation functions that are needed for the most accurate generation planning outcomes:

- IPPs can improve the accuracy with which they can assess their generation interconnection proposals before submitting to the TSO / DSO
- TSOs / DSOs benefit from an automated, trusted tool for assessing generation interconnection requests

Transmission Network Planning and Analysis

Transmission companies need to perform a wide variety of studies in order to ensure grid reliability, security, compliance with regulations, and sound capital investment decisions. These studies can be fairly complex and typically require software that can perform highly accurate simulations.

PSS®SINCAL supports a full spectrum of analysis across power transmission planning and operations workflows, including: load flow, advanced contingency analysis, steady state voltage stability, short circuit analysis, dynamics and transient stability simulation, harmonics, protection and probabilistic reliability analysis.

In addition, PSS®SINCAL supports operations planning workflows such as day-ahead and intra-day studies (including support for CIM / CGMES data exchange for European TSOs).

Distribution Network Planning and Analysis

PSS®SINCAL provides distribution engineers with the simulation tools they need for the planning, design, and operation of power distribution networks. It can be used in balanced, unbalanced, radial and meshed networks – including single-phase and multi-phase (including single wire earth return [SWER] networks and supports complex transposed systems).

The proven and easy to use PSS®SINCAL platform provides engineers with a high level of visibility, efficiency, and agility in the planning and operation of even large distribution networks. Predefined and customizable workflows speed-up daily work.

Some of the most typically used PSS®SINCAL functions for distribution include: load flow, short circuit analysis, dynamic analysis, optimal capacitor placement, Volt / VAR optimization, harmonics analysis, ripple control analysis, protection coordination, and power quality assessments.

Industrial Networks

PSS®SINCAL provides industrial facility operators and designers with the tools they need for the planning, design, and operation of industrial power networks – such as those for refineries, chemical plants, oil platforms, mining, automobile, and other manufacturing facilities.

Typical capabilities and use cases include:

- Short circuit calculation
- Power flow analysis
- Cable and transformer design
- Protection coordination
- Arc-flash hazard
- Harmonics and filter sizing
- Motor start
- Dynamic stability simulation

Protection

System operators, planners and protection engineers face an ever-increasing landscape of challenges around power system protection due to the integration of variable energy resources.

These challenges include:

- Maximizing the ability to detect and localize faults
- Ensuring protection system coordination
- Validating accuracy and designs of the protection schemes
- Managing the large quantity of protection settings

With PSS®SINCAL, protection engineers can master these challenges by:

- Monitoring and studying the management of protection devices and their settings
- Facilitating protection performance assessments, including stepped-event fault clearance analysis, as well as dynamic fault sequence simulation
- Providing interactive protection coordination with graphical documentation
- Verifying settings directly within the network model

In addition, the built in protection security assessment module allows for an automated system-wide protection study, as well as the identification and mitigation of critical fault scenarios.

Renewables and Distributed Energy Resources (DER)

Due to the proliferating deployment of DER on transmission and distribution networks, planners need to perform an increasing number of grid interconnection studies. In order to keep up with this trend, both utilities and DER investors need tools that can help them automatically assess the viability of various interconnection proposals. Meaning: what can be economically connected to the grid without compromising the health of the network?

The maximal hosting capacity module within PSS®SINCAL achieves this goal. It automates different calculation functions (such as load flow, short circuit analysis, protection checks with network adoptions, voltage fluctuations due to DER coming online and offline, etc.) – turning hours of work into minutes.

Additional PSS®SINCAL features for DER integration include:

- Time series load flow with grid controllers (voltage, power)
- Short circuit with defined contributions of generators and converters
- Harmonic distortion limits according to standards
- Unbalanced RMS and EMT simulation
- Standard and vendor-specific dynamic models for wind generators, solar, batteries, SVC, STATCOMs, etc.

Railway Traction Systems

PSS®SINCAL helps engineers design and analyze power networks for rail systems. It fully supports the unique requirements of rail systems, including:

- Constantly moving loads (trains)
- 180° 2-phase AC systems
- Single- and 3-phase auto transformers including center tapped options
- Converter models for synchronous machines
- Detailed protection devices and schemes
- Different reference voltage levels
- Complex load profiles

Typical evaluations include:

- Load flow / load profile simulation with back feeding engines
- Sort circuit with specific attention to converters
- Harmonic simulations
- Transient Stability and EMT for investigation of sub-synchronous power oscillations and influence of slower control systems

Model Management

PSS®SINCAL offers model management solutions that reduce modeling efforts and keep multiple network models up to date from within a single application. Its master database function makes it possible for multiple users to work on a network simultaneously. Special synchronization functions – including conflict management, incremental model update, and network model merge – ensure data consistency. PSS®SINCAL can also automatically create cases on-the-fly.

PSS®SINCAL can integrate network models from other applications across the utility IT landscape – including SCADA.

For European TSOs, PSS®SINCAL can merge, validate and configure the entire Pan-European network (consisting of individual CIM / CGMES grid models from each of the 42 member TSOs) in less than 10 minutes. This enables operators to perform tasks such as operational security analysis, outage planning and coordinated capacity allocations in real time.

Pipe Networks

In addition to electric power systems, PSS®SINCAL also supports the planning of gas, water, and district heating and cooling networks. Utilities that oversee these different network types can optimize their costs and IT overhead by utilizing a single tool instead of multiple applications.

PSS®SINCAL also enables companies to perform linked simulations between electrical and pipe networks to optimize the efficiency from the renewables, and use the storage capacity of the pipe networks.

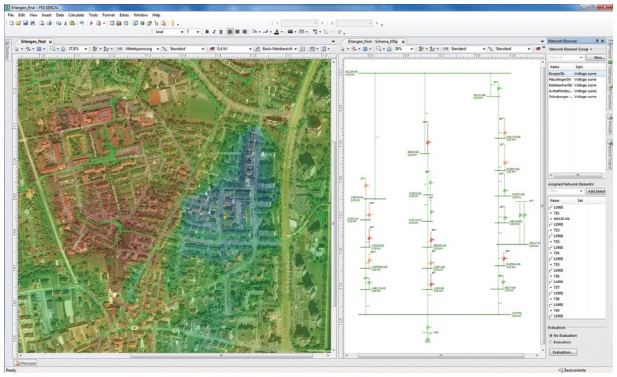
Typical analysis modules for pipe networks include:

- Steady state analysis
- Quasi dynamic simulation
- Contingency analysis
- Water tower filling

Highlights

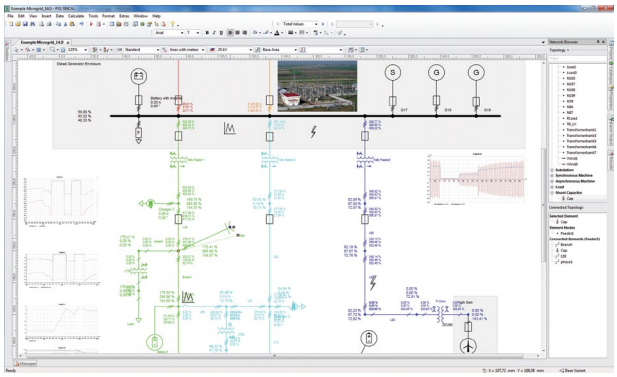
Graphical User Interface

- Geographical visualization capability that reflects the interactiveness of a GIS application
- Interactive web-based overlay of online and offline background maps
- Integrated network editor and report generator (List & Label) to simplify the presentation of data / analysis
- Network models can be maintained in multi-dimensional view (schematic, geographic) for different tasks with comparison options



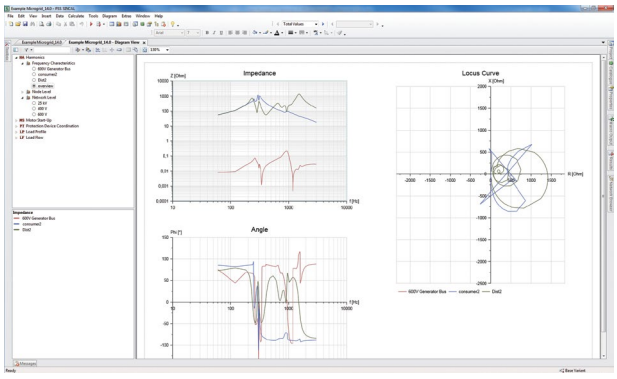
Network Model

- From a simple bus-branch to a full substation model PSS®SINCAL can run various co-simulations off of a single network model
- Network modeling can be done within a simple balanced up to a full four wire system or complete transposed system
- Large network model can be simulated with timestamps, variants, scenarios, and can be split into separate models via the “include network” option



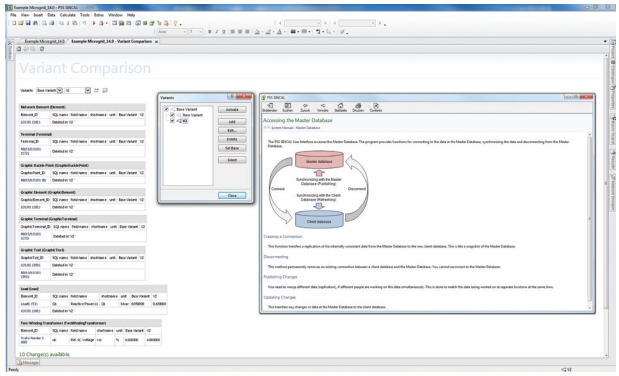
Simulation Engine

- High-level algorithms that are optimized for precision and performance
- As the complexity of the data is adapted to the task, the program works targeted-oriented, with high-speed including parallel processing
- Modeling options are not limited in network structure, phases or frequency
- Fully integrated modular structure allows users to customize their license according to their needs



Project Management

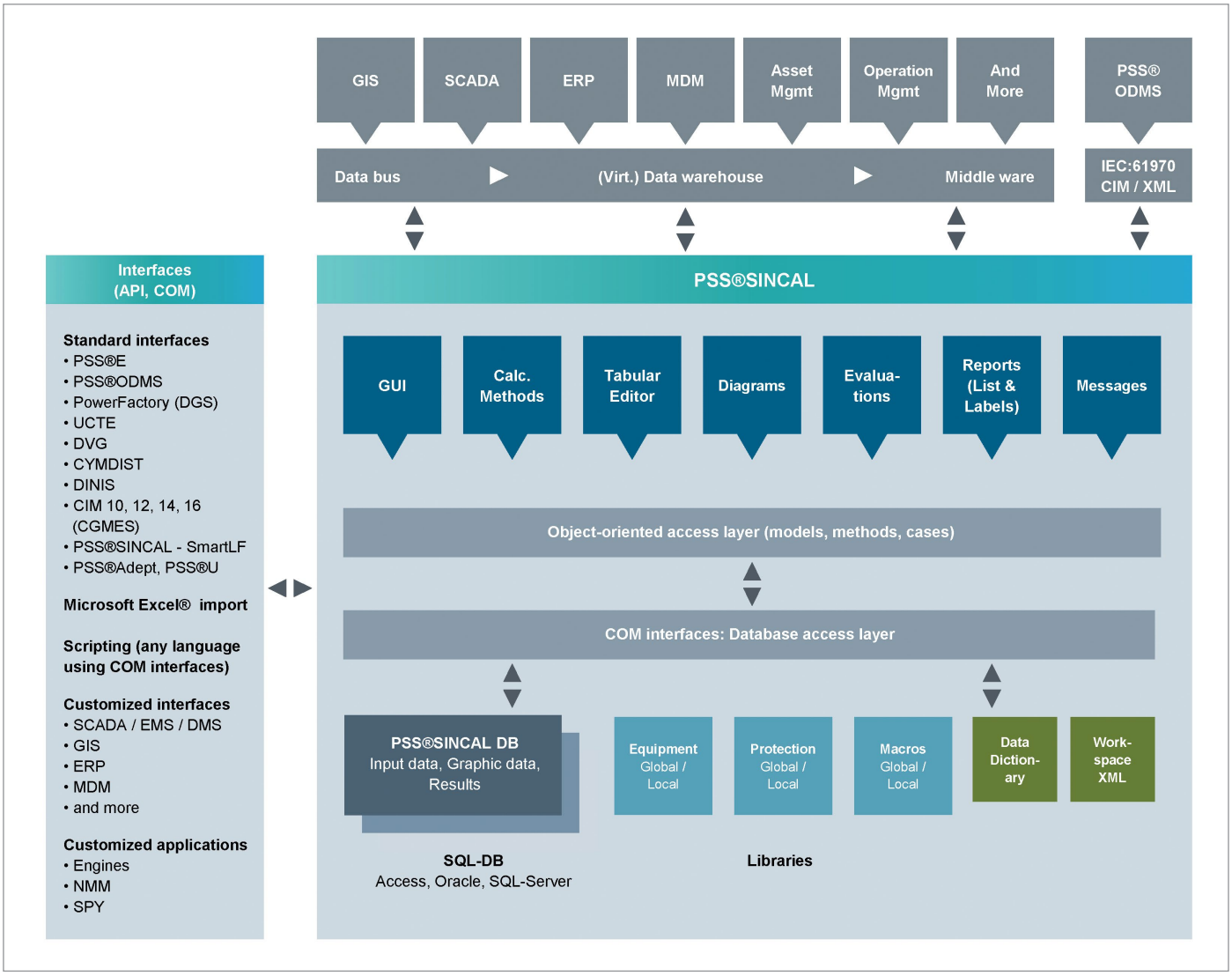
- Model management is based on standard databases (i.e., Microsoft® Access®, ORACLE®, SQL Server, SQLite)
- Users can perform and track various analysis by working off a single master database using logins with user roles
- Changes can be tracked and network states can be set back according to labels states
- Distributed databases can be temporarily linked together and reconfigured via “include networks”



Architecture

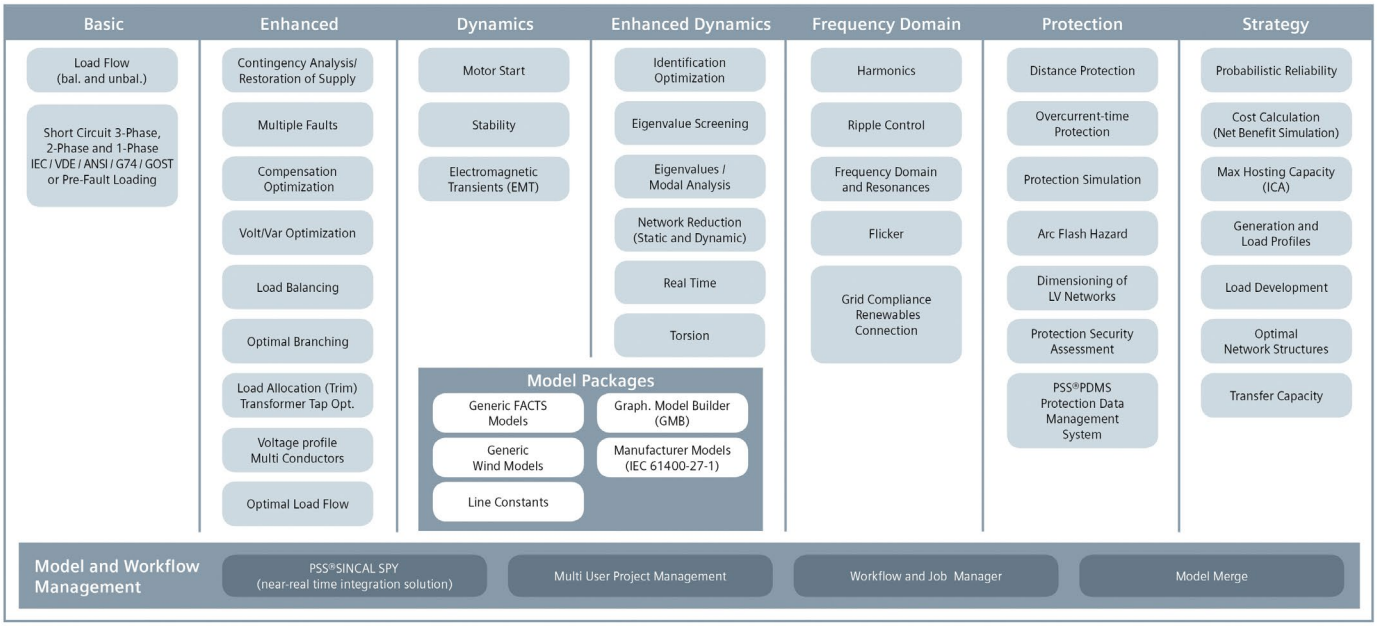
PSS®SINCAL is a database application based on COM-server technology. The tool can communicate with external applications, and users can extend its functionality via programming scripts.

In addition, the open and fully documented data structure allows users to create custom applications using PSS®SINCAL as the network analysis engine. The automation solution integrates the calculation methods directly into the source system and can be used either as an external server (with separate processes) or as an in-process server (within the same process). During simulation it is possible to pass data interactively from external sources to the simulation core.



PSS®SINCAL IT architecture

Electricity Modules



Basic Modules

Load Flow Analysis

- Several robust load flow solutions which support multi-phase systems and fully transposed line representation
- Tap changer, phase shifter, switched shunt capacitor / reactor, SVC control
- Network control features not limited to Q(U), P(cos phi), V(cos phi), droop and user-defined BOSL models
- Local and remote distributed voltage control options
- Enhanced load models up to user-defined formulas
- Active and reactive power limits including generator capability curves
- Anti islanding options
- Support of multiple and distributed slacks bus configuration
- Automatic load management / shedding based in voltage and power
- Consideration of dynamic element models
- Area interchange control (local area slack)
- Corrective action solution for automatic adjustment of controls (generator dispatch, tap adjustment, etc.) to mitigate violations
- Load factor and TLF calculations for nodes
- Advanced load and generation scaling options
- Consideration of temperature dependency
- Fully automated PV and QV curves calculation – voltage stability assessment with plots
- Automatic feeder evaluation and switching capacity calculation

Short Circuit

- Perform short circuit analysis according to standards or with pre-load conditions (super position method)
- Meet various global standards such as: IEC 60909 (multiple versions including 2016), IEC 61353, G74, VDE 0102 / 0103, ANSI C37, GOST R 52735-2007, GOST 28249-93

- Option to simulate short circuit based on phase data
- Full peak short circuit current (ip) method support
- Selections for different treatment of block elements
- DC equipment can be modeled as user-defined
- Automatic fault at each node or full current and voltage distribution for a single fault location
- Evaluation of the weighted one sec short circuit current end of line faults and other parameters
- Provide vector diagrams in polar plot

Advanced Modules

Contingency Analysis and Restoration of Supply

- Automatic user-configured contingency creation
- Ability to save and recreate any contingency individually
- Probabilistic contingencies
- Automatic N-1-1 solution
- Contingency creation from restoration of supply results
- Substation and node outages with restoration
- Free user-defined outages and restoration scenarios
- Automatic corrective actions according to user-given rules with different strategies (support of FLISR)
- Event-based post-fault actions
- Regional assessments
- Fast contingency screening and ranking to find the most critical outages in large system
- Automatic definition of outages and recovery actions
- Several contingency comparison modes
- Tracing of individual contingency cases
- Interactive result monitor including graphical representation
- Comprehensive interactive spreadsheet reporting
- High speed solution due to parallel processing

Optimal Branching (Tie Open Points)

- Optimization of tie open point positions subject to loss minimization and / or improvement of system reliability
- Consideration of load flow constraints
- Support of balanced and unbalanced systems
- Pre-defined options to keep actual switching states
- Regional assessment or across all voltage levels
- Enhanced reporting features and graphical visualization
- Automatic switching

Compensation Optimization

- Determination of optimal locations, types, phase technology and sizes of capacitors or shunts due to power factor needs
- Economic assessment considering costs of losses against installation costs
- Placement of available equipment
- Various methods including heuristic approach

Volt / Var Optimization

- Optimize feeder voltages and losses with load variations e.g., min / max values or operation points
- Combine and place capacitors automatically at all locations
- Different methods including heuristic approach
- Determine transformer and capacitor set points
- Compare the optimized results in spreadsheets and diagrams before and after

Load Balancing

- Reduction in unbalances at transformer or unbalances in feeder
- Automatic reconnection of node and branch elements or whole feeders per phase
- Generic optimization algorithms

Load Allocation (Trim) / Transformer Tap Optimization

- Supporting meter elements for scaling at any network position
- Radial and meshed systems
- Successive meters with different parameter sets and directional information including voltage, current, power
- Balanced and unbalanced networks
- Load and generator scaling on provided meter values including DER
- Meters support profiles
- Loads can support whole feeder with transformer information and voltage drops under different conditions
- Load flow solution fits to minimal and maximal network states

- Optimization of transformer tap positions of outgoing feeders to keep the voltage in an optimal range for min and max consumption
- Color representation in single line diagram
- Voltage diagrams for feeders with min and max voltages

Optimal Power Flow

- Optimizes the grid by minimizing network losses by optimal equipment set points
- Various controls and constraints such as voltage profiles, element load limits, generator power and transformer taps
- Determination of set points of controllable elements such as generators, transformers and switched shunt elements
- Robust solution which is independent from starting point
- Supporting several weighting and penalty parameters

Voltage Profile / Homogenous Multi-Conductor Systems

- Simulation of tunnel systems e.g., for railway systems
- Unlimited conductor systems
- Moving loads (trains) over time (location)

Multiple Faults

- All type of faults and interruptions at bus bars or branches with user-definable distances
- Any combination of faults (fault packages) including unbalanced faults and interruptions at different locations at the same time
- Toggling between the different outage scenarios

Dynamics

Motor Start

- Steady state motor starting
- Single and multiple motor starting at different times
- Analysis based on vendor data available without motor identification (load torque, motor torque, starting current)
- Automatic motor identification from standardized characteristic
- Various motor starting methods (star, delta, soft starter, reactor, transformer, etc.)
- Full stepped through results in single line diagram
- Customized graphs for network parameters, e.g., powers, torques, Hevland circle

Stability (RMS)

- Graphical diagram of all signals during simulation
- Multi-phase AC and DC networks
- Support of balanced and unbalanced grid conditions
- Fast algorithms for fixed and adaptive step sizes
- Flexible event definition with and without conditions (time, voltage, current)
- Simulation of any kind of balanced and unbalanced fault or event
- Short and long time simulations
- Differential equations for synchronous machines with Park 5th or 2nd order model
- Synchronous machines with original data or compensation data for direct and quadrature axis
- Transient motor starting (synchronous and asynchronous machines)
- Simulation scan feature, e.g., frequency scan, loss of synchronism scan, synchronous machine speed scan, voltage- / voltage recovery scan, fault ride through scan or common variable scan
- Frequency domain analysis tool, including Fast Fourier Transformation (FFT)
- Prony / Matric Pencil analysis for single point in time as well as time-range assessment
- Support of protection devices in RMS simulation
- Combined RMS and EMT simulation mode (hybrid)
- Real-time simulation mode
- Real-time interface support of standard protocols such as IEEE C37.118 (PMU) and IEC 104 (RTU)
- Variant calculation with nested variants and intelligent variant control

Electromagnetic Transients (EMT)

- Graphical diagram output of all signals during simulation
- Integrated simulation of electromagnetic transients in multiphase AC and DC systems
- Simulation of FACTS, HVDC interconnections (two / multi-level VSC, thyristor-based), static var systems (SVCs, STATCOMs), etc.
- Fastest algorithms for fixed and adaptive step sizes
- Power electronic devices (PWMs, rectifiers) and discrete components (diodes, thyristors, etc.)

- Constant and frequency-dependent distributed parameter OHL models
- Universal frequency-dependent model for lines and cables
- Non-linear elements and saturation characteristics
- Series capacitors including spark gap model
- Surge arrestor models
- Impulse voltage and current source for lightning surge analysis
- Support of AC-DC inter-system fault events
- Accurate EMT models of renewable generation (wind / PV, etc.) and storage systems
- Discrete RLC elements
- Flexible template definition to create and re-utilize user-specific models library
- Insulation coordination analysis including temporary (TOV), switching (SOV) and lightning (LOV) transient over-voltages
- Stochastic switching analysis and point-on-wave (POW) switching
- Frequency Analysis Tool, including Fast Fourier Transform (FFT) and Prony Analysis for single point in time as well as time-range assessment
- Inrush, ferro-resonance, sub synchronous resonance (SSR), sub synchronous torsional interaction (SSTI) and TRV studies
- COMTRADE and SIGRA file export
- Combined RMS and EMT simulation mode (hybrid)
- Various options of triggering breaker closer events
- Variant calculation with nested variants and intelligent variant control

Program Interfaces

- Integrated in PSS®SINCAL User Interface (UI) with graphical single line support (phase by phase)
- Dedicated dynamics UI for expert application
- COM interface to access all dynamics functions from external programs for scripting and automation tasks

Enhanced Dynamics

Identification and Optimization

- Parameter identification with measured time curves for all kinds of models and machines
- Parameter identification in RMS, EMT and frequency domain
- Parameter identification to improve modal characteristic from eigenvalue analysis
- Equivalent for dynamic loads
- Parameter identification of controllers in closed loop
- Parameter identification of cable and OHL from geometric configuration

Eigenvalue Screening

- Overview of dominant oscillation frequencies and damping from time-domain simulations
- Identification of optimal placement for damping equipment
- Optimized method for large network models
- Tuning of stabilizers during time-domain simulation

Eigenvalue / Modal Analysis

- Evaluation and optimization of power system small signal stability including inter area oscillations
- Efficient algorithms for very large network models (QR, Subspace Iteration or Dominant Pole method)
- Valuable eigenvalue filter capability in modal analysis
- Differentiation between real and augmented state variables
- Parameter identification to improve modal characteristic from eigenvalue analysis
- Interactive mode overview in s-plane
- Residues / frequency response Y(s) (Bode, Nyquist) and time response
- Tabular reports of modes incl. frequencies, relative damping, omega and sigma values
- Tabular reports of state variables incl. left and right eigenvectors, residues, participation factors, etc.

Network Reduction (Static and Dynamic)

- Static network reduction for load flow, 3-phase and 1-phase short circuit

- Ward, Extended Ward equivalents for boundary definition
- Dynamic network reduction with automatic generation of a dynamic equivalent network with the same dynamic behavior using coherent generators
- Identification of controller parameters for all equivalent generators
- Graphical selection of network parts for reduction
- Scripting solutions
- Variants capability to maintain the original and equivalent grid

Torsion

- Analysis of SSR and SSTI
- Multistage turbine models
- Support of extensive modeling approaches for drive shafts

Real-time Simulation

- Testing and optimization of real-time systems such as Wide Area Monitoring System [WAMS]) or SCADA / EMS systems via standard interfaces
- Dynamic stability assessment (DSA) for real time operational use in control room
- Closed-loop hardware in-the-loop tests (protection devices, controller, etc.) – additional hardware (DINEMO-II, OMICRON) needed
- Dynamic co-simulation within SCADA systems (e.g., SPECTRUM, SICAM230, T3000)

Frequency Domain

Harmonics

- Balanced and unbalanced model with different element modeling such as wave equations, full frequency dependency, or CIGRE models
- Modeling of skin and proximity effects
- Unbalanced harmonic sources (currents and voltages)
- Non-characteristic and inter-harmonics calculation
- Active and passive resonance networks

Harmonic Distortions

- Embedded Harmonic voltage and current standards (IEC 61000-3-6, IEEE 519, BDEW) also supporting user-defined planning levels
- Simulating various harmonic distortion indices and telephone influence factors such as THD, TRD, TIF, IT, etc.
- Harmonic distortion plot with pre-defined distortion limits according to international standards or user-defined
- Plots and reports for each node / per voltage levels

Frequency Sweep

- Self and mutual impedances and admittances
- Automatic step size adaption or constant step size
- Spectral density of voltage amplitude / angle
- Locus curves in complex plane
- Parallel and series resonances

Filter Analysis

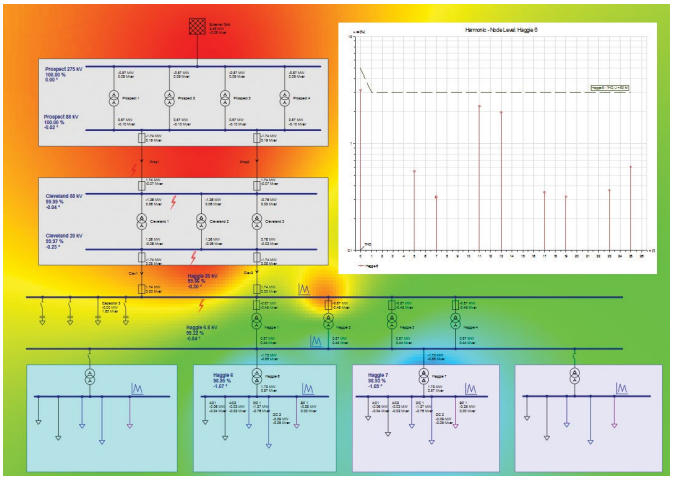
- Various filter models
- Filter sizing and verification reports
- Automating contingencies via scripting

Ripple Control

- Ripple control level and distribution
- Specific series and parallel signals / transmitter
- Embed voltage or current sources
- Specific reactive / inductive components of elements

Flicker

- Flicker disturbance factors (short term and long term)
- Different evaluation methods such as UIE / IEC or IEC 61000-4-15



Harmonic analysis modeling and simulation

Protection Modules

Dimensioning of Low Voltage Networks (fuse check)

- Setting assessment of fuses in meshed and radial LV systems with short circuit sweep
- Evaluations based on:
  - Safety factor (factor rated current)
  - Conductor cross section
  - Thermal damage – short circuit
  - Thermal load time – and large control current
  - Maximum breaking time
  - Support of VDE 0102 and VDE 0100

Setting Calculation for Distance Protection

- Automatic calculation of settings for up to 6 zones plus autoreclosure and teleprotection
- No network configuration limitations
- Detailed vendor-specific relay library
- Automatic evaluation of protection zones and worst case configuration
- Multiple user-customizable setting strategies including one method that is selective for any network configuration
- Calculation of primary and secondary settings
- Diverse diagrams including R-X or Zt

Overcurrent-time Protection

- Stepped event simulation and coordination and documentation of overcurrent-time protection in radial and meshed systems
- Automatic grading path and diagram creation
- Interactive stepped event / sequence analysis including graphical display of coordination
- Simulation of main and backup protection
- Support of ANSI codes 27, 47, 49, 50, 51, 59, 67, 79, 81, 87, etc., including negative phase, over / under frequency, over / under voltage and enhanced differential protection
- Steady state short circuit, multiple faults and dynamic event simulation with user-defined complex fault impedances
- Fault at nodes and branches including fault sweeps
- Signal transmission between relays for tripping, interlocking or transfer trip
- Protection library with several thousand relays
- User-defined protection devices based on predefined blocks
- Coordination across different voltage levels
- Adjustable settings with the diagram
- Multi axis diagram
- Discrimination time calculator / checker
- Cable and generator, motor (stator and rotor) and transformer damage curves
- Motor startup curves also with NEMA models including different voltage conditions
- Directional elements
- Common and individual timer for pickup and tripping
- Stepped color coding of device states in the network diagram
- Display of all settings and states in the network diagram
- Reports for device settings and coordination checks

Enhanced Protection Simulation with Distance Devices

- Automatic simulation of protection routes with fault sweeps
- Set of result diagrams such as Z-t, X-t, Z measured-Z path (Z and X), R-X with line trajectories
- Color coded reach zone displays in the network diagram
- Fault locator

Protection Security Assessment

- Automatic validation of protection settings by systematic short circuit sweeps throughout the entire network (or network groups)
- Fault type with user-defined fault impedances
- Dynamic simulation for frequency protection checks
- Main and backup protection assessment
- Substation protection assessment
- Backward protection, machine protection, specific transformer treatment
- Pickup and tripping sequences, tripping times, fault clearing times
- User-defined max fault clearing time limits and line damage limit checks
- Interactive matrix based total assessment overview with color coding to identify critical settings
- In-depth evaluation of preselected events

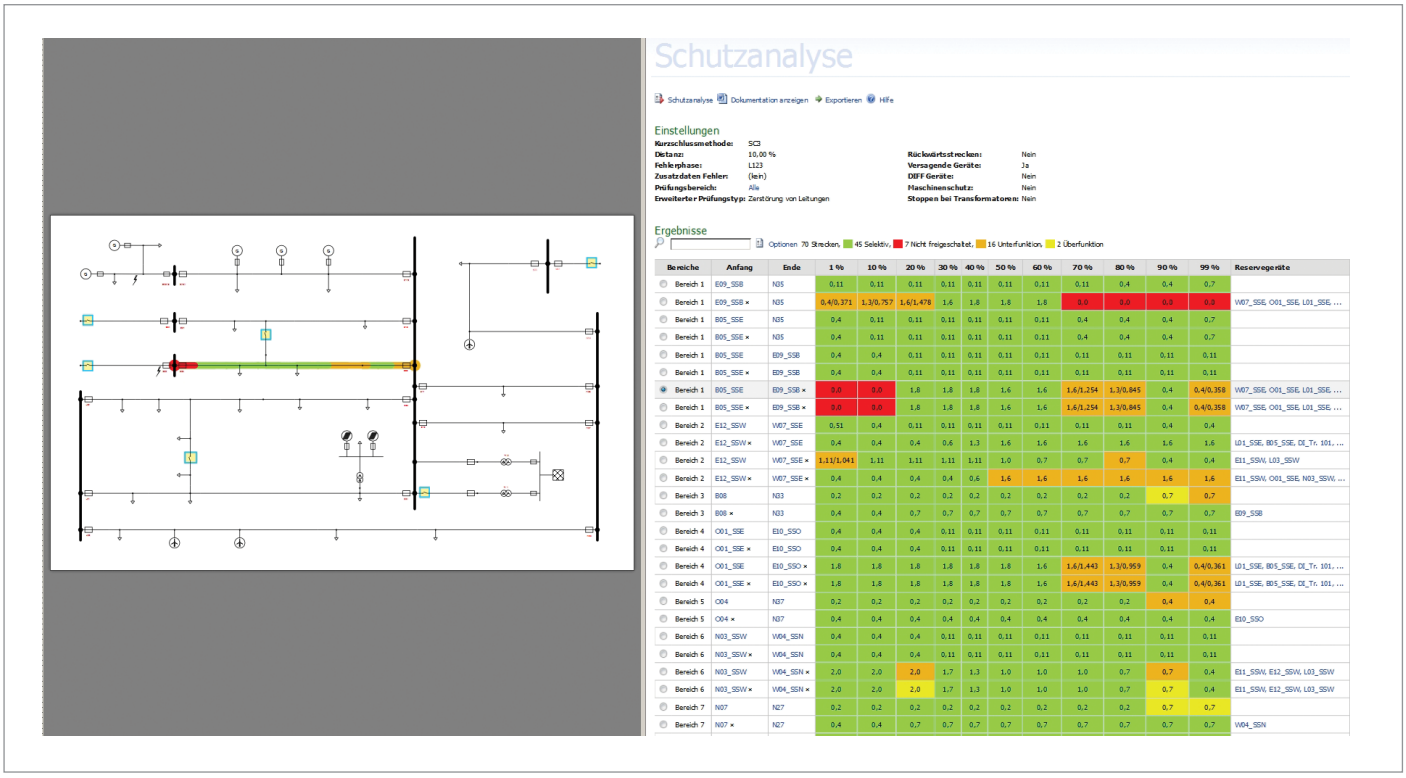
- Color coding visuals of results in the network diagram
- Enhanced automatic reporting generation
- Aggregated result matrix across multiple fault types

Protection Data Management System (PSS®PDMS)

- Multi-user enterprise application
- All data stored in one central relational database (Microsoft® Access®, Oracle® Database or Microsoft® SQL Server®)
- Modern Microsoft® Windows® user interface for optimal data management
- Protection devices modeled comprehensively with all functions and settings, including different parameter sets for the same relay
- Settings checked against setting ranges
- Creation and management of protection device templates which can be used to generate protection devices
- Extensive functions for relay import and export
- Easy connection to external documents
- Specification and customization of access rights according to the company's needs
- Supports user defined workflows (e.g., planned, approved or active settings), including historical settings
- Data exchange with PSS®SINCAL enables the planner to verify the settings directly in the network model

Arc-Flash Hazard

- Arc-Flash calculation in accordance with IEEE-1584, NFPA 70E-2012 and BGI / GUV-I 5188
- Support of empirical formulae ranging from 208V to 15 kV
- Theoretical model for any voltage to cover every equipment
- User-defined protection devices
- Several options for incident energy calculation (meshed systems)
- Calculation of arcing-current energy
- Automated preparation of arc flash labels with flash protection boundary, PPE category and work permits



Protection security assessment

Strategy Modules

Probabilistic Reliability

- Analytic and stochastic (Monte Carlo) simulation of all reliability indices SAIFI, SAIDI, MAIFI, ASIFI, ASIDI or CAIDI (IEEE 1366)
- Independent single outage (long / short), common mode, multiple faults, maintenance (long / short), protection outage, protection over function, circuit breaker failures
- Automatic generation of all failure combinations of equipments disconnected at the same time
- Load variations
- Annual load duration curves
- Various tariff and cost models
- Detailed result reports with restoration plans and plots
- Color coded results in network diagram
- Support of parallelized analysis for multiprocessor hardware
- Results aggregated for each consumer or contribution of each component
- Diverse automatic restoration strategies including optimal restoration schemes

Cost Calculation (Net Benefit Simulation)

- Economic assessment (CAPEX and OPEX) of network expansion planning across a planning horizon
- Acquisition and shutdown cost, interest cost, maintenance cost and others, technical losses, etc.
- Locational net benefit analysis
- Yearly tranches for net values, net preset values and residual values based on summation method
- Cumulated cost for the total planning horizon
- Calculation of loss cost during the entire time frame based on cost profiles

Generation and Load Profiles

- Load flow study over a user-defined study period with dynamic generation and consumption schemas
- Two different superposeable profile types (e.g., day / year) with freely defined time step
- Impact of load / generator fluctuations on network controls (regulators, capacitors, etc.), battery working points and load shedding
- Load trimming in each time step according to meter data (profiles)
- Calculation of loss cost during full study period based on cost profiles
- Element groups with defined switching sequences
- Calculation and diagram presentation of power and energy losses of the complete time span
- Consideration of network changes (outages, expansion stages, etc.) during time span
- Adjusted load flow due to diversity of consumer clusters and Gauß probability
- Diagrams for voltage and current violation
- Aggregated load flow result with maximum loadings and minimum voltages
- Long term dynamics analysis with full dynamic models for the calculation of the working point of elements
- Smart load flow with COM-server for direct / synchronous meter data reading e.g., from historians in near real-time without data storage

Load Development

- Long term network development with consideration of network changes and load forecasts
- Table for operation states for all elements
- Calculation of loss cost during full time frame based on cost profiles
- Show network limitations and propose future network enhancement dates
- Combine load development with economic efficiency to support optimal placement of DER
- Diagrams for network states, and load / generation profiles
- Combine load development with economic efficiency to support optimal placement of DER
- Iso-area color-coding of e.g. load density over time for different areas interactively

Optimal Network Structures

- Determination of the optimal structure based on CAPEX and OPEX over a defined planning horizon

- Optimization of the “travelling sales man problem” by algorithms like rotating ray, best savings, best follower including also post-optimization processes
- Open loops, links, pre-defined links, substation swap
- User-defined limits such as maximum power per loop or maximum number of substations
- Calculation of erection cost for each network structure
- Creation of proposed networks
- Consideration of existing networks with evaluation of lines for reuse, new or dismantled lines

Transfer Capacity

- Determination of maximum power transfer capacity between two regions
- Results include all relevant data like TTC, NTC, TRM or ATC and AAC or NTF and TTF
- Ability to take into consideration already predefined transfers between areas and determine if an additional capacity can be transferred
- Outages in the transfer areas can optionally be considered

Maximal Hosting Capacity (ICA)

- Automatically determines the maximal generation or load capacity that can be installed independently at each point of the distribution system without violating any user-given constraints in a systematic and cost effective way
- Load scaling factors or different operation states or load profiles
- Interactive method with

  - cluster technology and distributed computing,
  - thermal limit of all elements in the network under all conditions,
  - voltage limits and power quality,
  - voltage fluctuation caused by sudden generation or load fluctuations,
  - short circuit limitations, and protection assessment checks including zone factors, and
  - load flow tripping

- Interactive result display including tabular views
- Limiting elements for each criteria including time stamp
- Word documentation
- Result display in maps with background views
- ISO-area color coding
- Automatic creation of DER in the network model after the simulation for further checks

Maximal hosting capacity (ICA) analysis

Models Modules

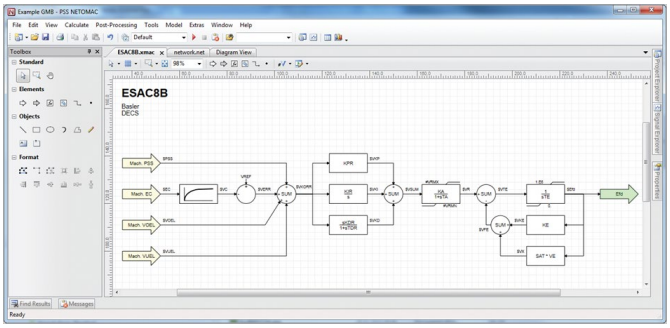
Line Constants

- Cable and OHL with open configuration and selection of conductors
- Conductor and ground wire libraries
- Variety of cable constructions
- Support of 1-phase systems with return path, 2-phase systems, e.g., for railway traction systems and 3-phase systems
- Up to nine parallel systems with diverse number of earthing conductors and mutual coupling in up to nine sections
- Fully filled matrix can automatically integrate into line model
- Simulation of parameters up to several kHz

Graphical Model Builder (GMB)

- Graphical editor for drawing any kind of block diagram (AVR, GOV, FACTs, Wind, complex model, etc.)
- BOSL language for fully flexible user-defined models usable in different software packages (e.g., PSS®E)
- Library with more than 100 predefined graphical function blocks and structures
- Block oriented structures can be combined with FORTRAN-like terms , such as mathematical functions, logical terms or instructions
- Easy forward initializing of models
- Testing environment of models with built-in signal generators and test points interactive stepping through the time and see each signal in the diagram

- Complex open and closed-loop control and protective functions
- Libraries of dynamic models such as AVR, GOV, Wind, FACTs, and smart grid elements
- Support of compiled dll models or model components according to IEC 61400-27 for the integration of manufacturer models, c/c++ code, Matlab/Simulink models, Co-Simulation etc.



Dynamic block diagram

Network modeling in PSS®SINCAL

- Single-phase, two-phase, bi-phase and three-phase technology to model any network type
- Supports any network structure
- Predefined work element groups (i.e., zones, areas, owners, etc.)
- Defined and automatically detected restoration schemes
- Co-simulation options between applications (including AC and DC or real-time usage)
- Node-branch / Bus-breaker, substation models or any user-specific configuration
- Enhanced protection modeling
- Equipment such as (remote) circuit breaker, disconnector unit, CT, VT, fault observations, etc.
- Trench model for automatic network design and cost model layer for CAPEX and OPEX simulations
- Cost model layer for CAPEX and OPEX simulations
- Extensive localized equipment libraries and libraries for protection devices
- Libraries with dynamic models such as FACTs, wind generators, PV, batteries and others
- Libraries with simulation characteristics such as motor start-up / torques curves, harmonic distortions, operation and load profiles, and reliability patterns
- Built in calculator for line drop compensation, automatic motor identification, and cable and transformer design tool

Workflow / Automation Modules

Grid Code Compliance Renewables (EEG)

- Automatic check of the interconnection rules according to different international standards (BDEW,VDE, NER, IEEE 1547, etc.)
- Interactive evaluation
- Ready to use reports for network operators or regulators

Network Model Merge

- Merge of the pan-European transmission network from the individual grid models (CIM CGMES format or other) in a short term cycle
- Evaluate and reduce the model according to different criteria to enable the operators to perform tasks such as operational security analysis, outage planning, or coordinated capacity allocations
- Facilitate day-ahead congestion forecasts (DACF), two-day-ahead congestion forecasts (D2CF) and even intraday congestion forecast simulations (IDCF) or simulations based on various snapshots

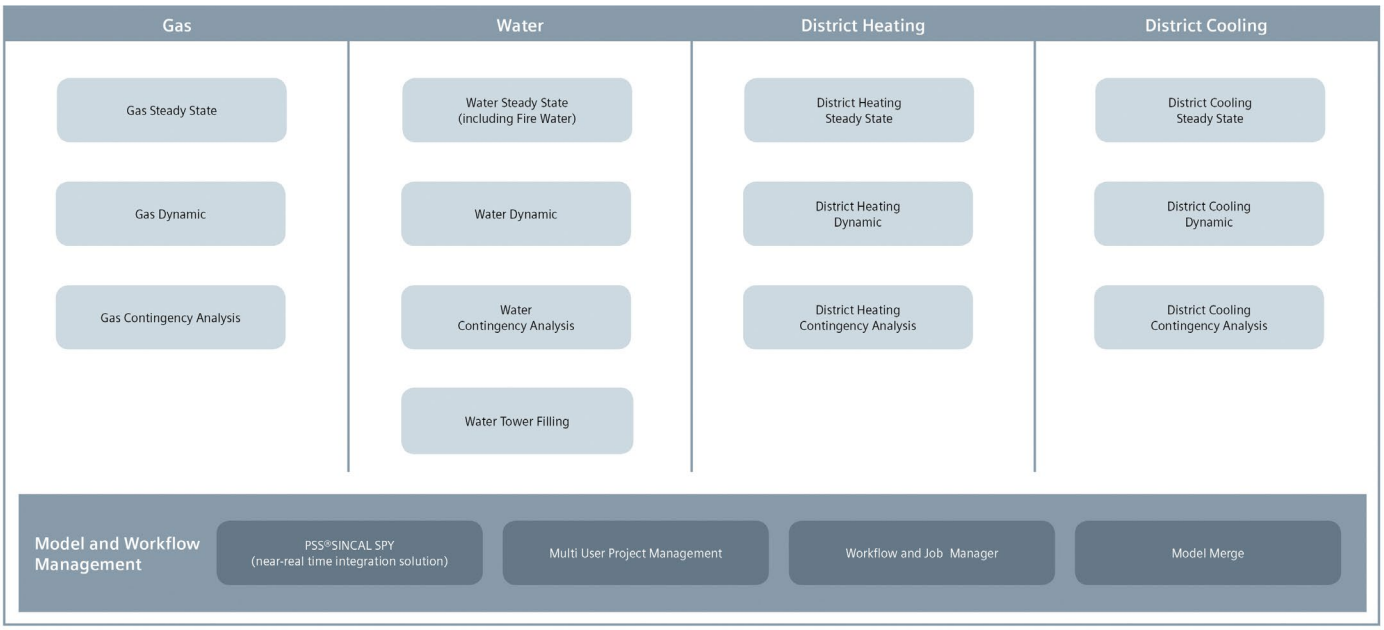
PSS®SINCAL SPY

- Monitor the state of the power system in an interactive evaluation
- Near-real time system information by integrating with utility SCADA systems, metering systems, data historians, and other real-time data management systems are presented in an ongoing simulation loop
- User defined rules to improve the control and visibility of a distribution network and protect against critical network states or security at risk

Scripting and Automation

- API for full automation of GUI and simulation of PSS®SINCAL including HTML GUI development directly within the application
- COM-server allow scripting via most programming languages such as Python, C++, Java, VBS, VBA, etc.
- Embed PSS®SINCAL Engine into other applications (e.g. Bentley)
- Easy integration with external applications such as GIS and SCADA

Pipe Network Modules



Gas, Water, and District Heating / Cooling Modules

Thermal and Hydraulic Simulations

- Different solvers such as Hardy-Cross and second Kirchhoff rule
- Lambda-calculation according to Nikuradse, Prantl-Colebrook or Unger and Prantl-Colebrock

Features

- Undersupply
- Redispatch of supply
- Locking of pipes
- Definition of characteristic curves for pumps and valves
- Checking of the operating points and limits of pumps, valves and network groups
- Weak-point analysis and color-coded visualization
- Graphical identification of elements which are affected by pipe failures
- Tables and reports for general network data and all element data; node reports with pressure and altitude and all connected elements with flow, flow speed and pressure difference; pipe elements with flow, pressure, pressure decrease, flow speed, length and diameter; results summaries with minimal and maximum pressure and maximum velocity
- Diagrams for longitudinal cuts and operation points
- Network diagram
  - Nodes: altitude, consumption, absolute and relative pressure
  - Pipes: flow, absolute pressure, pressure drop, length, diameter, flow speed, type of pipe
  - Color-coded filter functions for pressure, flow, speed, consumption, etc.
- Usage and creation of user specific pipe libraries

Profile Simulation

- Time series
- Increase series
- Operation points
- Simultaneity depending on the number of consumers of identical types
- Results: All flow calculations for all time steps including maximum or minimum values
- Diagrams showing daily profiles of the result data observed at selected nodes and branches in the network

Contingency Analysis

- N-1 criteria and N-1-1 criteria
- Interruption of supply
- Detect network states outside limits during outages
- User-defined outages of single elements outage groups or function
- Results: minimum, maximum, unsupplied elements, overloaded elements, etc.

Addtional Water Modules

- Hydrant simulation
- Fire water simulation

Water Tower Simulation

- In- and out-flowing water during changing geodetic heights of the water level in water towers
- Stored water volume defined by the water tower shape and the height of the water level
- Calculation time and time steps user-defined
- Result diagrams for height, pressure, volume and flow as functions of time

Heating / Cooling Enhancements

Thermal and Hydraulic Simulation

- Symmetrical and asymmetrical networks
- Four-conductor (or more) networks (two flow pipes and two return pipes)
- Simulation of primary and secondary networks
- Temperature controlled compulsory blending in flow and return flow
- Heating generators with different flow temperatures
- Different cool-down temperatures of consumers
- Flow pipes can be connected via bypasses
- Closed simulation of flow and return flow

Product Support

Support

- Application support offered by dedicated in-house Siemens PTI Customer Care team with direct access to subject matter experts
- Premium access to product updates, enhancements and improvements as well as new functionality
- Interactive online forums to facilitate knowledge sharing among the community of professionals
- Extensive knowledge database
- Power packed technical user conferences with regional focus to increase product roadmap awareness, providing opportunities to meet with Siemens PTI experts and fellow users

Siemens Power Academy

- Beginner to advanced level certified PSS® software training
- Flexible delivery options including e-learning or at a customer site
- Standard and customized training

Licensing Options

- **Single user-licenses** (PC-bound)

  - Local or network SQL databases
  - Programming and Engine support
  - Free interfaces

- **Dongle licenses**

  - Local or network SQL databases
  - Programming and Engine support
  - Free interfaces

- **Network licenses**

  - Local or network SQL databases
  - Multi-user license
  - Floating license
  - Check-out options
  - Programming and Engine support
  - Free interfaces

- **Flexible network licenses**

  - Local or network SQL databases
  - Multi-user license on module level
  - Unrestricted site license
  - Check-out options
  - Programming and Engine support
  - Free interfaces

- **Leasing license of all types**
- **Hourly licenses**
- **Installation on virtual machines** (e.g., CITRIX support)
- **Application:** 32- and 64-bit
- **Language Support**

  - English, German, Spanish, Chinese, Russian, Turkish

Integration Options

- Support during integration
- Turn key offering

Minimum System Requirements

Minimum Hardware Requirement

- CPU: 2 GHz
- RAM: 4 GB
- Hard disk: 10 GB
- Graphics card: 1280 x 1024, True Color

Supported Operating Systems

- Windows 7, 8, 8.1, 10 (x86 & x64)
- Windows Server 2008 R2, Windows Server 2012 R2, Windows Server 2016

Supported Database Systems

- Microsoft Access
- Oracle 9i, 10g, 11g
- SQL Server 2008, SQL Server 2008 R2, 2012, 2014,2016
- SQL Server Express 2008, SQL Server Express 2008 R2, 2012, 2014, 2016
- SQLite

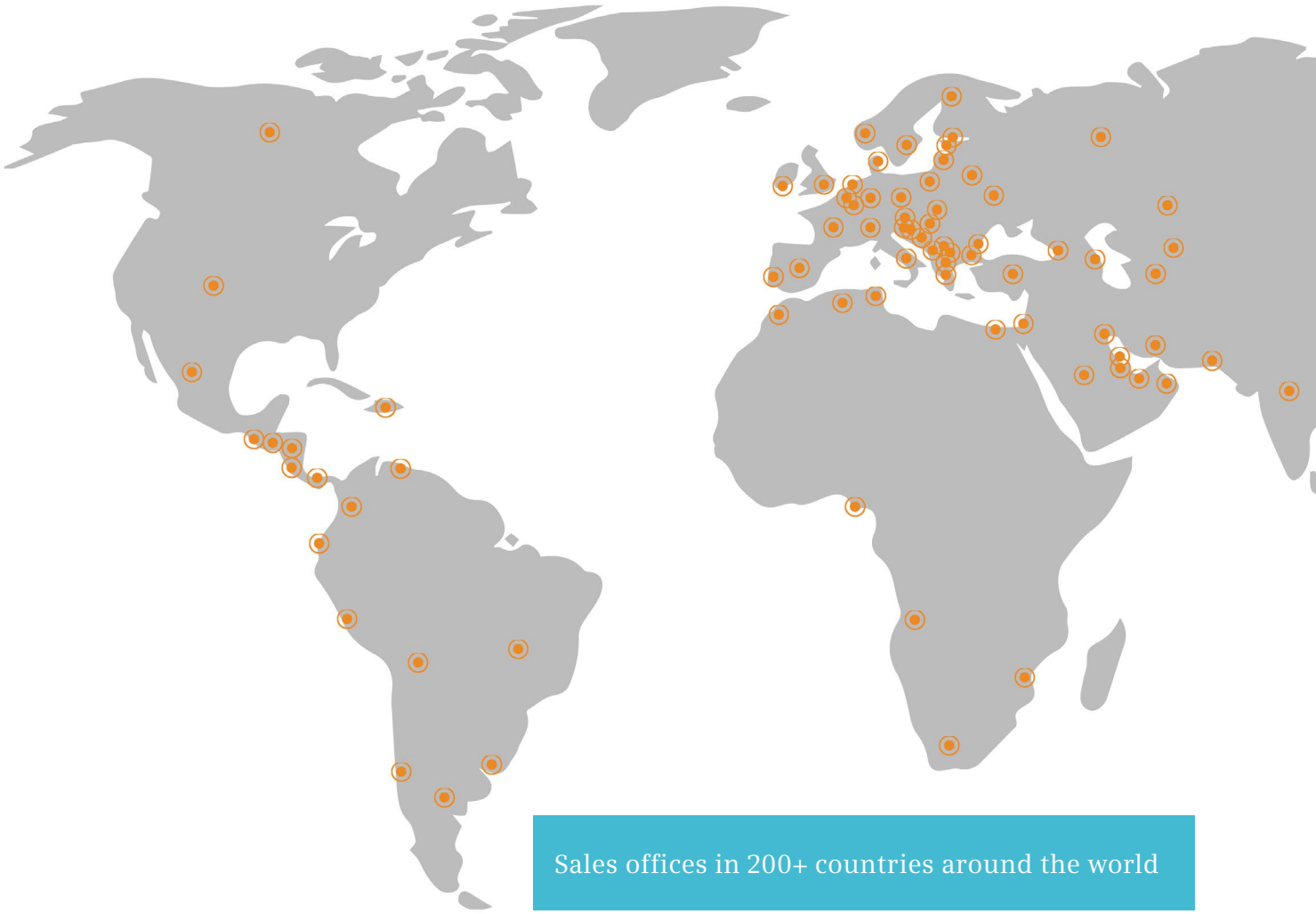
Sales Contact

- Email: *pti-software-sales.ptd@siemens.com*

Company Profile

Siemens Power Technologies International

From strategic advisory to technical consulting and state-of the art software solutions: Siemens PTI offers a holistic approach to mastering the technical and economic challenges of today's and future energy systems. Drawing upon more than 60 years of experience and continuous innovations in power system planning, Siemens PTI's renowned experts address the full scope of power system analysis, design and optimization studies. Experiences gained in international studies and the dynamic changes to the industry, directly flows into Siemens PTI's comprehensive suite of power system planning and software tools which reliably support the power and energy industry around the world. Our strategic consultants help optimize business value by providing valuable advice in the fields of business transformation, infrastructure development, as well as market and transaction advisory. Siemens' financial strength and regional competence centers around the world make Siemens PTI an ideal partner to develop individual, innovative solutions which create sustainable value for our customers and turn change into opportunities.



Sales offices in 200+ countries around the world

Software Solutions

Siemens PTI offers a powerful suite of software applications and solutions to efficiently support system planning and operations with their daily simulation and analysis work. The Power System Simulator (PSS®) Product Suite provides a full set of integrated and specialized applications for the simulation, analysis, and modeling of transmission, distribution, and industrial power networks, as well as gas, water, heating, and cooling infrastructures. Readily integrated into any existing IT environment, these powerful and user-friendly tools feature an intuitive graphical user interface, customizable visualization options, automation capabilities, and efficient data management. Data exchange with other systems (e.g., EMS, DMS, AMS, GIS, other planning tools, etc.) is provided through industry standards (i.e., CIM) and native interfaces. Siemens PTI also provides custom software solutions based on its blend of engineering and software architecture expertise, custom software development capabilities, award-winning project management, and existing product functionality.

Energy Business Advisory

Regulatory bodies are increasingly pushing for level playing fields, environmental responsibility and increased transparency. Siemens Energy Business Advisory is a leading provider of strategic consulting services to utility customers across the US. For nearly 40 years as Pace Global, it has participated in over $100 billion of energy asset transactions around the world and has managed portfolios at over $10 billion. By combining rigorous analysis and with deep consulting expertise, Siemens EBA ensures its clients innovative services to support the execution of business transformation, market planning, and risk management. Siemens EBA represents clients in all segments of the energy value chain, including exploration, production, generation, midstream, storage, transportation, distribution, and end-use.

Power System Consulting

Ever changing industry challenges and opportunities along with the rising complexity of modern power systems call for comprehensive, systematic grid planning. Siemens PTI's renowned Power System Consulting experts leverage experiences gained in numerous and diverse projects to derive grid concepts which follow the overall business strategies of utilities and end-customers. Profound power system analysis, both technically and economically, together with leading planning competence provide insight that enable our clients to take well-informed decisions influencing the structure, performance and operation of their systems. Our services address utility as well as industrial or commercial grids and cover the complete range of studies: from steady-state, dynamic and transient analyses to protection and control concepts or power quality aspects. In studies, continuous partnerships, long-term planning or research projects, we tailor our services to individual demands.

Did you know?

- Siemens PTI founded in 1956
- Headquartered in Erlangen, Germany
- Global leader in power systems planning
- 2,000+ customers and 3,000+ projects p.a.
- 200+ renowned experts with profound experience

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