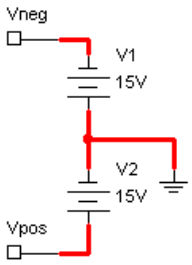
# Sub-circuits in Multisim

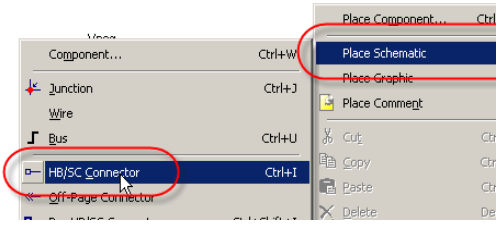
There are many uses for Sub-circuits but this tutorial will focus on only one of them. The circuits and components in Multisim are by necessity designed to be as close to real life as possible. For this reason, most of the op-amp models need power supplies. (There are a couple of virtual models where the power supplies are not available, along with no power inputs on the op-amp).

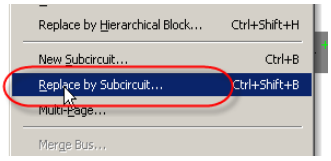
There is a negative aspect to having to have power supplies in the circuit: They take up space! For this reason I tend to place the power supplies into a sub-circuit and place it up in the corner of the circuit out of the way and connect the pins "virtually".



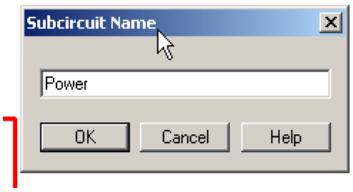

The first thing we do is to build the circuit shown to the left. The connectors are applied via a right click/Place Schematic/HB/SC Connector as shown below.

Once the connectors are in place double click on them and name them. This will make it easier once the sub-circuit is enclosed. I name the negative terminal 'neg' and the positive terminal 'pos'.

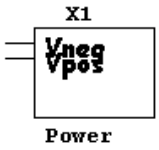


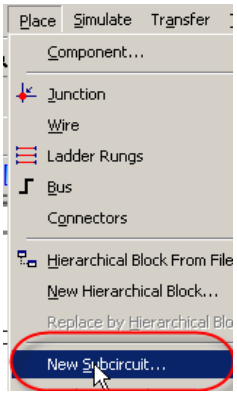

Next, Select the future sub-circuit and then select PLACE/Replace by Subcircuit from the top menu. A window will open up requiring a name for the sub-circuit as shown to the right.



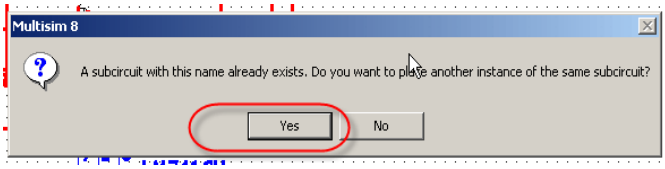

Finally, what is left is shown to the right.




This Sub-circuit is useable anywhere in this circuit but CAN NOT BE COPY/PASTED into any other circuit diagram. If you do try, it will look like it copied but it will be EMPTY!

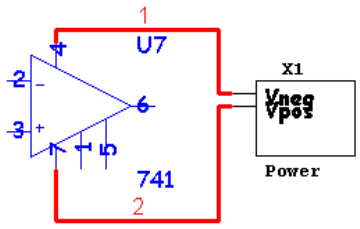



This sub-circuit is available within the current circuit via the Place/New Subcircuit command (left) from the pull-down menu. A window will open up and you type in the name of the sub-circuit. Since the sub-circuit exists the message below will appear and you then select yes.




The sub-circuit is still not connected. There are 3 ways to connect the sub-circuit to the circuit:

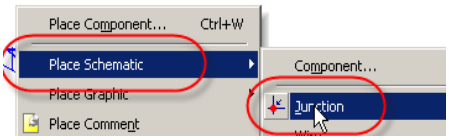
1. Direct connect: This method is the obvious method and is shown to the right.

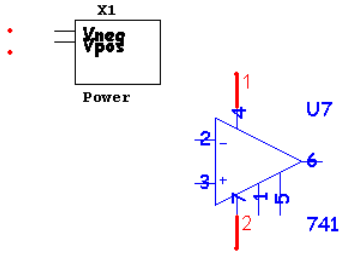



2. Connection virtually via junctions:

The problem with directly connecting a sub-circuit like this power supply is that it takes up space when it really is just a background function which is not really directly connected with the actual purpose of the simulation. So, we will connect it to the op-amp "Virtually". This method is not the preferred "industry standard" method but it does work.

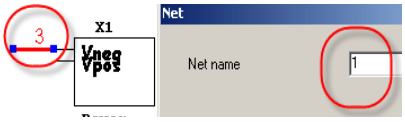
A junction needs to be connected to each of the power pins of the op-amp. The junctions are found by a Right Click/Place Schematic/Junction.

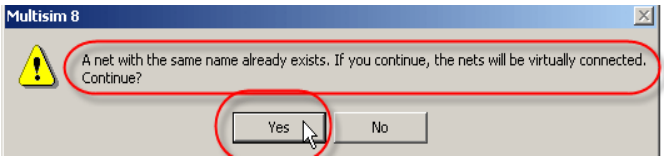


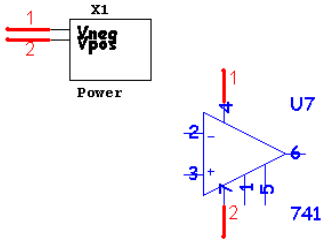

When the junctions are initially connected they are by default named with their NODE names. When the junctions are connected to the sub-circuit the wires will default to other (different nodes). In order to "virtually" connect the nodes to the correct nodes on the op-amp, the node names need to be renamed with the nodes names which they are to be associated with.

If you double click on the wire connected to the junction you will be able to change the Net Name of the junction. Since I named my positive connection 'pos', then I would name all net names that I want connected to 'pos' by the same name. Since the net name is currently being used, the system will pop up a warning as shown below on the next page.

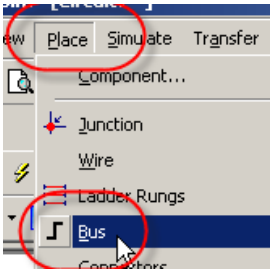





(In the figure to the right, the net names were left as 1 and 2 instead of applying meaningful names. Note that there are two 1's and two 2's.) In the example from which this figure was taken the HB/SB Terminals inside the sub-circuit were not named (just to show what would happen if you didn't do it).

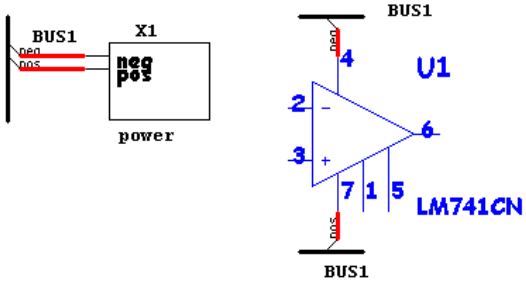



3. The third way (AND THE PREFERRED METHOD) to make the connections without a direct connect is thru the use of a bus. A bus is a single line which hides many lines on a schematic. In order to place a bus, select Place/Bus from the pull-down menu.

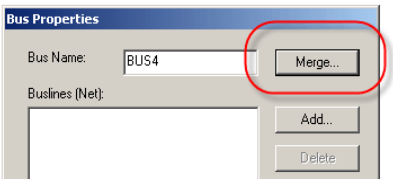


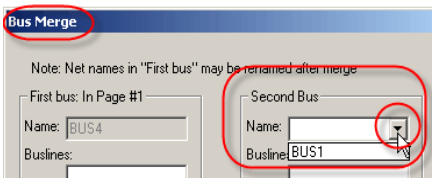

BUS2

Once selected you can draw the bus. *It does not have to be a straight line*. It can be as long as you want and it can go around corners. Once the bus is drawn a window will pop up with a default bus name. If there are no other bus' on the circuit or if you want to have a new bus with independent connections you can accept the default name.

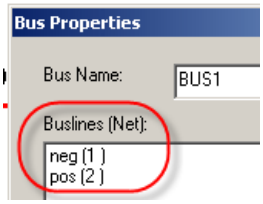


If however, you are drawing in a second Bus which you want share the same connections as a previous bus, click on MERGE in the Bus window and then select the desired bus from the menu window below the MERGE button.

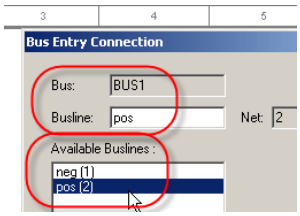



When you have merged the two bus' the list of connections on the Bus' will show on the Buslines (NET) list.

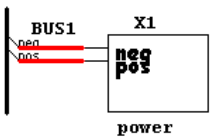


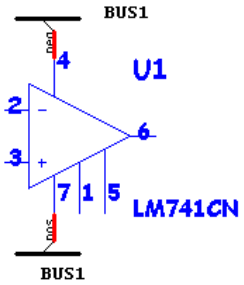

When want to connect a wire to the bus, all you have to do is select the Net name from the list which you want to connect to (unless it is a new name of course).



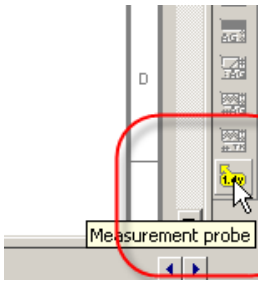

For our application, the first bus we draw will have the default name (Bus1 right). Once the bus is drawn, connect the wires which are needed to be bused elsewhere to this bus. As the wire approaches the bus, the wire will go off at a 45 degree angle. This is when you click to complete the connection. Sometimes you have to play around a bit to make the connection. Once connected a window will open up with a list of all the node names currently connected to that bus. Either select one (at which point the wire will be connected to whatever other wires have the same node name) or provide a new node name. (Below)

The figure to the right shows the final connection status. Note that all three bus' are named with the same bus name.



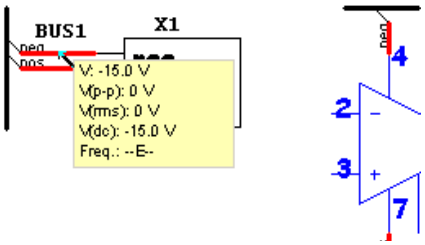



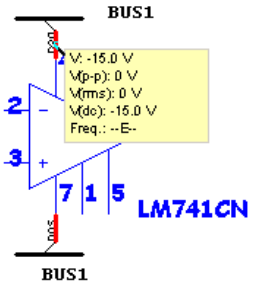

This particular schematic has the Node (net) names hidden. If you application needs the names/numbers to show (most of the apps in this lab) then pull them off of the wire connection to the other side of the bus line to keep them from hiding any info.




Let's now simulate the circuit and use the **Measurement probe (left)** to see that the connections have indeed been made. (**The probe only works when the simulation is running.**)

**Note that in the figure to the right that the neg line reads -15 volts. Now lets move the probe to the negative pin on the on the op-amp and note that it also reads -15 volts (below) even thought there is no direct connect.**




**Bus' are very powerful and are preferred over the junction method shown above since the use of bus' is an industry standard while the junction method is an EWB workaround!**