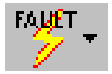
Fault Analysis

- Analysis of power system parameters resulting from a ground or line to line fault somewhere in the system
- Simulator contains a tool for analyzing faults in an automatic fashion
- Can perform single and three phase faults

Fault Analysis

- Fault types include:
  - Single line to ground
  - Line to line
  - Double line to ground
  - Three phase balanced
- 

The general fault analysis tool can be accessed in run mode by: **Tools** ribbon tab →**Fault Analysis**

Setting the Fault Location

- Information about the fault location can be filled in manually
- Alternatively, you can right-click on a bus or transmission line on the oneline diagram, and select Fault… from the menu to have the fault location fields automatically set
  - Selecting Fault… for a bus will set the bus number field
  - Selecting Fault… for a transmission line will set the from and to bus numbers, the circuit identifier, and the approximate line location as a percentage of the length of the line
  - Any of these fields can still be changed manually

Select Type of Fault

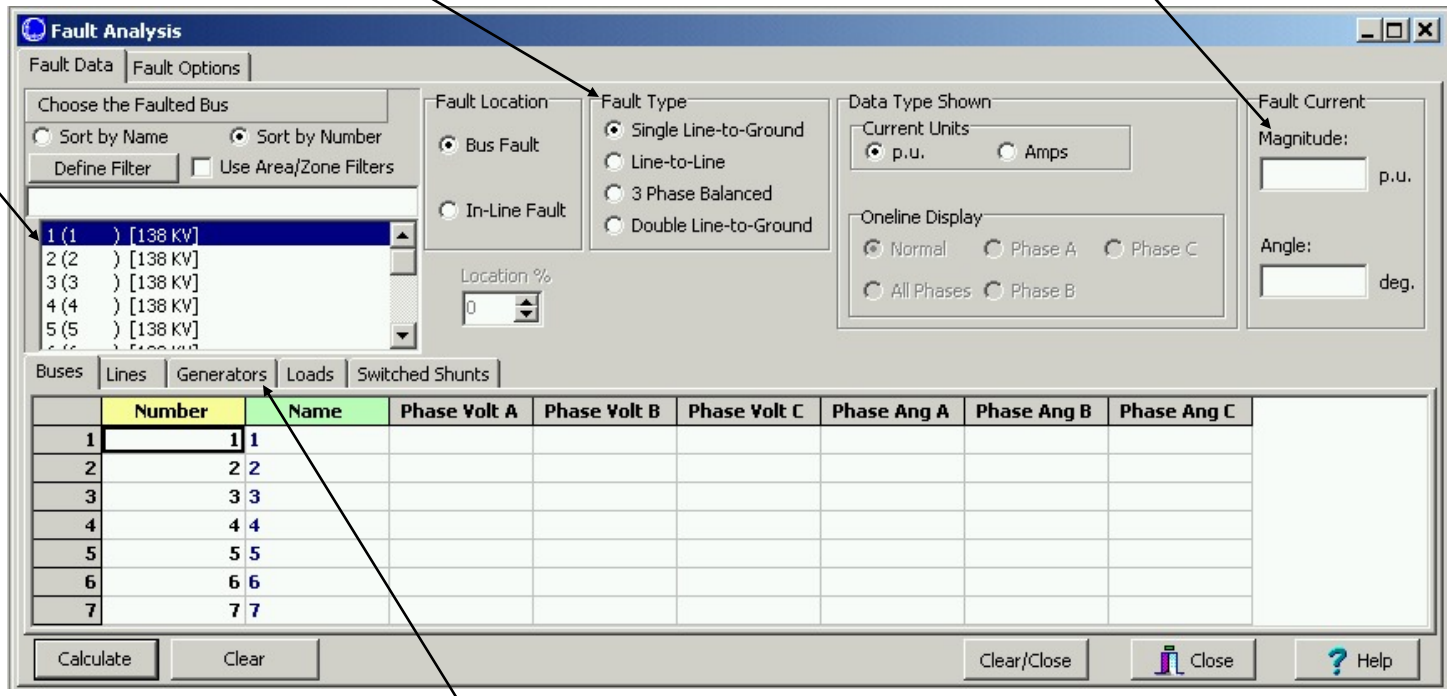
- Determines which calculations to perform
  - Line to ground: assumes phase A to ground
  - Line to line: assumes phase B to phase C
  - Line to line to ground: assumes phase B to phase C to ground
  - Three phase balanced
- A non-zero impedance to ground can be defined on the options tab, default is 0 (except for line to line)

Fault Dialog: Data

Set type of fault

Current through the fault

Devices listed here depend on bus or in-line fault



Results of analysis are displayed in the grids on these five pages

Sequence Data for Fault Analysis

- By default, sequence data for fault analysis is not stored with load flow data
- Sequence data can be loaded from the Options page
  - PowerWorld Auxiliary file (*.aux)
  - PTI Sequence Data file (*.seq)
- Sequence data can similarly be saved to the same types of external files; however, Simulator will store sequence data with the load flow case (*.pwb) if you save the case after loading the sequence data

Sequence Data for Fault Analysis

- Sequence data is required for various devices:
  - Generators
    - Internal sequence impedances
    - Neutral to ground impedance
  - Transmission Lines
    - Zero sequence impedance
    - Zero sequence line shunt admittance

Sequence Data for Fault Analysis

- Transformers
  - Zero sequence impedance and line shunt admittance
  - Phase shifts, entered as Phase in the load flow data
  - Transformer grounding configuration, as a combination of Wye, Grounded Wye, and Delta connections
- Loads
  - Negative and zero sequence load, as an admittance
  - Set on a bus-basis, with admittance given is total admittance for all loads at that bus

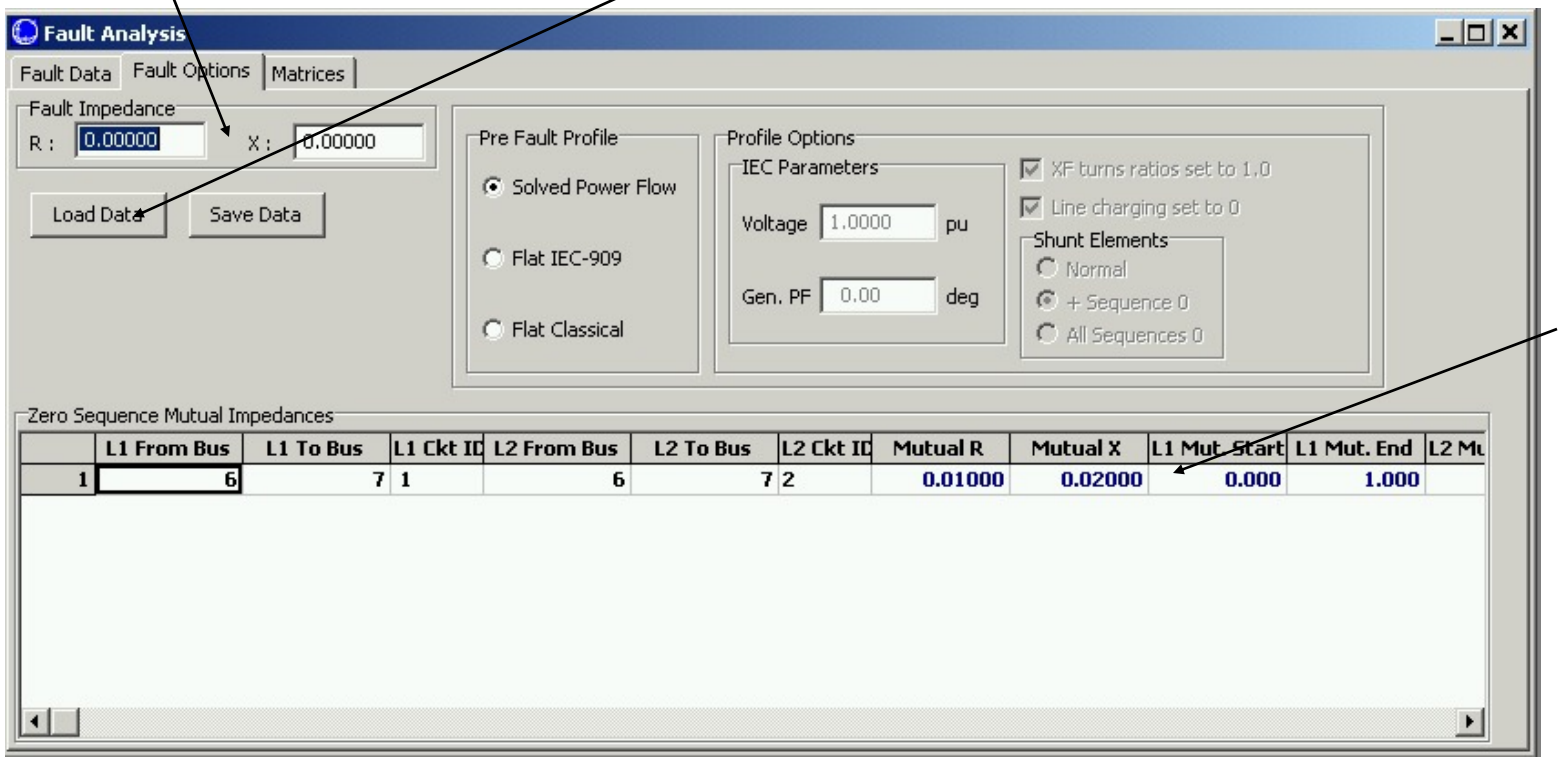
Sequence Data for Fault Analysis

- Transmission line mutual impedance
  - Zero sequence mutual impedance between part or all of two transmission lines
  - Displayed on Options tab
- Fault data for all devices (except mutual impedances) can be entered on the Information Dialogs

Fault Analysis: Options

Impedance to ground at the fault

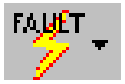
Load and save sequence data as a text file



Mutual impedance records

Fault Analysis Example

- Open B7FaultExample.pwb
  - No sequence data exists, so all fault analysis data fields are set to defaults



- Run the Fault Analysis tool from run mode by: **Tools** ribbon tab →**Fault Analysis**
- From the Fault Options tab, select Load Data
  - Confirm replacing sequence data
  - Load B7FaultExample.aux

Fault Analysis Example

- Switch to the Fault Data tab, and select fault bus number 3
- Leave as bus fault, single line to ground
- Click Calculate
  - The case will be solved first to make sure the analysis will be valid
  - The fault analysis calculation is a linearized calculation about the operating point

Fault Analysis Example

- Results are displayed on the five tab sheets on the Fault Data page
  - Per phase bus voltage magnitude (p.u.) and angle (deg.)
  - Per phase branch from and to bus current magnitude, with current direction at BOTH ends defined AWAY from the terminal bus
  - Per phase generator current magnitude and angle (deg.), with current direction defined OUT of the generator
  - Per phase load and switched shunt magnitude, with current direction defined AWAY from the terminal bus

Fault Analysis Visualization of Results

- Voltages and currents calculated during Fault Analysis can be visualized on a oneline diagram
  - In the Data Type Shown on Oneline box, select a single phase or all phases
  - When Data Type Shown is changed to phase or phases, Simulator searches for and replaces the following types of text fields on the oneline diagram:

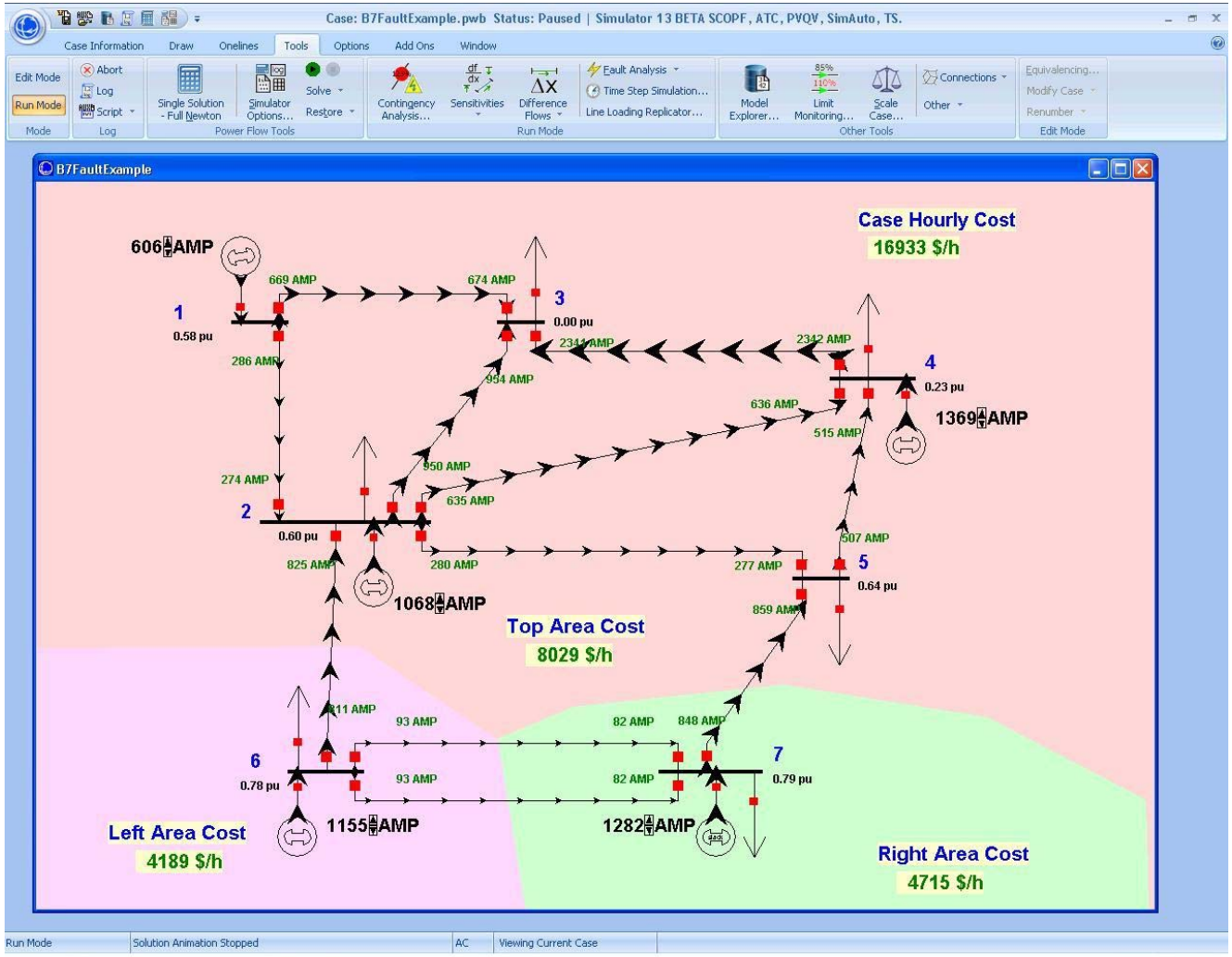
Fault Analysis Visualization of Results

- Bus voltage fields replaced with phase voltage magnitude(s) in p.u.
- Bus angle fields replaced with phase voltage angle(s) in degrees
- Branch MW or Amp fields replaced with phase current magnitude(s) in Amps or p.u., as specified
- Branch MVAR fields replaced with phase current angle(s) in degrees
- Generator MW fields replaced with phase current magnitude(s) in Amps or p.u., as specified
- Generator MVAR fields replaced with phase current angle(s) in degrees

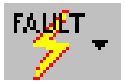
Fault Analysis Visualization of Results

Only fields switched to fault analysis results will remain on oneline

Currents shown are magnitude only; would need to include angles to determine direction



Fault Analysis Visualization of Results



- The phase of the fault data displayed on the diagram can be quickly toggled to a different phase by clicking on the drop-down arrow on the Fault Analysis toolbar button and choosing a new visualization setting

In-Line Faults

- Calculated based on a location given as a percentage distance from the From end of the line
- Inserts a temporary bus and line segments representing the fault point of the line; reflected on the oneline diagram
- Calculations performed the same as a bus fault at the temporary bus

Fault Analysis: Final Notes

- The fault analysis form can be closed while a fault is calculated without clearing the fault; the values will remain in memory until manually cleared or the case is saved or closed
- A Double Line fault automatically uses a Fault Impedance of 999+j999 and ignores the Fault Impedance settings; use a Double Line to Ground fault to specify a desired Fault Impedance

Fault Analysis: Final Notes

- Before visualizing fault analysis currents in p.u., you may need to first change the number of decimal places for the branch and generator MW and MVAR fields
- Once Sequence Data is loaded from an external file, saving the case file will store the sequence data with the *.pwb as well