Transient Stability Analysis with PowerWorld Simulator

T6: Storage of Transient Stability Results

PowerWorld Corporation

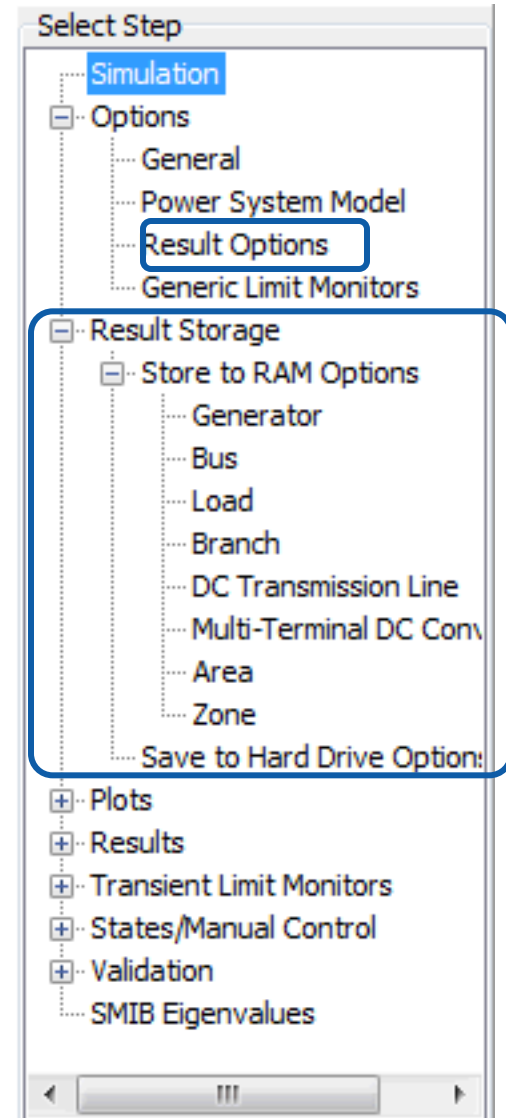2001 South First Street
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Result Storage

- Result Options

- What results can be stored

- Where results can be saved

- How often to save results

Transient Stability Options: Result Options

- Viewed from the Result Options tab of the Options page of the Transient Stability Analysis dialog

- When to Begin Checking Min/Max Values

  – When performing a fault, obviously the voltages will be very low during the fault

  – Do not start checking these values until after the last event to avoid reporting these values

  – This allows you to capture how values recover after a fault clears

Transient Stability Options: Result Options

- **Angle Reference**
  - If the slack bus is an infinite bus, this option is not used
    - the slack bus angle is reference
  - Otherwise, this option is used
    - *Average of Generator Angles:* the average of all rotor angles in the system
    - *Weighted Average of Generator Angles:* the average of all rotor angles weighted by each generator's MVA base
    - *Specified Angle Reference Generator Terminal Angle:* the terminal bus angle of the specified generator
    - *Specified Angle Reference Generator Internal Angle:* the internal bus angle of the specified generator
    - *Synchronous Reference Frame (No Angle Shift):* all rotor angles are reported on the synchronous reference frame.

- **Initialize the Reference Angle at Zero**
  - An additional constant shift is applied to all angles throughout the entire simulation. Shift is equal to the initial reference angle

Angle Reference Options

Angle Reference
- ● Average of Generator Angles
- ○ Weighted Average of Generator Angles
- ○ Specified Angle Reference Generator Terminal Angle
- ○ Specified Angle Reference Generator Internal Angle
- ○ Synchronous Reference Frame (No Angle Shift)

Angle Reference Generator 1 (Bus1) #1

☐ Initialize with Reference Angle at Zero

Note: This reference is not used if infinite buses are modeled

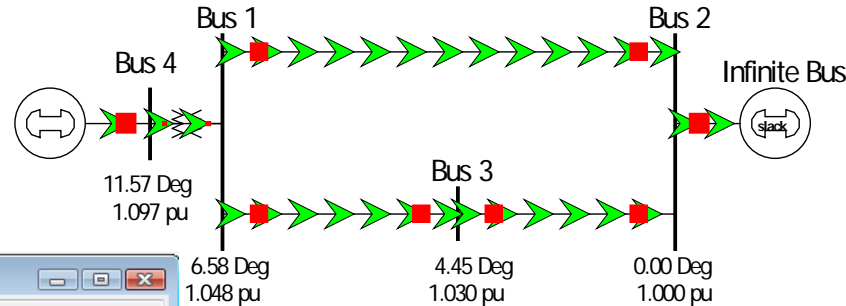# Transient Stability Options: Result Options\Angle Reference

- Angle, No Shift shows the actual angles
  - Angles are with respect to a synchronous reference frame moving at nominal frequency
  - If actual frequency increases then the raw angles will all increase as time increase
  - System can still be stable as angle angles converge toward the same slope

- Angle field is with respect to a reference
  - The reference itself is calculated at every time step
  - Angle = Angle, No Shift – Reference
  - Angle plots for stable systems will converge toward a flat line.
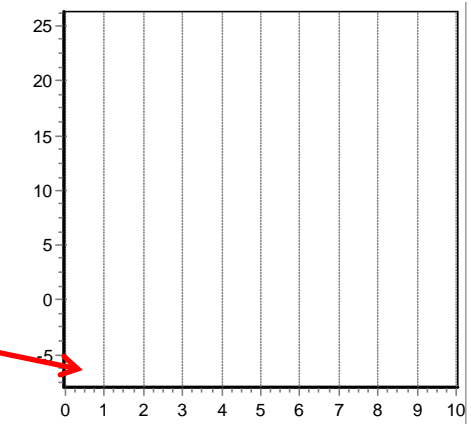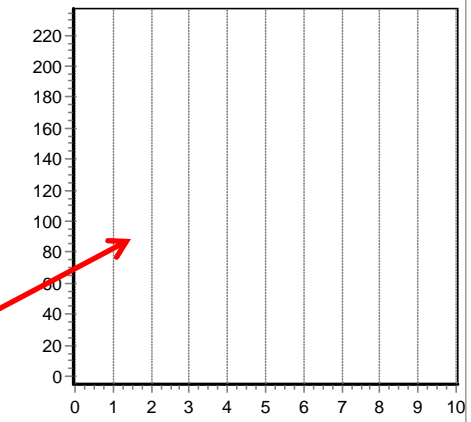
Result Storage

Open Example_13_4_WithPlot" –
This case has already been set up

Open the Transient
Stability Analysis
Dialog from the
ribbon tab to the
Result Storage
page

Determining the Results to Store for Viewing Afterward

For large cases, transient stability solutions can generate huge amounts of data.   PowerWorld Simulator provides easy ways to choose which fields to save for later viewing. These choices can be made on the "Result Storage" page.

- Avoid storing too many values in RAM, or you may run out of memory and either cause the simulation to fail or slow down your computer

- If you need to save out a lot of data, saving to hard drive is a good option
  - After a run, you can still load results from hard drive back into RAM for viewing
  - Can visualize plot charts directly from the hard drive

- When using transient limit monitors, it may _not_ be necessary to explicitly save any numerical results

Result Storage Page: Options

- On Result Storage page there are two check-boxes
  - Save Results to RAM
  - Save Results to Hard Drive
- Save Results Every n Timesteps
  - Results do not have to be stored for each time step. Increase this value to store them for only some timesteps
  - Note: This does NOT effect Max/Min Value Tracking, Generic Limit Monitoring, or Transient Limit Monitoring
    - They will always to look at every time step and report accordingly
- Save the Results stored to RAM in the PWB file
  - This can make the PWB pretty large

Result Storage Page: Options

- Two tabs on the Result Storage page to support
  - Store to RAM Options
    - Toggle fields to save for each object
      - Note: object fields that are part of a plot definition (as discussed in the Plot Definition section) will always be treated as though the respective field is toggled to *YES*
    - Option to **Set All to NO for All Types**
    - Option to **Set Save All By Type**
  - Store to Hard Drive Options
    - Choose directory location in which to save
    - File name will be the contingency name with extension *.TSR
    - Select object types to save
    - Area/Zone filters can be used to specify what to store
    - Note: An auxiliary file with the extension *.AUX will also be saved which stores the Min/Max Values, Summary, Events, and Solution Details information for the contingency as well

Result Storage Page

Where to save results

Can save results with the PWB file, but size of the file may significantly increase

When to save results

Scroll over to view which generator fields are currently saved

Save Results To RAM

Select what objects and fields to store to from the RAM Options tab

Many tabs are available here which correspond to different object types

Generator Tab

Toggle which fields to store

Each object type has many different fields that may be saved, including any dynamic states

Rotor Angle, Speed, Terminal MW, Terminal MVAr, and Field Voltage are currently being saved for Generator 4

Save Results to RAM

Toggle all to NO for the current object type or for all object types

Choose types for which to toggle the "Save All" column to YES

Dynamic States, Inputs, and Other Fields

- Later in the Plot Designer, you will see that some types of objects can have dynamic models

  - States
  - Inputs
  - Other Fields

- For the purpose of Result Storage, if you set *States of **** to YES, then States, Inputs, and Other Fields are all stored.

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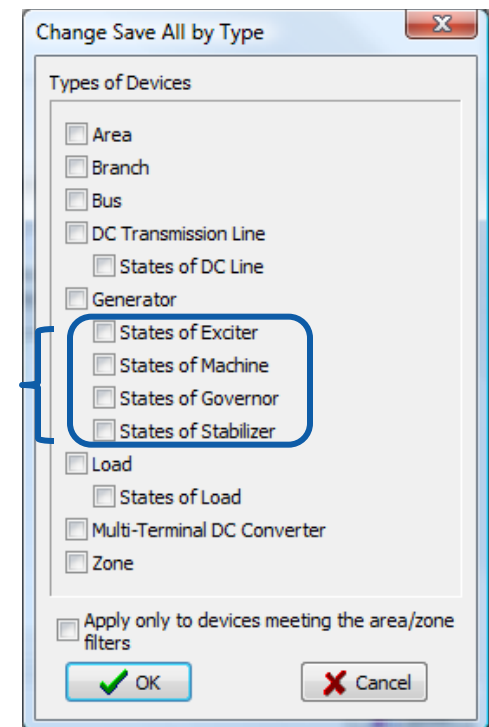
Results: Time Values From RAM

Click "Run Transient Stability"

The results saved to RAM will appear in the Results tab

There are many options for filtering and viewing results - discussed in the Reviewing Results section

Save Results to Hard Drive

Open the Save to Hard Drive Options tab

Select "Save Results to Hard Drive"

It's possible to save to both RAM AND Hard Drive

Specify directory for saving the results

Area/Zone Filters may be used

Specify what objects to save

Save Results to Hard Drive

- The only options for storing results to the Hard Drive are
  - Specify Object Types
  - Filter by Area/Zone/Owner Filters
- What fields are stored to the *.TSR file?
  - All stability fields
  - All dynamic model states
  - All dynamic model inputs
  - All dynamic model other fields
- TSR File Archiving
  - When a new set of results are created, old TSR files will be archived using a file name of type
    - *MyFileName_1.tsr, MyFileName_2.tsr,* etc…

Load from Hard Drive

When saving to Hard Drive, results will not automatically be shown

Click to load back in from Hard Drive in order to view the results in Simulator

This button is also available on the "Save to Hard Drive Options" Tab

Result Storage Example

- Open TS9Bus Bus Fault.pwb

- Go to Run Mode and open Transient Stability

- Go to the Result Storage page

- Case is configured to Store Results to RAM
  - *Save All* = YES for all generators
  - *Save All* = YES for all buses

- Click **Run Transient Stability**

- To see what's stored in RAM and the Hard-Drive you can go to the Plots page or the Results page

Result Storage:
Plots

Device Type = *Bus*

Device Type = *Load*

Green Text = in RAM

Black Text = not in RAM

Results Storage: Results\Time Values From RAM

Device Type = *Bus*

Results

Device Type = *Load*

No Results

Result Storage:
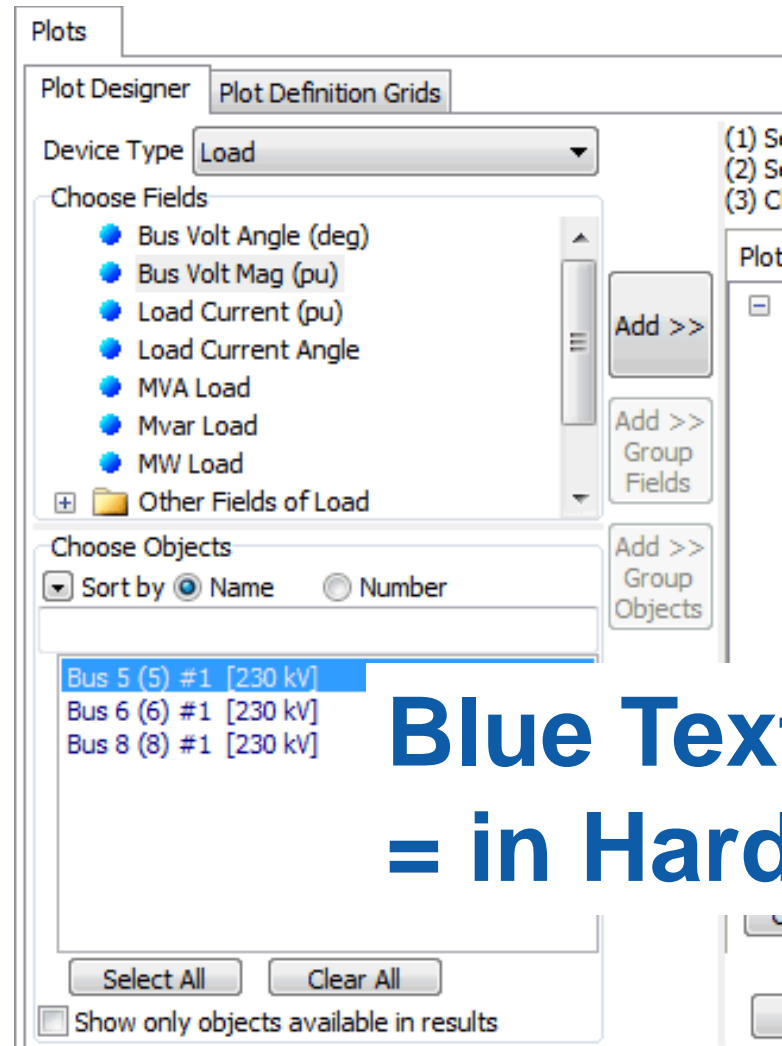# Save Results to Hard Drive

- Configure to Store Results to Hard Drive
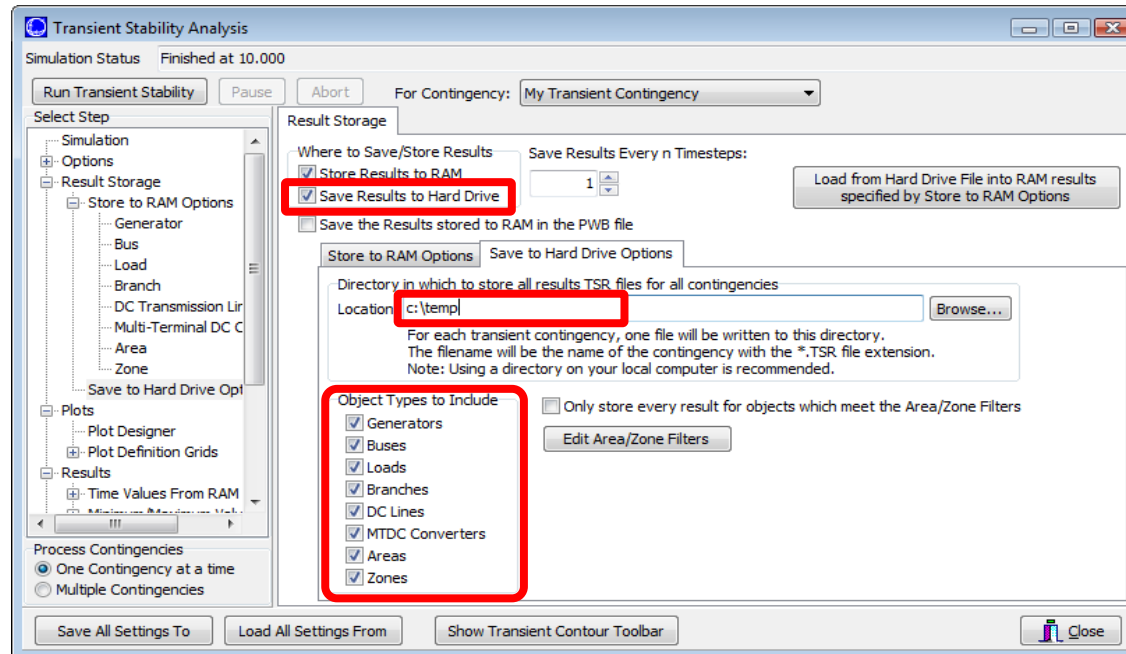
- Click **Run Transient Stability** again.

- Navigate in Windows Explorer to see that the TSR file has been created

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TS9Bus Bus Fault.pwb

Result Storage:
Hard Drive

- Plot Designer – Hard Drive Results objects in Blue
  - These results may be plotted directly
- Time Values From RAM
  - Still not available

Blue Text = in Hard Drive

Load Hard Drive Results into the RAM Results

- Possible to load results from Hard Drive for viewing in tables
  - Go back to Results Storage, Store to RAM Options
  - Go to Load
  - Specify *Save All* = YES for all loads
  - Click **Load from Hard Drive File into RAM …**

Load Hard Drive Results into the RAM Results

- Plots, Green Text for objects
- **Time Value From RAM** – available

Plotting Results and Result Storage

- Bringing data into "RAM" is not necessary for creating plots
- When you choose to create plots as will be discussed shortly the following hierarchy is followed for each *plot series*
  - Result stored in RAM are used first
  - If RAM not available, results stored to Hard Drive are used
  - Finally, if still no results, nothing is plotted.
- Thus one chart, could contain information from RAM and from Hard Drive

Plotting Results and Result Storage

- Instructor – play around with plots to show results storage

Blank Page

Blank Page