

# PowerWorld Simulator

---



## Quick-Start Guide



**PowerWorld**  
Corporation

2001 South First Street  
Champaign, Illinois 61820  
+1 (217) 384.6330

[support@powerworld.com](mailto:support@powerworld.com)  
<http://www.powerworld.com>

# Purpose

---



- This quick-start guide is intended to provide a brief explanation of the essentials to analyzing power systems with PowerWorld Simulator
- It is not comprehensive
- Greater detail is available in our full-length training, on-line or in-person
- Other quick-start guides discuss specific advanced features of Simulator
- For more details, visit <http://www.powerworld.com/training/online-training>

# Outline

---



- Opening a power flow case (raw, epc, pwb)
- Solving a case
- Browsing power system elements with the Model Explorer
- One-line diagrams
- Limit Monitoring Settings

# Opening an Existing Power Flow Case

---

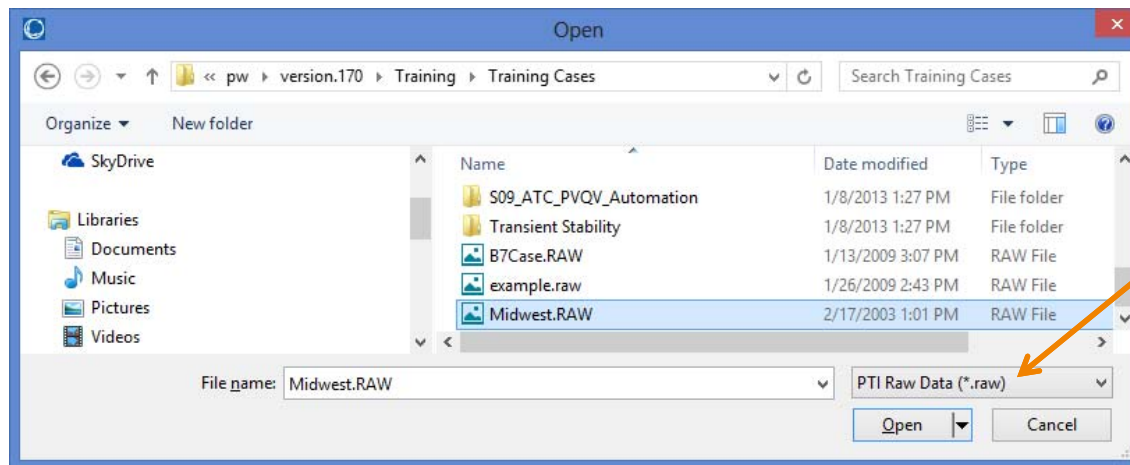


- PowerWorld Simulator can open files in the following text-based formats:
  - Siemens PTI PSS/E
    - \*.raw file extension
    - Common with FERC 715 filings and ISO cases
  - GE PSLF
    - \*.epc file extension
    - Common in the North American WECC
  - Other specific formats for real-time EMS models
- Simulator also has a proprietary binary format with \*.pwb extension

# Example



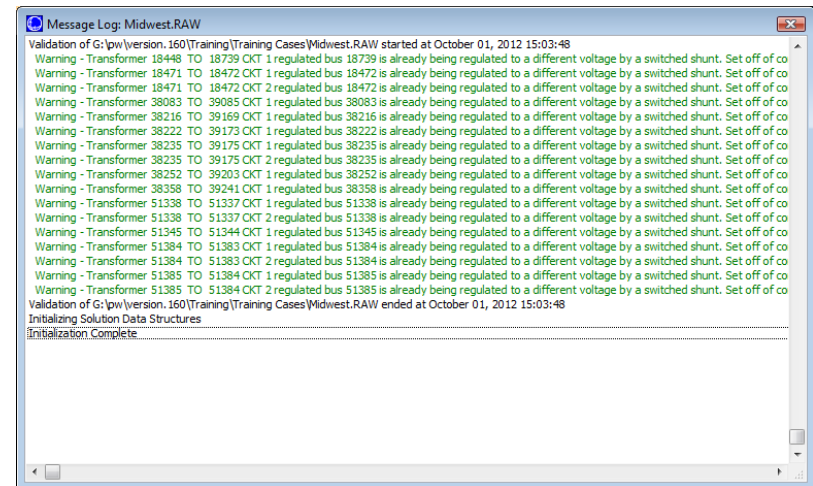
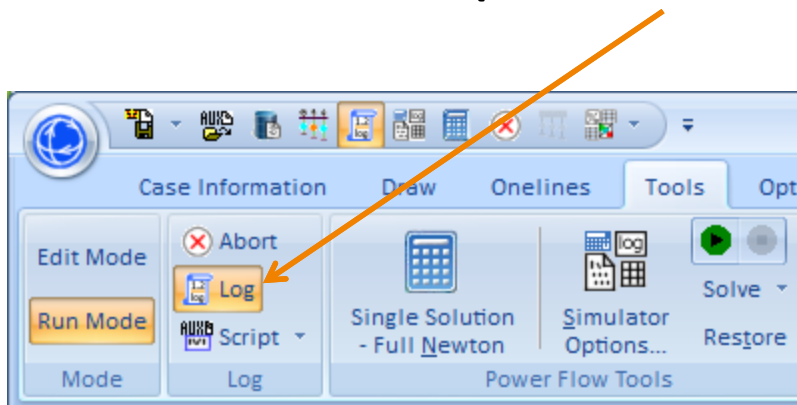
- Click the **File Menu** in the upper left
- Choose **Open Case...**
- From the drop-down box in the lower right, choose *PTI Raw Data (.raw)*
- Open the sample case **Midwest.raw** (available from the PowerWorld training website), or open any case that you need to analyze



# Solving the Case



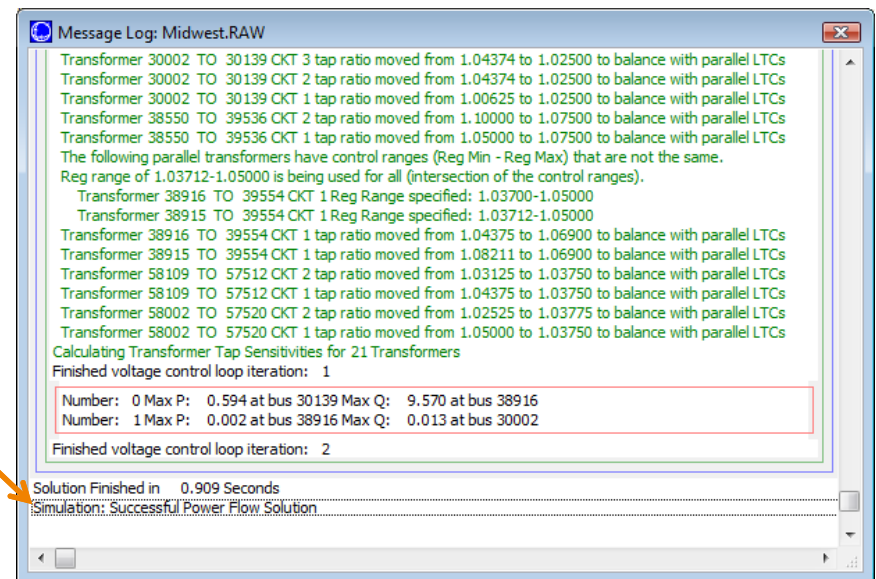
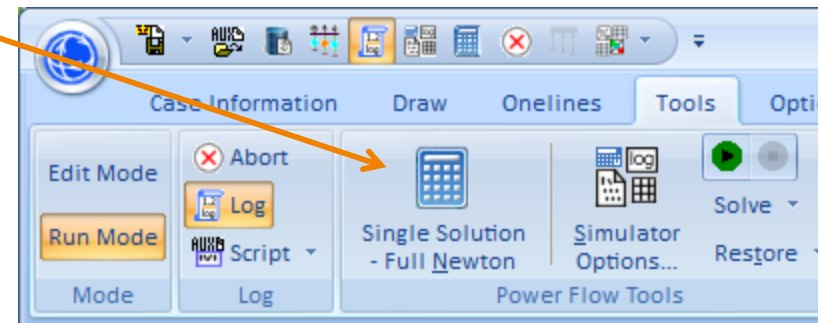
- For the data in a power flow case to be considered valid, a set of non-linear equations must be solved
- First, open the **Message Log** from the **Tools** ribbon tab (**Tools** → **Log**)



# Solving the Case



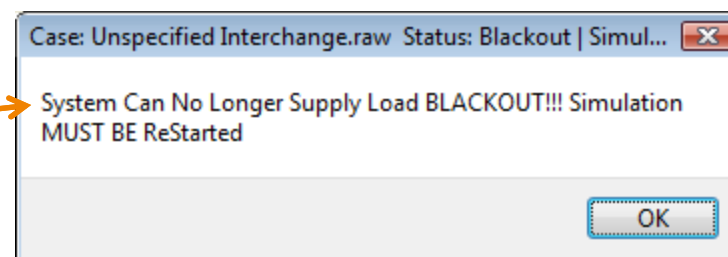
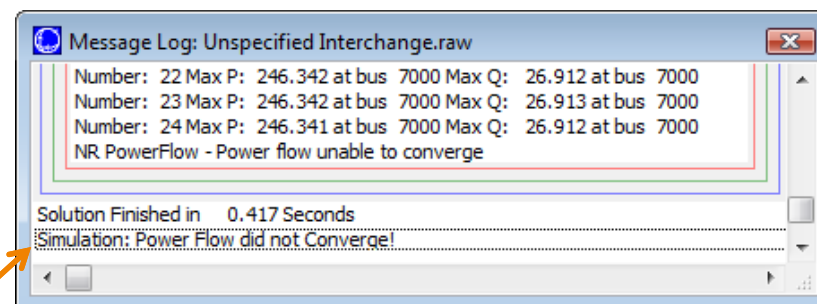
- Next, choose **Single Solution – Full Newton**, also on the **Tools** ribbon tab
- A series of nested loops should solve and a successful solution should be reported in the **Message Log**
- If the solution is successful, proceed to slide 15



# What if the Case Does not Solve?



- The case may not solve if:
  - It was not solved by the entity that created the file
  - It was solved, but with different controller settings than the Simulator defaults
  - There are certain kinds of data errors
- If the case fails to solve, you will see a message in the log and a pop-up window

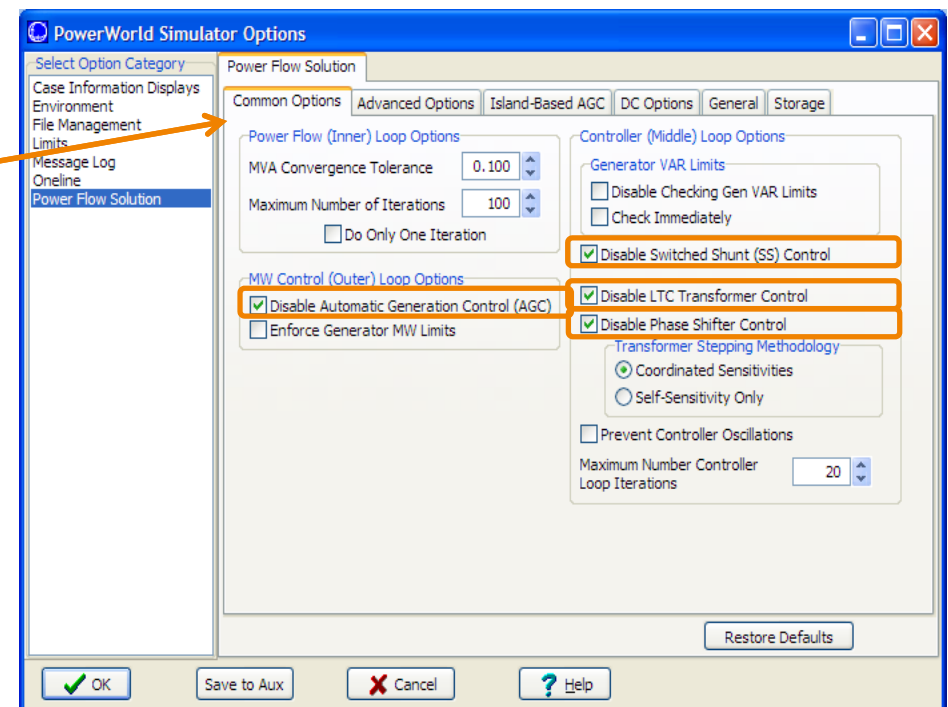
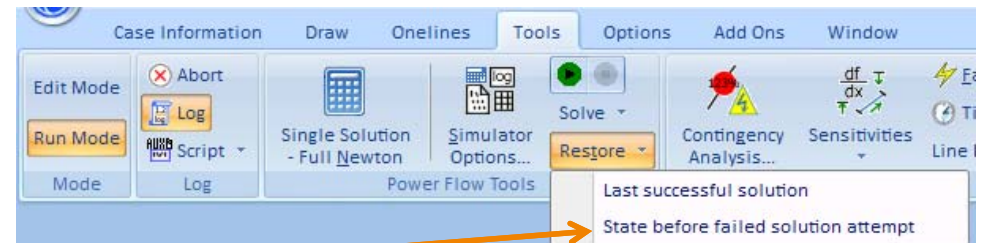




# Try to Solve with Controllers Disabled



- Unless the case was not solved by the entity that created the file, this will normally work
- Choose **Tools** → **Restore** → **State before failed solution attempt**
- Open **Tools** → **Simulator Options...**
- Check boxes
  - Disable Automatic Generation Control (AGC)
  - Disable Switched Shunt (SS) Control
  - Disable LTC Transformer Control
  - Disable Phase Shifter Control
- Click OK, then solve the case (**Single Solution – Full Newton**)



# Now Restore the Voltage Controllers

---



- Turn on the Switched Shunt Controllers First (uncheck the box in **Tools → Simulator Options...**)
- Solve Power Flow (**Single Solution – Full Newton**)
- Then turn on the LTCs
- Solve Power Flow
- Then turn on the Phase Shifters
- Solve Power Flow
- If the power flow fails to solve at any of these stages, it is likely that the controller option was not applied in the original solution
  - Restore the system state, uncheck the last option, and re-solve
  - You may still try enabling the other controllers

# Automatic Generation Control (AGC)

---



- Before you try to enable the AGC, ensure that the case was truly solved with AGC control
- The best way to check:
  - Open Model Explorer (**Case Information → Model Explorer...**)
  - Open the folder **Aggregations**, then choose **Areas**
  - Look at the “ACE MW” column
  - If values are very large, then the case was probably not solved with AGC

# Automatic Generation Control (AGC)

---



- If the ACE values are small, you can probably enable the AGC and solve the case
- Otherwise, you can either leave the AGC disabled, or enable it and adjust the area interchange

# Area Unspecified MW Interchange

---

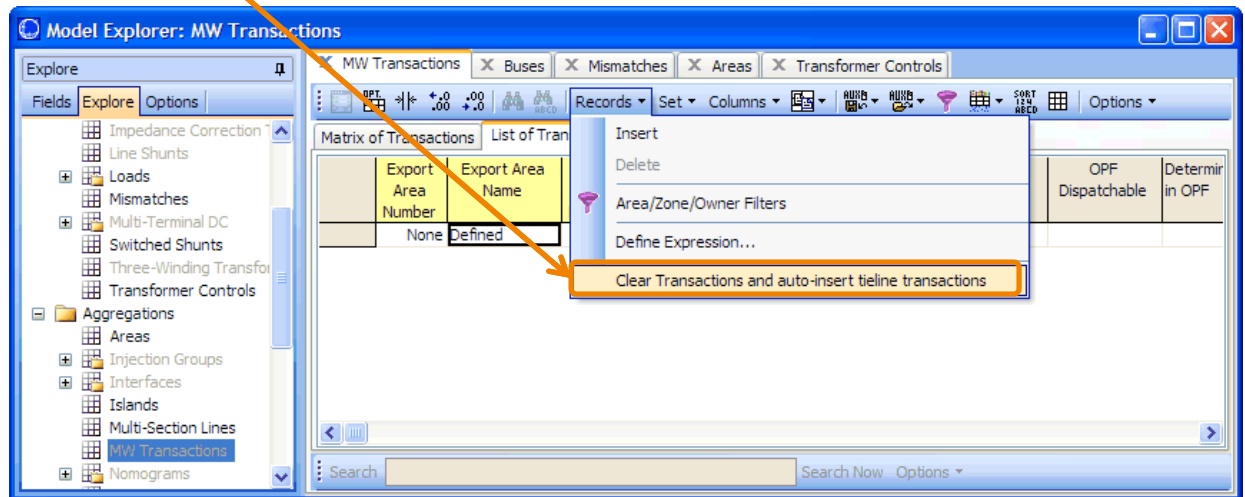


- Each Area can have an export specified which does not have a “receiving” end specified
- The Area display in the Model Explorer includes a column “Unspec. MW Inter.”, usually on the far right
- These unspecified values should sum to zero.
  - If they do not sum to zero, you have an “export to nowhere”
  - When this occurs, the Area with the slack bus will be turned off AGC and all unspecified interchange will be sent to the island slack bus

# What if Interchanges Don't Look Right or ACE Values are Large?



- In the Model Explorer, Open the folder **Aggregations**, then choose **MW Transactions**
- On the Case Info Toolbar, choose Records, Clear Transactions and auto-insert tie-line transactions
- Now try to re-enable AGC and re-solve the case



# Examining the Data in the Case

---



- There are 3 primary ways to interact with the power flow case
  - Model Explorer: spreadsheet-like tabular displays
  - Bus-view one-line diagrams (automatically generated)
  - Other one-line diagrams (user-generated)
- We will next examine the use of the **Model Explorer**

# Model Explorer



- Choose the **Case Information** ribbon tab, then **Model Explorer...**

The screenshot shows the 'Model Explorer: Buses' window. The left pane displays a tree view of the network model. The right pane shows a table of bus records.

Number	Name	Area Name	Nom kV	PU Volt	Volt (kV)
1	13 PEACHBTM	EAST EQ	500.00	1.07033	535.165
2	15 WHITPAIN	EAST EQ	500.00	1.06296	531.478
3	19 BURCHES	EAST EQ	500.00	1.02812	514.061
4	24 LIMERICK	EAST EQ	500.00	1.06723	533.613
5	30 CONE G1	EAST EQ	22.00	1.05000	23.100
6	31 CONE G2	EAST EQ	22.00	0.96959	21.331
7	32 KEYS G1	EAST EQ	22.00	0.95862	21.090
8	33 KEYS G2	EAST EQ	22.00	0.95877	21.093
9	34 PCHBTM 2	EAST EQ	22.00	1.01000	22.220
10	35 PCHBTM 3	EAST EQ	22.00	1.01000	22.220
11	36 SALEM G1	EAST EQ	22.00	1.03170	22.697
12	37 SALEM G2	EAST EQ	22.00	1.00514	22.113
13	38 SUSQ 2	EAST EQ	24.00	0.99263	23.823
14	39 HOPE CG1	EAST EQ	22.00	0.96984	21.336
15	40 C CLF1	EAST EQ	25.00	0.96860	24.215
16	41 C CLF2	EAST EQ	22.00	0.97619	21.476
17	42 LIMERCK2	EAST EQ	22.00	1.01000	22.220
18	249 SENECA #1	EAST EQ	13.80	1.05200	14.518
19	501 HOMER C1	EAST EQ	22.00	1.00000	22.000
20	502 HOMER C2	EAST EQ	22.00	1.00000	22.000
21	503 HOMER C3	EAST EQ	22.00	1.00000	22.000





# Model Explorer



Recent Tabs

Explore  
Pane

Fields  
Pane

Object  
Types with  
no data  
grayed-out


Filter	Advanced	Generator	Find	Remove									
Number of Bus	Name of Bus	ID	Status	Gen MW	Gen Mvar	Set Volt	AGC	AVR	Min MW	Max MW	Min Mvar	Max Mvar	Cost Mod
5	10318 SJUAN_G1	1	Closed	360.00	6.28	1.02500	NO	YES	0.00	360.00	-121.00	173.20	None
6	10319 SJUAN_G2	1	Closed	350.00	5.73	1.02500	NO	YES	0.00	350.00	-118.00	168.00	None
7	10320 SJUAN_G3	1	Closed	544.00	9.39	1.02500	NO	YES	0.00	544.00	-183.00	261.70	None
8	10321 SJUAN_G4	1	Closed	490.34	9.22	1.02500	NO	YES	0.00	490.34	-183.00	261.70	None
9	10394 LEF_G1	1	Closed	124.30	0.00	1.02600	NO	NO	56.90	124.30	-183.00	261.70	None
10	10395 LEF_G2	1	Closed	124.30	0.00	1.02600	NO	NO	56.90	124.30	-183.00	261.70	None
11	10396 LEF_S1	1	Open										
12	10415 LVGT	1	Open										
13	10485 AFTONG	1	Open										
14	10486 AFTONG	1	Open										
15	10491 LRDSBGG1	1	Open										
16	10492 LRDSBRG2	1	Open										
17	10903 VEF	1	Open										
18	10995 ARGONNEG	1	Closed										
19	10997 LONEMS	1	Open										
20	11010 AMRAD	1	Closed										
21	11051 COPPER_G	1	Open										
22	11112 NEWMANG1	1	Open										
23	11113 NEWMANG2	1	Open										
24	11114 NEWMANG3	1	Closed										
25	11115 NEWMN4G1	1	Closed										
26	11116 NEWMN4G2	1	Closed										
27	11117 NEWMN4S1	1	Closed										
28	11133 RIOGD_G6	1	Open										
29	11134 RIOGD_G7	1	Open										
30	11135 RIOGD_G8	1	Closed										
31	11208 NEWMN5G1	1	Open										
32	11209 NEWMN5G2	1	Open										
33	11261 NEWMN5S1	1	Open										
34	12020 CLAPHAM	1	Closed	0.00	8.02	1.02000	NO	YES	0.00	0.00			
35	12058 PEGS1	1	Closed	208.80	-8.15	1.03700	NO	YES	0.00	230.00			
36	12063 ROSEBUD	s1	Closed	-36.42	0.79	1.02000	NO	YES	0.00	0.00			

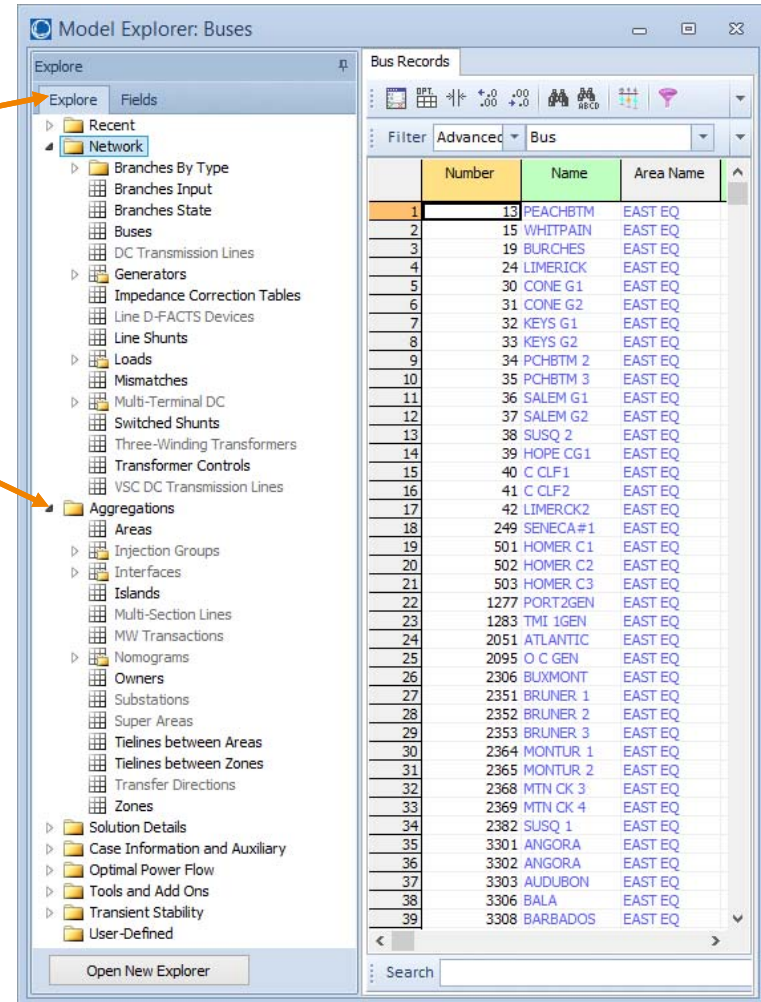
Toolbar

Note: The options available on the Case Information right-click local menu are also available on the Case Information Toolbar directly above the display

# Model Explorer



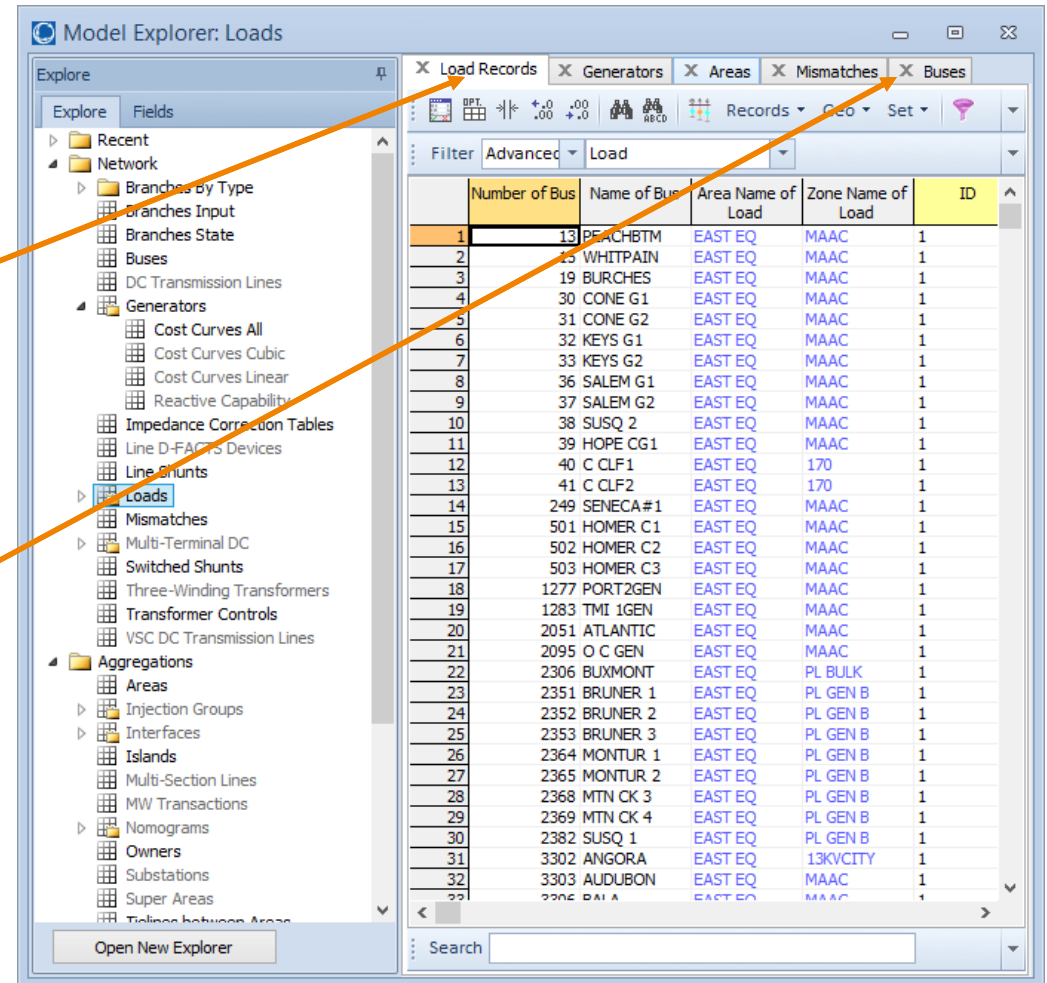
- The left side initially contains the Explore pane
- Spreadsheet-like **case information displays** are organized in folders that can be expanded or collapsed
- Click on an item with a  to open the corresponding case information display



# Model Explorer



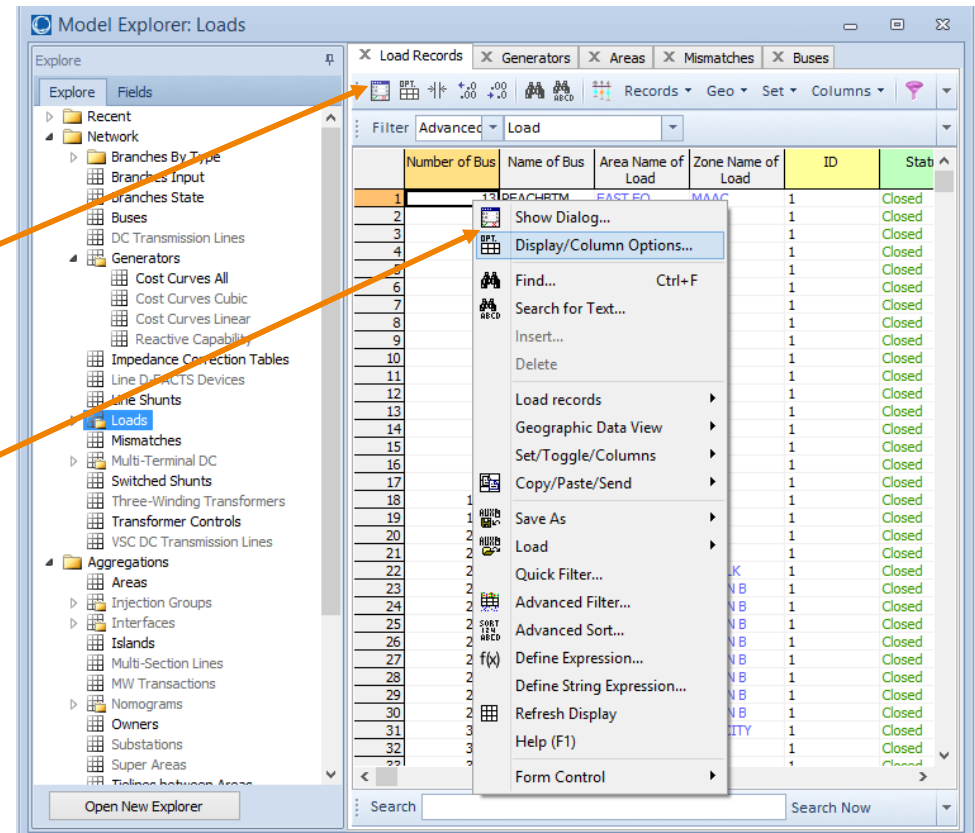
- Once opened, a case information display is contained within its own tab
- To close a case information display, click its “X”



# Toolbar and Local Menu



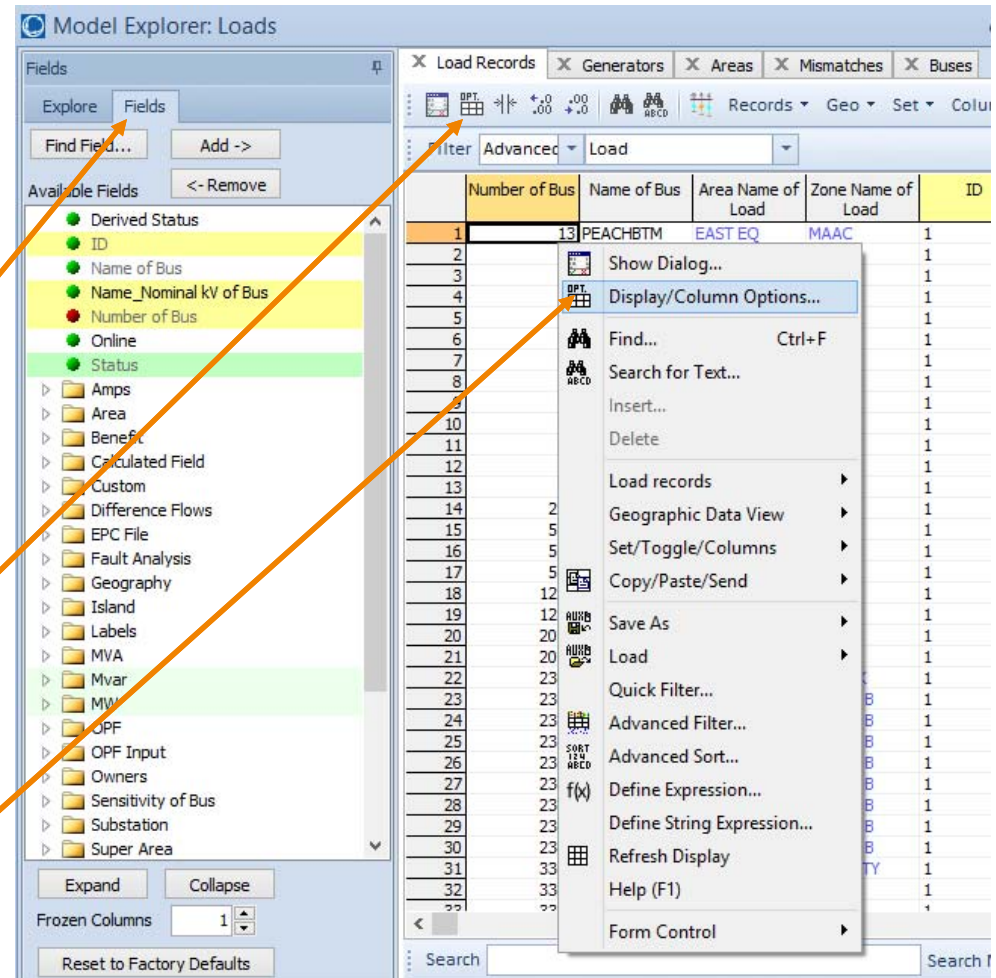
- Many functions in Case Information Displays can be accessed by:
  - Case Information Toolbar
  - Local Menu (right-click)
- Mouse over the buttons on the toolbar for a description of their function



# Columns and Appearance



- All displays have a set of default fields
- These can be modified
  - from the Fields pane,
  - or
  - with the Display/Column options on the toolbar or local (right click) menu







# Display/Column Options

## Column Options

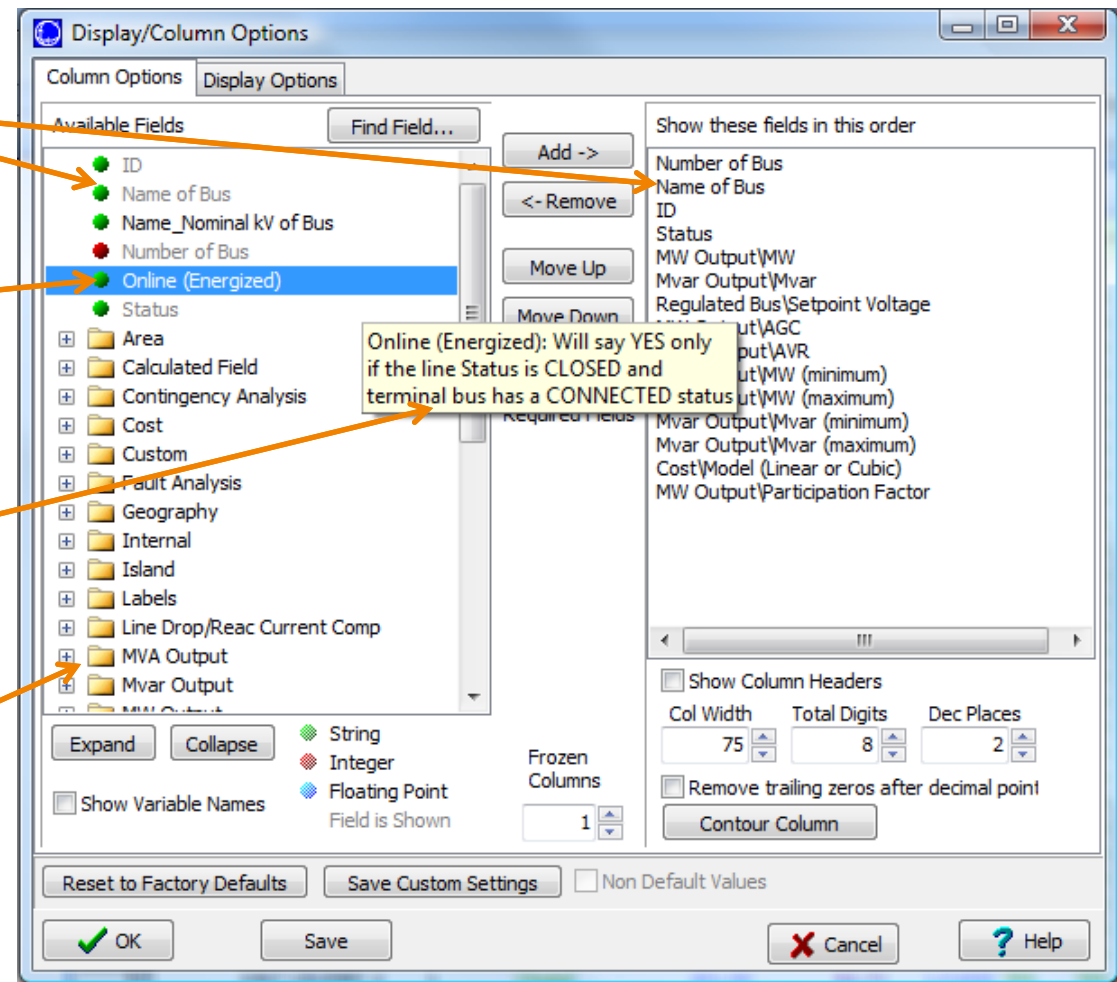


Gray text means the field is already shown

Colored Dots represent the field type

Hints automatically appear giving a description of the field

Fields organized by folder





# Display/Column Options

## Column Options

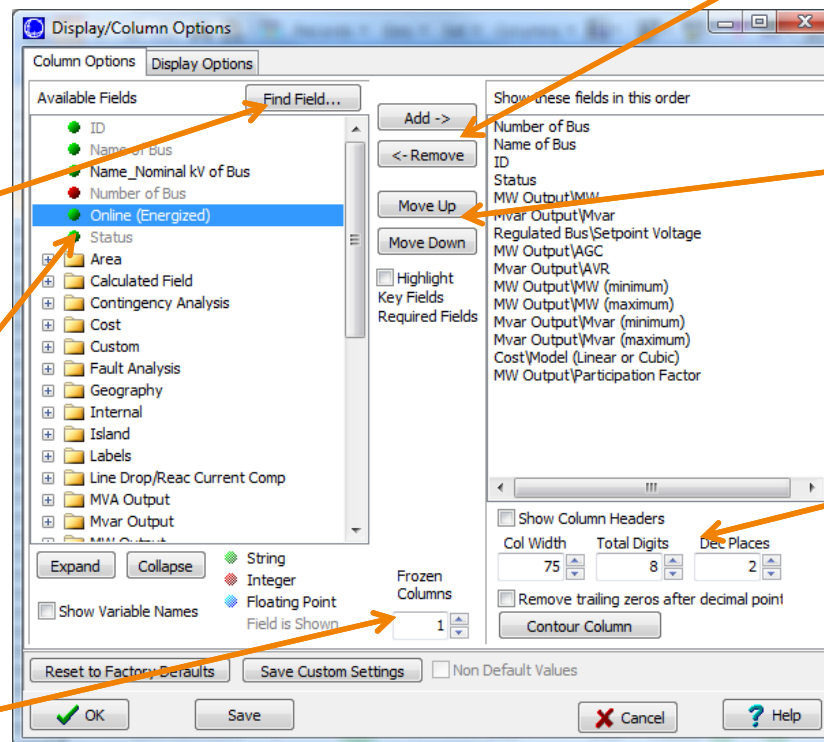


- Choose fields from the **Available Fields** list. Then left-click and drag into the **Show these fields in this order** list

Also can click the **Add →** or **← Remove** Buttons to modify the fields shown

Click **Move Up** and **Move Down** to change the order of the columns

Change attributes of the display columns. Also, use toolbar buttons



Use a wildcard find for a particular field

Fields grayed out if already in display

Number of frozen columns



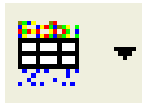


# Display/Column Options

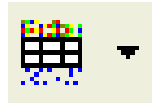
## Display Options



Will disable the area/zone filtering for a single case info display. Also available via a toolbar button

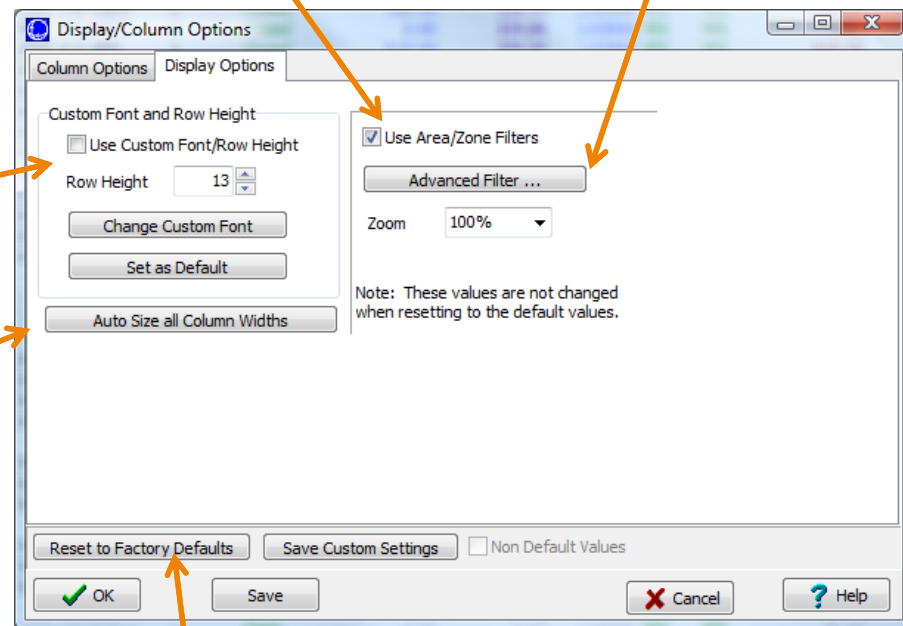


Define a custom filter  
Also available via a toolbar button



Change custom fonts and row heights

Auto resize all column widths. Also available via a toolbar button



Reset all values to default



# Simple Sorting



- To sort a column, left-click on the column heading. Click again to sort in the opposite direction
- SHIFT + Left-Click will sort by Absolute Value

Sorted Descending by Gen MW

Note: Arrow showing sort direction

	Number	Name	Area Name	Nom kV	PU Volt	Volt (kV)	Angle (Deg)	Load MW	Load Mvar	Gen MW ▼	Gen Mvar	Switched Shunts Mvar	Act G Sh MW ▲
1	14931	PALOVRD1	ARIZONA	24.00	1.00652	24.157	-40.10	61.76	46.36	1382.00	354.38		0.
2	14933	PALOVRD3	ARIZONA	24.00	1.00651	24.156	-40.08	61.76	46.36	1382.00	354.38		0.
3	14932	PALOVRD2	ARIZONA	24.00	1.00642	24.154	-40.19	61.76	46.36	1379.00	354.38		0.
4	35412	DIABLO 2	PG AND E	25.00	1.03000	25.750	-50.82	47.40	9.62	1200.00	-20.62		0.
5	35411	DIABLO 1	PG AND E	25.00	1.03000	25.750	-51.15	47.40	9.62	1180.00	-34.56		0.
6	40063	CGS	NORTHWEST	25.00	0.99601	24.900	-10.30	54.55	37.49	1155.00	-152.83		0.
7	24110	S.ONOFR3	SOCALIF	22.00	0.97937	21.546	-69.92			1080.00	127.08		0.

Absolute Value Sort

Click here to remove sorting

	Number	Name	Area Name	Nom kV	PU Volt	Volt (kV)	Angle (Deg)	Load MW	Load Mvar	Gen MW	Gen Mvar ▼	Switched Shunts Mvar	Act G Sh MW ▲
1	14932	PALOVRD2	ARIZONA	24.00	1.00642	24.154	-40.19	61.76	46.36	1379.00	354.38		0
2	14931	PALOVRD1	ARIZONA	24.00	1.00652	24.157	-40.10	61.76	46.36	1382.00	354.38		0
3	14933	PALOVRD3	ARIZONA	24.00	1.00651	24.156	-40.08	61.76	46.36	1382.00	354.38		0
4	30000	PTSB 7	PG AND E	20.00	1.05000	21.000	-62.54	16.10	3.27	710.00	214.61		0
5	26040	INTERM2G	LADWP	26.00	1.03668	26.954	-54.44	53.00	40.00	950.00	188.81		0
6	26039	INTERM1G	LADWP	26.00	1.03668	26.954	-54.44	53.00	40.00	950.00	188.81		0
7	40063	CGS	NORTHWEST	25.00	0.99601	24.900	-10.30	54.55	37.49	1155.00	-152.83		0

# Color Conventions



- Font color denotes type of cell
  - Black: read-only
  - Green: toggle between a set of allowable values (double-click or click drop-down to change)
  - Blue: user-enterable
  - Red: value at a limit
  - Gray: disabled (mouse over for explanation)
  - Purple: special or calculated

	Number of Bus	Name of Bus	ID	Status	Gen MW	Gen Mvar	Set Volt	AGC	AVR	Min MW	Max MW	Min
1	30	CONE G1	H	Closed	445.00	226.73	1.05000	YES	YES	262.00	445.00	-
2	30	CONE G1	L	Closed	405.00	205.60	1.05000	YES	YES	238.00	405.00	-
3	31	CONE G2	H	Closed	445.00	-21.00	0.96671	YES	YES	262.00	445.00	-
4	31	CONE G2	L	Open	0.00	0.00	0.96671	YES	YES	238.00	405.00	-
5	32	KEYS G1	H	Closed	433.00	5.00	0.95862	YES	YES	262.00	433.00	-
6	32	KEYS G1	L	Closed	417.00	4.57	0.95862	YES	YES	238.00	417.00	-
7	33	KEYS G2	H	Closed	433.00	5.05	0.95877	YES	YES	262.00	433.00	-
8	33	KEYS G2	L	Closed	417.00	4.62	0.95877	YES	YES	238.00	417.00	-
9	34	PCHBTM 2	1	Closed	1093.00	193.91	1.01000	YES	YES	1093.00	1093.00	-3
10	35	PCHBTM 3	1	Closed	1093.00	194.50	1.01000	YES	YES	1093.00	1093.00	-3
11	36	SALEM G1	1	Closed	1106.00	550.00	1.07310	YES	YES	1086.00	1106.00	-2
12	37	SALEM G2	1	Closed	1118.56	257.52	1.00514	YES	YES	1086.00	1124.00	-2
13	38	SUSQ 2	1	Closed	1110.00	64.33	0.99263	YES	YES	1094.00	1110.00	-2
14	39	HOPE CG1	1	Closed	1031.00	2.09	0.96984	YES	YES	1031.00	1031.00	-2
15	40	C CLF1	1	Closed	844.00	6.50	0.96860	YES	YES	835.00	844.00	-1
16	41	C CLF2	1	Closed	840.00	62.47	0.97619	YES	YES	837.00	840.00	-
17	42	CLMERCK2	1	Closed	1115.00	98.18	1.01000	YES	YES	1115.00	1115.00	-4
18	249	SENECA 1	1	Closed	210.00	62.64	1.05200	YES	YES	84.00	210.00	-
19	501	HOMER C1	1	Closed	620.00	-0.15	1.00000	YES	YES	300.00	620.00	-2
20	502	HOMER C2	1	Closed	614.00	71.33	1.00000	YES	YES	300.00	614.00	-2
21	503	HOMER C3	1	Closed	650.00	76.71	1.00000	YES	YES	300.00	650.00	-2
22	1277	PORT2GEN	H	Closed	122.00	4.32	1.00000	YES	YES	50.00	122.00	-
23	1277	PORT2GEN	L	Closed	122.00	4.32	1.00000	YES	YES	50.00	122.00	-
24	1283	TMI 1GEN	1	Closed	786.00	176.33	1.00000	YES	YES	786.00	786.00	-2
25	2051	ATLANTIC	1	Closed	0.00	224.84	1.03000	YES	YES	0.00	0.00	-1
26	2095	O C GEN	1	Closed	619.00	208.00	1.03500	YES	YES	619.00	619.00	-
27	2351	BRUNER 1	H	Open	0.00	0.00	1.03000	YES	YES	69.00	161.00	-
28	2351	BRUNER 1	L	Closed	161.00	-22.87	1.03000	YES	YES	69.00	161.00	-
29	2352	BRUNER 2	H	Open	0.00	-27.46	1.03000	YES	YES	70.00	189.00	-
30	2352	BRUNER 2	L	Closed	189.00	-27.46	1.03000	YES	YES	70.00	189.00	-
31	2353	BRUNER 3	1	Closed	735.00	223.19	1.03000	YES	YES	433.00	735.00	-2
32	2364	MONTUR 1	1	Closed	745.00	209.14	1.03900	YES	YES	356.00	745.00	-
33	2365	MONTUR 2	1	Closed	745.00	193.34	1.03900	YES	YES	356.00	745.00	-



# Area/Zone/Owner Filters



- Filtering can be applied to Areas, Zones, and Owners to simplify the Case Information Displays to show only parts of the system of interest
- Select **Area/Zone Filters** from the **Case Information** ribbon or the case information toolbar
- Example: set all areas to NO except a few of interest
  - Click **Set all No** on Areas tab
  - Toggle **NO** to **YES** in the “Shown” column by double-clicking the cell.
- An element will appear in Case Information Displays if its Area, Zone, and Owner “Shown” fields are all set to YES

Area/Zone/Owner Filters

Set all Area/Zone/Owners to Yes

Close

Areas Zones Owners

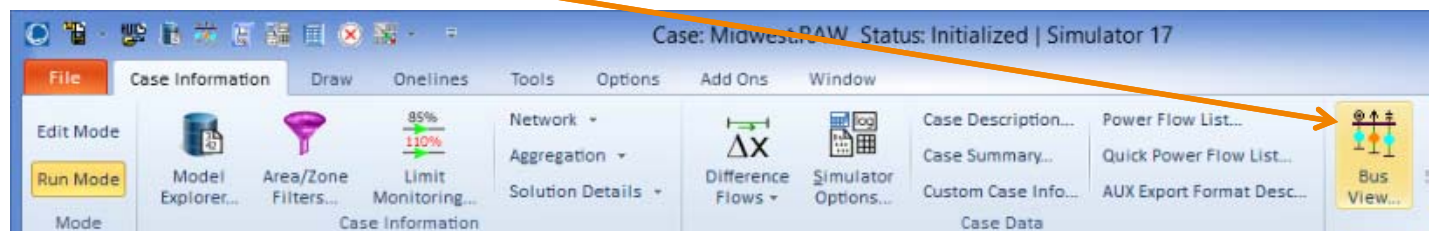
Records Geo Set Columns

	Area Num	Area Name	Shown	# of Buses	Min Bus Num	Max Bus Num
1	5	AEP	NO	943	22551	24131
2	7	HE	NO	168	24971	25201
3	8	CIN	NO	640	25371	26010
4	11	LGE	NO	72	26941	27160
5	12	KU	NO	128	27181	27308
6	14	BREC	NO	19	27551	27620
7	16	IPL	NO	59	27821	27995
8	17	NIPS	NO	57	28001	28057
9	18	CP	NO	220	28191	28429
10	20	EKPC	NO	186	29191	29579
11	39	EAST EQ	NO	532	13	29694
12	47	TVA	NO	944	15003	19971
13	48	DOE	NO	5	18034	18039
14	55	SERC EQ	NO	208	10094	16750
15	56	EMO	NO	257	31001	31993
16	57	IP	YES	171	32268	32999
17	58	CIPS	YES	107	33435	33556
18	59	CILCO	YES	37	30001	30300
19	60	CWLP	NO	38	30301	30338
20	61	SIPC	NO	17	30351	30369
21	62	EEI	NO	2	30391	30392

# Bus View One-Line Diagrams



- Another useful way to interface with a power system model
- Auto-generates one-line diagrams at each bus, one at a time, showing all devices connected to bus and all flows.
- Choose the **Case Information** ribbon tab, then **Bus View...**



# Bus View One-Line



Back and forward buttons

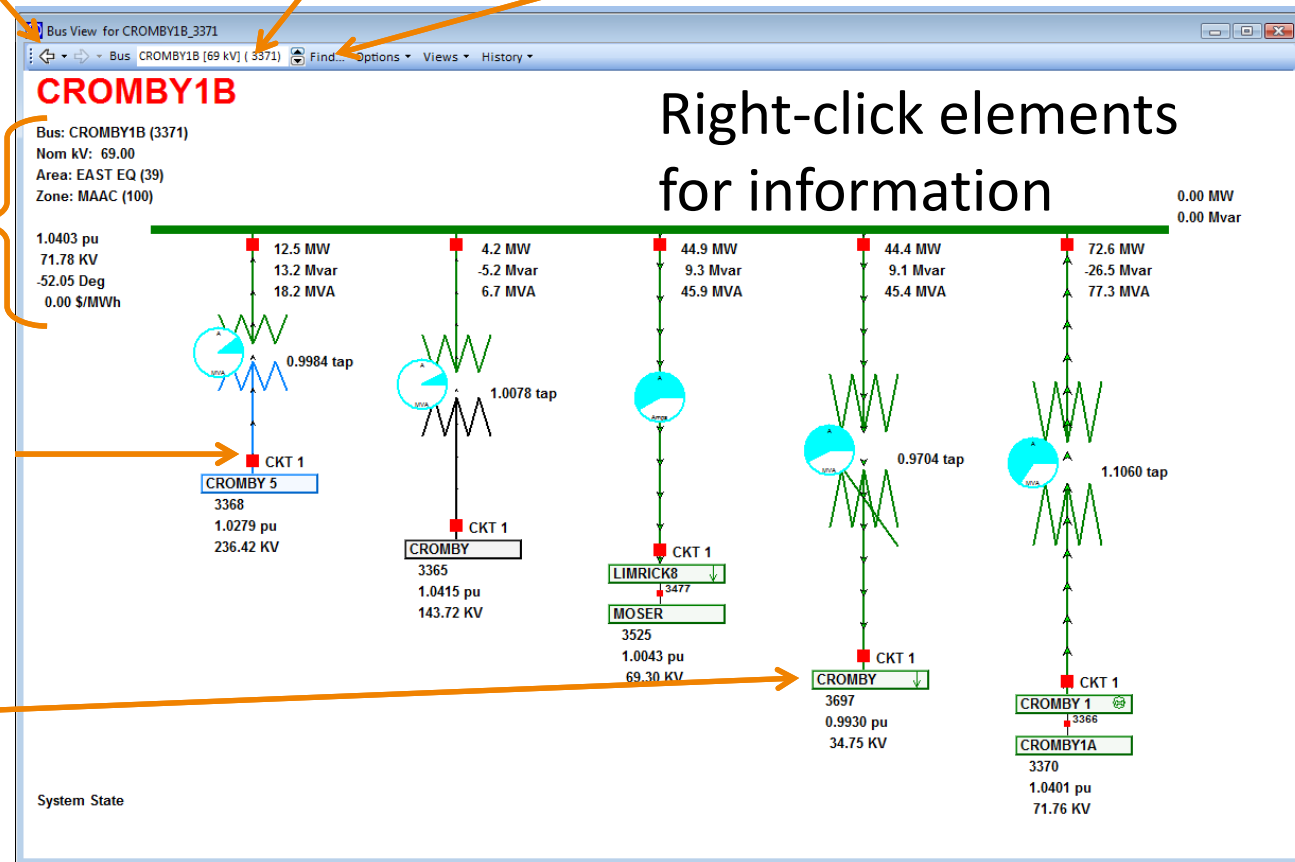
Enter a name or number to go to a bus

Click to find a bus

Bus and Flow information

Left-click circuit breaker to open/close

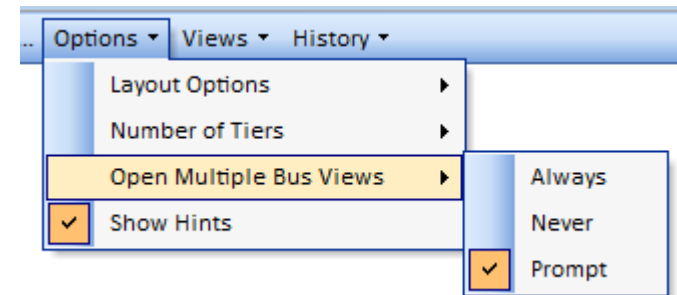
Click links to jump to new bus



# Bus View Online: Click Options > to reveal



- Number of Tiers – specify 1 or 2
- Show Hints
  - As you move your cursor over an object it will show information
- Show Serial Buses
  - Buses that are in series will be cascaded
- Show Equivalent Lines
  - Change to hide/show equivalent lines
- Represent Multi Section Line Objects
  - Show endpoints of MS Lines without intermediate buses
- Open Multiple Bus views
  - Specify whether to create a new Bus View when a new one is requested.
  - Choosing Prompt means you will be prompted each time
- Include Field Labels
  - A description of what each field is will be shown.
- Change Bus Link Color
  - The fill color of the bus links can be changed



# One-Line Diagrams

---



- Custom one-line diagrams may also be created and edited by the user
- One-line diagrams are well-suited for wide-area, regional, or local power system visualization
- One-lines need only be created for the portion of the system of interest, but Simulator always models the ENTIRE system in calculations
- Simulator automatically links diagrams to the opened power system model

# One-Line Diagrams

---



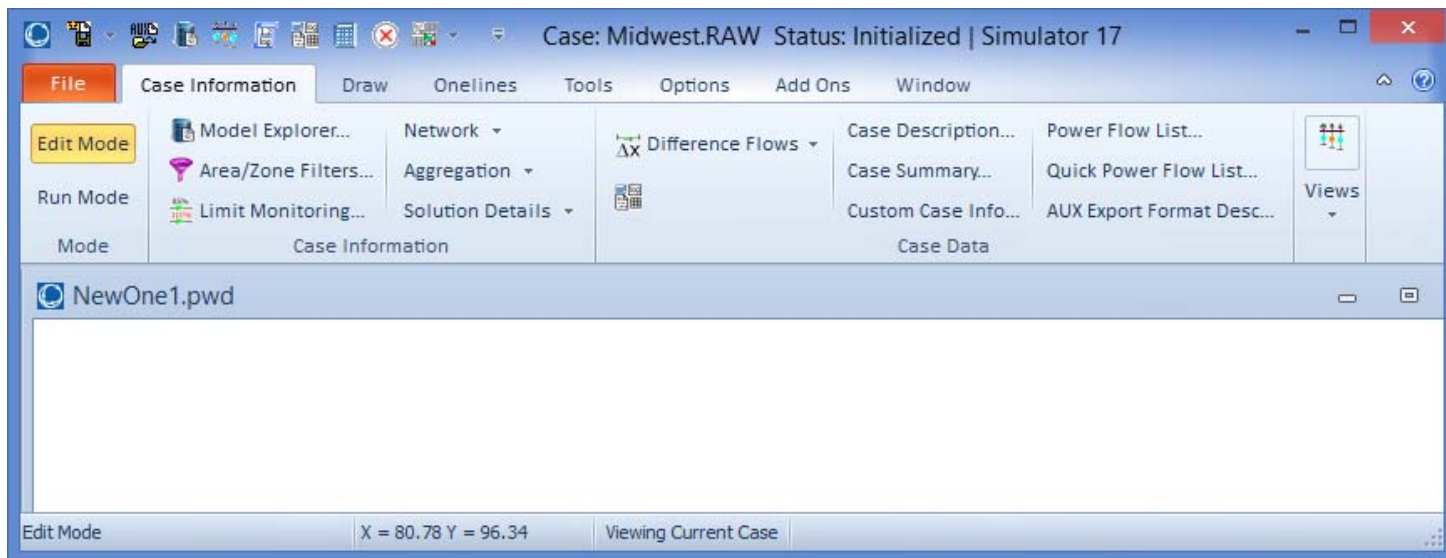
- One-lines may be geographic or schematic in nature
- For geographic diagrams, Simulator has built-in borders for US states and counties, Canadian Provinces, and entire countries for the rest of the world
- For schematic diagrams, simply omit the borders and arrange system elements as desired



# Creating a One-Line Diagram



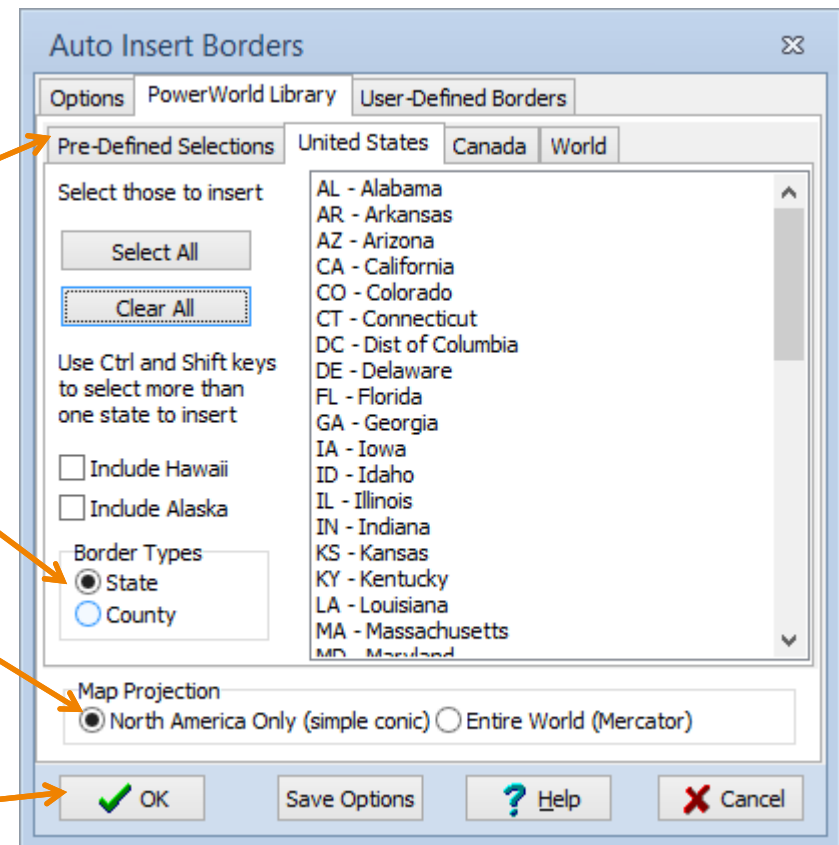
- Choose the **File Menu**, then **New OneLine...**
- Simulator will automatically switch to **Edit Mode** if necessary and open a blank window to draw objects on the one-line diagram



# Insert Borders



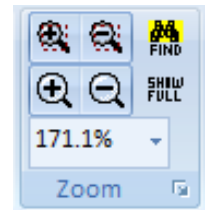
- From the **Draw** Ribbon, choose **Auto Insert** → **Borders**
- Select Region
- State or County for US
- Choose Map Projection (once set, do not change)
- Click OK to insert



# Panning and Zooming



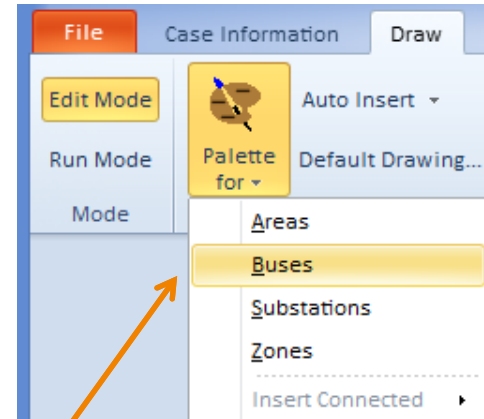
- Pan and Zoom to navigate around the one-line diagram
- Panning
  - Click and drag the one-line background (not on any particular object)
  - Use Arrow Keys (up, down, left, right) or Home, End, Page Up, Page Down to move more quickly
- Zooming
  - Group of buttons on the **Draw** and **Onelines** Ribbons
  - “Zoom In” with Ctrl-Up Arrow key (or Ctrl-Page Up to zoom more quickly)
  - “Zoom Out” with Ctrl-Down Arrow key (or Ctrl-Page Down to zoom more quickly)



# Object Palettes



- Use the **Draw** ribbon to add objects to the one-line
- Drag-and-drop palettes are available for several object types
  - Buses (common)
  - Substations
  - Areas
  - Zones
- Choose **Palette for → Buses**
- Drag-and-drop buses from Palette onto the Diagram

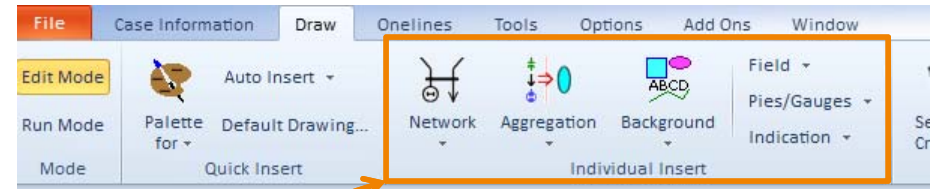


History List	Define a Filter...	Options >	Help
Displayed (0)	Displayed Neighbors	Undisplayed Neighbors	All Undisplayed (10452)
		KEYS G1 (32) 22.0	01HATFD1 (20580) 18.0
		KEYS G2 (33) 22.0	01CARNEG (20311) 138.0
		01DOUBS (20105) 500.0	01DOUBS (20105) 500.0
		01PRNTY (20112) 500.0	01FMRTN1 (20583) 22.0
		01WYLLIER (20114) 345.0	01FMRTN2 (20584) 22.0
		01KAMMER (20117) 500.0	01GILBOA (20333) 138.0
		01GILBOA (20333) 138.0	01GRASSY (20340) 138.0
		01GRASSY (20340) 138.0	01HARRN1 (20585) 20.0
		01NMARTN (20378) 138.0	01HARRN2 (20586) 20.0
		01WINDSR (20428) 138.0	01HARRN3 (20587) 20.0
		01WOLFCK (20430) 144.0	01HATFD1 (20580) 18.0
		01HATFD1 (20580) 18.0	01HATFD2 (20581) 18.0
		01HATFD2 (20581) 18.0	01HATFD3 (20582) 18.0
		01HATFD3 (20582) 18.0	01KAMMER (20117) 500.0
		01FMRTN1 (20583) 22.0	01MAHNSL (20363) 138.0
		01FMRTN2 (20584) 22.0	01MDWBRK (20110) 500.0
		01HARRN1 (20585) 20.0	01NMARTN (20378) 138.0
		01HARRN2 (20586) 20.0	01INSHEND (20496) 138.0
		01HARRN3 (20587) 20.0	01PLEAS1 (20590) 26.0
		01PLEAS1 (20590) 26.0	01PLEAS2 (20591) 26.0
		01PLEAS2 (20591) 26.0	01PRNTY (20112) 500.0
		01STRASB (20513) 138.0	01S CHST (20404) 138.0
		01WELR IT (20406) 138.0	

# Individual Insertion



- Objects may also be added to the diagram individually
- Objects are grouped by type, as in the Model Explorer
- For example, choose **Network** → **Bus**, then click on the diagram where you would like to place the bus
- If necessary, change the bus number and other options, then click OK



Bus Options

Bus Number: 3371 Find By Number Find ...

Bus Name: CROMBY1B Find By Name

Nominal Voltage: 69.0 kV

Labels ... no labels

	Number	Name
Area	39	EAST EQ
Zone	100	MAAC
Owner	1	1
Substation		

Bus Information Display Attached Devices Geography Custom

Orientation: ☒ Right ☐ Up ☐ Left ☐ Down

Shape: ☒ Rectangle ☐ Ellipse

Size: 3.00 Width: 0.200 Scale Width with Size

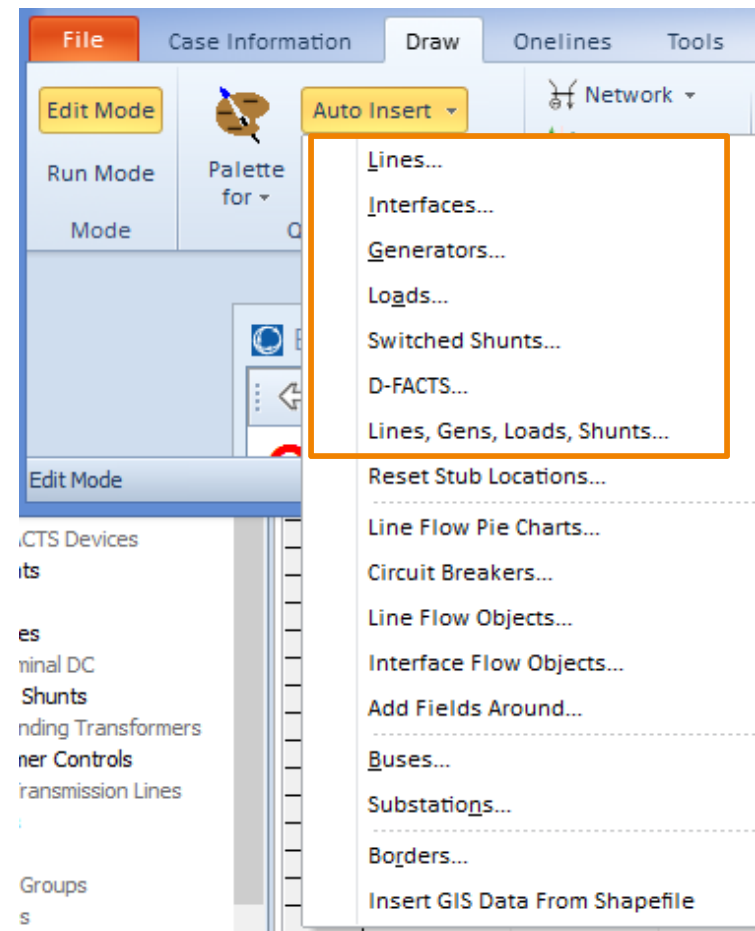
Link to New Bus

OK Save Cancel

# Auto-Insertion



- The layout of a one line diagram is generally determined by the location of buses, substations, areas, or zones
- Once these are in place, other objects that attached to them may be automatically placed



# Arranging Objects on a Diagram



- You can generally relocate or reposition objects by clicking and dragging
- Certain “object handles” may be used for stretching, resizing, or rotating
- The **Formatting** group has options for changing the appearance of selected objects
- If you make a mistake, choose **Undo Oneline...**



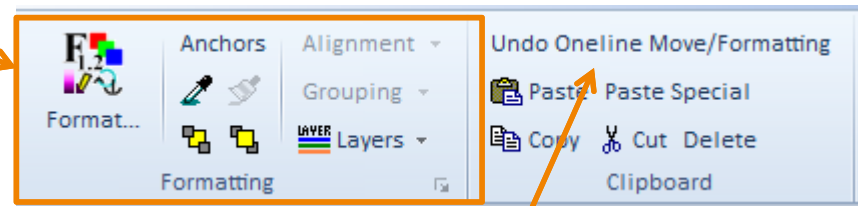
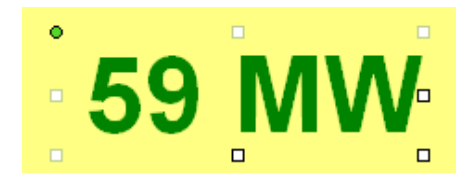
Green Circle:  
Rotation Point



Gray Square:  
For looks only



Black Square:  
Resize Handle



# Scaling Load

---



- It is often desirable to change the power system load from initial levels in the power flow case
- It is usually a good idea to begin with a case with load as close to the desired level as possible
  - Small changes (about +/- 10% or less) can usually be performed without too much manipulation
  - Larger changes often require adjustments, such as voltage controller settings, area transactions, generator unit commitment, and/or the use of the DC power flow. These topics are discussed in greater depth in our full training curricula.



# Area AGC Settings

---

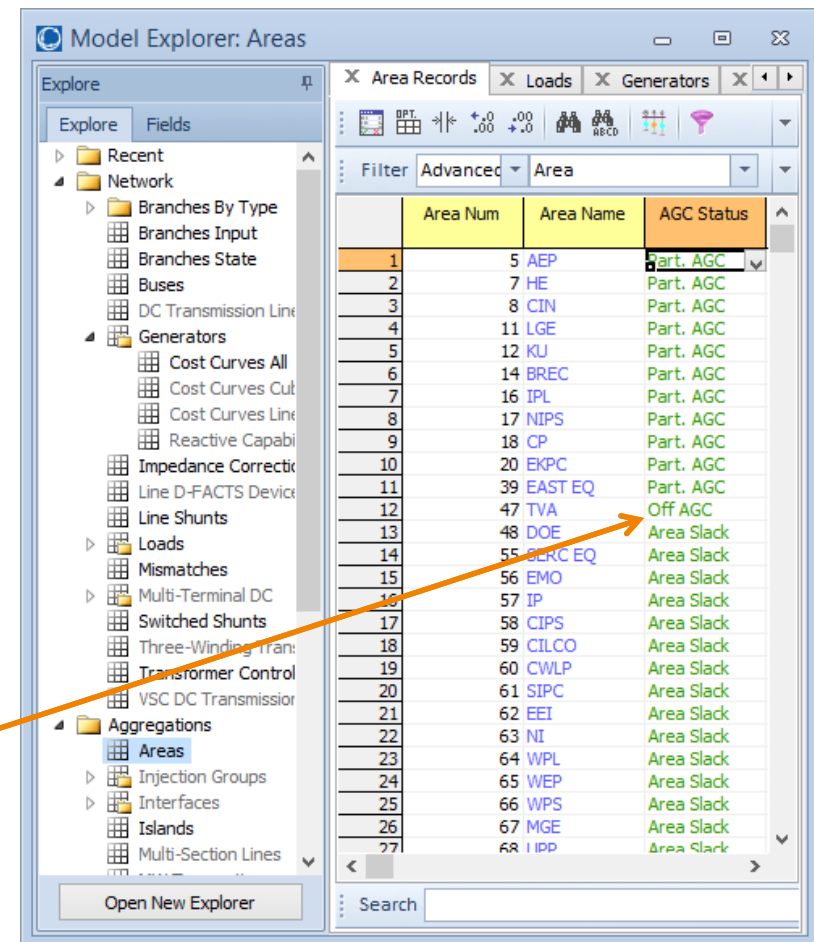


- Before scaling load, it may be desirable to change some default settings
- \*.raw and \*.epc files commonly use “Area Slack” control
  - “Area Slack” means changes in area load are absorbed by generators at a single bus, the area slack bus
  - This may be useful for holding constant the output of all other generators, but may not be realistic when making large changes to load
- “Participation Factor” control may be used to distribute the “make-up power” requirement across the system

# Participation Factor Control



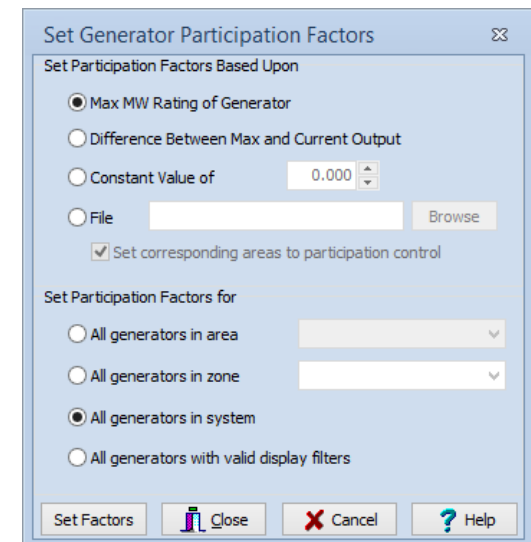
- In the Model Explorer, open **Aggregations** → **Areas**
- If desired, toggle the AGC Status field to “Part. AGC”
  - Hint: click and drag from the lower left of a cell to fill other cells with the same value
- Areas that are initially “Off AGC” should normally remain “Off AGC”, as they often contain island slack buses or swing buses



# Participation Factor Control



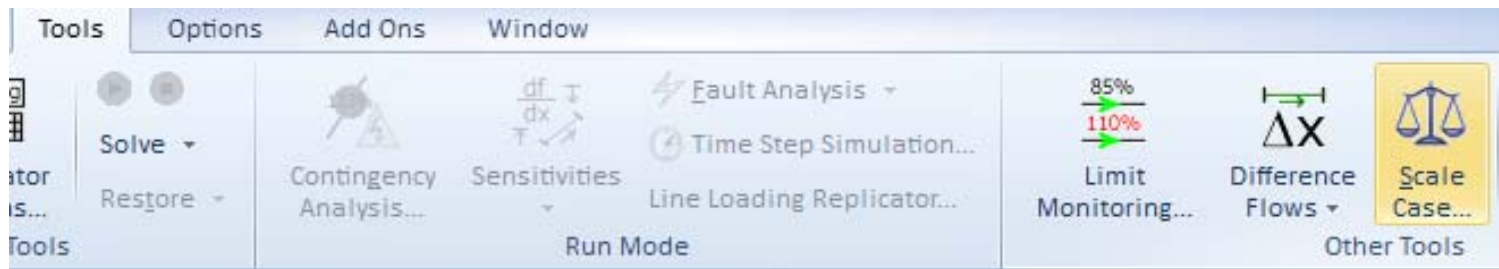
- To set generator participation factors, from the Tools Ribbon, choose **Other** → **Set Generator Part. Factors...**
- The default options are usually appropriate



# Scaling Load



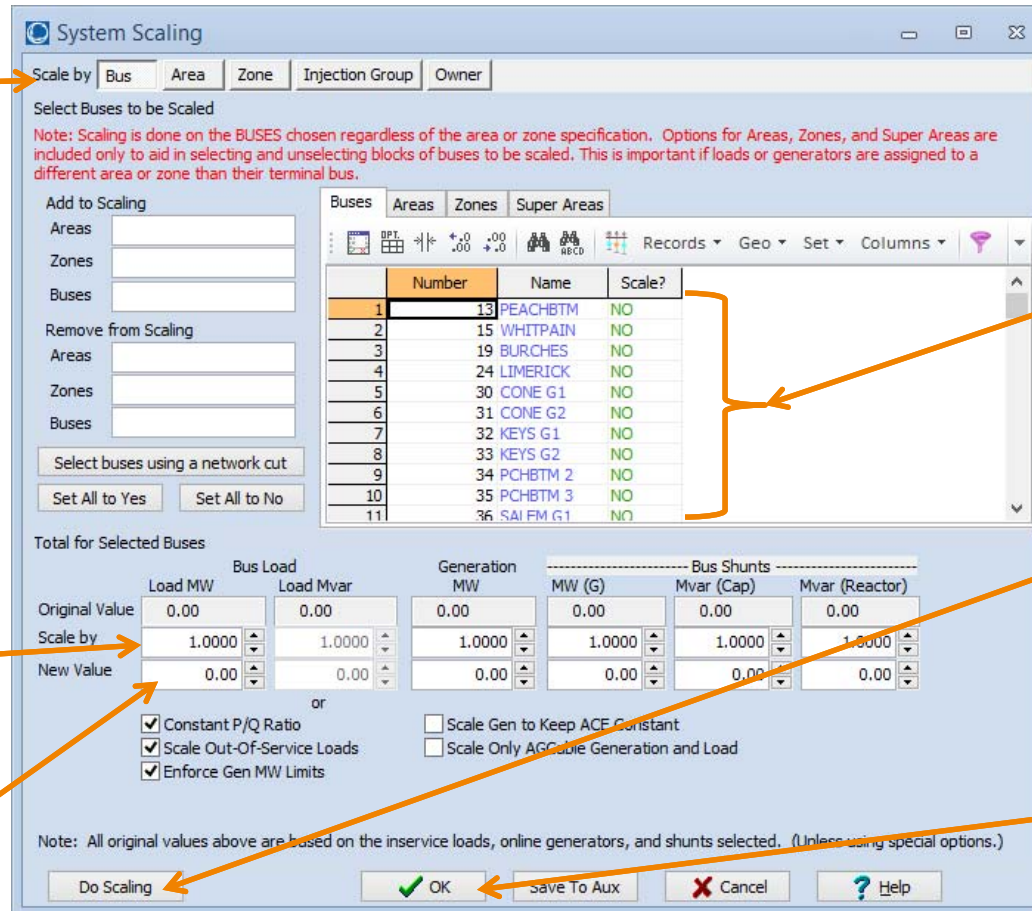
- Loads may be scaled individually
  - from **Model Explorer** → **Network** → **Loads**
  - usually edit the “S MW” and “S Mvar” columns
- Or in bulk from **Scale Case...** on the **Tools** Ribbon



# System Scaling Display



Choose object to scale by



The dialog box is titled "System Scaling". It has tabs for "Scale by", "Area", "Zone", "Injection Group", and "Owner". The "Scale by" tab is selected. Below the tabs, there is a section "Select Buses to be Scaled" with a note: "Note: Scaling is done on the BUSES chosen regardless of the area or zone specification. Options for Areas, Zones, and Super Areas are included only to aid in selecting and unselecting blocks of buses to be scaled. This is important if loads or generators are assigned to a different area or zone than their terminal bus." Below this, there are sections for "Add to Scaling" and "Remove from Scaling", each with input fields for Areas, Zones, and Buses. There is also a "Select buses using a network cut" button and "Set All to Yes" / "Set All to No" buttons. The main part of the dialog is a table with columns "Number", "Name", and "Scale?". The table lists 11 buses: 13 PEACHBTM, 15 WHITPAIN, 19 BURCHES, 24 LIMERICK, 30 CONE G1, 31 CONE G2, 32 KEYS G1, 33 KEYS G2, 34 PCHBTM 2, 35 PCHBTM 3, and 36 SAI FM G1. The "Scale?" column has "NO" for all buses. Below the table, there is a section "Total for Selected Buses" with input fields for "Original Value" and "New Value" for "Load MW", "Load Mvar", "Generation MW", "MW (G)", "Mvar (Cap)", and "Mvar (Reactor)". There are also checkboxes for "Constant P/Q Ratio", "Scale Out-Of-Service Loads", "Enforce Gen MW Limits", "Scale Gen to Keep ACE Constant", and "Scale Only AGCable Generation and Load". At the bottom, there is a note: "Note: All original values above are based on the inservice loads, online generators, and shunts selected. (Unless using special options.)" and buttons for "Do Scaling", "OK", "Save To Aux", "Cancel", and "Help".

Number	Name	Scale?
1	13 PEACHBTM	NO
2	15 WHITPAIN	NO
3	19 BURCHES	NO
4	24 LIMERICK	NO
5	30 CONE G1	NO
6	31 CONE G2	NO
7	32 KEYS G1	NO
8	33 KEYS G2	NO
9	34 PCHBTM 2	NO
10	35 PCHBTM 3	NO
11	36 SAI FM G1	NO

	Load MW	Load Mvar	Generation MW	MW (G)	Mvar (Cap)	Mvar (Reactor)
Original Value	0.00	0.00	0.00	0.00	0.00	0.00
Scale by	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
New Value	0.00	0.00	0.00	0.00	0.00	0.00

Select specific objects to scale

Enter either a scaling factor

"Do Scaling" scales the values, but leaves dialog open

Or directly enter a new value

"OK" also scales the values, then closes the dialog

# Scaling Example



- Scale by Area
- Choose one or more areas by toggling “Scale?” field to “YES”
- Specify new load with either
  - Scaling multiplier, OR
  - New MW value
- Click OK
- Re-Solve the Power Flow (**Single Solution – Full Newton**)

Area Num	Area Name	Scale?
1	5 AEP	NO
2	7 HIL	NO
3	8 CIN	YES
4	11 LGE	NO
5	12 KU	NO
6	14 BREC	NO
7	16 IPL	NO

Load MW		Load Mvar		Generation MW		MW (G)		Mvar (Cap)		Mvar (Reactor)	
Original Value	10707.76	2049.65		11176.57	69.60	468.70	254.30				
Scale by	1.0273	1.0273		1.0000	1.0000	1.0000	1.0000				
New Value	11000.00	2105.59		11176.57	69.60	468.70	254.30				

☒ Constant P/Q Ratio ☐ Scale Gen to Keep ACE Constant  
☒ Scale Out-Of-Service Loads ☐ Scale Only AGCable Generation and Load  
☒ Enforce Gen MW Limits

Note: All original values above are based on the inservice loads, online generators, and shunts selected. (Unless using special options.)

Do Scaling OK Save To Aux Cancel Help

NOTE: With Participation Factor AGC, it is usually not necessary to scale generation; this will occur on power flow solution. However, you may optionally scale generation on the System Scaling display

# Scaling Notes

---



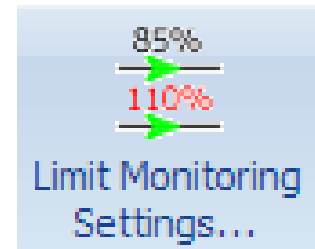
- With the AC power flow, several iterations of partial scaling followed by solving the power flow may be required to achieve a desired load
- With Participation Factor AGC, it is usually not necessary to scale generation; this will occur automatically with the power flow solution.
- You may optionally scale generation by
  - Entering a “Scale by” factor or “New Value” for Generation, OR
  - Check the box “Scale Gen to Keep ACE Constant”



# Limit Monitoring



- Most power systems analysis tools make use of limits to define boundaries of safe, reliable operation
- Define settings for monitoring limits by selecting the **Tools** ribbon tab, then **Limit Monitoring Settings**.
- By default, **ALL** elements in the power system are monitored
- Use **Limit Monitoring Settings** to exclude power system elements that are of no interest for a particular study
- Different Line, Interface and Voltage limits can be assigned to each Limit Group, and each device within a Limit Group will adhere to its own Limit Group Settings





# Limit Monitoring

---



- Monitoring may be done on **buses** (voltage), **lines** (MVA or Amps), **transformers** (MVA), **interfaces** (MW)
- An element is monitored only if ALL of the following conditions are met:
  - Its “Monitor” field is set to YES
  - Its assigned “Limit Group” is Enabled
  - Its Area’s “Report Limits” field is set to YES and its nominal kV is between its Area’s “Report Min kV” and “Report Max kV”
  - Its Zone’s “Report Limits” field is set to YES and its nominal kV is between its Zone’s “Report Min kV” and “Report Max kV”

# Limit Monitoring: Key Components



Area and  
Zone settings

Monitored  
element  
types

Limit Monitoring Settings and Limit Violations

Use the Modify/Create Limit Groups to tab to modify and create limit groups to which Buses, Lines and Interfaces can be assigned. Use the Buses, Lines and Interfaces tabs to assign elements to different limit groups. The Areas and Zones tabs are provided here for your convenience.

Save Monitoring Settings  
Load Monitoring Settings

Elements to Show  
☒ All Elements  
☐ Monitored Elements  
☐ Violating Elements

Number Of Violations  
 Low Voltage Buses: 27  
 High Voltage Buses: 19  
 Low-voltage Suspects: 0  
 Lines/Transformers: 53  
 Interfaces: 0

Limit Group Values  
 Limit Group: Default  
☐ Group Disabled / Do Not Monitor  
 Lines & Transformers: Interfaces: Buses: Percentage: 100.0  
 Normal Rating Set: A  
 Contingency Rating Set: A  
☐ Treat Line Limits as Equivalent Amps  
☐ Do not monitor radial lines and buses (applied to all limit groups)

Only show the primary bus for each superbus

Number	Name	Area Name	Monitor	Limit Group	PU Volt	Volt (kV)	Limit Low PU Volt	Limit High PU Volt	Contingency Limit Low PU Volt	Contingency Limit High PU Volt
1	13 PEACHBTM	EAST EQ	YES	Default	1.07109	535.545	0.90	1.10	0.90	1.10
2	15 WHITPAIN	EAST EQ	YES	Default	1.06366	531.830	0.90	1.10	0.90	1.10
3	19 BURCHES	EAST EQ	YES	Default	1.02786	513.932	0.90	1.10	0.90	1.10
4	24 LIMERICK	EAST EQ	YES	Default	1.06780	533.898	0.90	1.10	0.90	1.10
5	30 CONE G1	EAST EQ	YES	Default	0.95000	23.100	0.90	1.10	0.90	1.10
6	31 CONE G2	EAST EQ	YES	Default	0.98274	21.620	0.90	1.10	0.90	1.10
7	32 KEYS G1	EAST EQ	YES	Default	0.95862	21.090	0.90	1.10	0.90	1.10
8	33 KEYS G2	EAST EQ	YES	Default	0.95877	21.093	0.90	1.10	0.90	1.10
9	34 PCHBTM 2	EAST EQ	YES	Default	1.01000	22.220	0.90	1.10	0.90	1.10
10	35 PCHBTM 3	EAST EQ	YES	Default	1.01000	22.220	0.90	1.10	0.90	1.10
11	36 SALEM G1	EAST EQ	YES	Default	1.03186	22.701	0.90	1.10	0.90	1.10

Limit  
Group  
settings

Element's "Monitor"  
Field (YES/NO)

Element's assigned Limit Group  
(all initially belong to "Default")

# Limit Monitoring: Tabs



- Buses, Lines, Interfaces, and Nomograms
  - show the individual elements of the power system
  - important columns
    - Monitor: specifies whether to monitor that specific element
    - Limit Group: specifies the Limit Group that the element belongs to
- Area Reporting and Zone Reporting
  - Specify which areas and zones to monitor
  - Specify nominal kV range to monitor in each
- Modify/Create Limit Groups
  - Specify limit levels and rating sets for lines, buses, and interfaces under normal and contingency conditions
  - Most fields also present in the upper-right corner of the dialog (Limit Group Values)

# Limit Monitoring Example



- Use the “B” rating set for Lines & Transformers during Contingencies
- Ignore all radial lines and buses
- Report Limits only in a few areas, at 100 kV and above

Limit Monitoring Settings and Limit Violations

Use the Modify/Create Limit Groups to tab to modify and create limit groups to which Buses, Lines and Interfaces can be assigned. Use the Buses, Lines and Interfaces tabs to assign elements to different limit groups. The Areas and Zones tabs are provided here for your convenience.

Save Monitoring Settings  
Load Monitoring Settings

Elements to Show  
☒ All Elements  
☐ Monitored Elements  
☐ Violating Elements

Number Of Violations  
 Low Voltage Buses: 0  
 High Voltage Buses: 0  
 Low-voltage Suspects: 0  
 Lines/Transformers: 3  
 Interfaces: 0

Limit Group Values  
 Limit Group: Default  
☐ Group Disabled / Do Not Monitor  
 Percentage: 100.0  
 Normal Rating Set: A  
 Contingency Rating: B  
☐ Treat Line Limits as Equivalent Amps  
☒ Do not monitor radial lines and buses (applied to all limit groups)

Areas and Zones are not assigned to limit groups. However, a power system element is only monitored if ALL of the following are true  
 1. Its Monitor field is set to YES  
 2. Its Limit Group is Enabled  
 3. Its Area is set to Report Limits and it meets the KV range for reporting  
 4. Its Zone is set to Report Limits and it meets the KV range for reporting  
 Because of this, the Area and Zone Lists are provided here for your convenience

	Area Num	Area Name	Report Limits	Report Min kV	Report Max kV
1	5	AEP	YES	100.00	9999.00
2	7	HF	YES	100.00	9999.00
3	8	CIN	YES	100.00	9999.00
4	11	LGE	NO	100.00	9999.00
5	12	KU	NO	100.00	9999.00
6	14	BREC	NO	100.00	9999.00
7	16	IPL	NO	100.00	9999.00
8	17	NIPS	NO	100.00	9999.00
9	18	CP	NO	100.00	9999.00
10	20	EKPC	NO	100.00	9999.00