# Laboratory Experiment 6

## Including an HVDC Transmission Line for Power Flow Calculations in PowerWorld and Modeling of Thyristor Converters in PSCAD/EMTDC

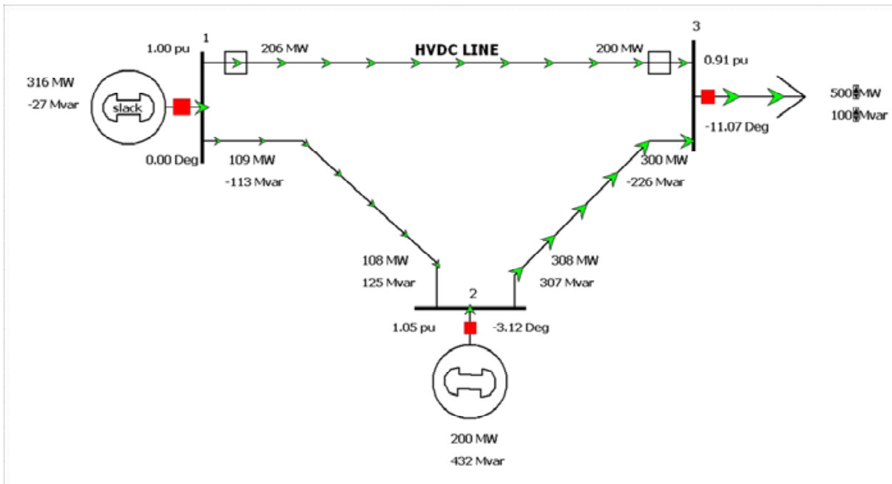
**Objectives:**

1. To include an HVDC transmission line and see its effect on power transfer on other transmission line.
2. To understand the operating principle of 12-pulse thyristor converters used in HVDC transmission systems.

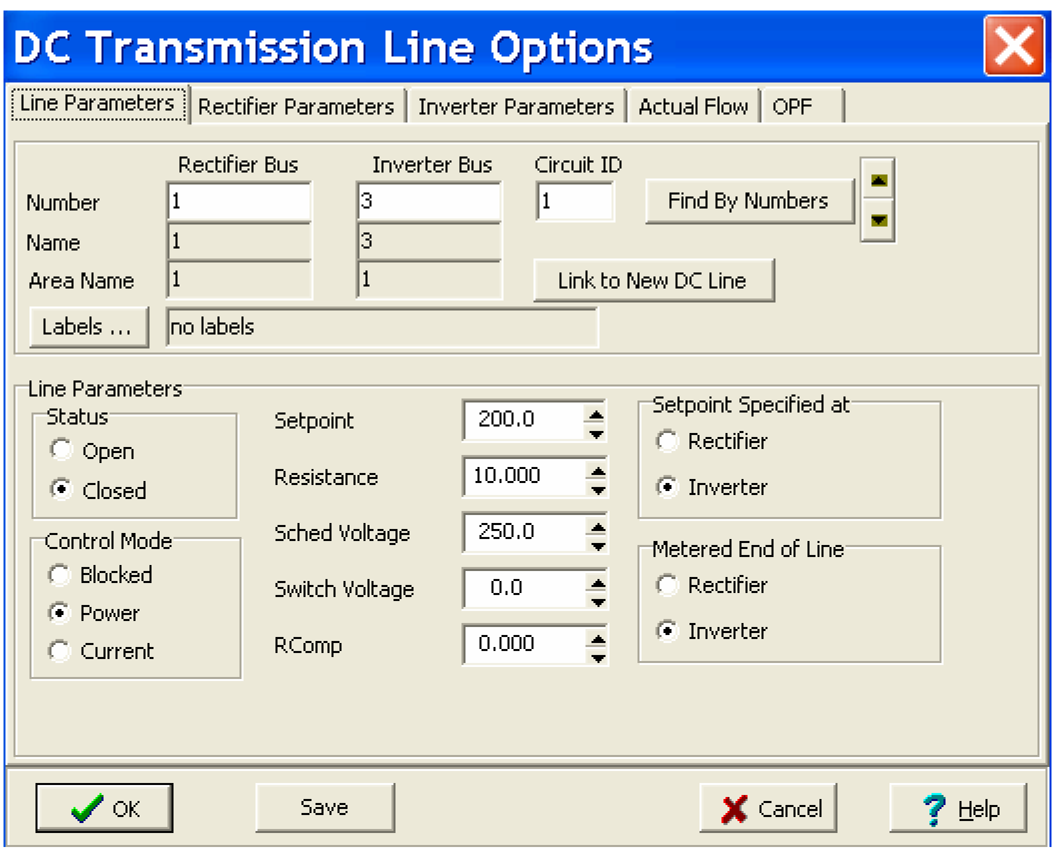
**Laboratory Tasks and Report:**

1. The transmission line between buses 1 and 3 is an HVDC line, as described in the *PowerWorld* file **PowerFlow_HVDCline.pwb** (see video clip# 8), which is located in this Folder. Double click on this file or open it through *PowerWorld*. Look at various characteristics of this HVDC system by examining its parameters; see dialog boxes below. Compare this case with that in Example 5-4 for the various bus voltages and the power flow on various lines due to this HVDC line. Change the set point from 200 MW to 300 MW and then to 400 MW. Explaing what you see.
2. Obtain the waveforms of individual Rectifier DC voltage and combined 12-pulse DC voltage output , for different firing angles , in a 12-pulse thyristor converter operating in a rectifier-mode described by the PSCAD/EMTDC file in this folder called **HVDC_Rectifier.psc** (see video clip# 9). Source: Courtesy of Prof. Ani Golé of the University of Manitoba.
3. Obtain the waveforms of individual inverter DC voltage and combined 12-pulse DC voltage input ,for different firing angles in a 12-pulse thyristor converter operating in the inverter-mode described by the PSCAD/EMTDC file in this folder called **HVDC_Inverter.psc** (see video clip# 9). Source: Courtesy of Prof. Ani Golé of the University of Manitoba.
4. By using the formula (7-12) and (7-13), for different firing angles, calculate the DC voltage and match with the value obtained from the waveform. For Rectifier: w*Ls = 13.6791 ohm, VLL=213 kV, Id= Obtain from simulation For Inverter: w*Ls=13.1843 ohm, VLL=207 kV, Id= Obtain from simulation.
5. Obtain the waveforms of the input and output currents for both the transformers in rectifier and inverter. Observe the phase shift between the primary and secondary of Wye-Delta transformer. Explain what you see.
6. Obtain harmonic components of secondary line current of Wye-Delta Transformer and harmonic components of the DC line voltage in the rectifier and inverter. What is the significance of the harmonics that appear?

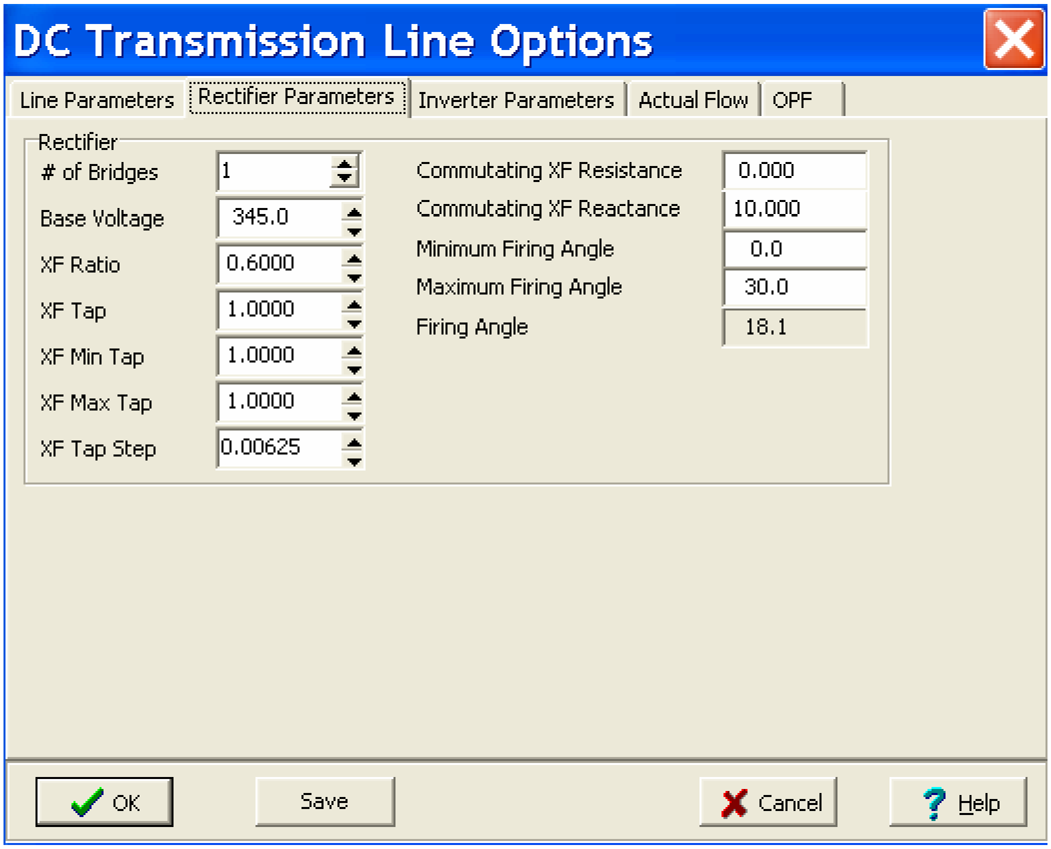
**PowerFlow_HVDCline.pwb**




Problem 7-22 HVDC Line between Buses 1 and 3 is set to deliver 200 MW to Bus 3. The voltage at the inverter terminal is 250 kV

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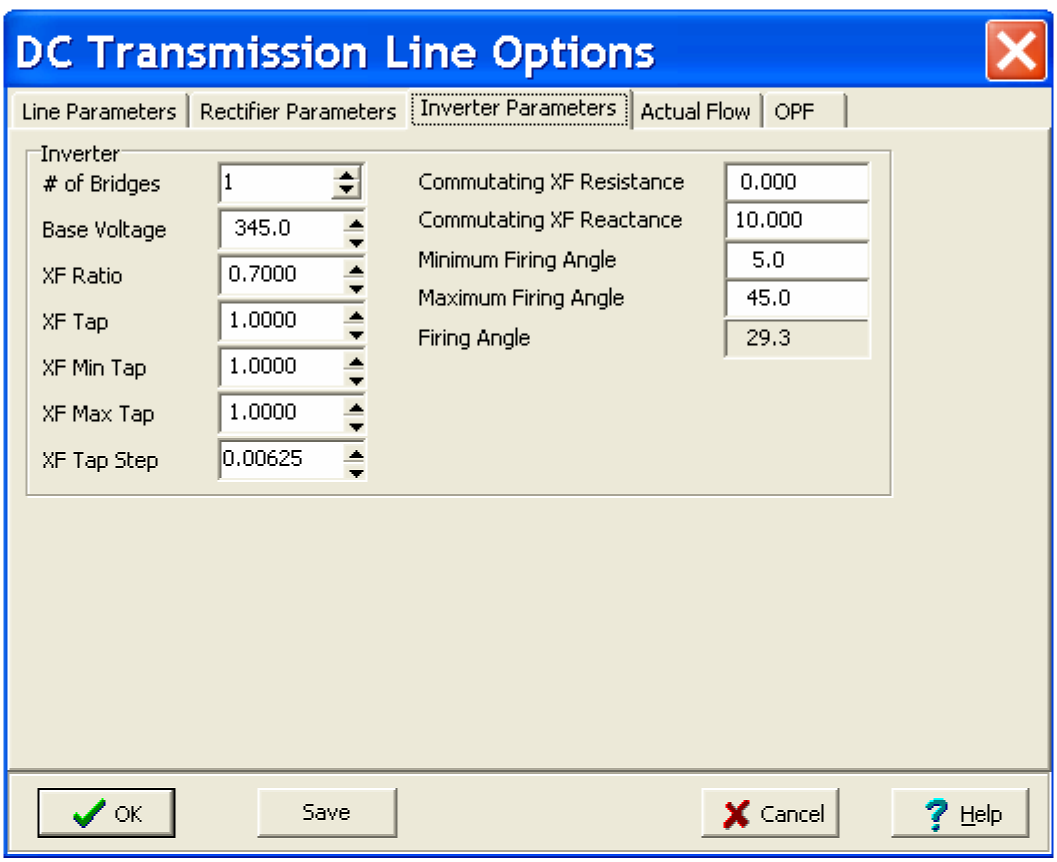
Line Parameters
Rectifier Parameters
Inverter Parameters
Actual Flow
OPF
Rectifier
# of Bridges
1
Base Voltage
345.0
XF Ratio
0.6000
XF Tap
1.0000
XF Min Tap
1.0000
XF Max Tap
1.0000
XF Tap Step
0.00625
Commutating XF Resistance
0.000
Commutating XF Reactance
10.000
Minimum Firing Angle
0.0
Maximum Firing Angle
30.0
Firing Angle
18.1
OK
Save
Cancel
Help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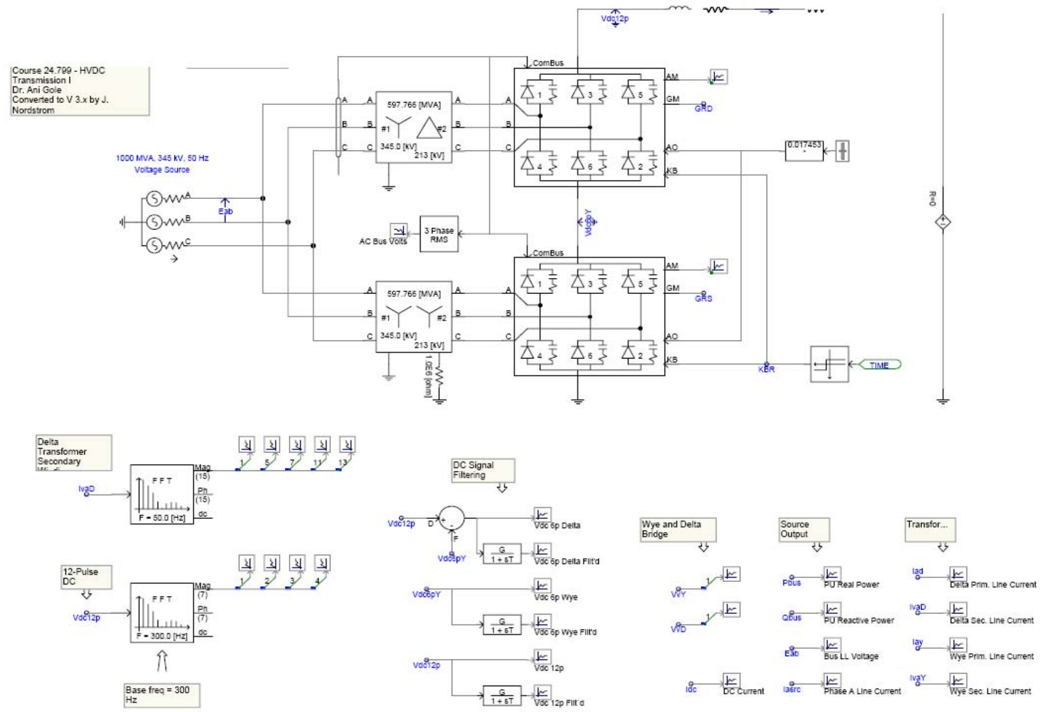
Line Parameters
Rectifier Parameters
Inverter Parameters
Actual Flow
OPF
Inverter
# of Bridges
1
Base Voltage
345.0
XF Ratio
0.7000
XF Tap
1.0000
XF Min Tap
1.0000
XF Max Tap
1.0000
XF Tap Step
0.00625
Commutating XF Resistance
0.000
Commutating XF Reactance
10.000
Minimum Firing Angle
5.0
Maximum Firing Angle
45.0
Firing Angle
29.3
OK
Save
Cancel
Help

## HVDC_Rectifier.psc



## HVDC_Inverter.psc