Rectifiers

We have discussed single phase full bridge rectifiers with a variety of loads as well as 3-phase rectifiers for two different configurations (both Wye). Today you will construct SPICE simulations of each type of rectifier to visualize the voltage and current for a variety of loads.

Full bridge rectifier from 1-phase AC

Resistive load

- Create a new schematic and place in it a voltage source will standard parameters (voltage =120V, frequency=60Hz). Send one end of the source to ground.
- Insert a full bridge rectifier being leaving room inside the 4 diodes to place a load.
- Insert a 1kΩ resistor load.
- Place labels () at each end of your load to simplify identifying voltage traces.
- Run a transient simulation for a duration of 50ms.
- Graph the voltage across the load and the current through the load, they should look substantially the same. Document a graph of your results and label it load. You can document this either with a sketch or by using the Windows snipping tool and saving the image to a file.
- What is the minimum current that runs through the load, the maximum?_____
- More useful is the average current. This can be found by control clicking on the current label in your trace window. What is <i>_____ and i_{rms} _____?

Resistive-Inductive load

The boundary between a primarily inductive load and a primarily resistive load is determined by the frequency of the voltage source, resistance, and inductance of the load. When the decay time constant for the LR series circuit is equal to the period of the oscillation we are at the boundary. What is the formula for the time constant in terms of L and R? _____

What inductance, L_B, will place the circuit above at that boundary (between a primarily resistive and primarily inductive load) given that R=1kΩ? _____

- Alter your simulation so that it has an inductor in series with the resistor. Use the inductance you found.
- Run a simulation for 50ms and sketch the behavior you see in the circuit's load and the voltage source (voltage across and current through).
- Repeat for a much larger inductance ($100L_B$) and much smaller inductance ($0.01L_B$).

3-phase Rectifier, 3 diode Configuration.

Open a new schematic.

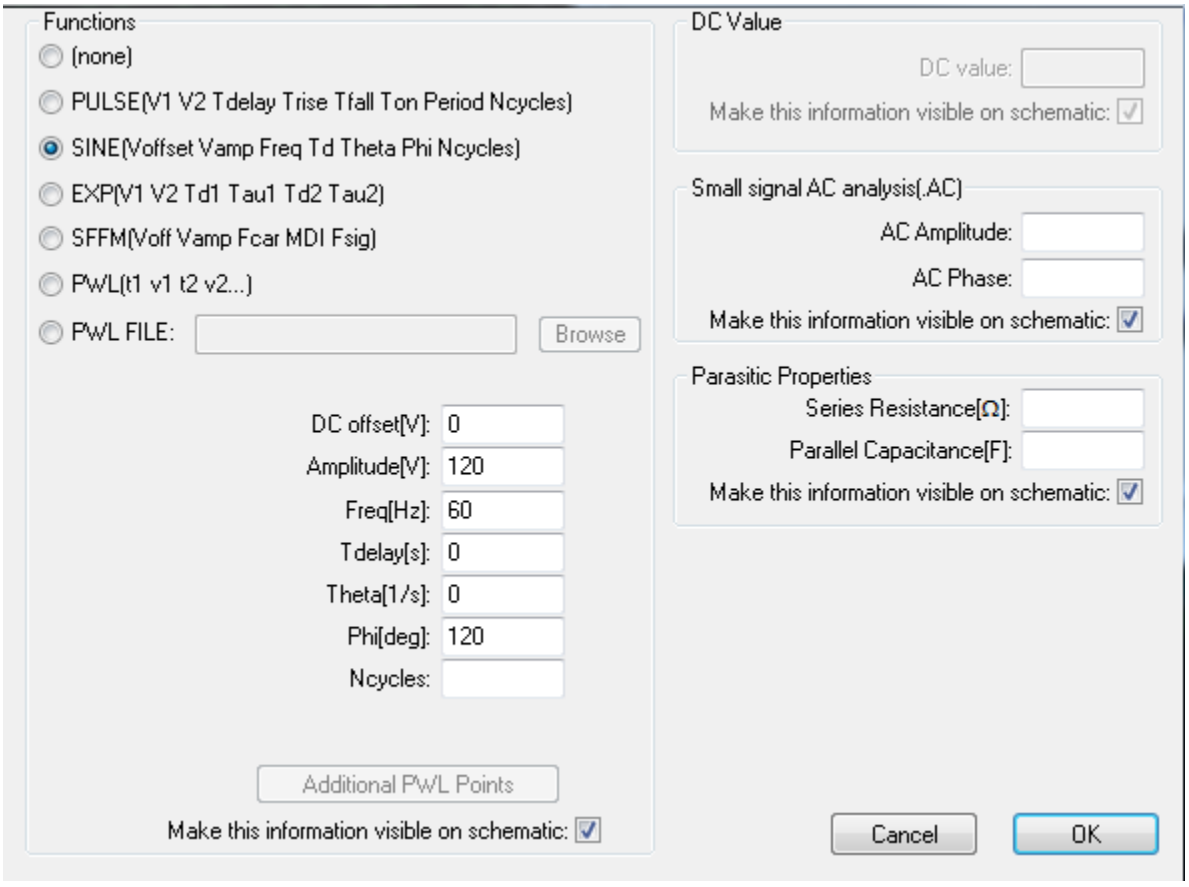
- Construct a 208Y/120V 3 phase voltage source. You can do this by placing 3 sinusiodal voltage sources in the simulation, each 120V and 60Hz. Set the phase shifts to be ϕ_1=0° , ϕ_2=+120°, ϕ_3.=-120°. Give them all a common ground. An example of the settings window for the voltage source that leads by 120° is shown in Fig 1.
- Construct a rectifier (star rectifier) using 3 diodes.
- Place a resistive load (1kΩ) between the diodes and ground.
- Run a transient simulation for a duration of 50ms.
- Graph the voltage across the load and the current through the load, they should look substantially the same. Document a graph of your results and label it load.
- What is the maximum current that runs through the load?_____
- What is <i>_____and $i_{rm,s}$_____?
- Graph the current through one of the voltage sources and classify this rectifier as either a half or full wave rectifier, justifying your answer._____
- 

Figure 1 The settings window of the advanced voltage source.

3-phase rectifier 6 diode Configuration.

Open a new schematic

- Place 3 sinusiodal voltage sources in the simulation, each 120V and 60Hz. Set the phase shifts to be ϕ_1=0° , ϕ_2=+120°, ϕ_3.=-120°. Give them all a common ground.
- Construct a rectifier (bridge rectifier) using 6 diodes.
- Place a resistive load (1kΩ) across the diode bridges.
- Run a transient simulation for a duration of 50ms.
- Graph the voltage across the load and the current through the load, they should look substantially the same. Document a graph of your results and label it load.
- What is the minimum current that runs through the load, the maximum?_____
- Graph the current through one of the voltage sources and classify this rectifier as either a half or full wave rectifier, justifying your answer._____