Transient Stability Analysis with PowerWorld Simulator

T2: Transient Stability Data Management

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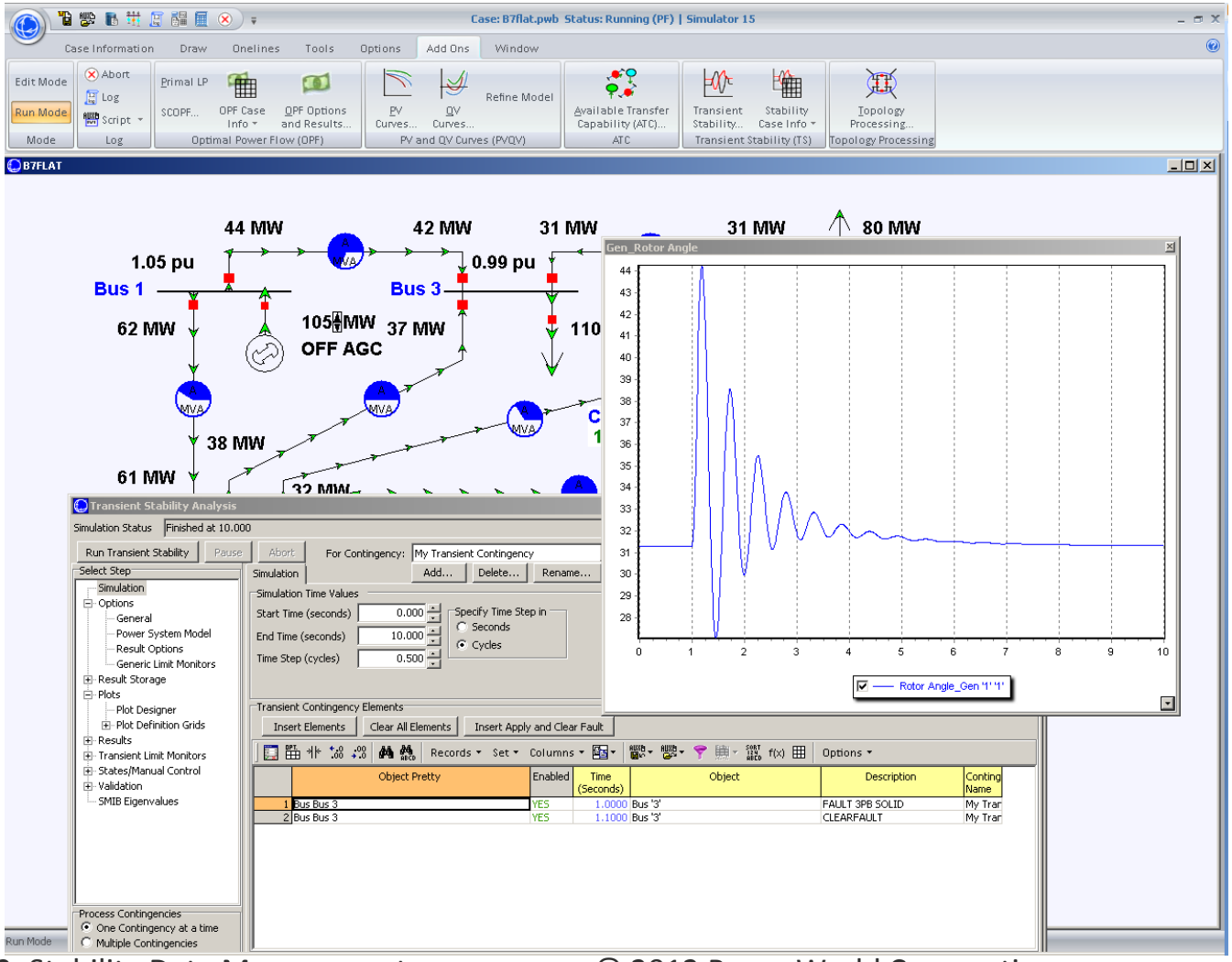
Transient Stability Data Management

- The Transient Stability tool makes it possible to deal with a large amount of input data (and result data, discussed later)
- Reading/writing to various file formats
  - Input data can be used to define the dynamic models of the system as well as the steady-state model of the system
  - Simulator also makes it easy to save out transient stability information to files
- Navigating available models
  - Model explorer
  - Stability tab of dialog for individual models
- Additional resources are available, including
  - Block diagrams
  - Simulator Help documentation

Design Philosophy

- PowerWorld's design philosophy is to make power system analysis as easy as possible.
  - This holds true in the transient stability domain. Our goal is to reduce the entry barrier to allow more power system professions access to transient stability
- As much as possible we have leveraged our existing methods for data interaction
- Transient stability data augments the power flow model data.

Example: Running Transient Stability on the B7Flat Case



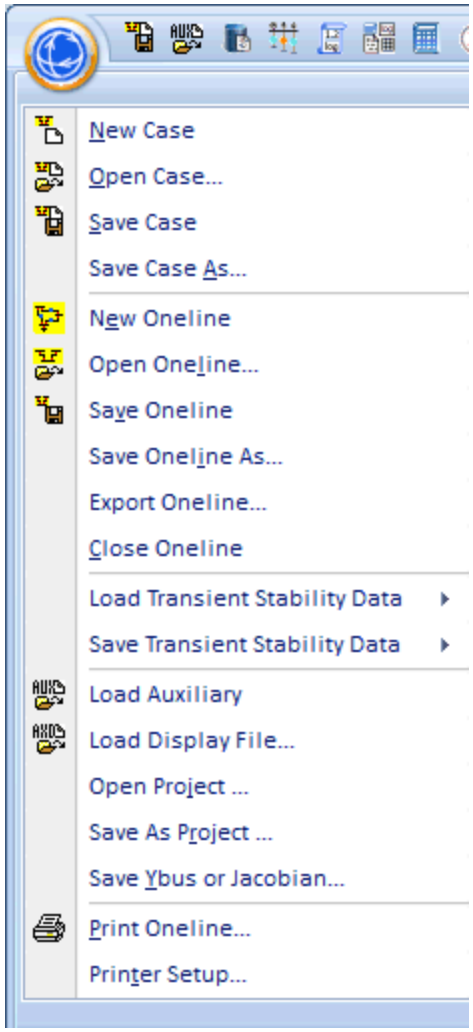
Our Philosophy: While doing transient stability solutions on large cases can certainly require large amounts of engineering expertise, the barriers of entry in learning to do such studies should not arise because of the software.

External Data Files

- A particular pwb case may or may not already have dynamic models saved in it, and there must be at least one model to do a transient stability simulation
- Models may be read in from an input file or manually entered
- Several external file types including
  - PowerWorld Auxiliary File (AUX)
  - PTI File (DYR)
  - GE File (DYD)
  - BPA File (SWI)
- PowerWorld Simulator can read and write Transient Stability data to these formats
- Only models which are supported by the specific format can be saved back into that format

External Data Files

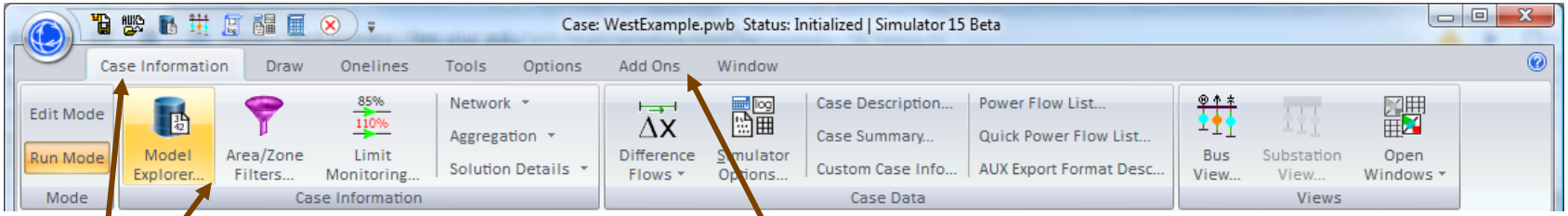
- Access for loading and saving these files can be found in several places within Simulator
- Application File Menu by clicking the PowerWorld icon in the top left corner of Simulator
- At the bottom of the specific model pane in the Transient Stability portion of the Model Explorer
- Stability Case Info Menu buttons
- Transient Stability Dialog buttons



Auxiliary Files (AUX)

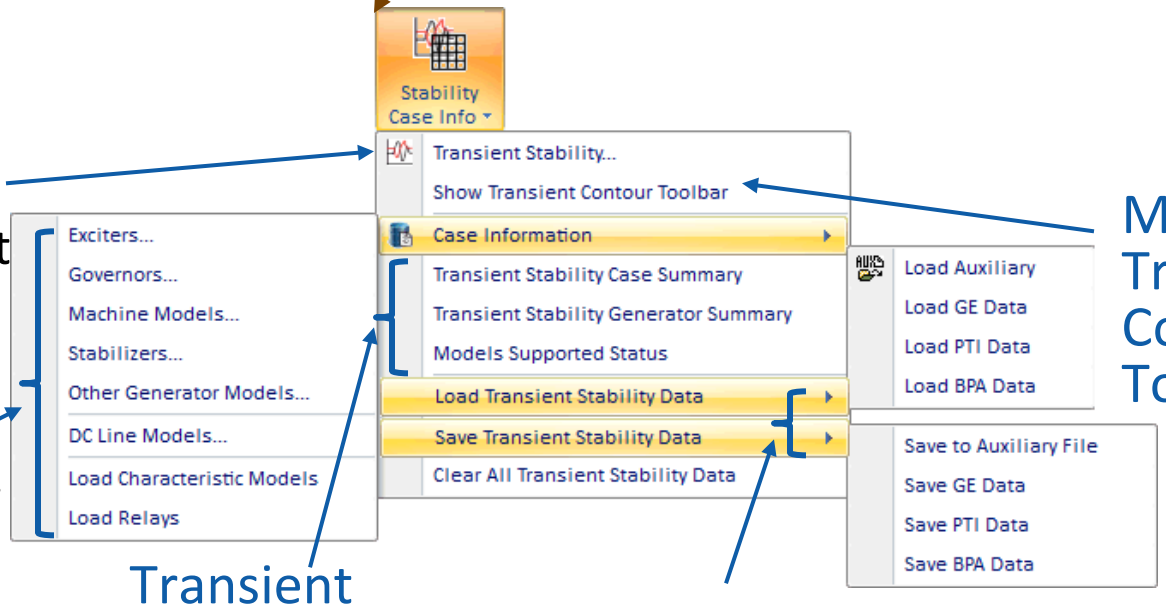
- The ability to use AUX files exists throughout Simulator, and it is something that is supported by Transient Stability as well
- Another training course covers AUX files in more detail
- Save to Auxiliary
  - Store any results and settings that need to be retained for future use
  - Easily loaded into different power flow cases
- Load Auxiliary
  - Load relevant option settings to be used during the transient stability analysis
  - Can load the same AUX file into many cases
- Transient-stability specific results and options can also be saved with the pwb case

Transient Stability Case Information and Model Explorer



Model Explorer from Case Information Toolbar

Stability Case Info, Case Information from Add-Ons Toolbar



Transient Stability - Opens the Transient Stability Analysis Dialog

Case Information - Opens the Model Explorer to the appropriate page

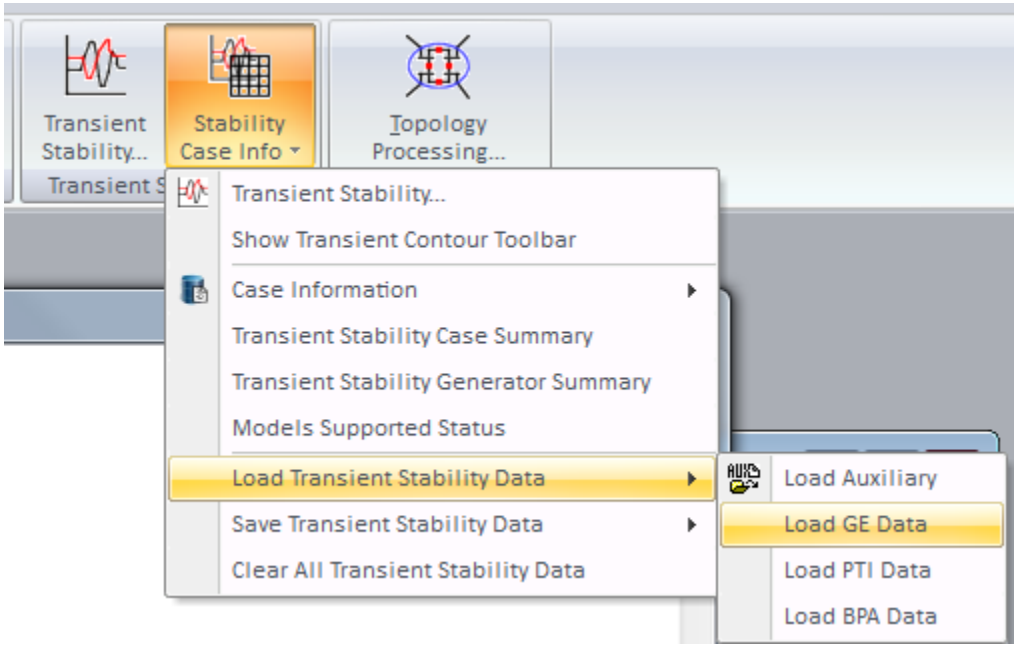
Transient Stability Summary

Load/Save Transient Stability Data

Make the Transient Contour Toolbar visible

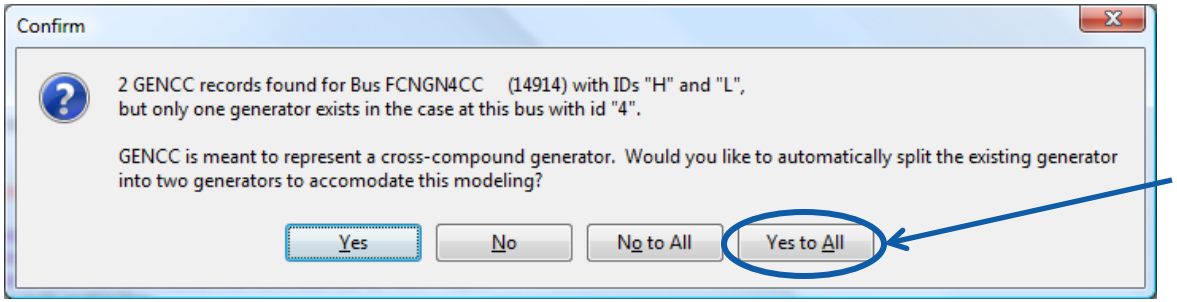
Example: Loading Data from External File Formats

- Open WestExample.epc
- This contains power flow model data
- Go to “Load Transient Stability Data” and “Load GE Data” from the Stability Case Info drop down menu on the main ribbon
- Load in WestExample.dyd
- This contains dynamic model data



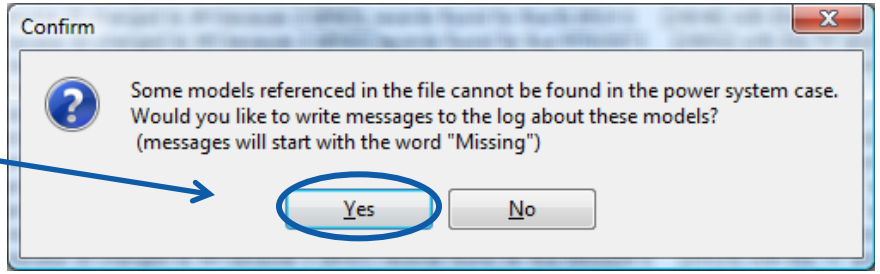
Example: Loading Data from External File Formats

- The following information dialogs will appear
- This has to do with the modeling of combined cycle units, represented by the GENCC model- there is a low pressure unit and a high pressure unit which are two different machines, but in the power flow case they are modeled as a single unit
- Several of the largest units in the West have this model



You should click "Yes to All" to have Simulator automatically split into two generators

Click Yes to write messages for models that exist in the dynamic data but not in the power system case



GE DYD Special Handling: Cross-Compound Units

- Cross-compound units are two generators which both operate off the same steam plant
- Often represented in a DYD file
  - 2 machine models
  - 2 exciters
  - 2 stabilizers
  - 1 governor which is either IEEEG1 or CRCMGV
- Ideally, the power flow model represented by the EPC file will model these two generators separately and will easily link to the DYD models

GE DYD Special Handling: GENCC model

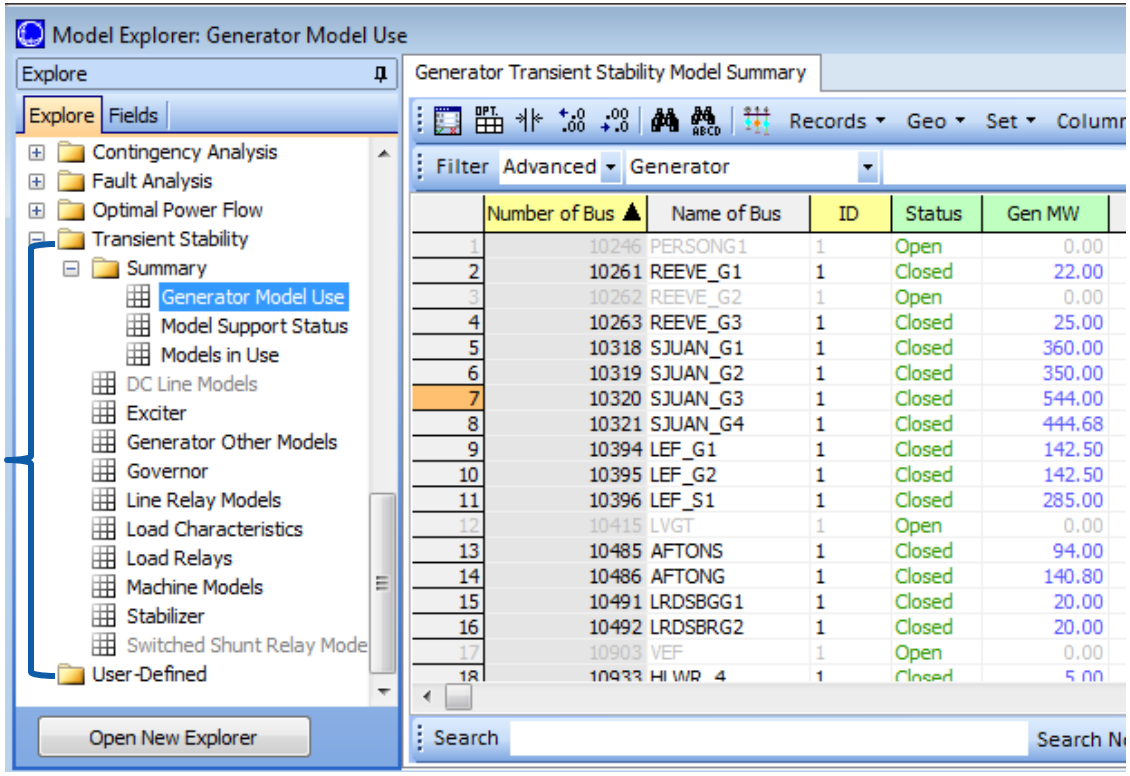
- The GENCC model is often modeled as one generator but signals that two generators in the DYD file may be represented by one in the EPC file
- When this situation is found, Simulator will ask the user to automatically split the existing generator into two
  - You should select “Yes”
  - An appropriate log message will be written
- Parameters *Pfac* and *Qfac* determine the percentage of MW and MVAr assigned to each of the two generators

Example: Loading Data from External File Formats

- Informational messages, warnings, and errors created by reading in the data will appear in the log
- Save the case as WestExample.pwb for future use

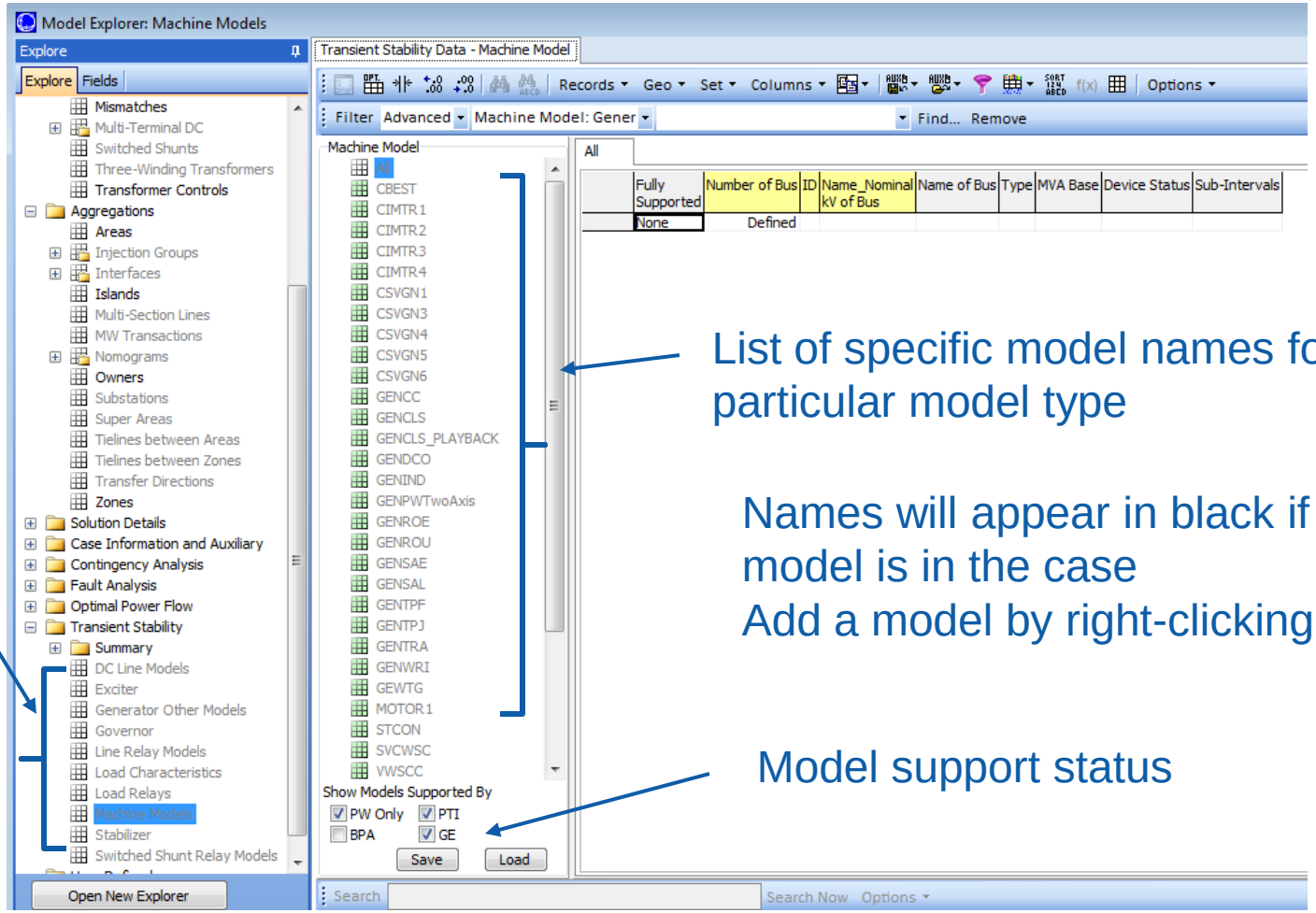
Transient Stability Case Information and Model Explorer

- Model Explorer contains a Transient Stability Folder
- The first item is the Summary sub-folder
- Also, pages are listed for each class of available model
- The same options and Model Explorer pages can also be accessed from the Stability Case Info menu



Navigating Available Models

Model Explorer lists the supported models



Classes of models

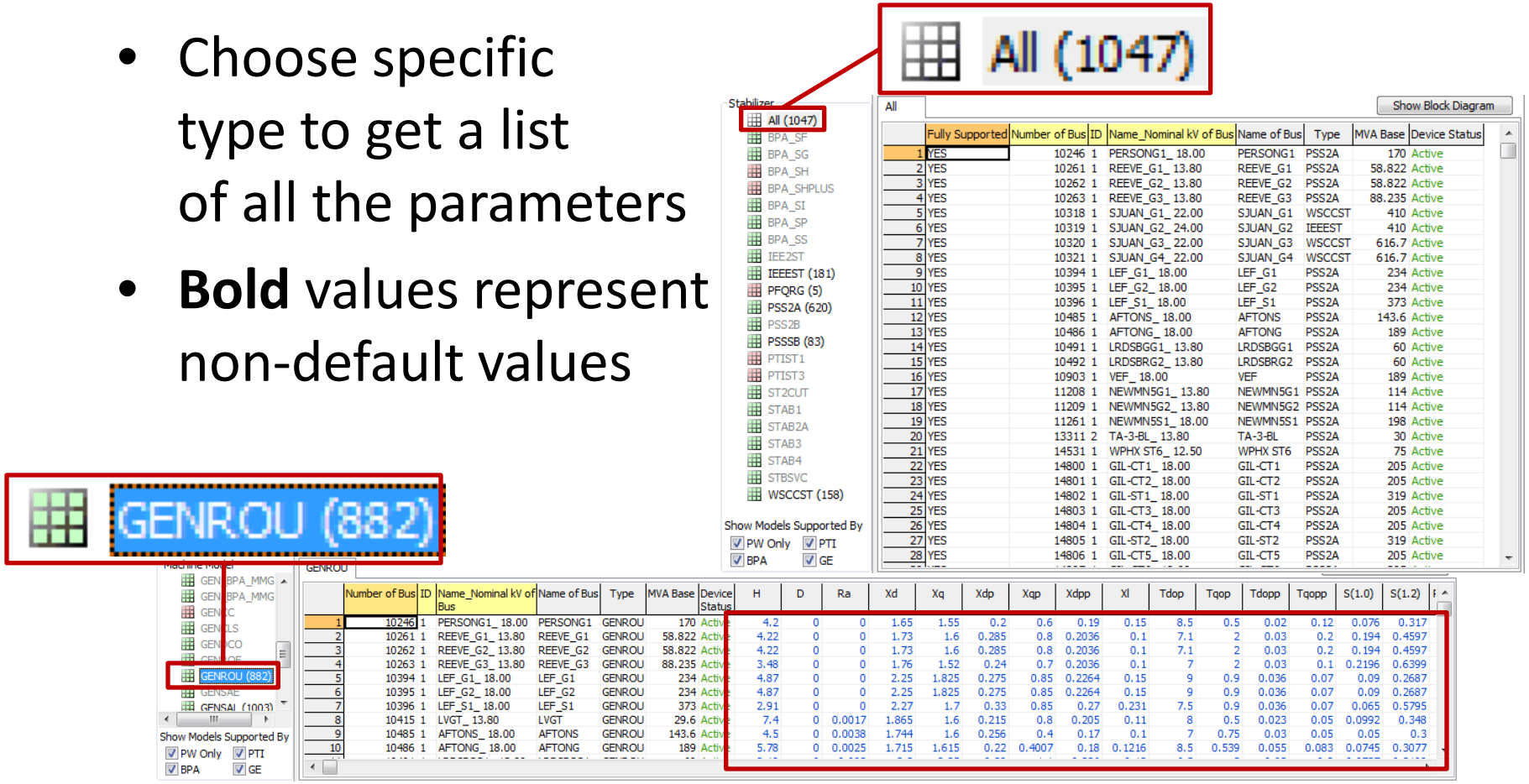
List of specific model names for the particular model type

Names will appear in black if the model is in the case
Add a model by right-clicking

Model support status

Navigating a List of Models

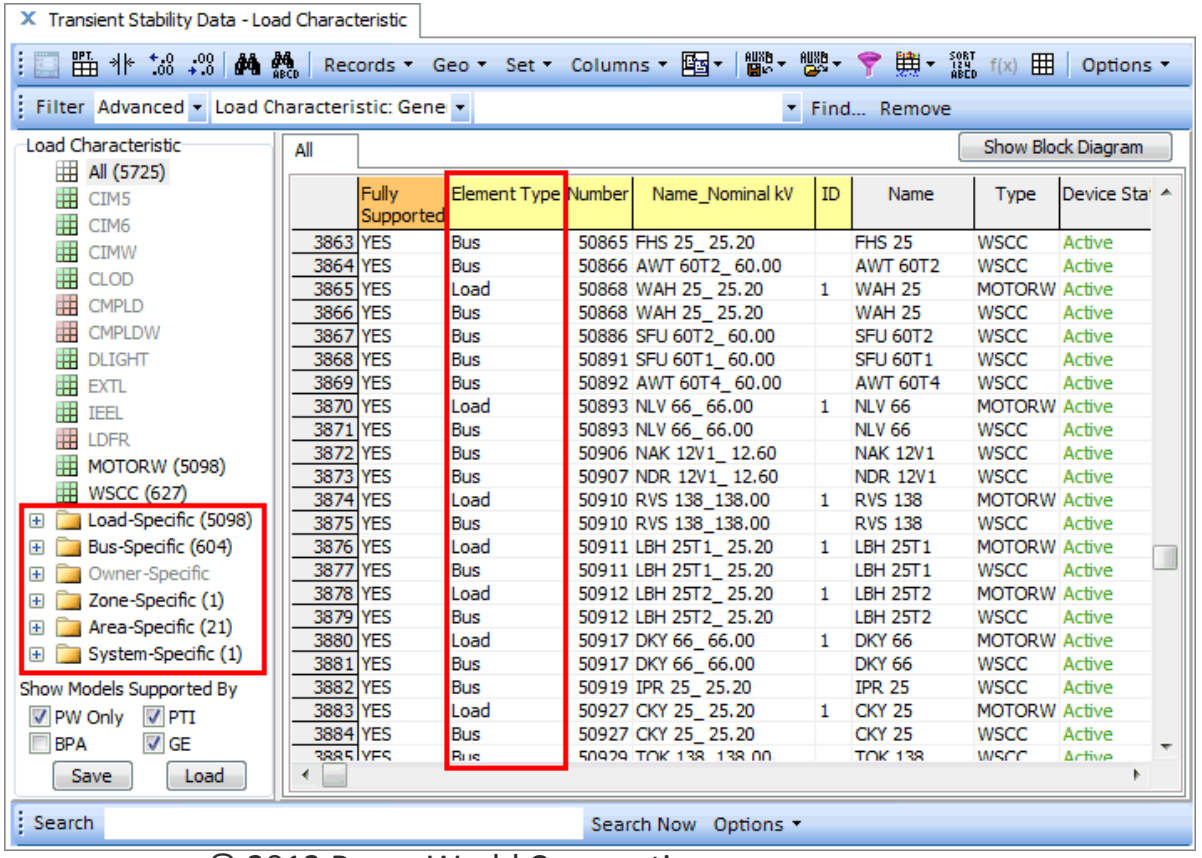
- Choose “All” to get a list of all Stabilizers
- Choose specific type to get a list of all the parameters
- **Bold** values represent non-default values



Load Characteristic Models

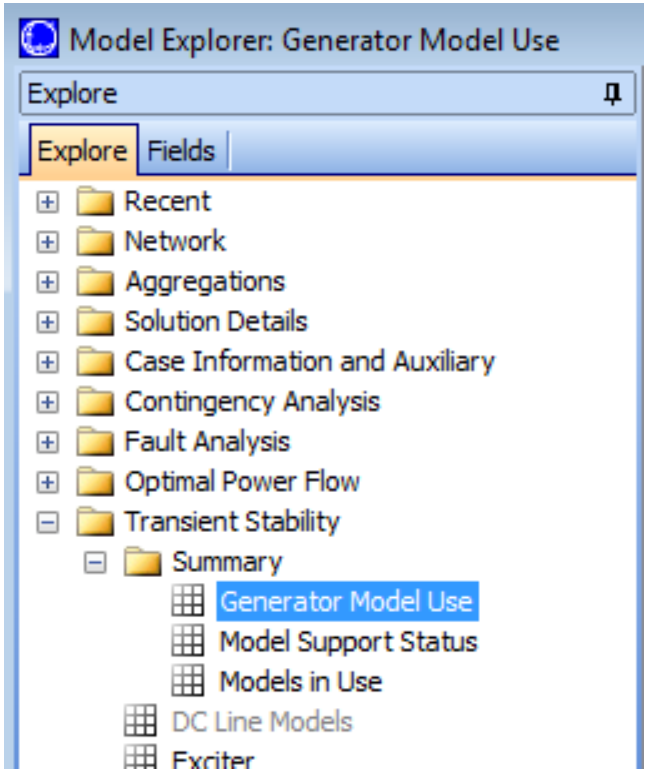
- Load models apply to either a load, bus, owner, area, or the entire case

Precedence:
Load-specific,
Bus-specific,
Owner-specific,
Zone-specific,
Area-specific,
System-specific



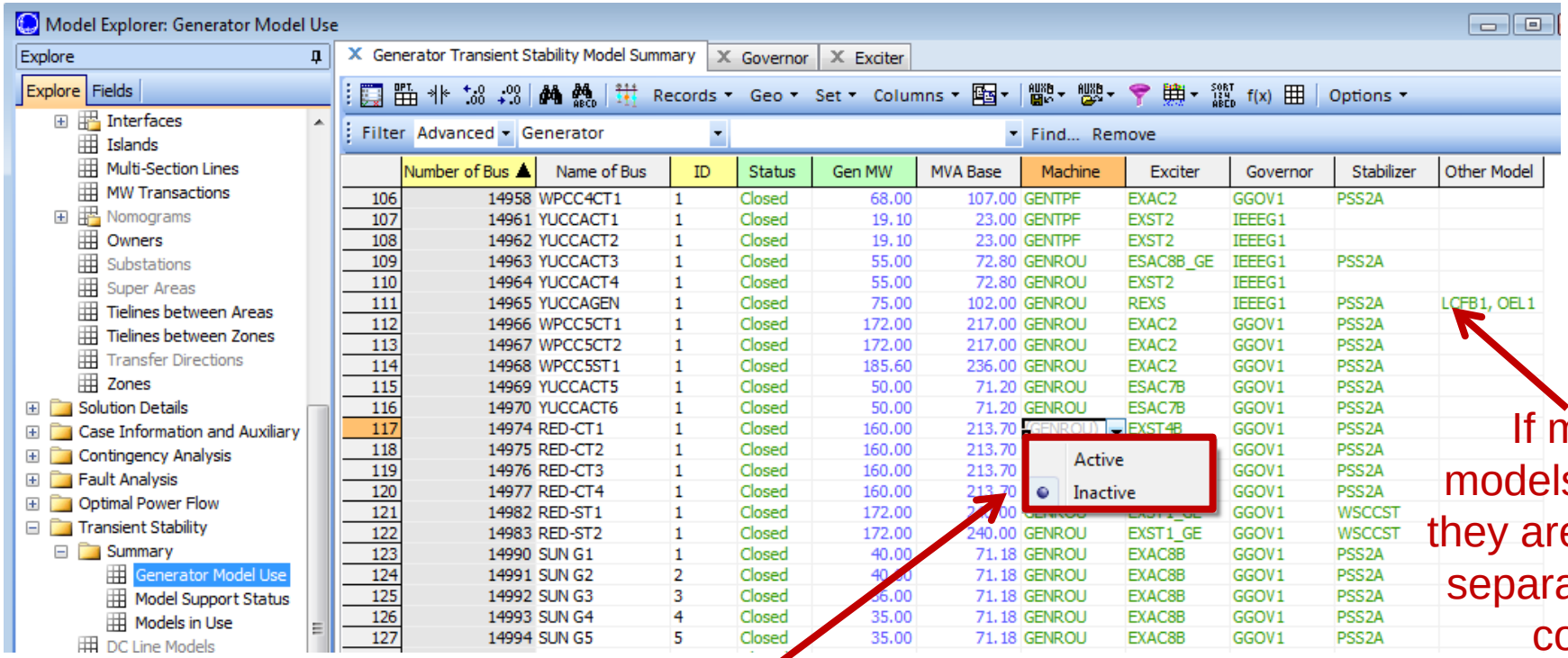
Model Explorer: Transient Stability\Summary\

- On the Model Explorer, under Transient Stability\Summary, there are three useful entries
  - Generator Model Use
    - Lists each generator along with the dynamic models it is using
  - Model Support Status
    - A list of all the models that Simulator can read/write along with which software supports them
  - Models in Use
    - A list of all the models used in this case, along with a count of each



Generator Model Use Example

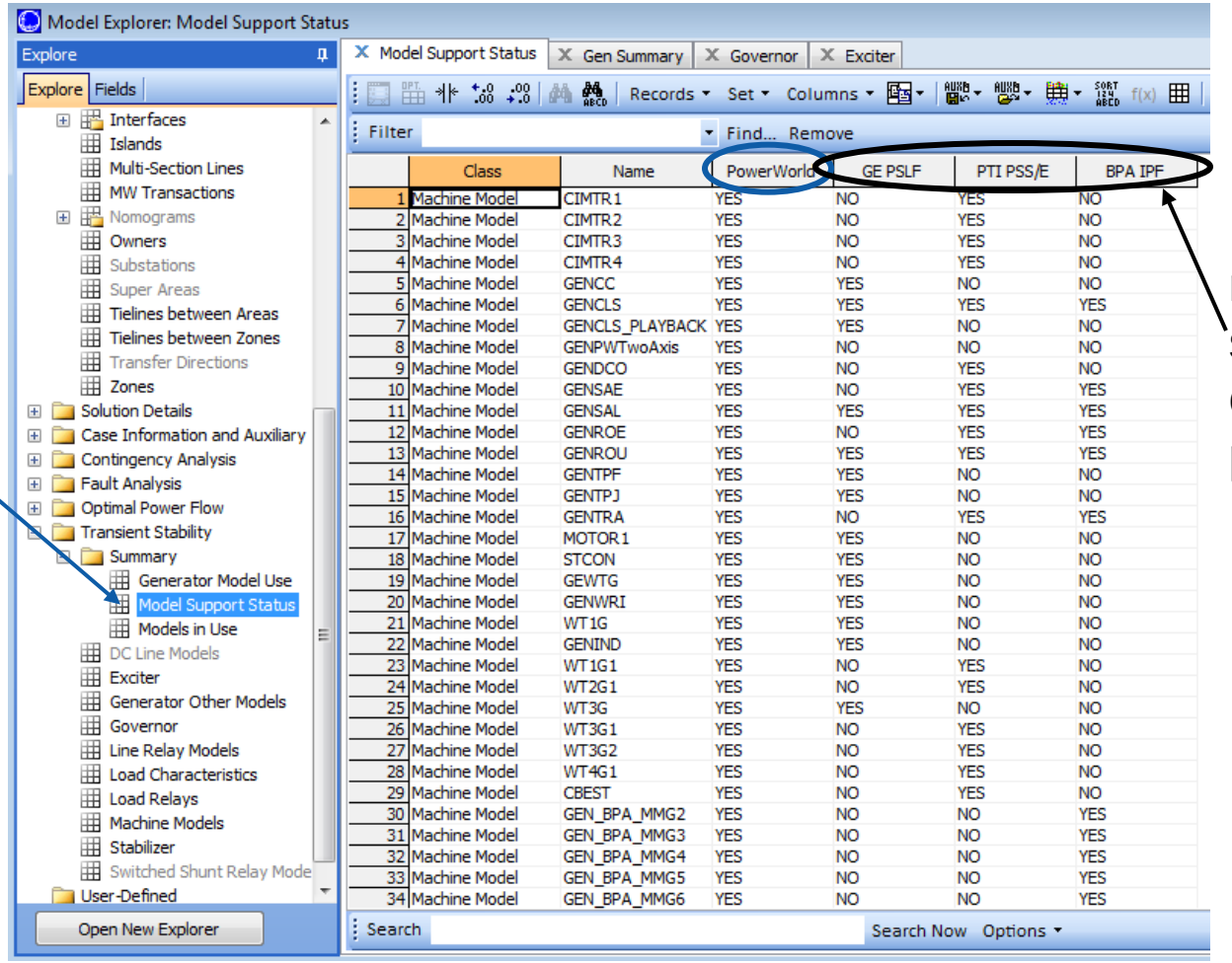
- For the example case, open the Summary folder
- On the Model Explorer, open the Transient Stability\Summary page
- Open the Generator Model Use page



WestExample.pwb

Model Support Status Example

- Open the Model Support Status page



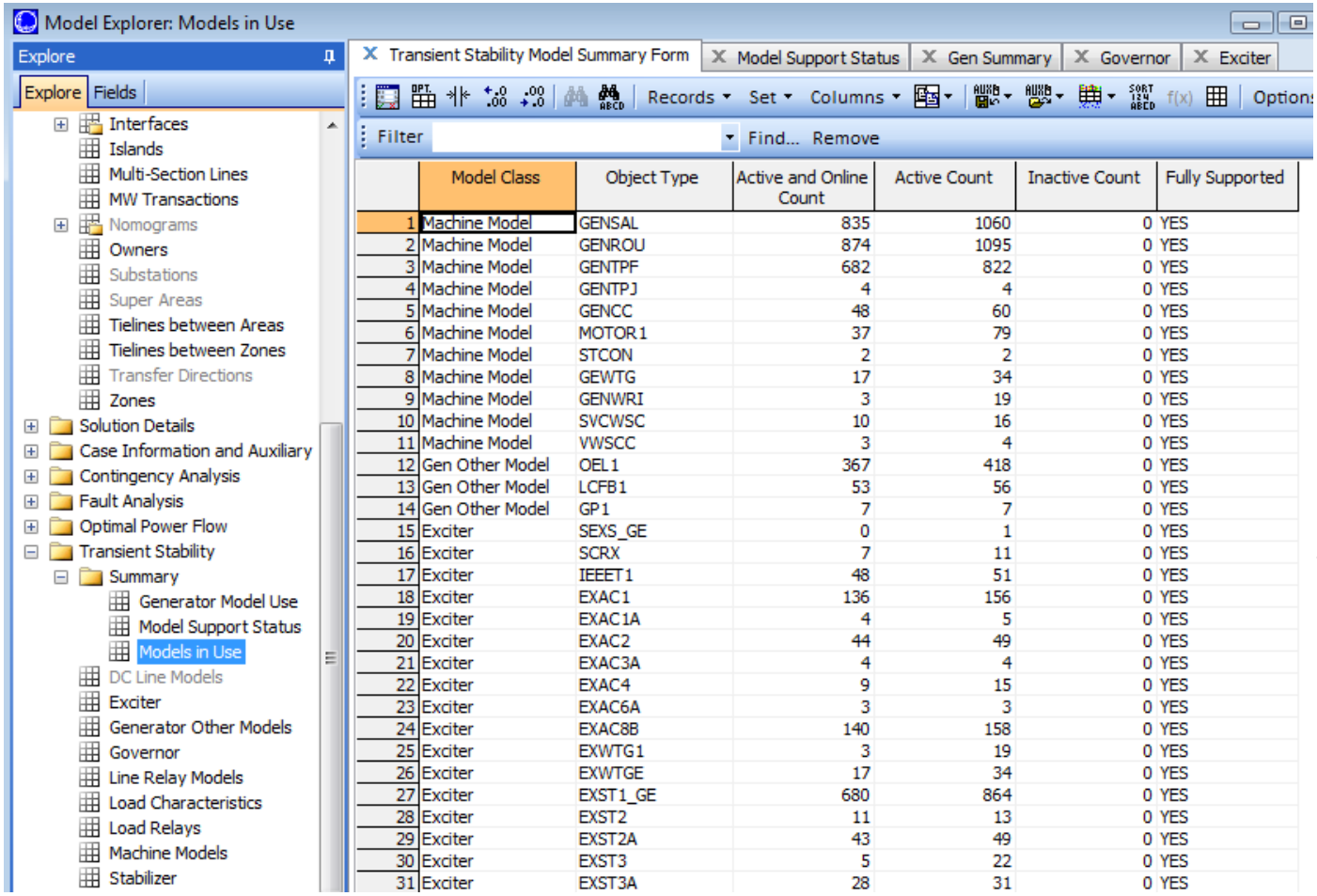
Model support statuses for all models

Listing of which models are supported by other software packages

WestExample.pwb

Models in Use Example

- Open the Models in Use page



	Model Class	Object Type	Active and Online Count	Active Count	Inactive Count	Fully Supported
1	Machine Model	GENSAL	835	1060	0	YES
2	Machine Model	GENROU	874	1095	0	YES
3	Machine Model	GENTPF	682	822	0	YES
4	Machine Model	GENTPJ	4	4	0	YES
5	Machine Model	GENCC	48	60	0	YES
6	Machine Model	MOTOR1	37	79	0	YES
7	Machine Model	STCON	2	2	0	YES
8	Machine Model	GEWTG	17	34	0	YES
9	Machine Model	GENWRI	3	19	0	YES
10	Machine Model	SVCWSC	10	16	0	YES
11	Machine Model	VWSCC	3	4	0	YES
12	Gen Other Model	OEL1	367	418	0	YES
13	Gen Other Model	LCFB1	53	56	0	YES
14	Gen Other Model	GP1	7	7	0	YES
15	Exciter	SEXS_GE	0	1	0	YES
16	Exciter	SCRX	7	11	0	YES
17	Exciter	IEEET1	48	51	0	YES
18	Exciter	EXAC1	136	156	0	YES
19	Exciter	EXAC1A	4	5	0	YES
20	Exciter	EXAC2	44	49	0	YES
21	Exciter	EXAC3A	4	4	0	YES
22	Exciter	EXAC4	9	15	0	YES
23	Exciter	EXAC6A	3	3	0	YES
24	Exciter	EXAC8B	140	158	0	YES
25	Exciter	EXWTG1	3	19	0	YES
26	Exciter	EXWTGE	17	34	0	YES
27	Exciter	EXST1_GE	680	864	0	YES
28	Exciter	EXST2	11	13	0	YES
29	Exciter	EXST2A	43	49	0	YES
30	Exciter	EXST3	5	22	0	YES
31	Exciter	EXST3A	28	31	0	YES

A summary of the models defined in this case

Includes whether the model is active or inactive, and whether its associated object is online

WestExample.pwb

Transient Stability Model Explorer: Model Classes

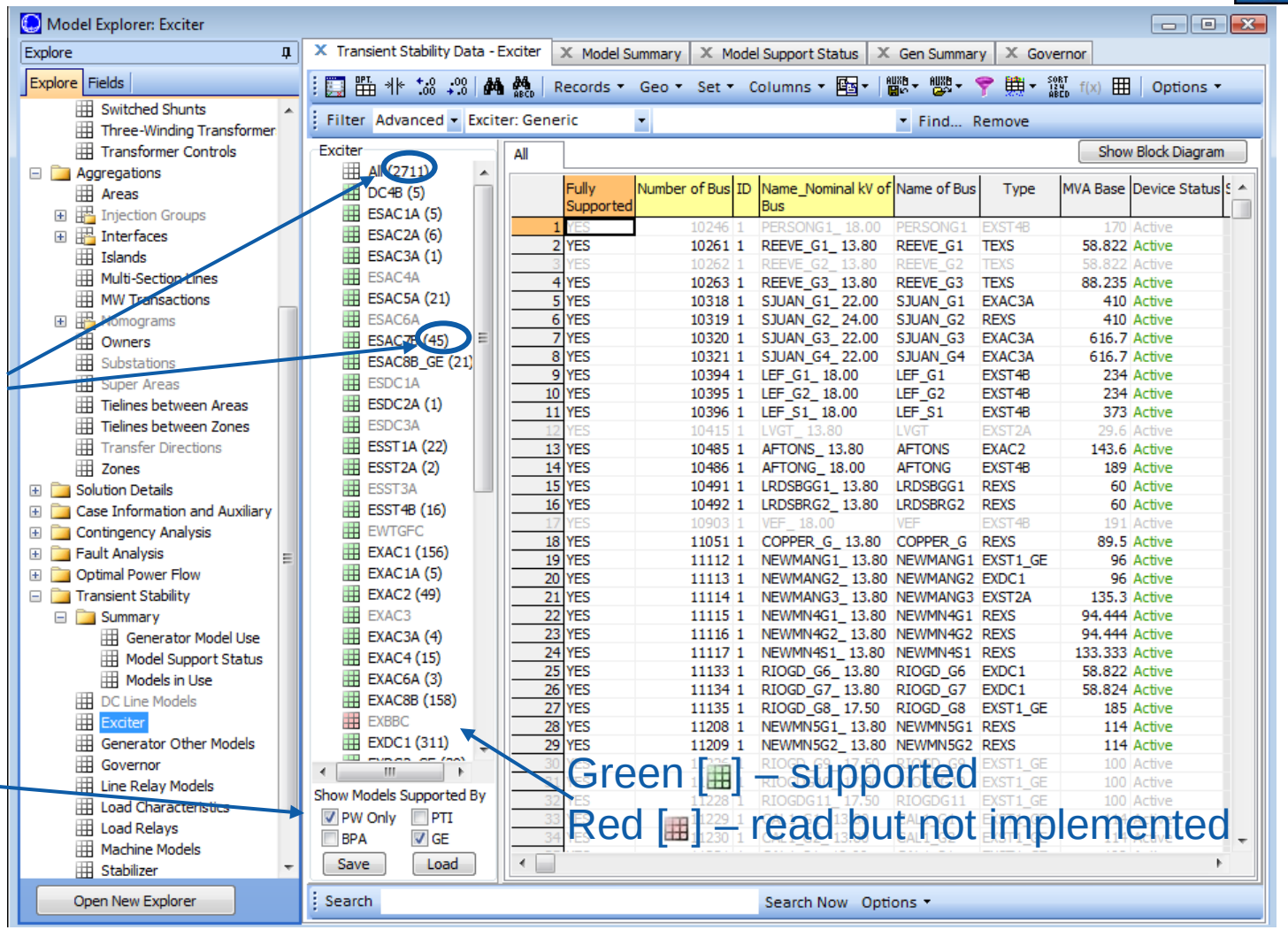
- Clicking on a particular model class opens a new pane in the right portion of the Model Explorer showing the available model types for that class
- Gray text indicates a model class or type not presently used by any device
- This pane has the following attributes
  - "All" shows all present models of the model class
  - Number in parenthesis indicates the number of models of that type which are present
  - Green icons indicate that a model is fully supported by Simulator
  - Red icons indicate that a model can be read/written but is not currently supported by the transient stability numerical integration
  - "Show Models Supported By" and a set of four check boxes- *PW Only*, *PTI*, *BPA*, and *GE* to filter the displayed list
  - At the bottom are buttons to save or load dynamic data from an external file

Model Classes Example

- Open the Exciter page

Next to each model type states the total number of that model type in the present data set

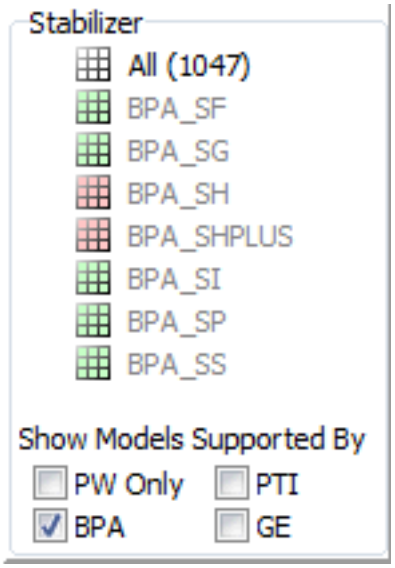
Save or load dynamic models

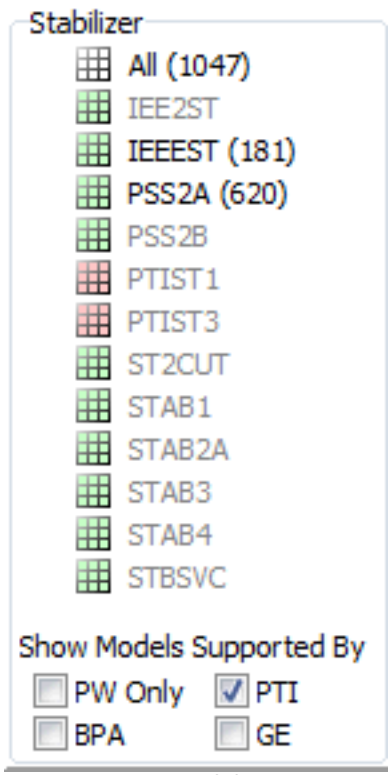


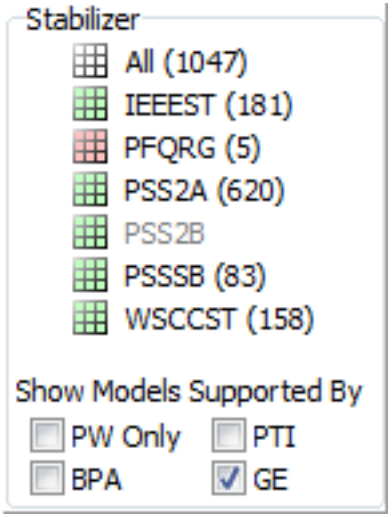
WestExample.pwb

Model Classes- Filter the Shown Formats

- Types can be further filtered to show only those models supported by other formats

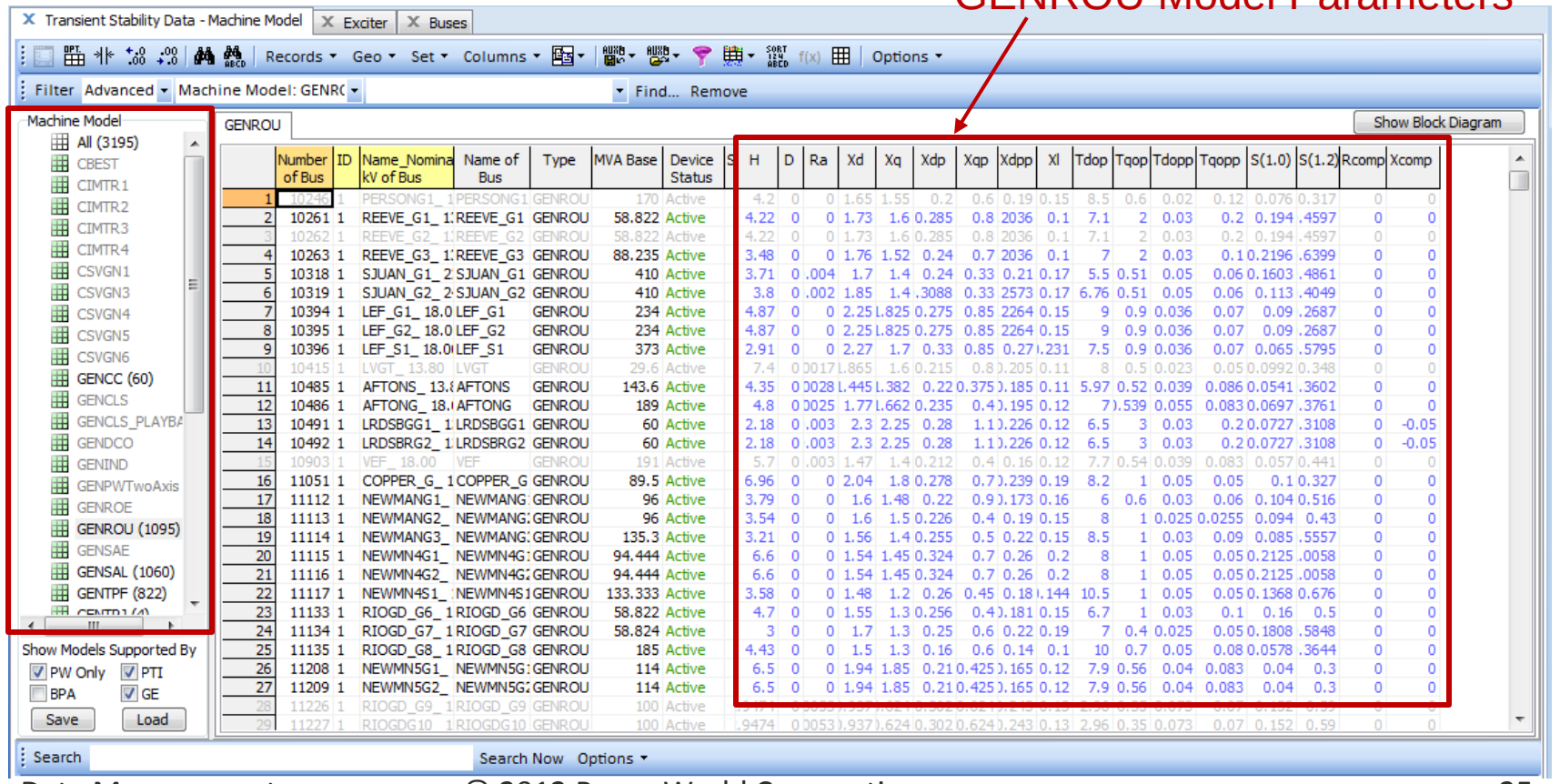






Model Type Example

- When you choose a particular model type from a model class, additional columns will appear which show all the input parameters for that model type

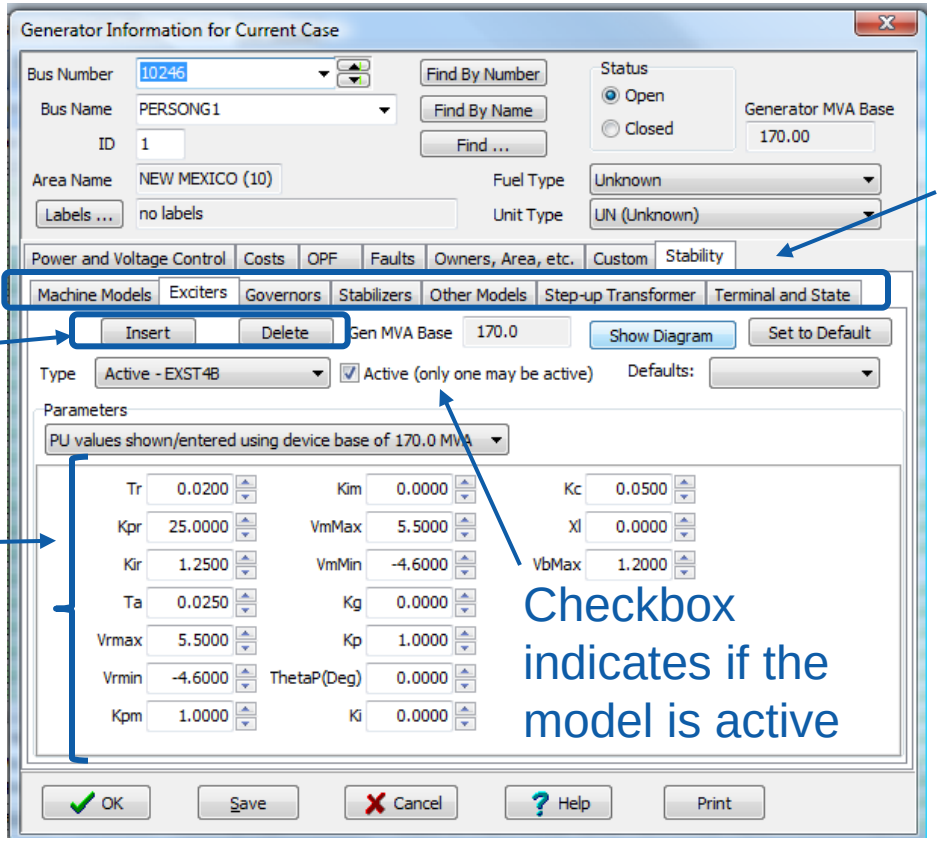


Transient Stability Data: Object Dialogs

- In general, Simulator devices have Information Dialogs, and models can be edited both by using these dialogs and by using the Model Explorer
- On the various dialogs for devices such as Generators, Loads, Switched Shunts, etc., there will be a tab labeled “Stability”
- This tab can be used to define the transient stability models for the device
- Stability tab attributes
  - Insert button
  - Delete button
  - Type of model and whether it is active
  - Show Diagram (displays the model’s block diagram)
  - Parameter list

Example Object Dialog

- Right click on a model in the Model Explorer and select “Show Dialog”
- An example of an exciter’s dialog is shown here



Several model class tabs

Models can be inserted or deleted here

Model parameters can be modified here for the selected type of model

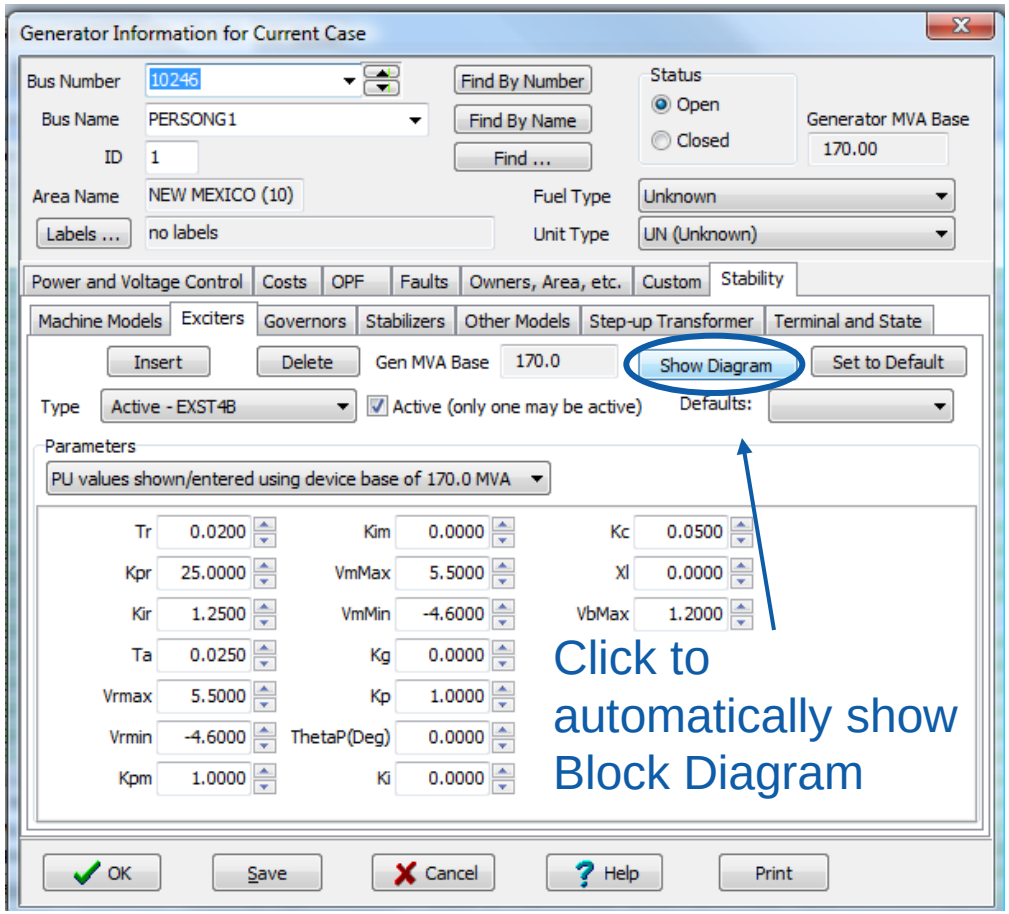
Hovering the mouse will cause a hint to appear with a description of the parameter

Checkbox indicates if the model is active

WestExample.pwb

Object Dialog: Block Diagrams

- The “Show Diagram” button is available on the Stability tab of the individual dialogs for objects with Transient Stability models
- *Block Diagrams.pdf* contains block diagrams for the models implemented in Simulator
- To view, click on the “Show Block Diagram” button
- You can also manually open the document at any time from the location where it was saved when you installed Simulator

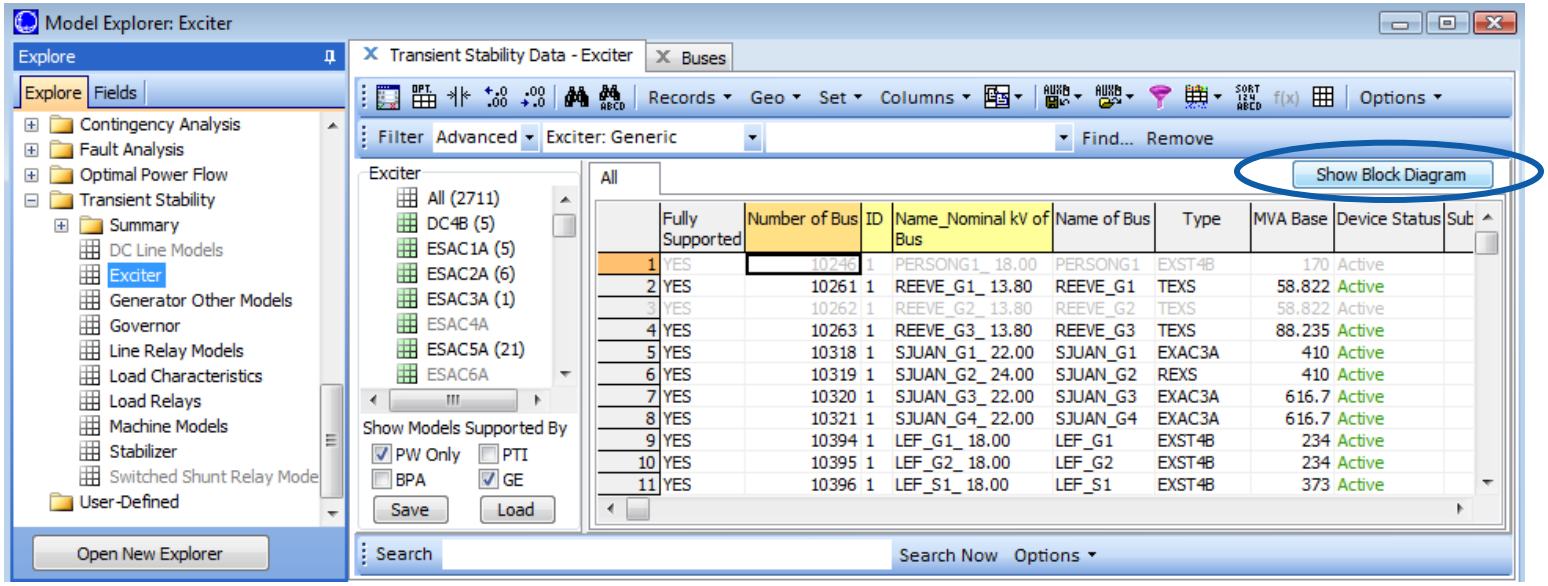


WestExample.pwb

Block Diagrams

- The "Show Block Diagram" button is also available on the Model Explorer
- The block diagram document will be navigated to the page containing the model that is currently selected
- If "All" is selected, the pdf document will just open to the first page

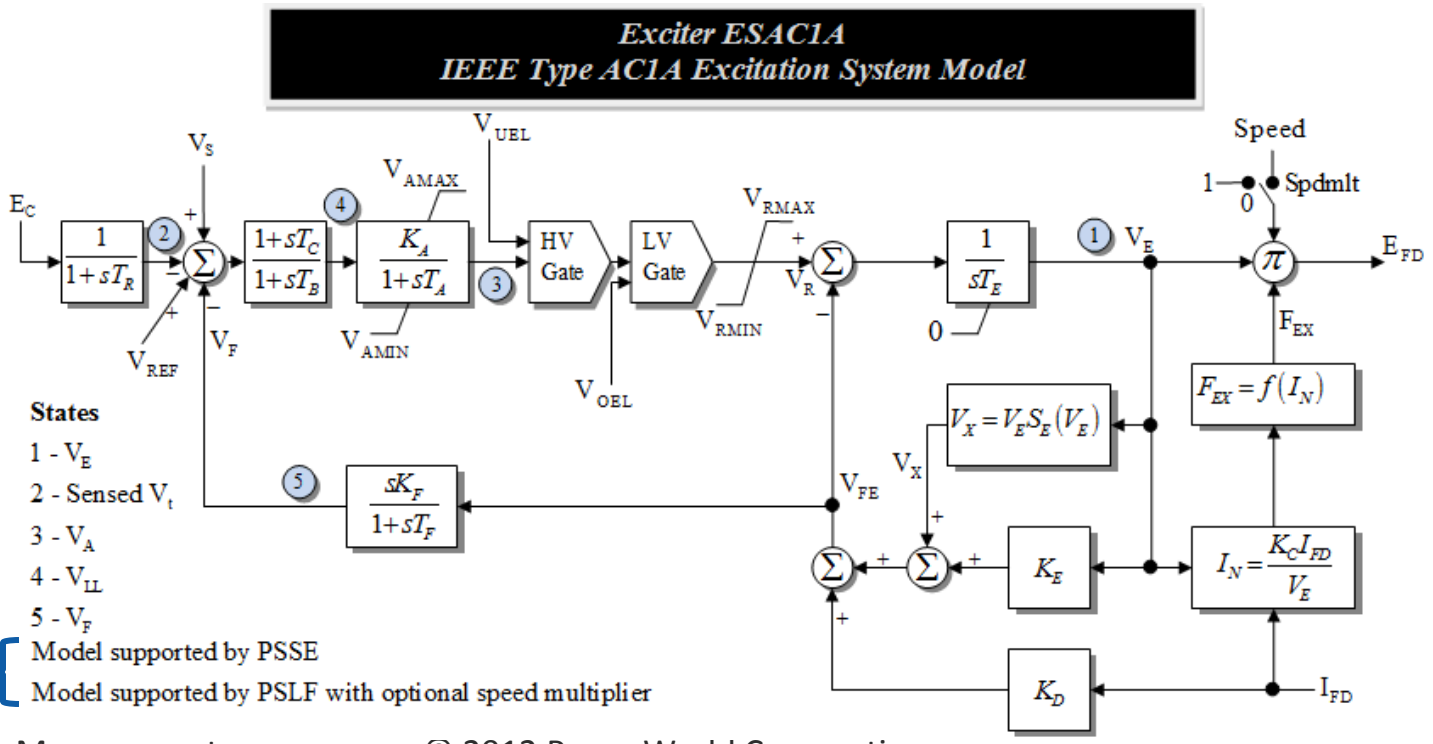
Click to show Block Diagrams



WestExample.pwb

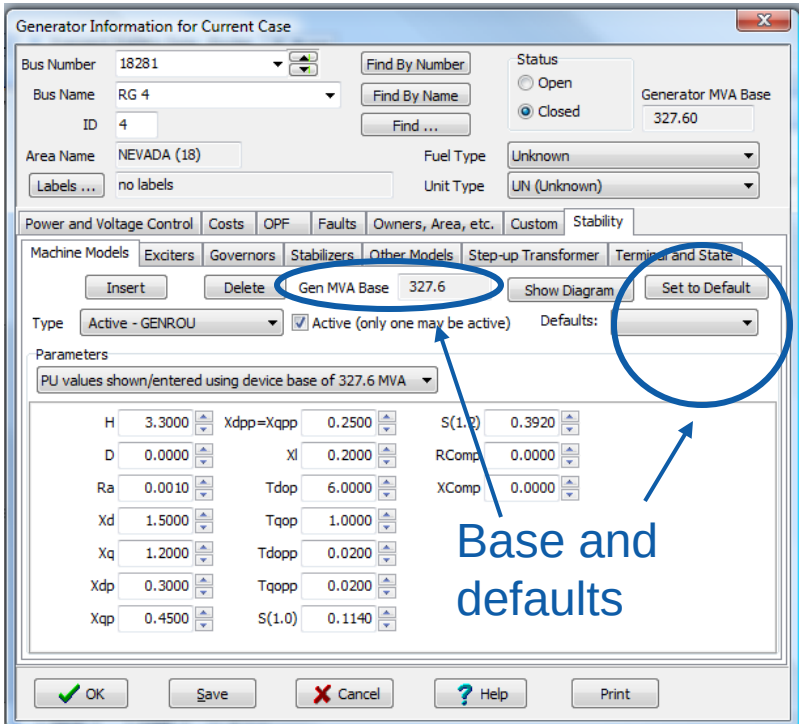
Block Diagrams

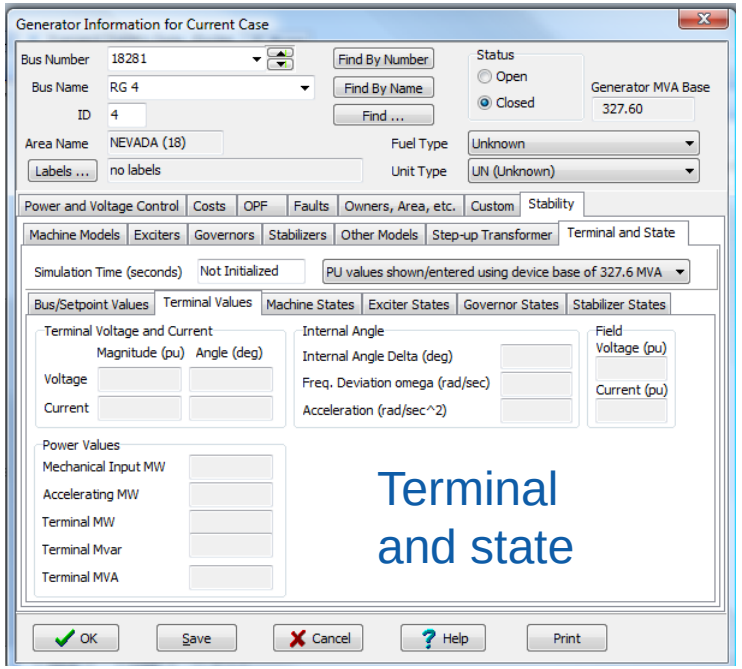
- Standardized block diagram format
- States will labeled to match how Simulator numbers them
- There will be comments regarding whether another software product supports the model



Object Dialog: Other Special Generator Options

- Set to Default and Defaults drop-down
- Option to enter values in Device MVA base or System MVA base





- Step-up Transformer Tab
- Terminal and State Tab
  - Bus/Setpoint Values
  - Terminal Values
  - More Tabs for various classes of models

WestExample.pwb

GE DYD Special Handling

- Generator Baseload Flag
  - When loading GE EPC files, a flag for each generator record exists called the *Baseload flag* which determines how governor limits are handled during a transient stability run
  - Supported by a Simulator generator field called *Transient Stability\Governor Response Limits*- options are *Normal*, *Down Only*, or *Fixed*
  - *Baseload flag* of *0* maps to *Normal*, *Normal* means that the limits specified in the governor model will be used for the simulation
  - *Baseload flag* of *1* maps to *Down Only*, *Down Only* means that the upper limit is set equal to the initial condition value (and thus control can only go down.
  - *Baseload flag* of *2* or more maps to *Fixed*, *Fixed* means that both the upper and lower limits are set equal to the initial condition, thus control will be approximately constant
  - The *Governor Response Limits* field is shown when looking at governor case information displays

GE DYD Special Handling

- EPCMOD models
  - Often used to represent a user-defined model of a Series Capacitor Relay and a Capacitor Relay Model
  - Since these models were so common, PowerWorld added them as two new kinds of relay models
  - CAPRELAY can be assigned to a switched shunt record which, based on voltage, can open and close a switched shunt
    - Created when “MSC01.p” is read from an EPCMOD record
    - An appropriate log message will be written upon creation
  - SERIESCAPRELAY can allow a series capacitor to be bypassed during a fault and placed back in service when appropriate
    - Created when “MSC01.p” is read from an EPCMOD record
    - An appropriate log message will be written upon creation

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