Fault Analysis

Introduction (1)

- **Several modules as follows are available in PSSE for fault-level study.**
  - **SCMU**
    - ✓ **Gives a detailed fault analysis result.**
    - ✓ **Gives contribution to fault current at the faulted bus from all the network elements connected to that bus.**
  - **ASCC**
    - ✓ **Uses a simplified model**
    - ✓ **Uses FLAT (to specify zero-sequence and –ve sequence models)**
    - ✓ **With ASCC, it is possible to visualise not only effect on the faulted bus, but also on other buses of the system**
    - ✓ **The results of ASCC can be shown on a SLD (Slider) file**

Introduction (2)

- **IEC 60909**
  - ✓ **Most widely used method, although it tends to give a higher fault level value.**
  - ✓ **Uses IEC 60909 standard to derive an equivalent network model i.e. and equivalent impedance. Main parameters used are**
    - **a) Short-circuit ratio i.e. SCR (X/R) ,**
    - **b) Nominal Power,**
    - **c) Z source**
  - ✓ **2 options are available:**
    - **a) Maximum Short Circuit calculation: estimate CB rating**
    - **b) Minimum Short Circuit calculation: minimum possible fault current**

Basics of Sequence parameters (1)

- In general, there would be 6 basic fault networks for all 10 types of Short-circuit faults

- The method of Symmetrical Components as developed by Charles Fortescue are used for simplified calculations.

- Only Positive Sequence network has a driving source and it will appear for all types of faults.

- The positive sequence impedance of network elements is same as that entered for Load-flow studies.

- Zero sequence network appears for faults involving ground (G) viz. LG / LLG / LLLG faults.

Basics of Sequence parameters (2)

- **Negative sequence network appears for Unbalanced faults viz. all faults other than 3-phase faults**
- **L-G fault => All 3 sequence networks are in Series, and fault impedance is multiplied by 3**
- **LL fault => Positive and Negative sequence networks come in parallel**
- **LL-G fault => All 3 networks come in parallel**
- **3-phase fault => Only +ve sequence network connected upon itself at Neutral by Fault impedance**

System Modeling (1)

- System modeling
  - Resistances & reactance, including all shunts and line charging in the three sequences
  - Ratios and phase shift angles of transformers
  - Loads converted to equivalent shunt admittances
- Input data
  - Generator sequence data
  - Load sequence data
  - Transformer sequence data
  - Zero sequence non transformer
  - Branch data

System Modeling (2)

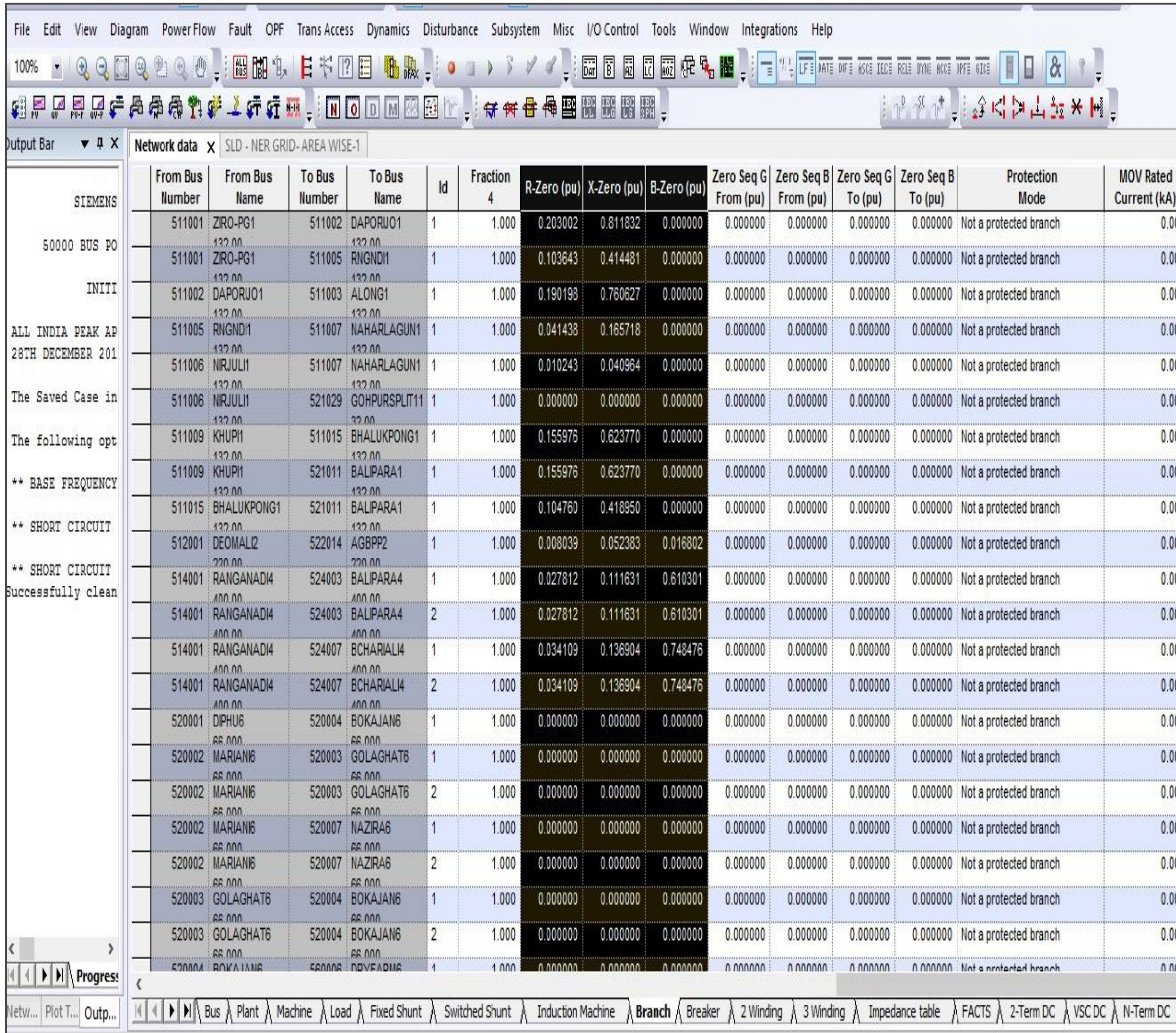
- **Load sequence data**
  - **Negative sequence data is supplied only where load is different than positive sequence.**
  - **If not supplied negative sequence load is assumed to equal the positive sequence value.**
  - **All positive sequence loads (from power flow case) are automatically converted to constant shunt admittance values.**
  - **Where no zero sequence load record is specified, PSS®E assumes no shunt load component (open circuit in zero sequence).**

Assumptions in modeling of negative and zero sequence networks

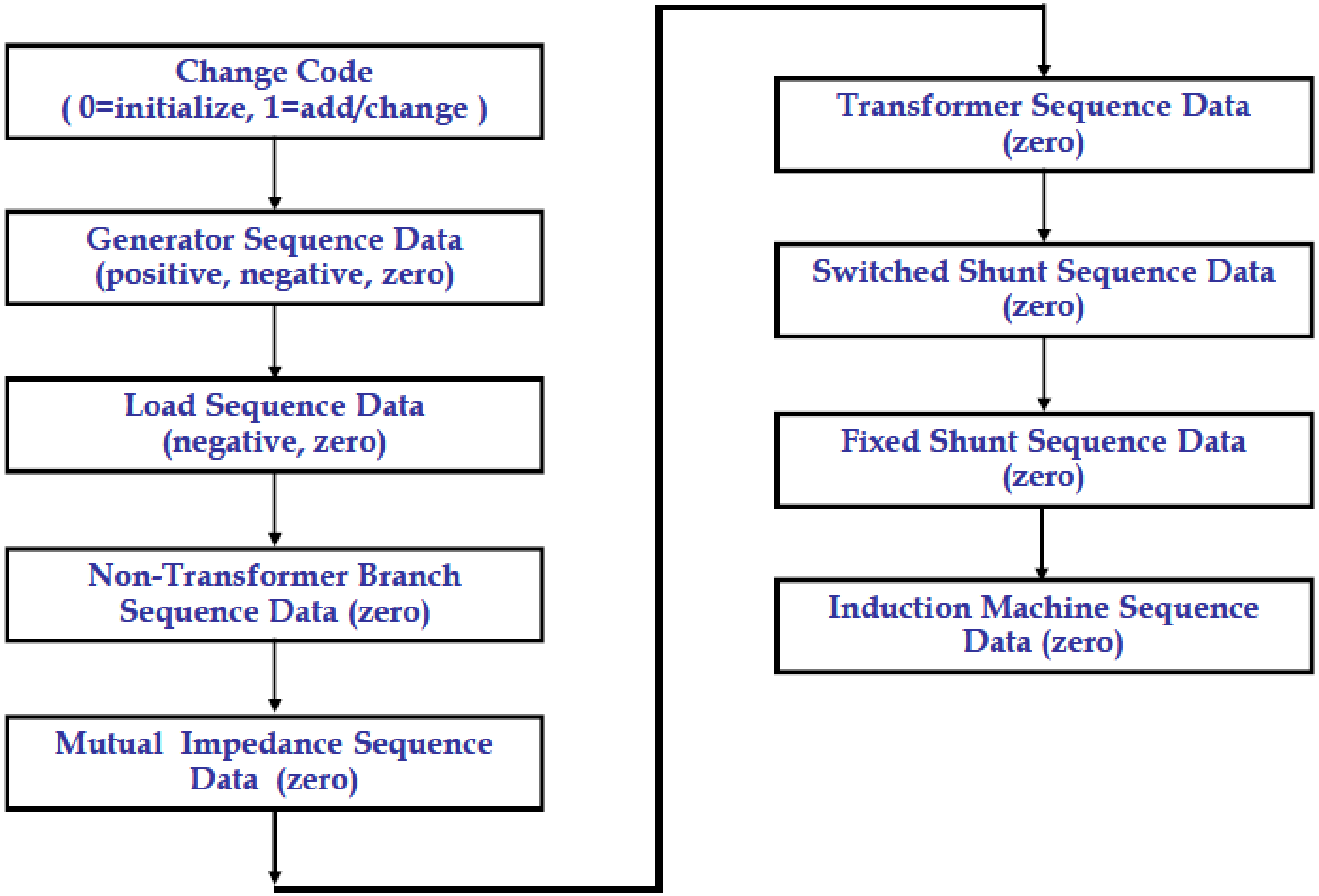
- **All branches (lines & transformers) have the same impedance, charging and line shunts in the negative sequence as in the positive.**
- **All transformers have phase shift in the negative sequence equal and opposite to that in the positive sequence.**
- **All zero sequence branches and shunts are assumed to have infinite impedance, unless a different value is entered specifically.**
- **All loads are represented by the same shunt admittance in the negative sequence as in the positive, unless a different value is entered for negative sequence specifically.**
- **Loads are open circuits in the zero sequence unless represented specifically by entry of a value for zero sequence shunt admittance.**
- **User appends negative and zero sequence data to the Power Flow Model. Data is saved and retrieved with SAVE and CASE.**
- **DC and FACTS devices are assumed either as a load or blocked. The default option is blocked, and thus they are ignored.**

Preparation of Base case

- To perform all types of fault analysis, it is necessary to *insert values of Zero sequence impedances (as per Highlighted portion in figure)*



Fault Analysis Modeling



Automatic Sequencing Fault Analysis (ASCC)

Fault Options:

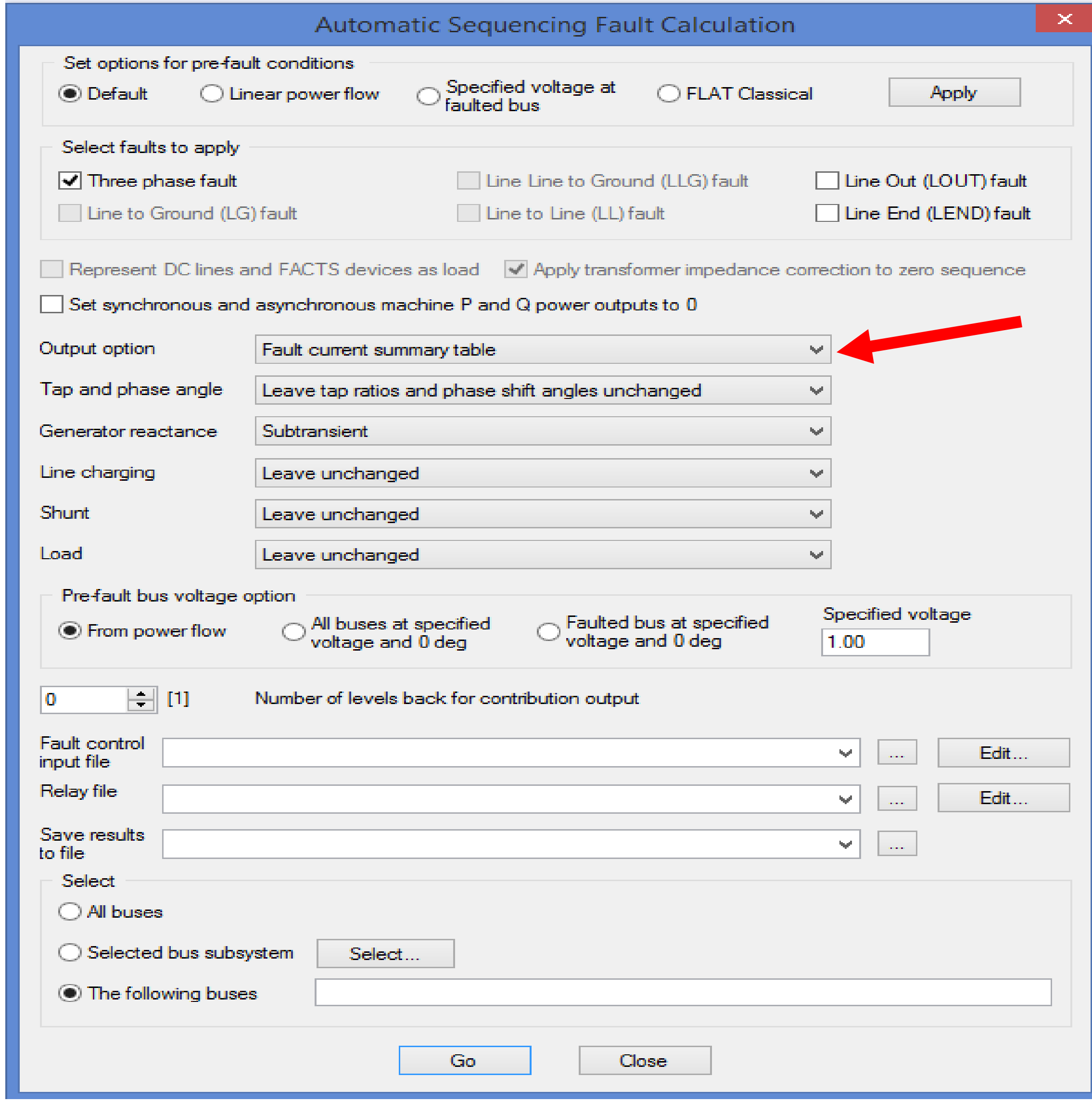
- ✓ **Fault types: 3Ph, SLG, LLG, L-L, line out, line end.**
- ✓ **Fault calculations with each branch connected to "faulted" bus in turn removed from service**
- ✓ **Fault calculations with far end of each branch connected to "faulted" bus in turn opened, and fault applied at line end location**

Output Options:

- ✓ **Outputs momentary symmetrical RMS fault current and branch current contributions up to N levels away from "faulted" bus**
- ✓ **Selection of Output File containing summary of calculation for each fault.**

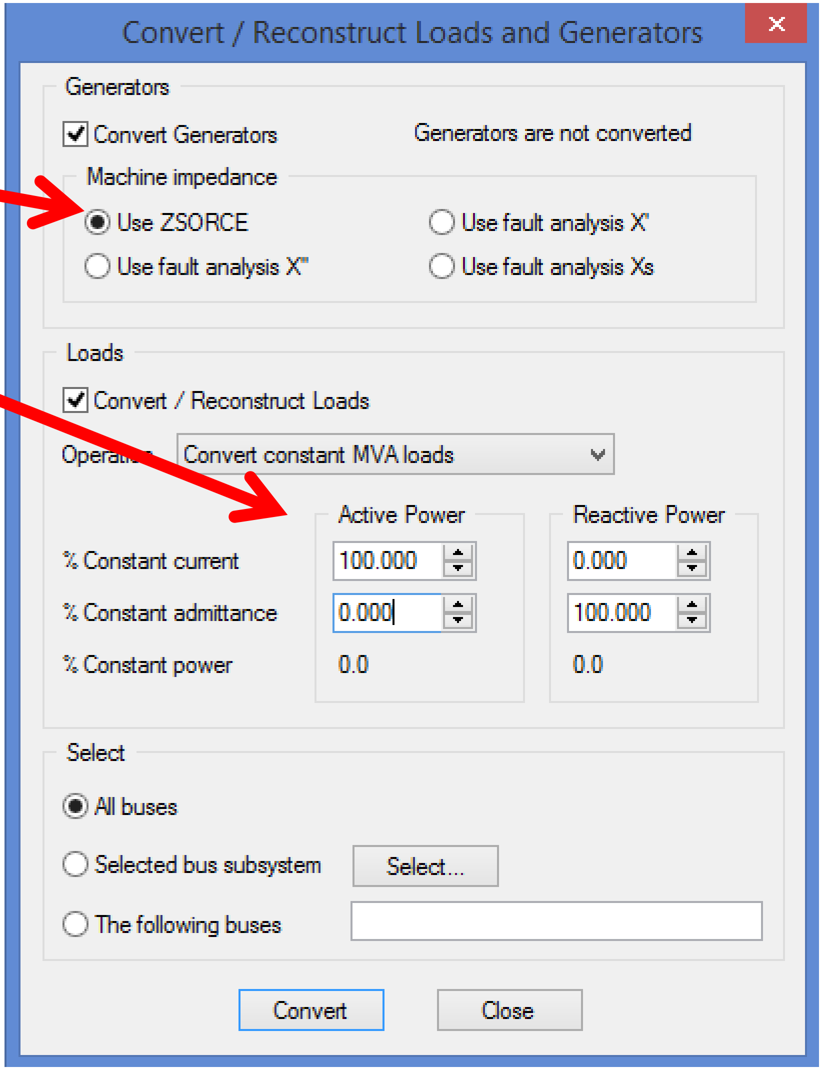
Automatic Sequencing Fault Analysis (ASCC)

- **Fault current calculation carried out for:**
  - **All system buses**
  - **All buses of a selected bus subsystem**
  - **Individually selected buses**



Balanced Switching Calculation (1)

- **Steps to follow:**
  - ✓ Generator Conversion
  - ✓ Load Conversion
  - ✓ Solve pre-switching network
  - ✓ Apply a fault
  - ✓ Solve post-switching network
  - ✓ View results



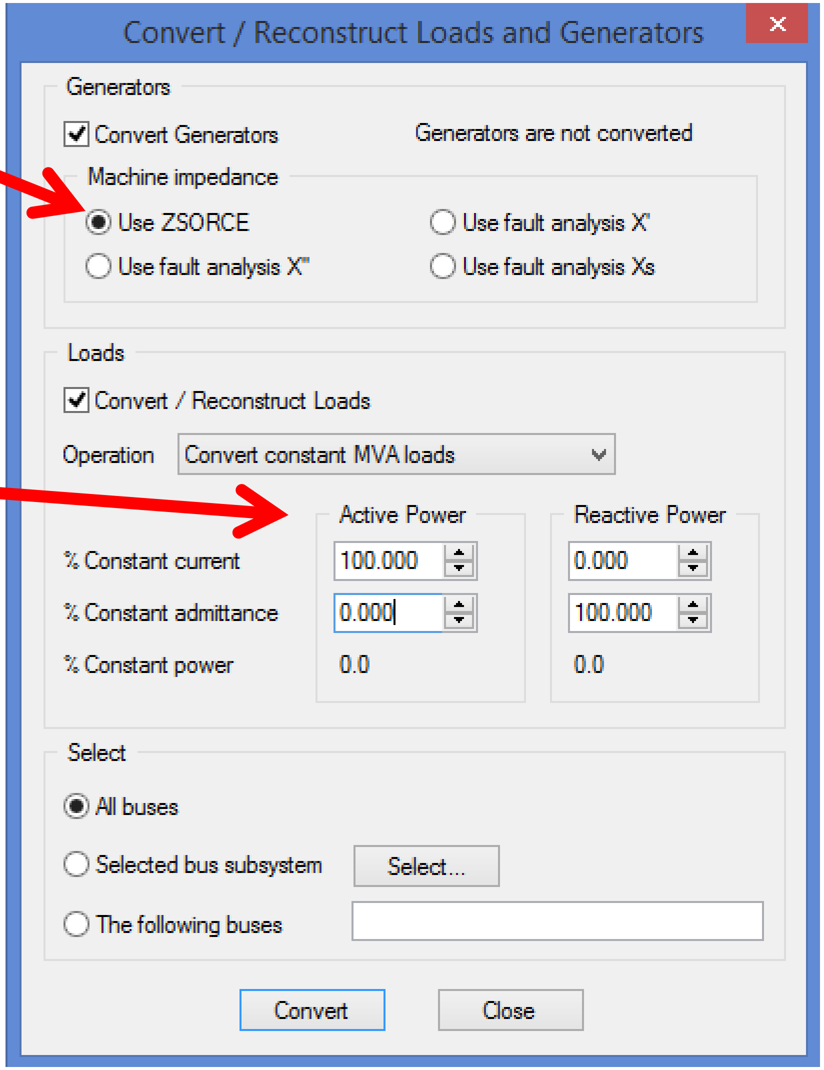
Balanced Switching Calculation (2)

- ✓ **Generator Conversion**

  Convert generators using ZSORCE machine impedance

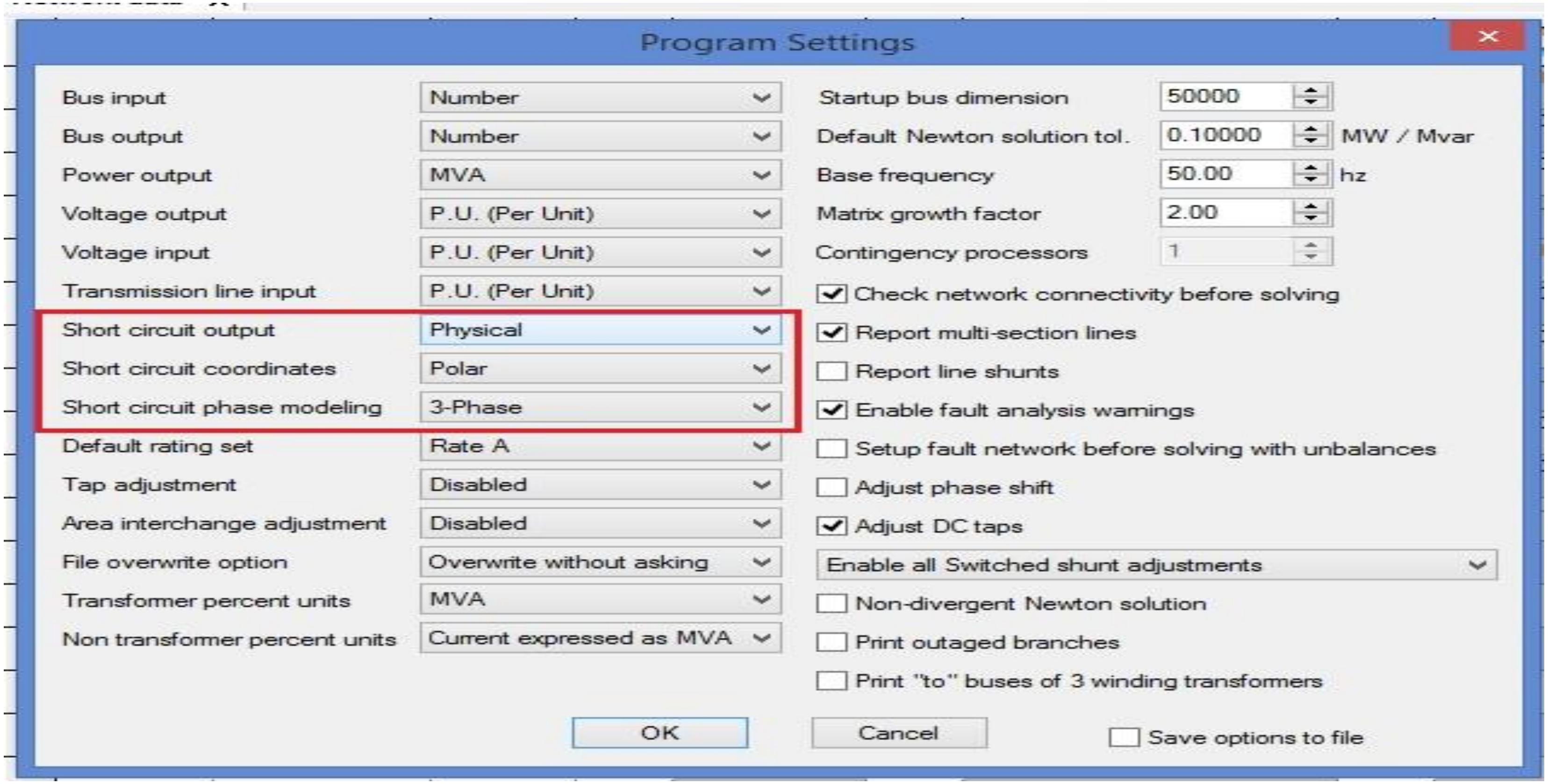
- ✓ **Load Conversion**

  Convert loads using 100% constant current active power and 100% constant admittance reactive power

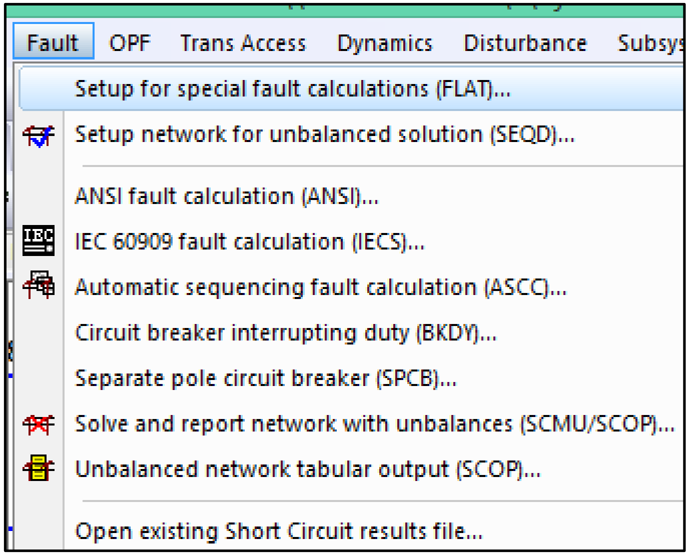


Changes in Program Options

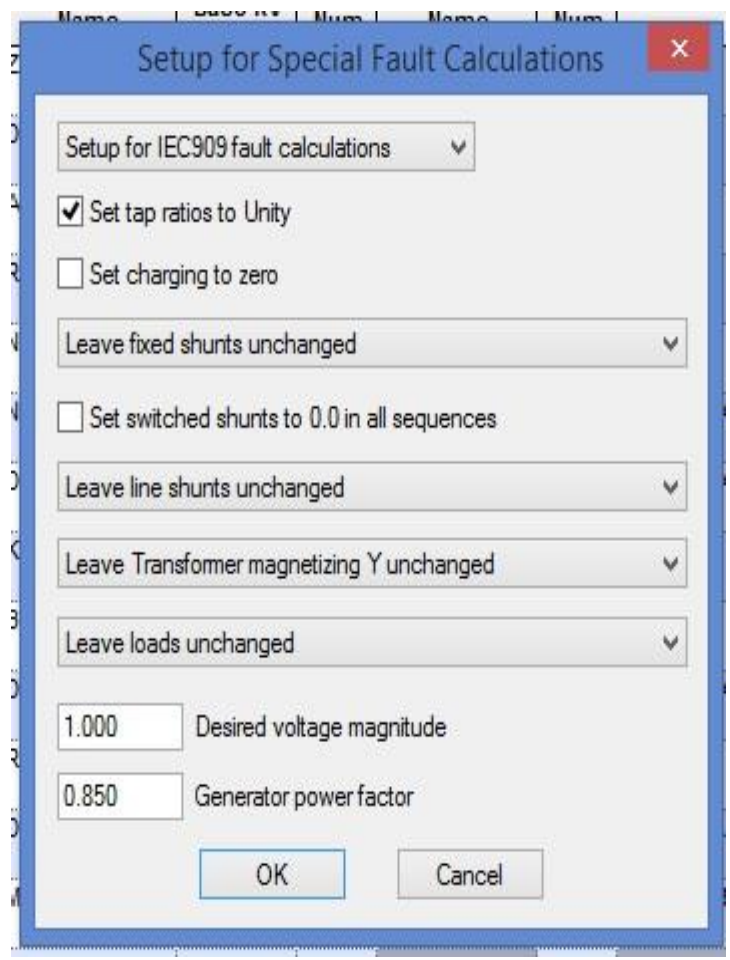
- Go to => Misc > Program Options > Change
  a) 'Short Circuit Output' to Physical and
  b) 'Short Circuit Co-ordinates' to Polar



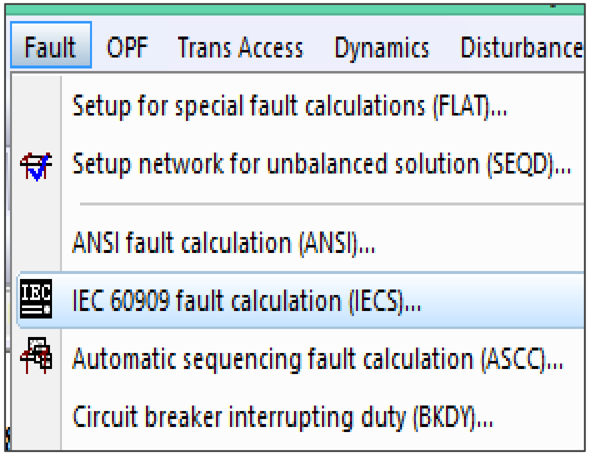
IEC 60909 Fault Calculation (1)

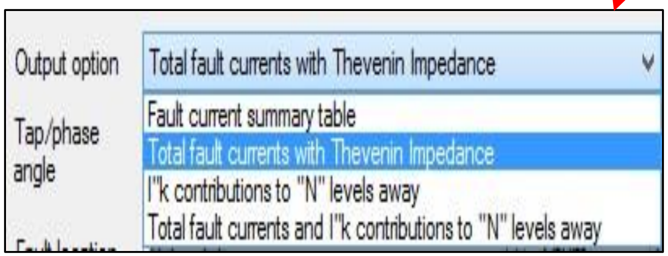


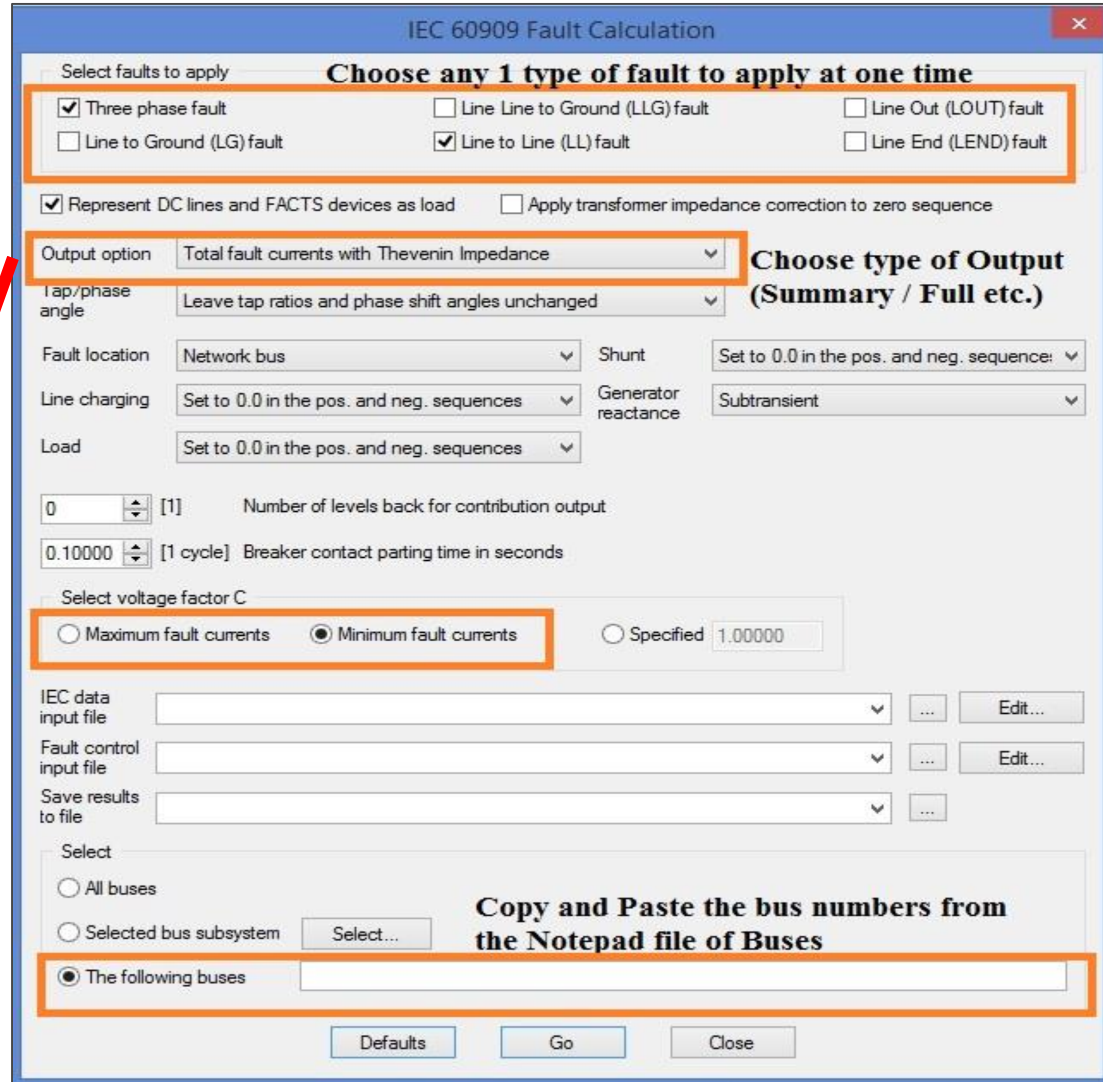
- Leave voltage magnitude at present value or set all at specified magnitude and set all phase angles at zero.



IEC 60909 Fault Calculation (2)

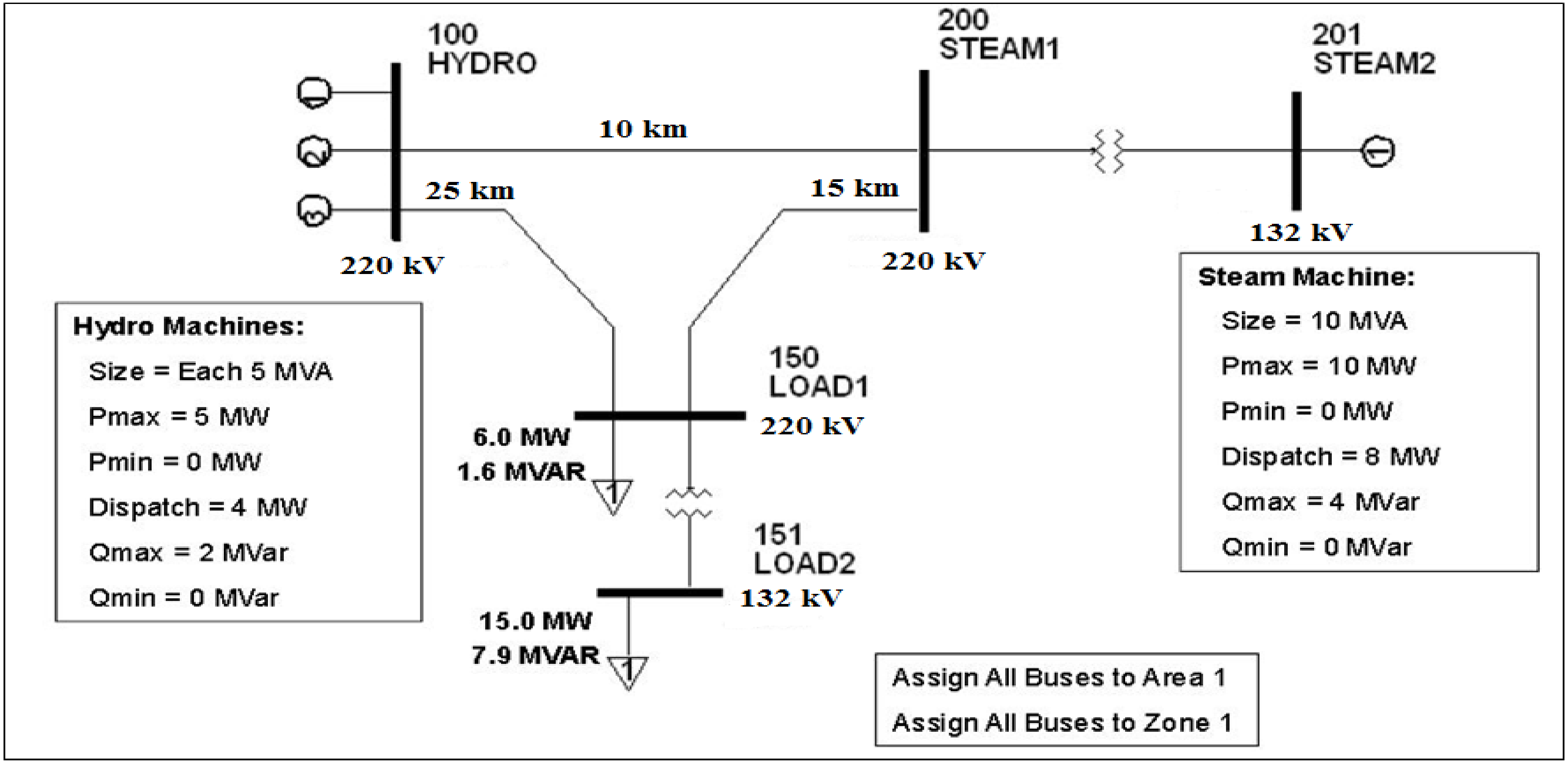






- To see the fault contributions from Individual feeders at the Faulted Bus, choose the appropriate option (*Option 3 or Option 4*).

Exercise



Zero sequence data for Branches:

R_0 = 0.0004545 per unit / km / circuit

X_0 = 0.002767 per unit / km / circuit

B_0 = 0.0008906 per unit / km / circuit

Exercise

1. Calculate the fault level of all bus.

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