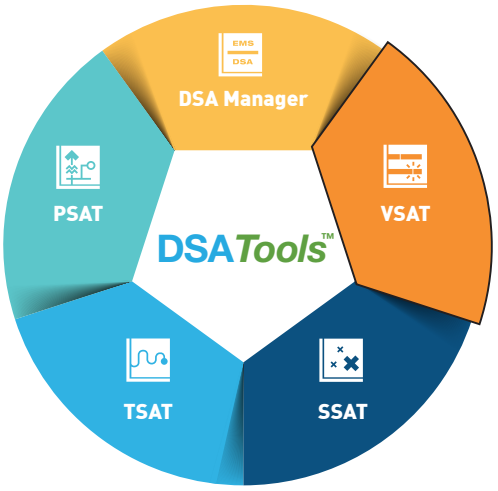
VSAT Voltage Security Assessment Tool

VSAT is a software tool that provides advanced features for voltage security assessment of power systems.



VSAT's extensive computational capabilities allow comprehensive analysis for predicting and preventing voltage insecurity problems.

VSAT uses static analysis methods for voltage security assessment and transfer limit computations subject to voltage security criteria and contingencies. Its modal analysis feature provides valuable information regarding the location of instability and participation of buses in specific modes of instability. Its remedial action module determines the most effective controls for prevention and correction of security violations. A comprehensive model library is available for all analyses to consider important factors for voltage stability, such as generator reactive capabilities, switchable shunts, automatic transformer tap changers, special protection systems, etc.

Complemented by PSAT (Powerflow & Short circuit Analysis Tool), TSAT (Transient Security Assessment Tool), and SSAT (Small-Signal Analysis Tool) of DSA*Tools*™, VSAT helps system planners and operators in accurate and complete assessment of the security of a power system.

As an off-line analysis tool, VSAT greatly facilitates the voltage stability analysis of a system under various operating conditions, contingencies, and power transfers. In deregulated environments, because of the uncertainty associated with generation, load, and power transactions, the number of conditions that must be analyzed may become unmanageable with conventional tools. But, with VSAT, a large number of scenarios can be set up and analyzed very quickly, providing detailed information regarding critical contingencies, voltage security violations, locations and mode-shape of instability, etc.

In the on-line application, VSAT determines the security of the current system state (as obtained from the EMS state estimator) and forecasts future states (such as hour-ahead or day-ahead) for a large number of contingencies. In addition, as in off-line mode, it computes thermal and voltage security limits of any given number of power transfers. These limits, together with transient and small-signal security limits, determine the Total Transfer Capability (TTC) of various flowgates in the system.

PRODUCT FEATURES

- *Powerful off-line analysis capabilities*
- *Readily configured with EMS for on-line use*
- *Selection of various security criteria:*
  - thermal overloads
  - voltage declines
  - reactive power reserves
  - voltage stability margin
  - weighted short-circuit ratio
- *Comprehensive modeling support*
- *PV curve and VQ curve computation*
- *1- and 2-dimensional transfer limit search*
- *Modal analysis*
- *Remedial measure identification*
- *Scalable distributed computation engine*

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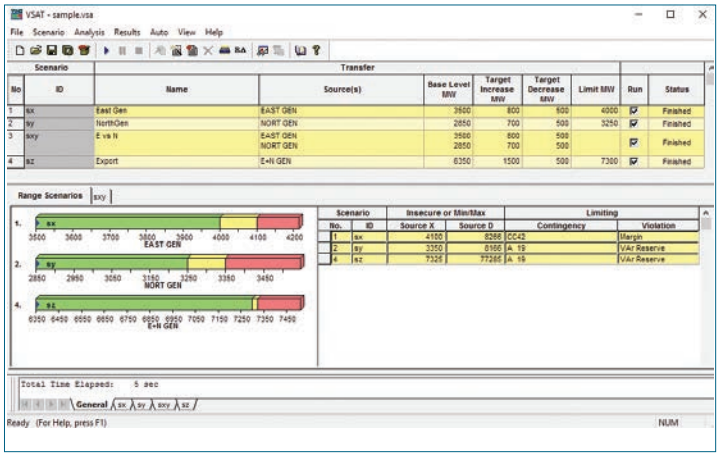
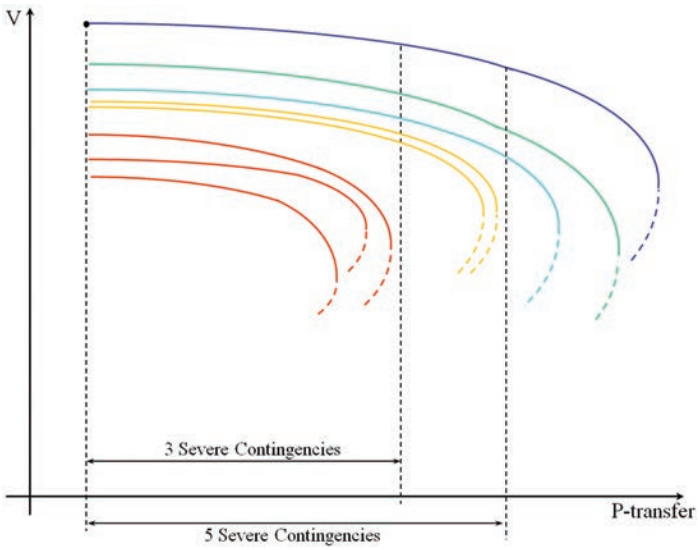


CONTINGENCY SCREENING

To reduce the number of contingencies to be fully analyzed, VSAT uses a special powerflow-based contingency screening method to select a number of critical contingencies from the full list. The main features of contingency screening are:

- The method accounts for all non-linearities (i.e. not based on inaccurate linearized indices or interpolated trajectories).
- The method always accurately classifies the contingencies based on their true voltage stability margin.
- Screening is performed for specified power transfer.



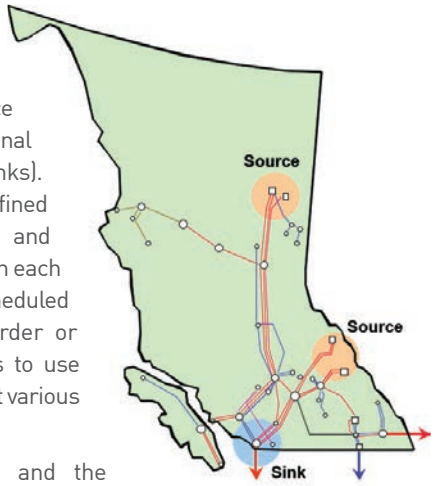
SCENARIO DEFINITION

In VSAT you can specify a large number of scenarios to be analyzed, each defined by the following:

- Base case condition (powerflow)
- Power transfer definition
- Contingencies
- Security criteria
- Analysis and solution control options
- Other applicable models

For scenarios with a power transfer, VSAT determines the voltage security limit of the transfer. Without a transfer definition, VSAT determines whether the base case is voltage secure or insecure. In either case, a variety of reports are produced to show security violations identified, PV curves, voltages, flows, critical modes, and other system information.

SECURITY ASSESSMENT AND TRANSFER LIMIT

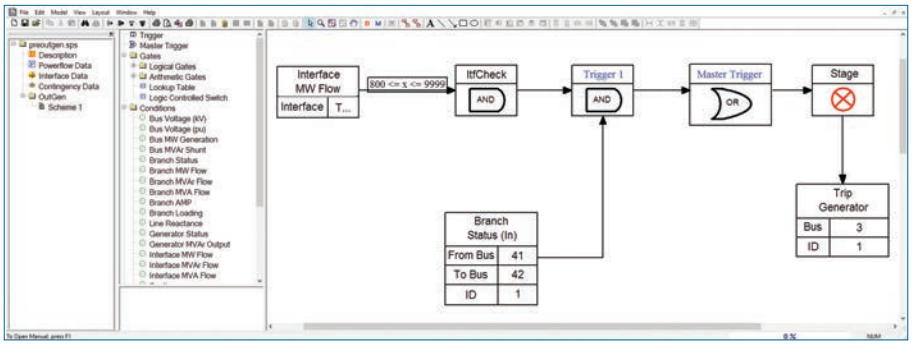


VSAT finds the security limit of any number of specified one-dimensional transfers (defined in terms of one source and one sink) and two-dimensional transfers (three sources/sinks). Each source or sink may be defined as any combination of load and generation groups. Generation in each group can be scaled or rescheduled based on the user-defined order or share. There are more options to use when scaling generation to meet various dispatch requirements.

The security of the system and the transfer limits are based on the user-defined security criteria, which may include:

- Thermal limits
- Voltage decline/rise limits
- Reactive reserve margins
- Voltage stability margin
- Weighted Short Circuit Ratio (WSCR)
- Other

VSAT displays the limit of each transfer and identifies the limiting contingency as well as the criteria that are violated under that contingency.



A special protection scheme model that can be included in VSAT analysis.

MODELING AND MONITORING

VSAT offers advanced modeling capabilities required for voltage stability analysis:

- Generator reactive power capability (D curves).
- Inclusion of AGC actions and governor responses in powerflow solution.
- Various load models.
- ULTC control modes for pre and post-contingency.
- Special protection scheme (SPS) models.
- Combined cycle plant models.
- Flexible definition for contingencies.

The network can be modeled in the conventional bus/branch format, superimposed with optional node/breaker details for breaker-based switching actions in contingencies and SPS.

In addition, different quantities can be monitored while performing PV analysis:

- Bus voltages.
- Circuit interface flows.
- MW and/or MVAR in groups of generators.

SOLUTION OPTIONS

The VSAT engine uses a specialized powerflow solver designed to handle large complex systems and large number of contingencies. While achieving high computational performance, the VSAT engine can also be set to respect various solution options, such as switched shunt controls, ULTC controls, AGC, area interchange controls, FACTS controls, etc.

When solving a system, it is possible to purge a portion of the system with known voltage issues (for example, dominant local modes). This allows the analysis to focus on important modes of voltage collapse.

MODAL ANALYSIS

Modal analysis (eigenvalue analysis of the system Jacobian) determines the areas prone to voltage instability. It provides lists of buses ranked by their participation in the critical modes. VSAT can perform modal analysis at the voltage stability limit of the critical contingency, or any other user-specified operating point.

VQ CURVES

VQ curves can be computed at user-specified buses, for all or selected contingencies, and at any points along the PV curve. VQ margins are then reported in the output analysis module (DSAOA).

REMEDIAL ACTIONS

When VSAT indicates that an operating point is insecure, or the voltage stability margin is insufficient, the remedial action (RA) module can be called to determine the most effective controls to remove all or selected security violations, or to increase the voltage stability margin to a desired value.

The built-in RA module has the following salient features:

- It computes preventive, and if necessary, corrective actions required to achieve the objectives.
- Preventive actions include generator voltage adjustments, SVC/switchable shunt voltage scheduling, capacitor/reactor switching, ULTC tap adjustments, and generator redispatches; corrective actions include load shedding.
- Actions are selected based on sensitivities and their user-defined priorities.

In addition to the built-in RA module, an add-on module, OPF-RA, is available to provide an alternative for the determination of RA by using the Optimal Power Flow (OPF) technique.

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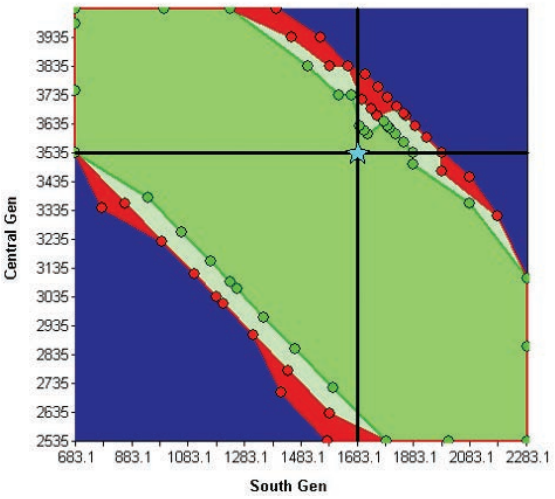
OUTPUT ANALYSIS

The output analysis module (DSAOA) is a tool for managing, viewing, and plotting the results of VSAT.

DSAOA displays all reports and outputs for each analysis scenario. The monitored variables (PV curves, QV curves, Interface flows, MVAR reserves, etc.) can be plotted in various combinations. 1- and 2-dimensional transfer limit plots can be created for all monitored quantities. Output plots can also be created in batch mode using scripts.



OTHER FEATURES

- Capability to integrate, through the DSA Manager and ST DSA Manager module, with EMS for on-line dynamic security assessment.
- Power system components can be identified using bus numbers, bus names, or equipment names.
- Connection with PSAT for viewing and editing base powerflow data.
- Powerflow case at any point on a P-V curve can be saved.
- Contingency script utility to automatically create single and multiple contingencies.
- Data conversion tool to import powerflow data in third-party formats including PSS/E, PSLF, etc.
- Case archive feature to store or share study cases.
- Distributed computation to enable simultaneous analysis of multi-contingency/scenario cases on multiple servers, or multiple CPU cores.
- Analysis of power systems of up to 100,000 buses.
- Runs on MS Windows 7/10/server 2012 R2/server 2016

OTHER POWERTECH SERVICES

- Licensing of the power system analysis software package DSA*Tools*™
- Licensing of other software products for utility applications
- Implementation of on-line dynamic security assessment (DSA) systems
- Development of custom software systems
- Development of models for use in power system analysis
- Generator field testing, model development and validation
- Training
- Technical consultancy studies including
  - Development of power system base cases
  - System planning and operation studies
  - Facility (including renewables) interconnection studies
  - Compliancy studies (such as NERC TPL, CIP, UFLS, etc.)
  - Post-mortem analysis of system disturbances

ABOUT POWERTECH LABS

Powertech Labs Inc. is one of the largest testing and research laboratories in North America, situated in beautiful British Columbia, Canada. Our 11-acre facility offers 15 different testing labs for a one-stop-shop approach to managing utility generation, transmission and distribution power systems.

Outside of the utilities industry, Powertech provides routine testing capabilities, product development, research and consulting services to support an array of industrial-type operations, electrical equipment manufacturers and automotive original equipment manufacturers.

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