GE VERNOVA

Consulting Services

POSITIVE SEQUENCE LOAD FLOW (PSLF*) SIMULATION SOFTWARE

Supporting detailed and comprehensive modeling of systems up to 125,000 buses

Full-Scale, Full-Scope Simulation

Effective power system performance analysis requires large-scale simulations and large volumes of data. PSLF recognizes these imperatives, and supports detailed and comprehensive modeling of systems up to 125,000 buses.

Effective data management is just as important as the engineering models for which the data is used. Data is structured using a relational database and a variety of input and output formats are supported, as well as easy and flexible reporting of engineering results. Additionally, several engineering-judgement-based data checks are also available within the program, for both steady-state as well as dynamic models of equipment.

PSLF's power systems analysis package includes Steady State and Dynamic Analysis (transient stability) packages. These programs are available for license and are important tools for GE Vernova's Consulting engineering work.

Steady State Analysis

The Steady State Analysis subsystem within PSLF includes power-flow data preparation, editing, viewing, and reporting, all of which are in turn tied to the power-flow solution engine and contingency analysis capabilities. System modeling is extremely detailed and flexible, allowing users to accurately describe and simulate their networks. Both AC and DC power-flow solution methods are available, including full Newton-Raphson and decoupled approaches. The AC power-flow includes a large array of solution and control options to achieve fast and reliable convergence. Graphical viewing and inspection of solution results is available within the user interface, and custom network diagrams are easy to build and use.

The SSTools (Steady State Analysis Tools) package has been developed for contingency analysis and is built into the main PSLF user interface. SSTools provides the ability to perform traditional thermal and voltage analysis, static voltage stability analysis, and transfer limit analysis. Additionally, SSTools allows the user to use one common data format for all input and output files. Within SSTools, an automated contingency creator can develop contingency lists for N−1, N−1−1, and N−2 contingencies. As always, custom contingencies may also be created by hand. Further SSTools can also be used to generate control and case files, in addition to performing the simulations.

Remedial action schemes (RAS) may be created for contingency simulations to better reflect corrective controls that will be executed in actual power system operation, that can in turn be used in these simulations:

Dynamic Analysis

Within the power industry, PSLF is regarded as one of the fastest and easiest tools with which to perform Dynamic Analysis. The Dynamic Analysis package in PSLF allows users to perform transient stability analysis for multiple events on cases. Dynamic Analysis can be run in batch mode, allowing the execution of multiple dynamic simulations without requiring user interaction. As with Steady State Analysis, users may also model and simulate RAS within dynamic simulations.

PSLF has a rich library of models of machines, exciters, prime movers, stabilizers, transmission devices, relays, HVDC, meters, and an advanced composite load model. Many models are available for wind turbine-generators, solar photovoltaic production, and energy storage. Users may also create and use their own equipment models using PSLF's scripting language EPCL. Some debugging tools are available to find out problem actors in simulations that don't initialize well or cases that run into division by 0 error due to bad data.

Our embedded dynamic contingency analysis tool DYTOOLS is designed to assist planning engineers in the batch processing of dynamic stability simulations. The input format allows engineers to define contingencies in plain terms very similar to SSTOOLS.

Advanced User Interface

Beginning with version 23 the production version of PSLF features a new, advanced user interface that revolutionizes the user experience and increases productivity. The advanced user interface includes a broad set of functionalities for editing data via tables and drawings. Additional features include:

- Export to PDF and Microsoft Excel format files as an integrated option within the context menus of data tables.
- Integrated Development Environment (IDE) for development of Python or EPCL scripts.
- Integrated plotting capability for review of dynamic simulation results. The plotter provides a table for all recorded signals too which contains the initial, final, maximum, and minimum values of that signal in the given transient stability simulation along

with the spread (max-min value) and the time at which the signal reaches its maxima and minima. These can be useful tools to find the needle in the haystack for potentially problematic cases or figuring out the area of concern. The plotting tool also provides the user the option of creating templates for plots with desired block/page formatting such as font, title etc. that can then be reused for reporting of other cases, useful for sensitivity studies for example.

- New and improved data editors with fully described data entries.
- Context-driven filtering and undo/redo support for all data tables.
- Automatic one-line diagrams (“scans”) of the associated target bus are displayed automatically when selecting a power flow asset from the data tables.
- Powerful one-line diagram designer with smart orthogonal lines; line characteristics such as line charging are illustrated directly on the branches.
- Visualization of system states (such as rating and voltage violations) on diagrams and the scan view.
- All windows within PSLF can be docked/re-arranged for multi-monitor support.
- Ribbon styled menu on the top that allows easy navigation.
- The new ‘models by type’ (‘edds’ equivalent) option allows user to easily and quickly access all the dynamic model data categorized by model names. This table also color-codes some parameters if the values are too high or too low in comparison to the typical range for such parameters.

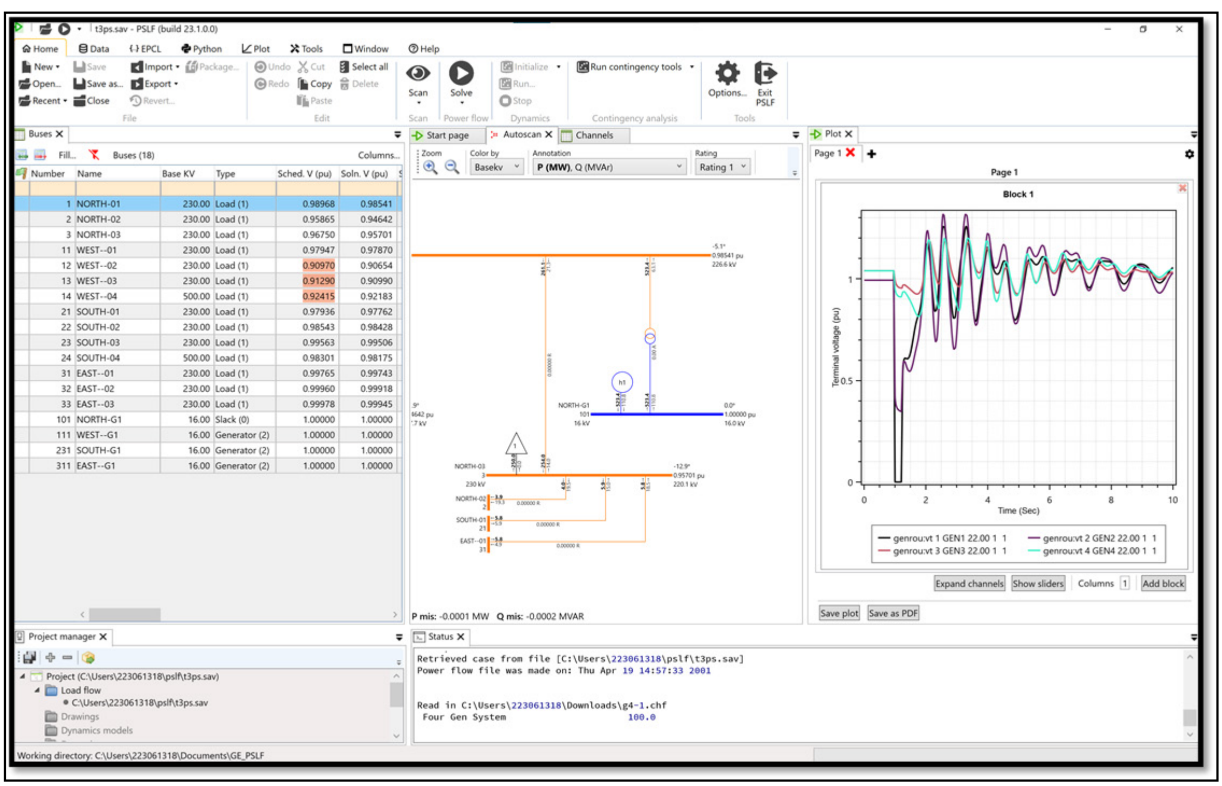
Scripting

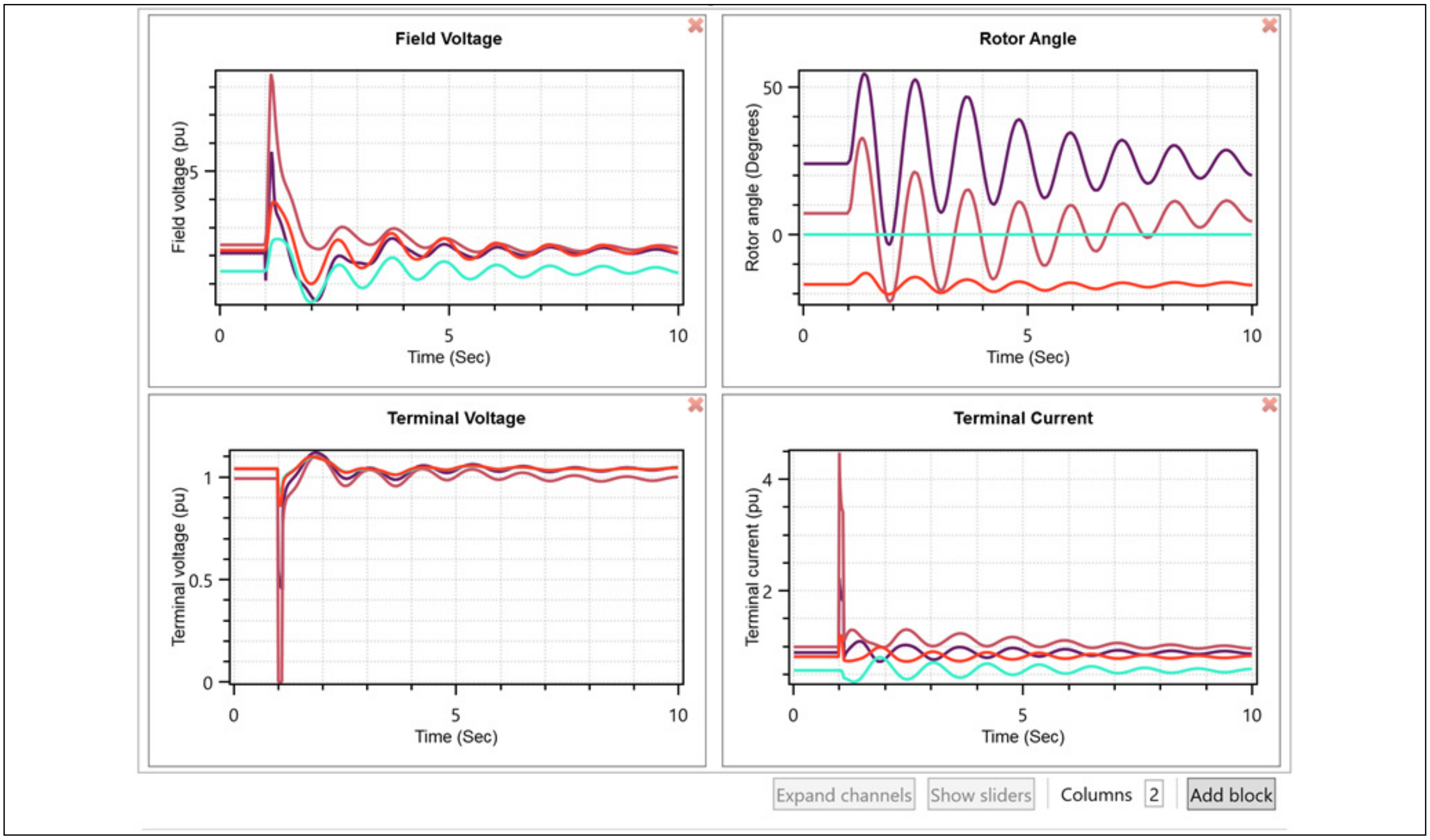
To efficiently achieve structured, reproduceable, and auditable results for complex simulations, most users will create scripts to “drive” PSLF. Since the program’s inception, the PSLF proprietary EPCL language has been available to call analytical functions; read, write, and update power-flow data; perform logical tests and arithmetical operations; loop; and output results to the console or a file. **Beginning with version 23, PSLF introduces Python scripting.** Using Python within PSLF matches all the functionality of EPCL, but also provides users access to the thousands of numerical, graphical, and other libraries associated with Python. With the addition of Python scripting the universe of additional computations and reports that can be achieved has been greatly expanded. **Both Python and EPCL programs may be edited within IDEs in the advanced user interface which also provides the user debugging capabilities.**

Add-on Programs

Special-purpose add-on programs may be licensed to complement the functionality found within PSLF.

- **ProvisoHD** enables users to quickly and visually analyze data produced by SSTOOLS for thousands of steady-state contingencies.
- **GMD** is an add-on to PSLF that allows planners to analyze the impact of geomagnetic disturbances on transmission systems.
- **Breaker-node** allows planners to analyze full topologies systems. This add-on has numerous features geared towards performing post-event analysis to compare real time data versus planning case results.
- **Ztools** allows planners to analyze the impact of series capacitors on subsynchronous resonance (SSR) for thermal generation, and subsynchronous control interaction (SSCI) for wind turbines.
- **OPF (Optimal power flow)** is used to find the set of system conditions that optimize a given power system-based objective function, subject to a set of constraints. Typical OPF objectives include least-cost dispatch, maximum power transfer between two areas, or identification of the minimum control shifts required to alleviate violations. A wide range of controls are available to achieve the objective, and numerous constraint types may be enforced.





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