MULTISIM DEMO 6.2: EXPONENTIAL SOURCES

You will sometimes encounter exponential sources being applied to circuits during your studies. While Multisim's Exponential Source is briefly discussed in the text, we'll go into a little more detail below since this can be a tricky component with which to work.

This demo will focus on exponential voltage sources, although the same basic principles apply to exponential current sources. There are two ways to create an exponential voltage source in Multisim. The first is with the EXPONENTIAL_VOLTAGE component. The second is with an ABM_VOLTAGE. Let's first investigate the EXPONENTIAL_VOLTAGE component, which can be obtained by selecting the component hierarchy shown in Fig. 6.2.1 below.

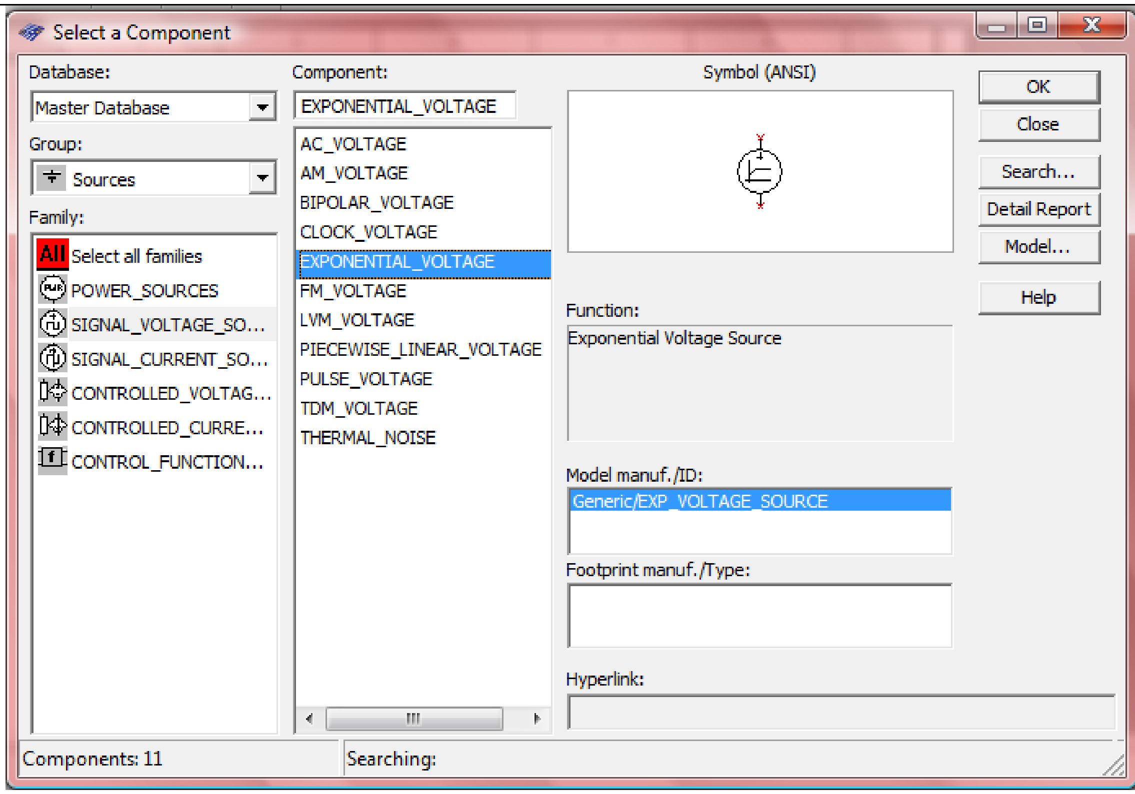

Figure 6.2.1 How to get a EXPONENTIAL_VOLTAGE source.

Incorporate the source in the circuit shown below in Fig. 6.2.2.

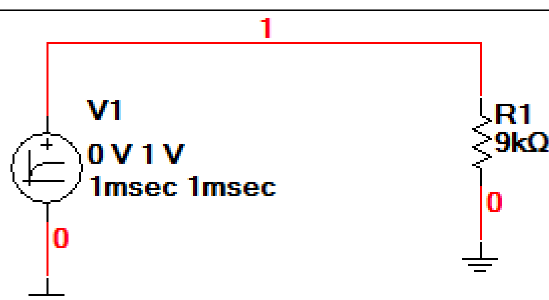

Figure 6.2.2 Simple circuit with exponential voltage source.

Double click on the Exponential Source to open up its control menu. Click on the Value tab to bring up the screen displayed in Fig. 6.2.3. There are bunch of fields which you can change. What are all of these fields? The Exponential source creates a certain type of signal explained below:

1. The signal starts out at the voltage dictated by **Initial Value**.
2. The signal holds steady at the **Initial** Value until the time **Rise Delay Time.**
3. At the **Rise Delay Time**, the signal begins to change to the **Pulsed Value** in an exponential fashion dictated by the **Rise Time Constant**.
4. The signal will continue to change until the time **Fall Delay Time** is reached.
5. At the **Fall Delay Time**, the signal begins to change to the **Initial Value** in an exponential fashion dictated by the **Fall Time Constant**.

The following values in Fig. 6.2.3 should be default for the EXPONENTIAL_VOLTAGE source, however you should probably double check just to make sure.

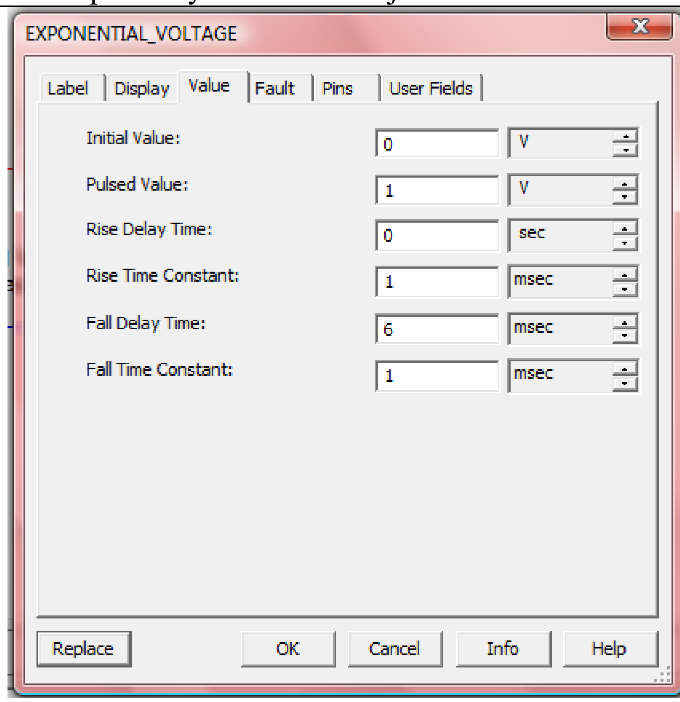

Figure 6.2.3 EXPONENTIAL_VOLTAGE control menu.

Run a Transient Analysis of the output voltage using the characteristics shown in Fig. 6.2.4 on the next page. Depending on your computer's speed you may need to increase the Maximum time step (TMAX).

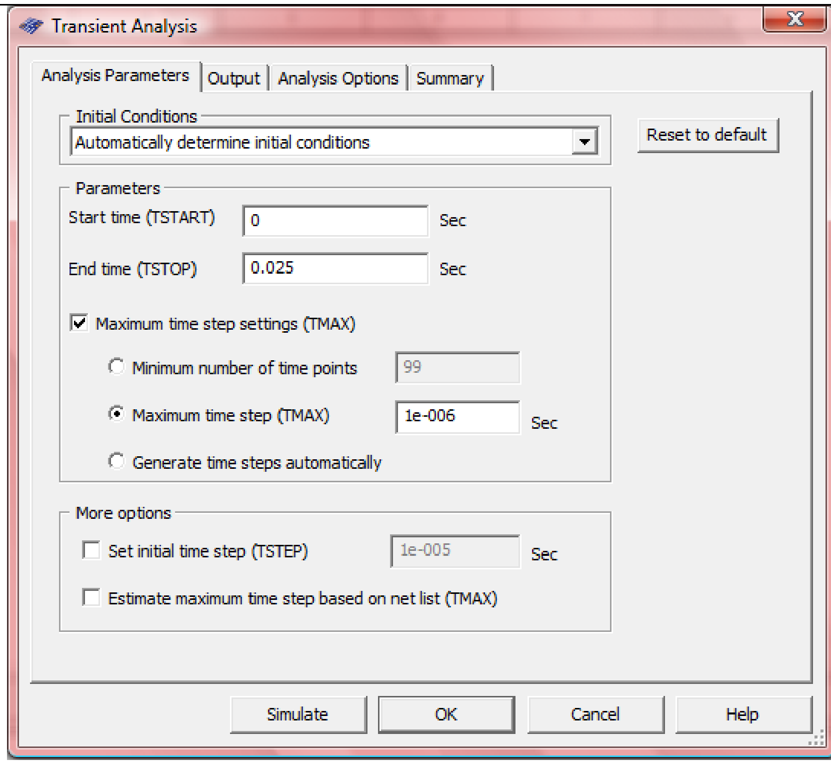

Figure 6.2.4 Transient Analysis settings for the simulation.

The output of the plot should resemble that shown in Fig. 6.2.5. As we can see the signal starts at 0 V (**Initial Value** = 0 V), and begins to rise immediately (**Rise Delay Time** = 0 ms) to 1V (**Pulsed Value** = 1V), with an exponential time constant of 0.001 s (**Rise Time Constant** = 1 ms). The signal continues to rise to 1 V, almost reaching it, before it begins to decrease starting at 6 ms (**Fall Delay Time** = 6 ms). The signal begins to fall back to 0 V (**Initial Value** = 0 V) with an exponential time constant of 0.001 s (**Fall Time Constant**= 1 ms).

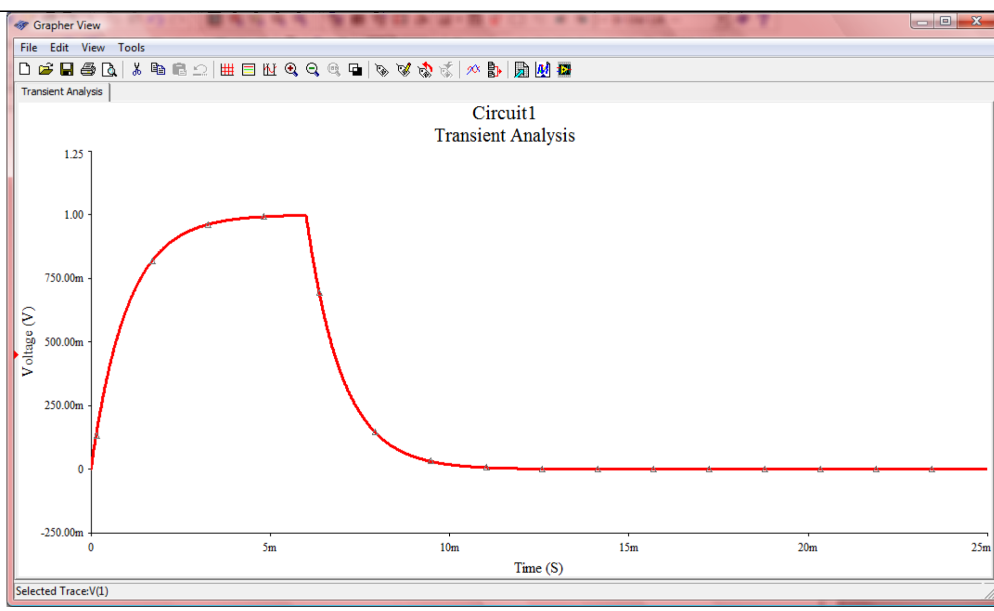

Figure 6.2.5 Output of exponential source with characteristics shown in Fig. 6.2.3.

Now let's enter a different set of values.

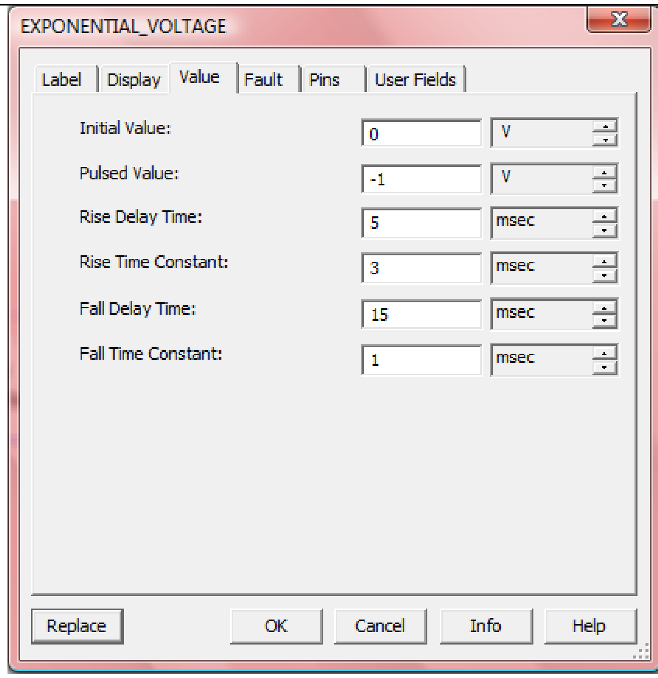

Figure 6.2.6 EXPONENTIAL_VOLTAGE Source control menu with different values.

The output of the plot should resemble that shown in Fig. 6.2.7. As we can see the signal starts at 0 V (**Initial Value** = 0 V), and begins to change at 5 ms (**Rise Delay Time** = 5 ms) to -1V (**Pulsed Value** = -1V), with an exponential time constant of 0.003 s (**Rise Time Constant** = 3 ms). The signal continues to change towards -1 V, almost reaching it, before it begins to change again starting at 15 ms (**Fall Delay Time** = 15 ms). The signal begins to fall back to 0 V (**Initial Value** = 0 V) with an exponential time constant of 0.001 s (**Fall Time Constant** = 1 ms).

It is interesting to note that in the signal shown in Fig. 6.2.7, the "Rising" portion of the signal is actually when the signal is decreasing, and the "Falling" portion of the signal is actually when the signal is increasing. For this Multisim component, all of the Rise fields correspond to the initial portion of the pulse, and the Fall fields correspond to the final portions of the pulse, regardless of whether or not one is actually "falling" or "rising" as we commonly think of signals. This is a confusing set of labels, indeed.

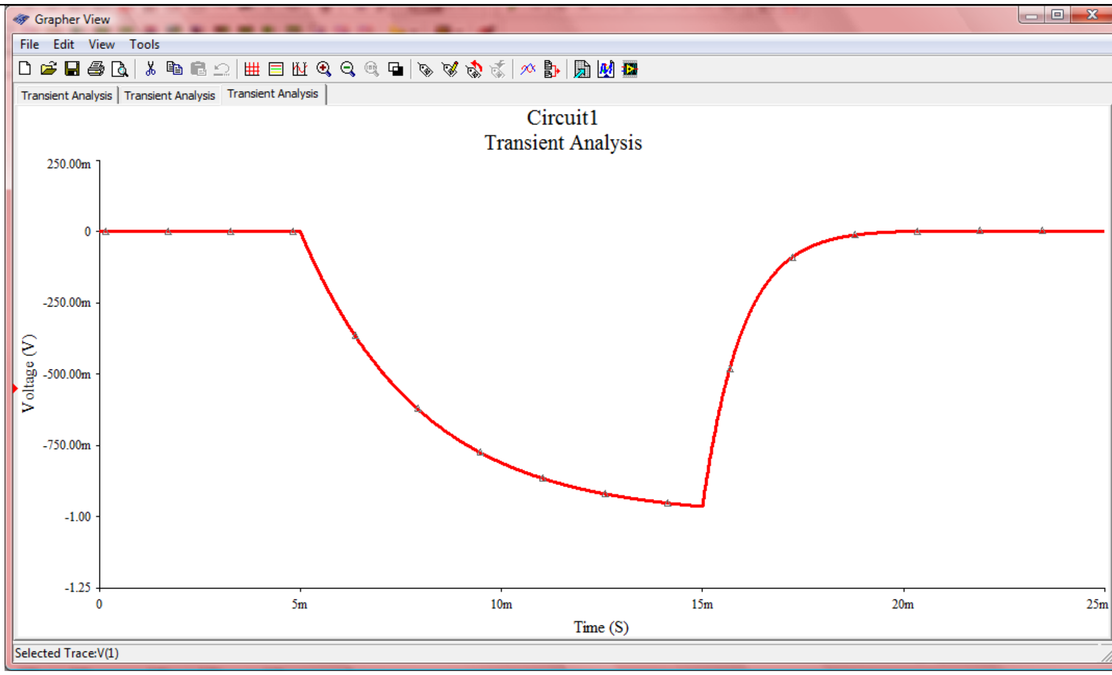

Figure 6.2.7 Output of exponential source with characteristics shown in Fig. 6.2.6.

Now at the beginning of this Demo, it was said that ABM sources could also be used to create exponential sources. Let's say we want to model the source: $5{\cdot}(1\text{-}e^{-5t})$ V. We can do this using the EXPONENTIAL_VOLTAGE, but that involves us decoding the equations and filling in the appropriate six fields of the exponential control menu.

For an ABM source, all we would have to do is enter: 5*(1-exp(-5*TIME)) into the Voltage Value field. Simple. To double-check that this is indeed what is produced, simulate using a Transient Analysis from 0 to 1 s. The output should look like that shown in Fig. 6.2.8 on the next page.

Note that you can pretty much make any exponential signal you want with an ABM source. While it might not be readily apparent, you can even do delayed exponential pulses like the EXPONENTIAL_VOLTAGE source allows. (Hint: use the stp() function). Either way, what source you use for your exponential needs will be up to you and your preferences.

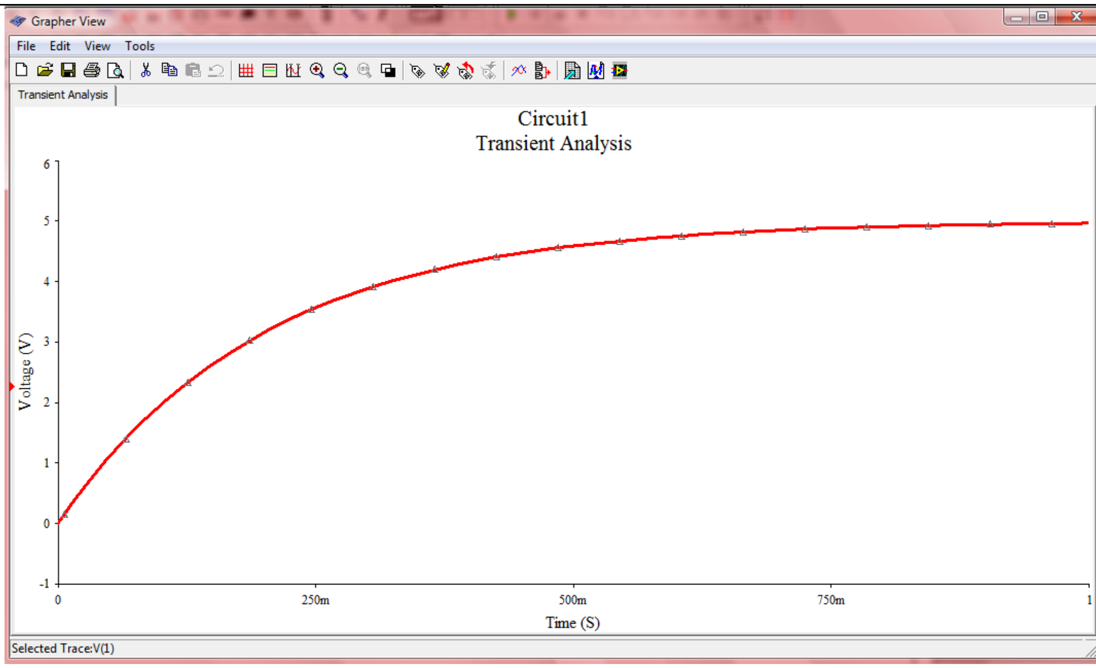

Figure 6.2.8 Output of circuit with ABM source producing exponential signal.