

**SIEMENS POWER SYSTEM SIMULATION FOR
ENGINEERS® (PSS/E)**

**LAB2
INTRODUCTION TO SLIDER BINARY (*.sld)
FILES**

**Power Systems Simulations
Colorado State University**

PURPOSE: The purpose of this lab is to introduce the one-line diagram, also known as the Slider files in PSS/E. This lab will introduce the following aspects:

- **Introduction to a one-line diagram and its elements.**
- **Explanation of the Slider (*.SLD) file**
- **Using the Slider file to create a one-line diagram**

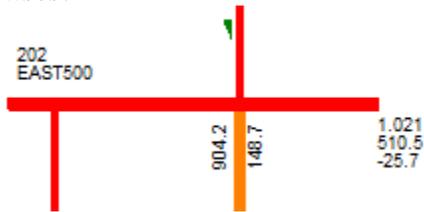
To properly perform this lab, start PSS/E and open the *sample.sav* file as we have done in LAB1.

Introduction to One-Line Diagrams

A one-line diagram is a simplified graphical representation of a three phase power system, used extensively in the electrical utility industry. In power engineering, if we assume that the three phases of a system are balanced, the 3 phase system can be represent with a single line (I.E. one line diagram) which simplifies schematics. This makes the evaluation of the system much less complicated without losing any information. Per unit voltage used extensively in one-line diagrams to further simplify the process.

The main components of a one-line (or single line) diagram are; Buses, Branches, Loads, Machines, 2 Winding Transformers, Switched Shunts, Reactor and Capacitor Banks. An explanation of these components will be given later in this lab.

Buses:



Buses are represented as a dot, circle or a thick line. The bus name (EAST500) and number (202) are given, as well as the voltage measured on the line (510.5kV and 1.021V in per unit). The final characteristic given is the angle (-26.1 degrees). The voltage is indicated by the color of the bus. In this example, red indicates 500kV. Associating KV levels with *color is a user configurable option.

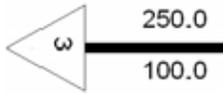
Branches:



Branches are represented as a line connecting busses. The real power P, as shown in the above image of a branch, flows from 431.5MW to -429.8MW and the reactive power Q, flows from 158.7MVA flow to -238.8MVA. Notice when selecting the animation icon, MW and MVar are shown as green and yellow arrows respectively.

In other words, the flows are from the positive number to the negative number shown below, and the number on top is the real power while the number on the bottom is the reactive power. The voltage is indicated by the color of the branch. In this example, red indicates 500kV.

Loads:



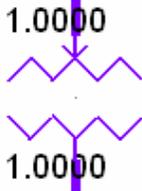
Loads are represented as a triangle with the ID number located inside the triangle. The real power, PLOAD, is denoted by the number on top (250MW), and the reactive power, QLOAD, is denoted by the number on bottom (100Mvar). The voltage is indicated by the color of the load. In this example, black indicates 230kV.

Machines:



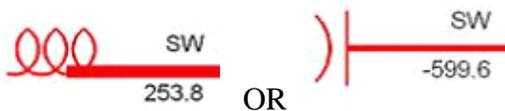
Machines are represented as a circle with the ID number located inside the circle. The real power, PGEN, is denoted by the number on top (321.0MW), and the reactive power, QGEN, is denoted by the number on bottom (142.3RMVAR). The “R” indicates this machine is in voltage regulation mode, and it is controlling a specific bus to a voltage set point which requires it to generate 142.3MVAR. The voltage is indicated by its color of the machine.

Two Winding Transformers:



Two winding transformers are represented as two separate windings with a gap separating them. The arrow pointing in at the connection reflects the primary side of the transformer. In this example, the primary voltage (1.0000 in per unit voltage) is given on the primary side of the transformer and the secondary voltage (1.0000 in per unit voltage), is given on the secondary side of the transformer. The voltage is indicated by the color of the transformer and is dictated by the primary side voltage. In this example, purple indicates 21.6kV

Switched Shunts:



Switched shunts are represented as either a capacitor or an inductor on a bus. The “SW” shown on top (or on the left if the shunt is shown vertical) indicates that this unit is a switched shunt compensator. If you see these symbols with a number in place of the “SW”, that particular device is a permanently installed reactor or capacitor bank (see below). The number on bottom (or on the right if the shunt is shown vertical) indicates the initial reactive charge admittance, BINIT (253.8MVAR or -599.6MVAR). The voltage is indicated by the color of the shunt. In this example, red indicates 500kV.

(*SAV). This way, a simple thin line represents all of the data located in the branch tab. All of this data is interconnected and linked so as to perform power flow analyses. Once a one-line diagram is created, it can be saved as a Slider (*.SLD) file. The Slider file can be amended and updated as necessary, as long as the amendments and updates correspond with the *.SAV file, since the two files are intertwined.

Another advantage of the Slider file is that one can view the power flow and the operating levels of a branch. This allows a Power Engineer to quickly see potential trouble spots in a power system and correct them before problems occur. The process of performing a power flow analysis is the main objective of these labs.

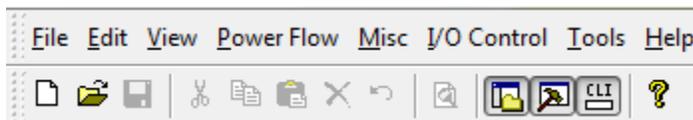
As mentioned above, in order to properly perform this lab, PSS/E needs to be running and the data file “sample.sav” opened. Refer back to Lab 1 if problems arise in doing this.

I. How to open the *.sld

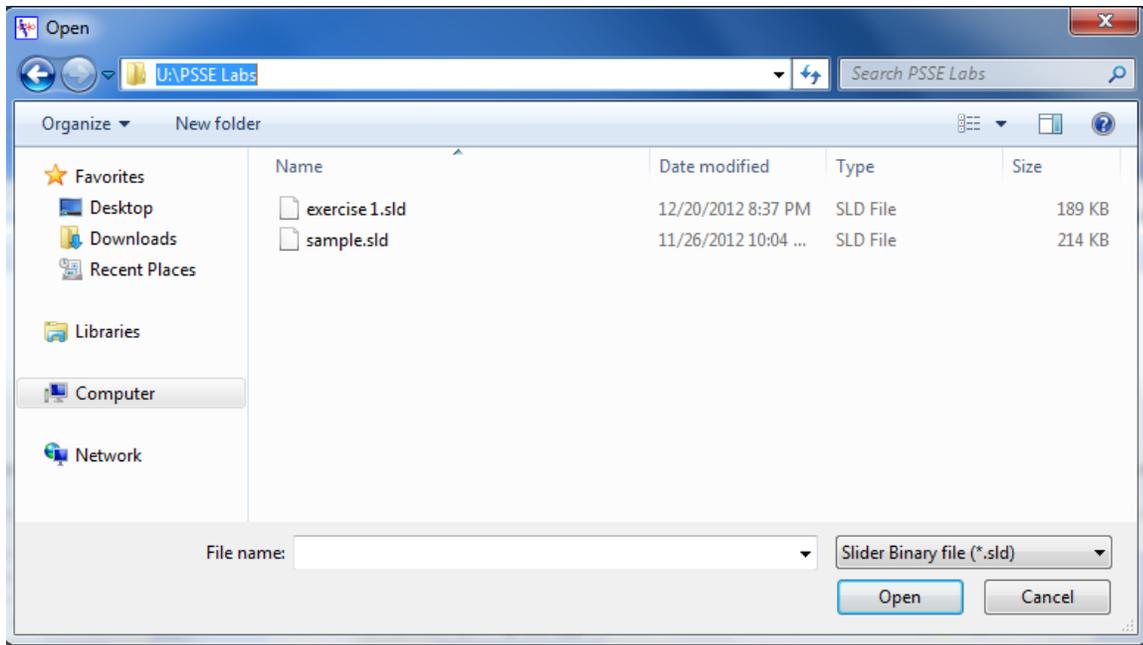
*.sld – Slider file (Single Line Diagram) This file allows for performing network analysis studies on the grid. Sliders are visual displays of the grid. It includes buses, branches, lines, loads, generators, transformers etc... All components should be color coded based on voltage level. The slider file can also show the operational ratings (power flowing across the component relative to the capacity) of the listed components.

Once the PSS®E program opened,

- a. Go to **second** toolbar. Click 



- b. The window will appear. Choose **Sample.sld** file. Make sure the description in the right box are **Slider Binary File (*.sld)**.



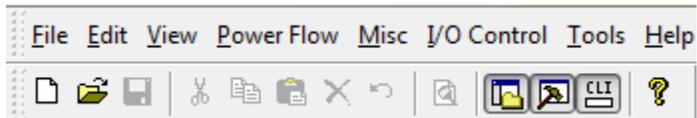
II. GROW Element

In this method, you learn how to create *.sld file based on any *.sav file available to you. The *.sld and *.sav files are interconnected *****Important***. Therefore any actions to the either file result change the other and to avoid that you need to learn how to use “**Bind items**”. Finally, you learn how to grow element on one-line diagram.

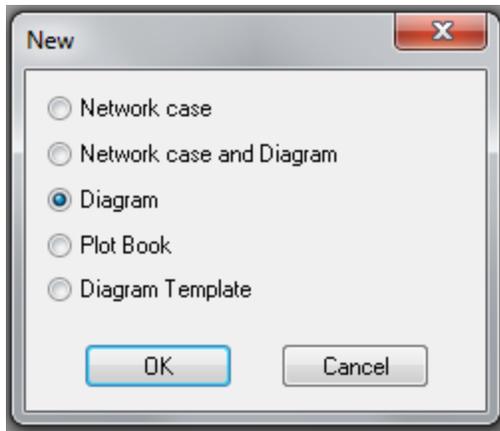
First: create new *.sld

a. open PSS®E (refer to part II)

b. Go to second toolbar. Click on 



c. The window will appear :



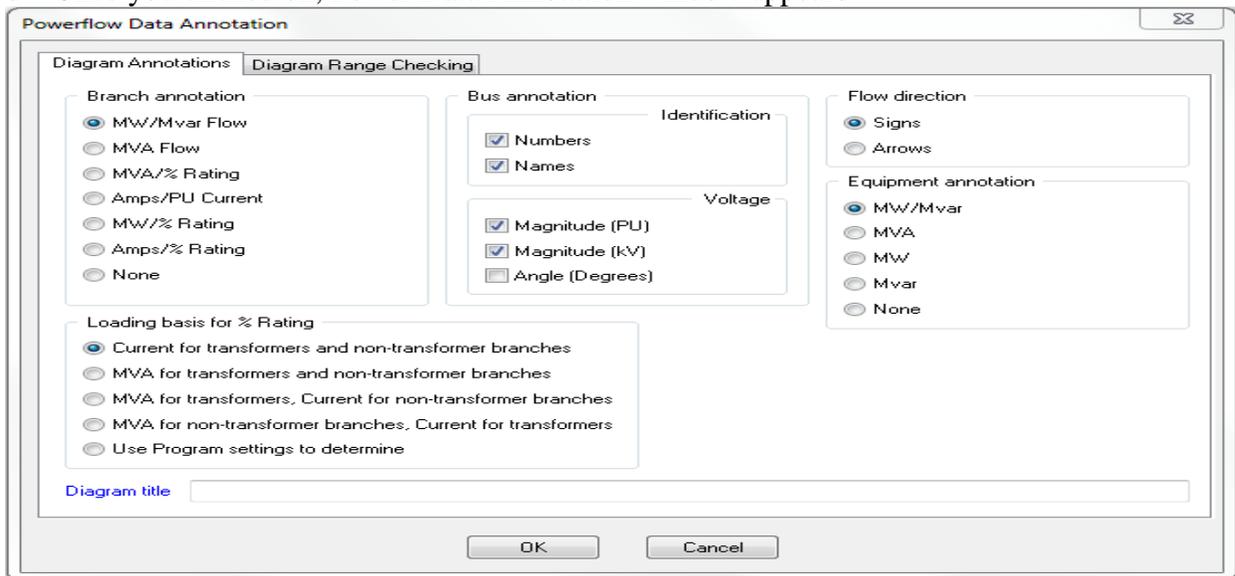
d. Keep Diagram selected. Click OK. A new Diagram created.

Second: Color code using Diagram Annotation.

a. Go to third Toolbar. Click on 

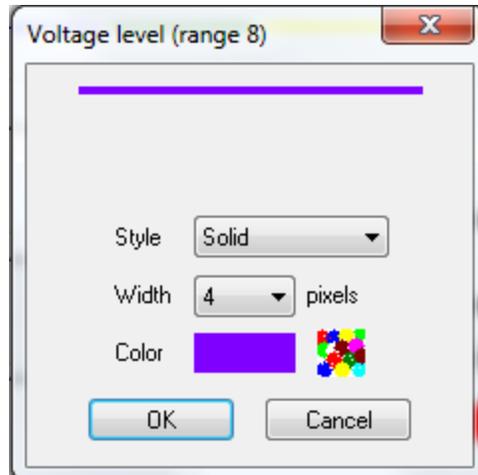


b. Once you clicked on, Power Data Annotation window appears



c. Go to Diagram Range Checking tab and Check Use voltage level thresholds to edit it with their corresponding colors. Set all values and colors to match the following standards by clicking on each color bar:

- Colors from the left to the right on the window:
Dark green - Black - Blue - Bright green - Yellow - Orange - Red – Purple

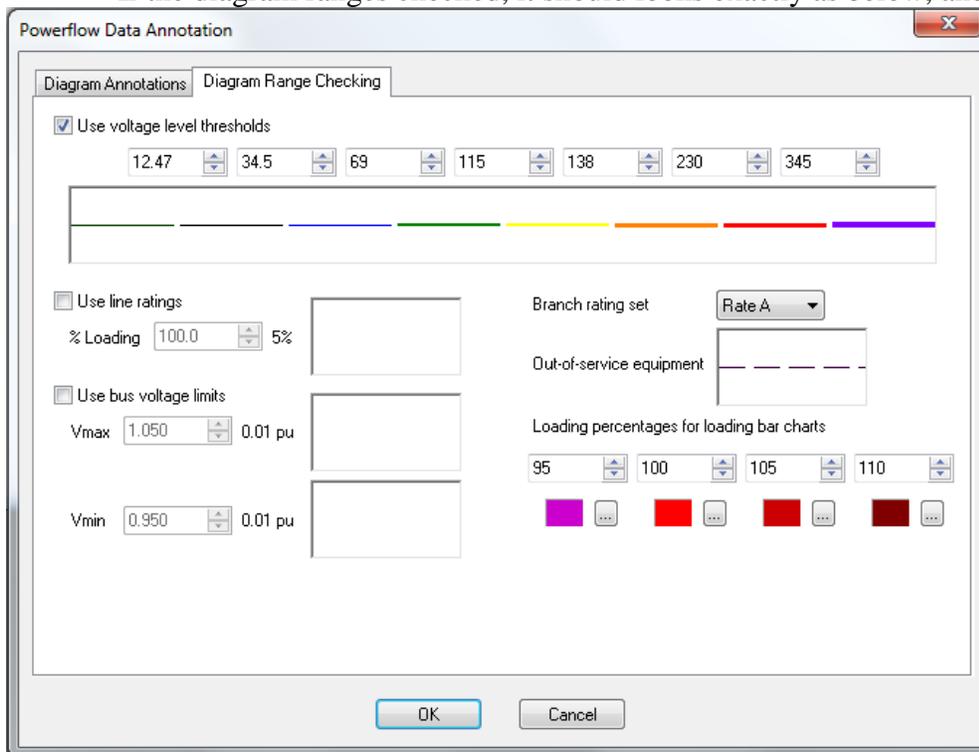


- Widths from left to right on the window:
1 - 1 - 1 - 2 - 2 - 3 - 3 - 4
- Now enter the threshold voltages as shown:

Use voltage level thresholds

12.47 34.5 69 115 138 230 345

** If the diagram ranges checked, it should look exactly as below, and then clicks OK.



Third: Display a bus within sample.sav file.

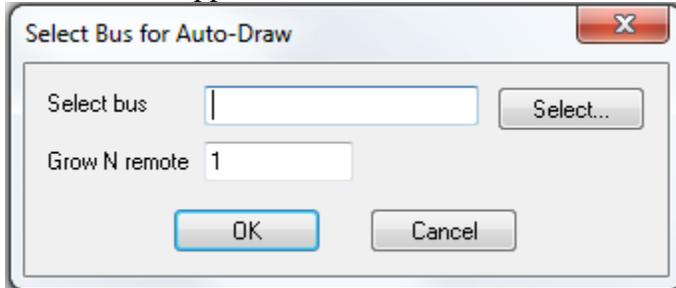
This step will display a bus into the blank diagram using Auto Selected Draw:

a. Open **sample.sav** file

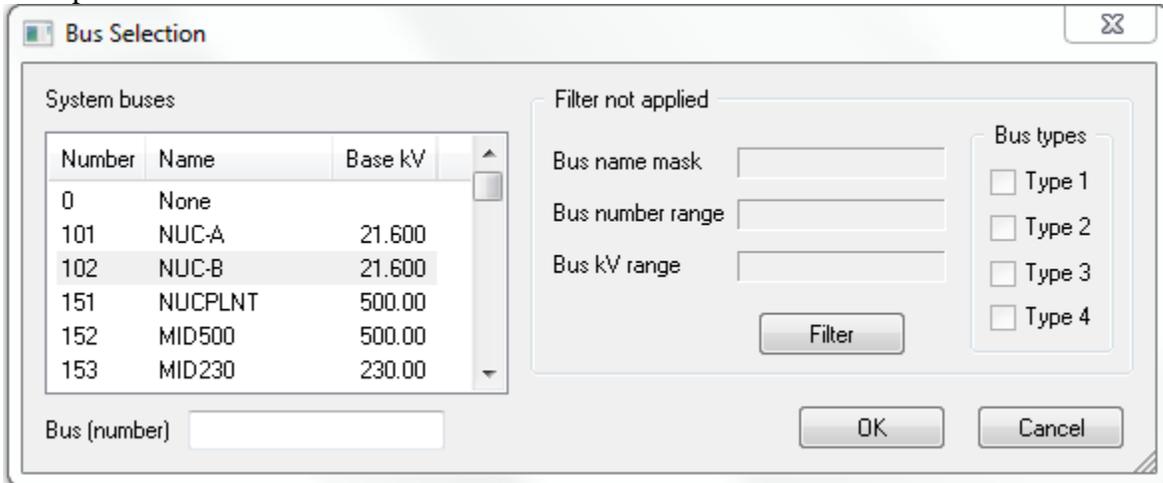
b. Return to blank diagram; go to third toolbar and Click on Auto Draw  and go back click on the blank.



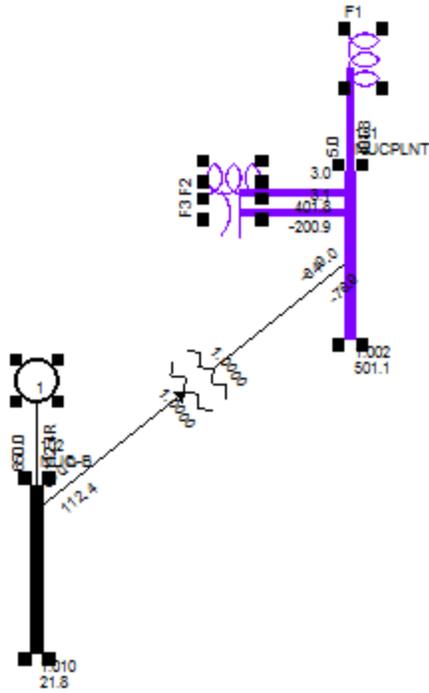
c. Auto-Draw appears:



d. Click on select and choose the desired bus number from the **sample.sav** file. In this practical example choose BUS 102. Then Click “OK”.



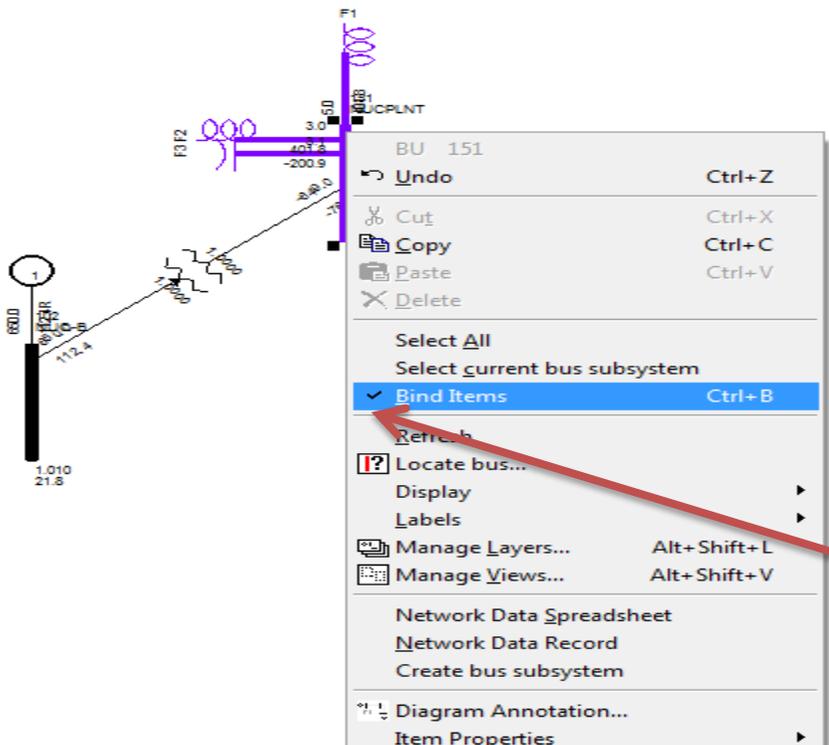
e. Click on Auto-Draw OK, then all elements connected to BUS 102 will displayed on the blank diagram.



f. Exit Auto-Draw by clicking Esc key.

Fourth: Un-Bind Items. *Important***

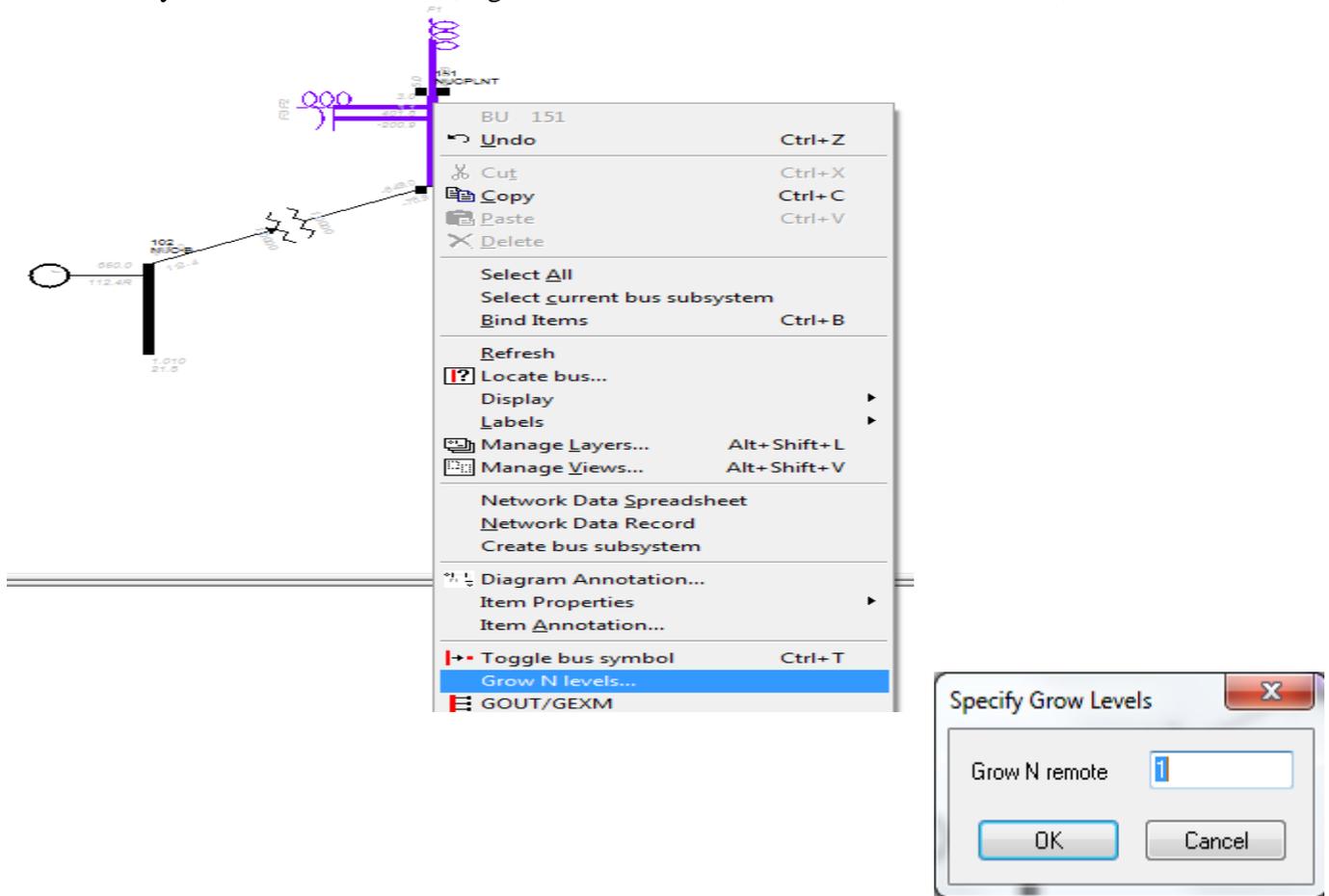
Because of the *.sav and *.sld are linked together (interconnected), any deleting of a bound item from a diagram removes it from the *.sav data file and will result in analysis corruption. This means that if a change is made to either files the other will be affected. This can be done by right click on a bus and **unselect** Bind Items or use Ctrl+B.



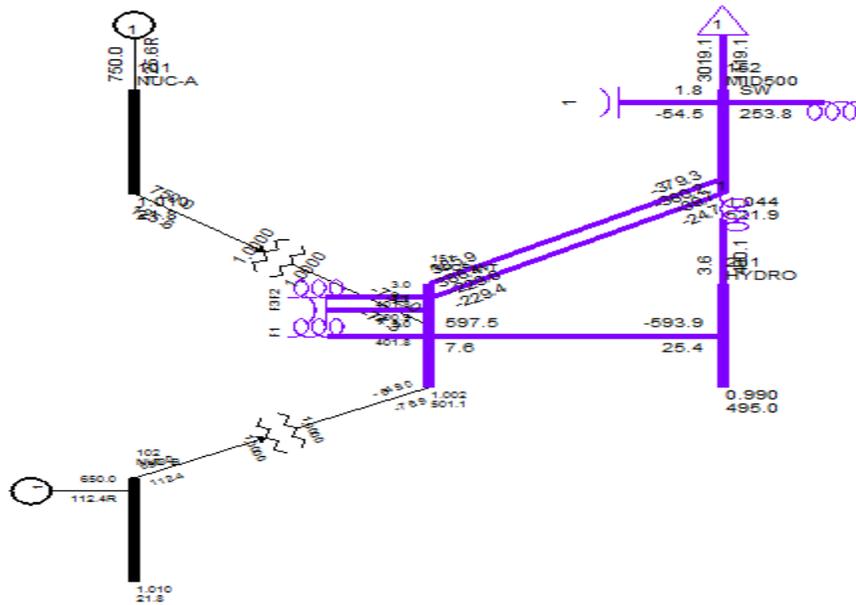
Note: Make sure there is no check mark!

Fifth: Grow N Level

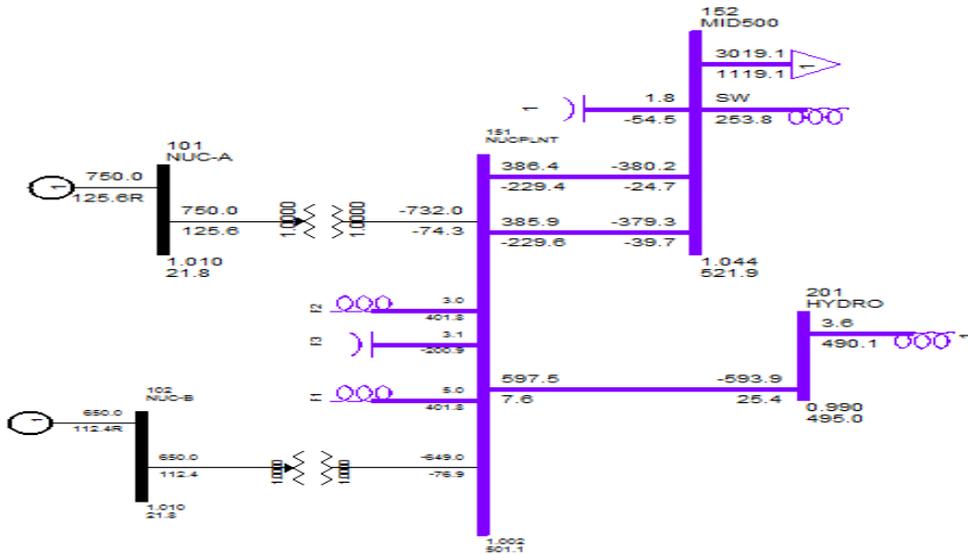
- a. Once you deselect Bind items, right click on a bus and choose Grow N Levels..., Choose 1



The BUS 102 will grow out 1 level:



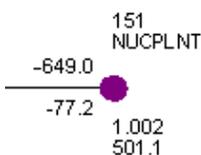
b. Rearrange the grid. Click on black space in the diagram and select an element and drag it to desired place to avoid overlapping in ratings or wires.



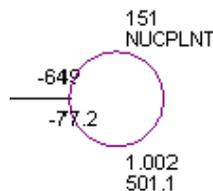
c. If needed, the toggle bus symbol feature can be applied to display buses as dots, circles, or lines. This is done by selecting a component by left clicking the component (the selected component will have a black square on each corner), and then right click the bus symbol and selecting Toggle bus symbol.

Different bus symbols shown below;

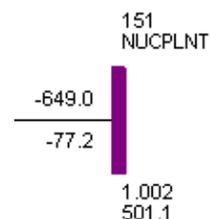
Dot:

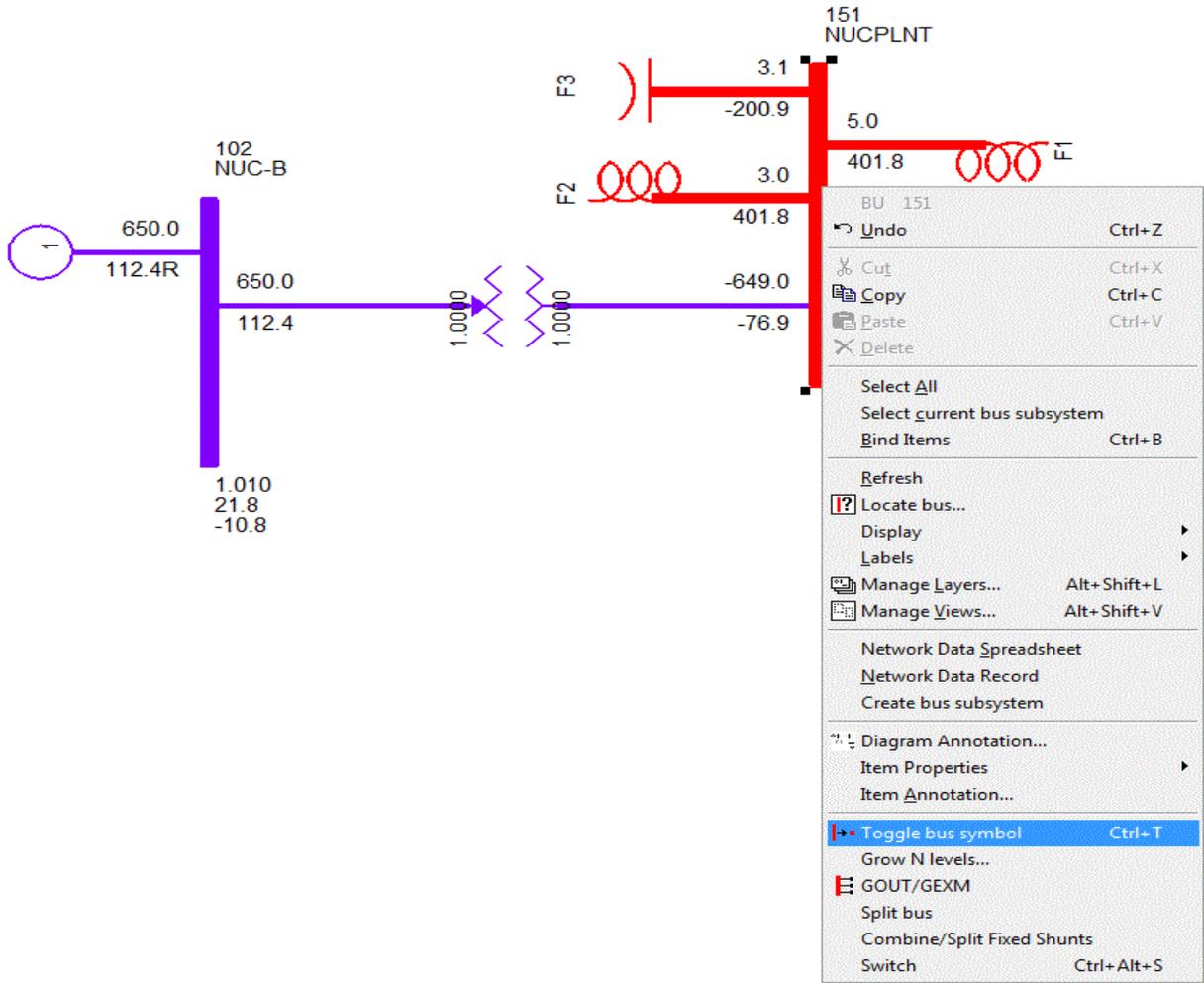


Circle:



Line:

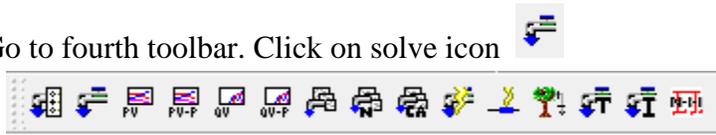




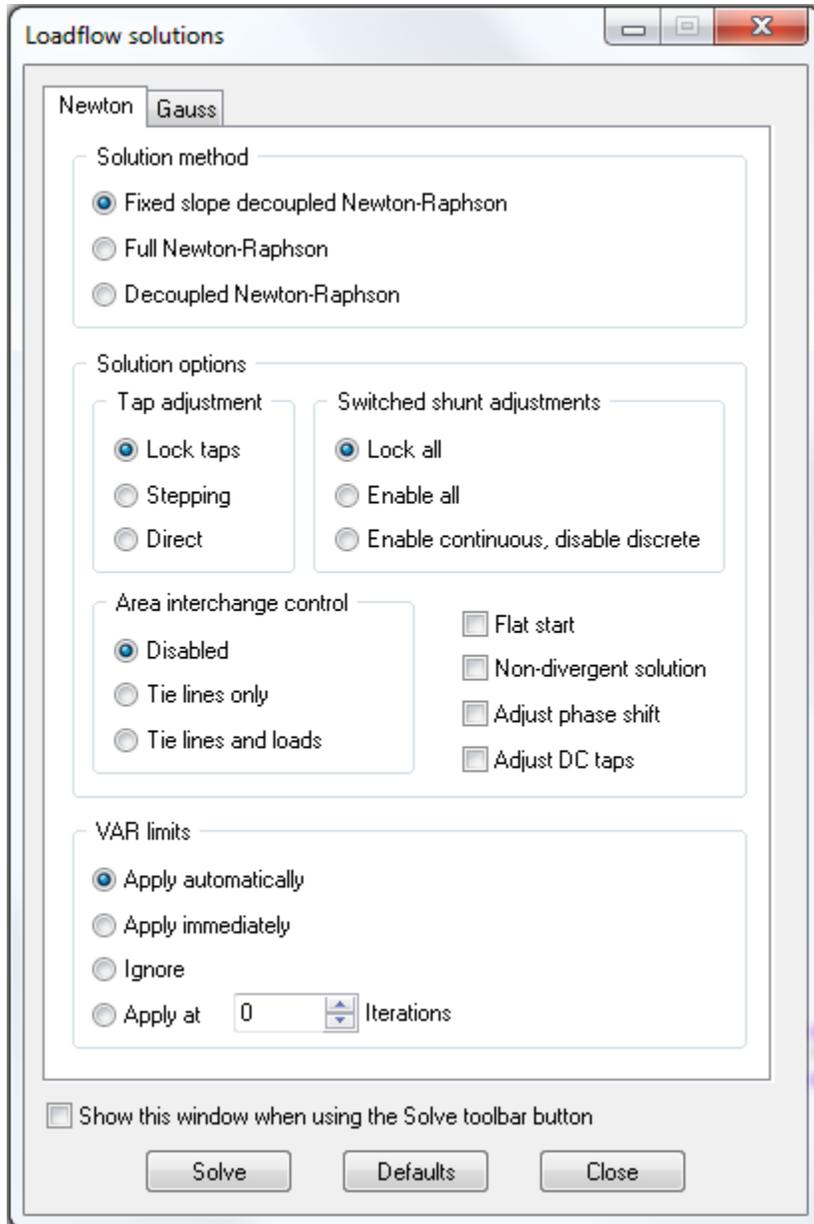
III. Solve a System

Solving a system allows PSS/E to make all the necessary calculations used in a power flow analysis.

Go to fourth toolbar. Click on solve icon



The following window will display:



Configure the Load flow solutions window to match the one displayed. This could include selecting the “Lock all” radio button under Switched shunt adjustments and uncheck “Adjust DC taps”.

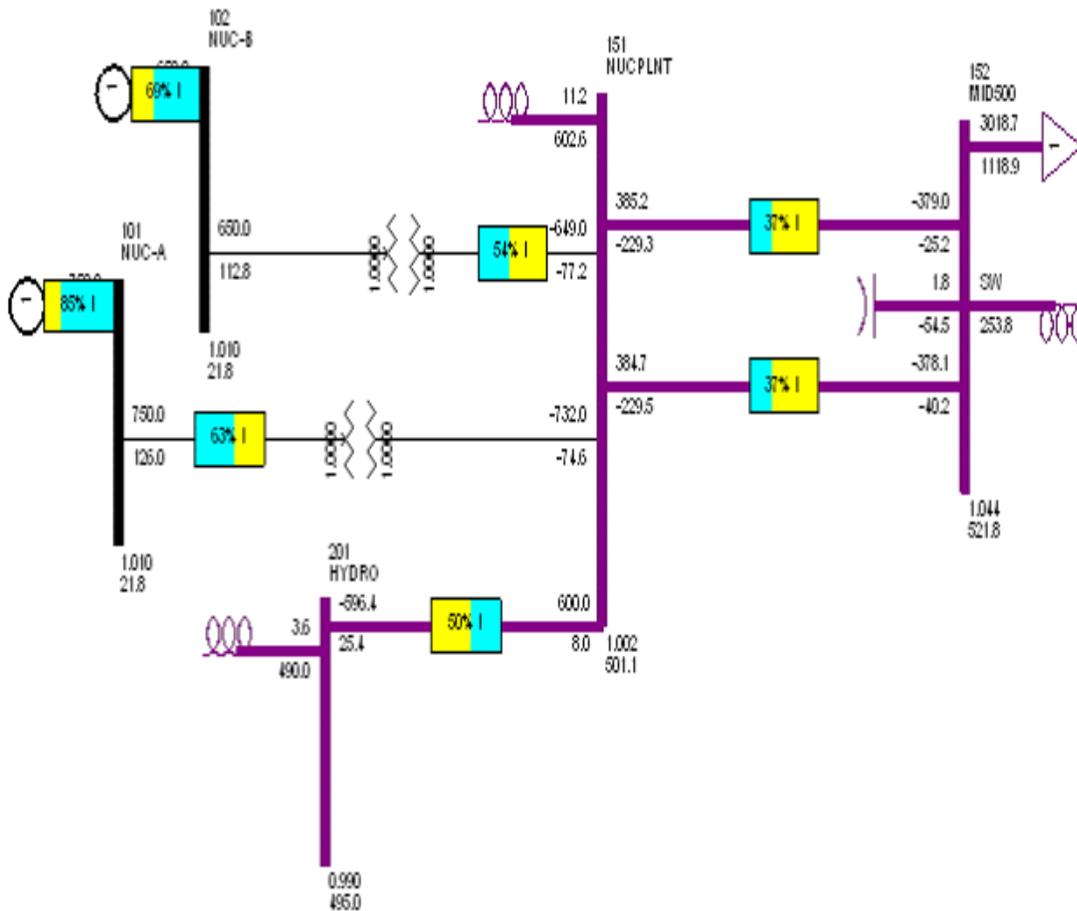
Click on button solve and PSS/E will solve the system and store the results in the progress window.

IV. The loading percentages

Go to third toolbar. Click on Current Loadings icon 



The following will be displayed:

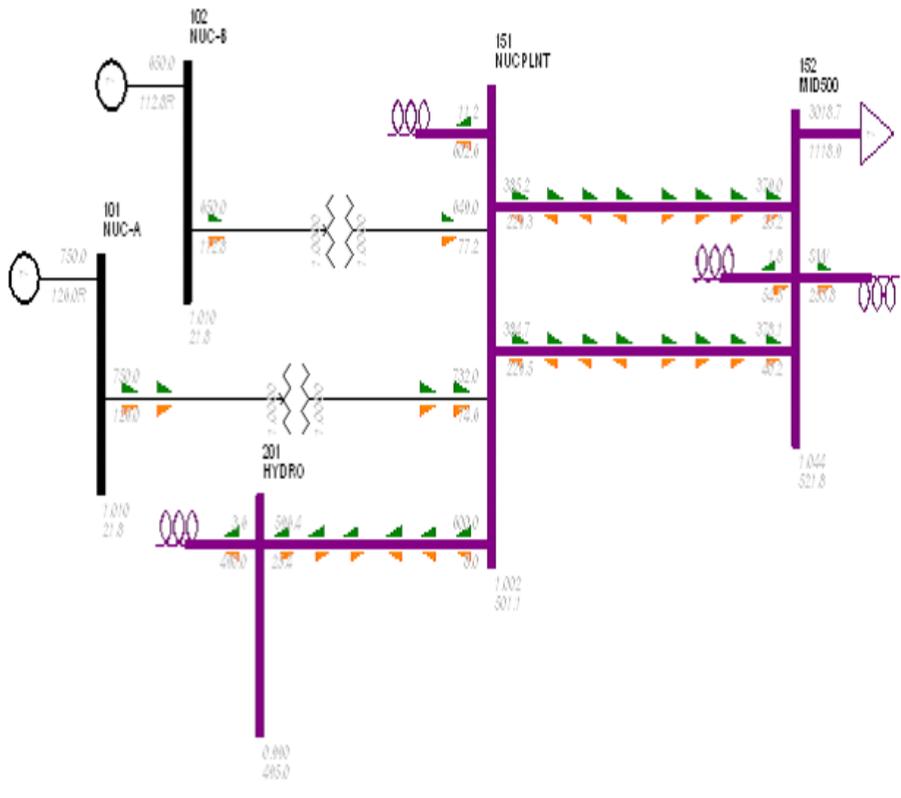


V. Animation

Go to third toolbar. Click on Animate Flows icon 

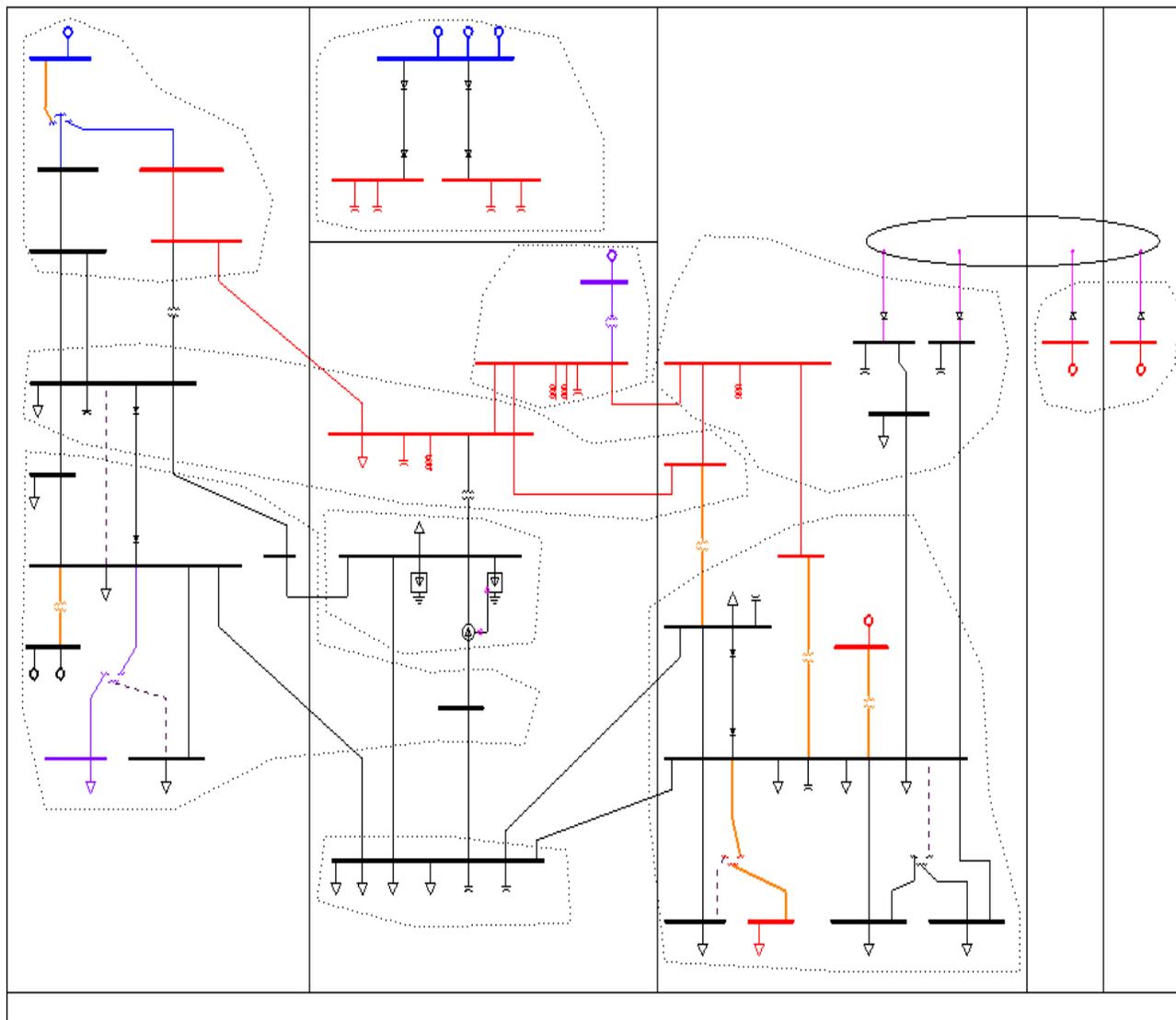


The following will be displayed:

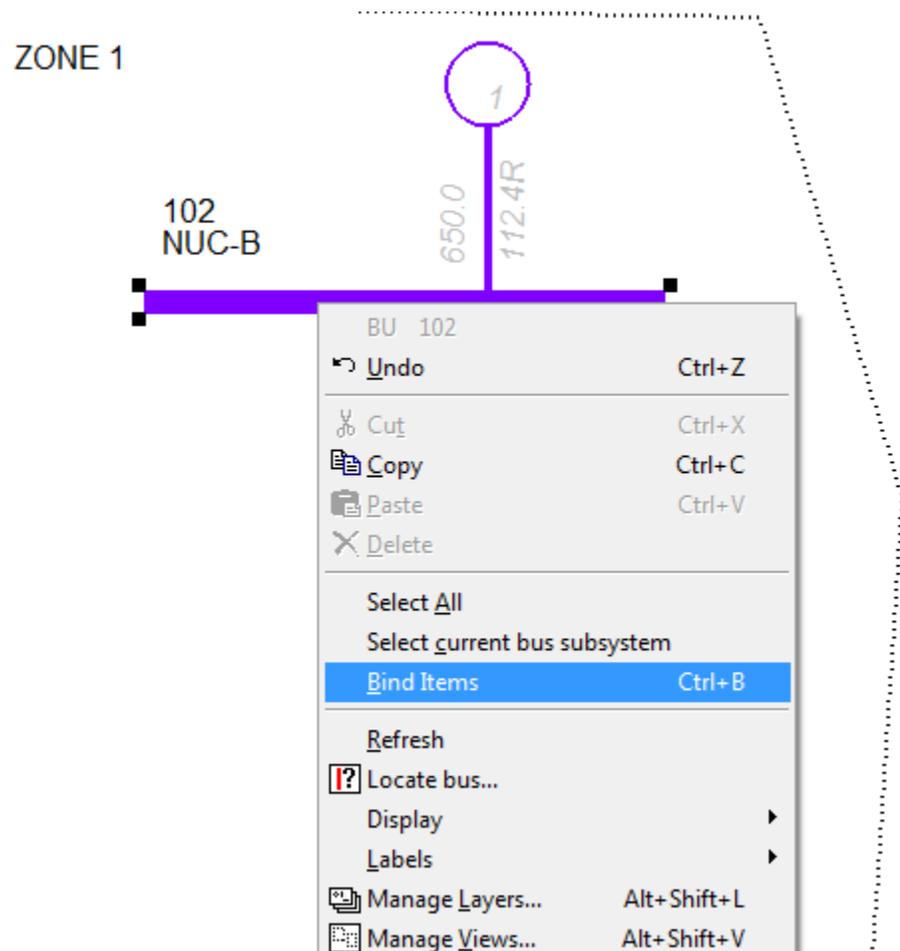


VI. Grow and Un-Bind in real application *.sld file

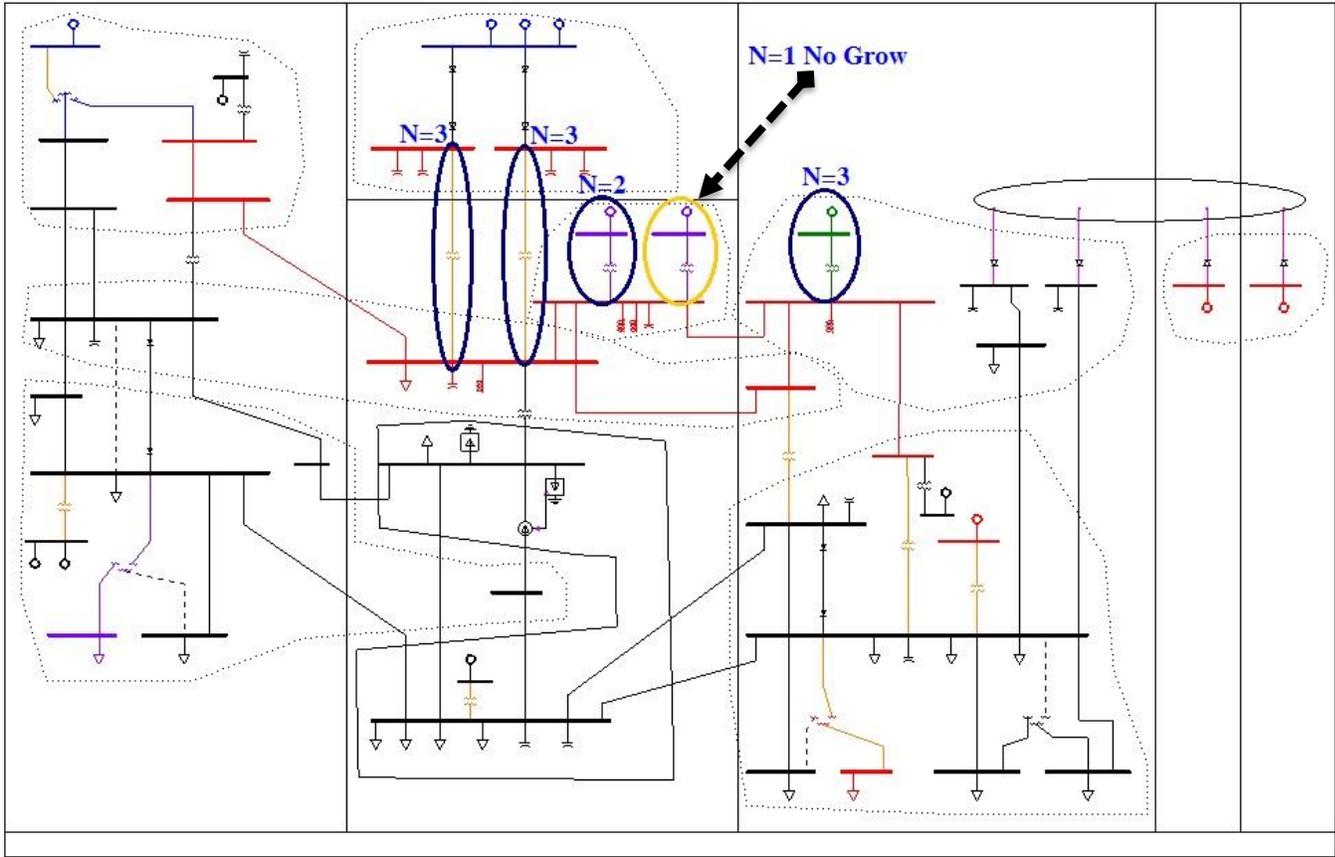
Open **exercise 1.sld** from your PSSE folder; its hiding some elements that need to be grown.



- Search for BUS 102 by zooming in and right click on the bus. **un-select Bind items**



- Grow N Levels: right click and select Grow N levels. Choose the level that displays new element to the grid. Once there are no elements added to the grid, and then you are done.
- Zoom, Rearrange, and Deliver with Lab Questions.
- You should have exactly the **sample.sld** file shown below:



PSSE Lab # 2 Questions:

The “*sample.sav*” and “*sample.sld*” must be open to perform this section of the lab.

First, build out a one-line diagram to include the following ten buses (and no others!):

101 NUC-A
102 NUC-B
151 NUCPLANT
152 MID500
153 MID230
201 HYDRO
202 EAST500
3004 WEST
3021 WDUM
3022 EDUM

This is best done by typing “101” into the auto draw function, then right clicking the “151” bus; select grow. From here, right click the “152” bus and select grow. This should prevent you from ending up with extraneous buses. Solve for the system. Display the current loading percentages and the power flow animation. Print out the one-line diagram and include it in the report. Save the one-line diagram as “lab2.sld”, this will be needed for future labs.

Using the one-line diagram, and answer the following questions to include in the report. Turn off the loading percentages and the power flow animation for clarity. Make sure that the system has been solved.

1) Looking at Bus #152 (MID500), what is the P_{LOAD} and Q_{LOAD} of the load connected to this bus? _____

2) Find the two generators within this sub-system. Which buses are they connected to?
What are the P_{GEN} and Q_{GEN} of the two generators?

3) How many reactive devices are in this system? _____
How many capacitors are in this system? _____
How many inductors are in this system?
How many switched reactive devices (switch shunts) are in this system?

How many of the switched shunts are represented as a) inductors b) capacitors?

4) Looking at Bus #153 (MID230), what is the actual voltage of the bus and
What is the per unit voltage? _____