Delay Macro

The delay macro is designed to provide a simple time delay element in transient analysis or a phase shift in AC analysis. This macro is designed to be used with analog circuitry. There is a digital delay line primitive that offers the same function for digital circuits. This macro is preferred for analog circuits for two reasons: 1) the digital delay line would need I/O models if connected to analog components, which would use more components than the analog macro and force the output of the delay line to the analog voltage equivalent of digital states, and 2) the digital delay line has no AC equivalent whereas this macro will produce a phase shift. The delay macro appears in Figure 1 below.

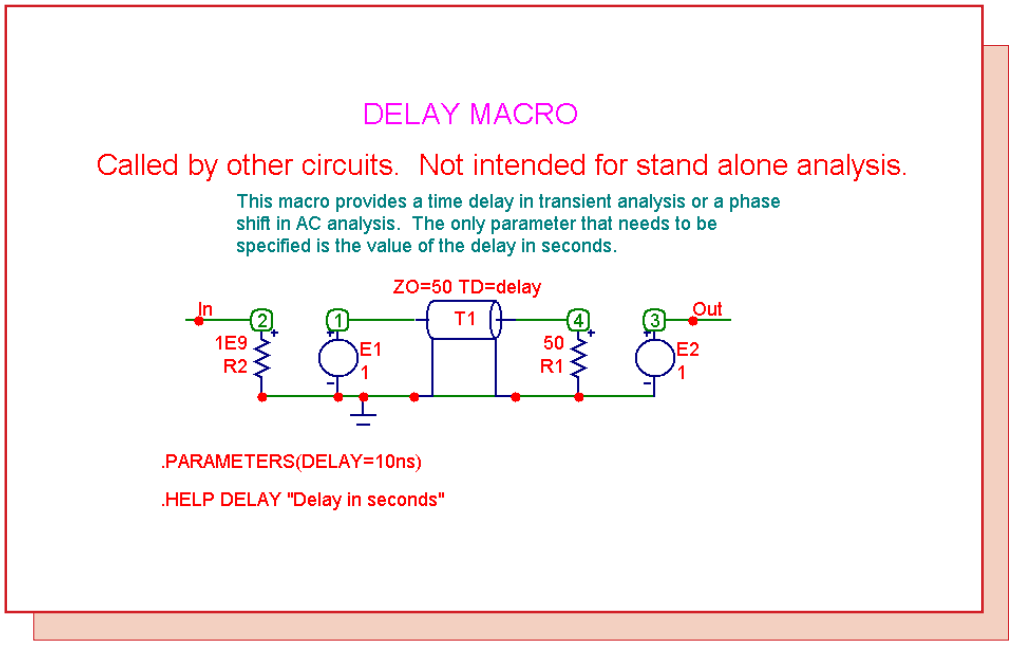

Fig. 1 - Analog delay macro

The single parameter in the macro is delay. This parameter defines the time delay that the macro will produce. The macro consists of two resistors, two VofV dependent sources, and an ideal transmission line. The two VofV dependent sources are used as buffering for the transmission line. The ideal transmission line is defined with a characteristic impedance of 50 ohms and a time delay that will be defined by the delay parameter. There is a 50 ohm termination resistor at the output of the transmission line to match the characteristic impedance of the line. This insures that the input waveform is passed cleanly through to the output without any reflections from the line. The 1E9 resistor is used to provide a DC path to ground at the input.

The test circuit for this macro is simply a 1MHz sine wave going into the input of the Delay macro. The macro has its Delay parameter defined as 100ns which will of course provide a 100ns delay for the sine wave. Figure 2 is a plot of the input and output waveforms of the macro from a transient analysis. The input waveform is passed cleanly through the macro with a 100ns shift at the output. Figure 3 is an AC analysis plot of the phase at the output of the macro for the same circuit. The phase values at 1MHz and 10MHz are shown in the cursor information. The 100ns delay is 10% of the period at 1MHz and 100% of the period at 10MHz. The macro produces the correct phase shifts of -36 degrees and -360 degrees at these frequencies.

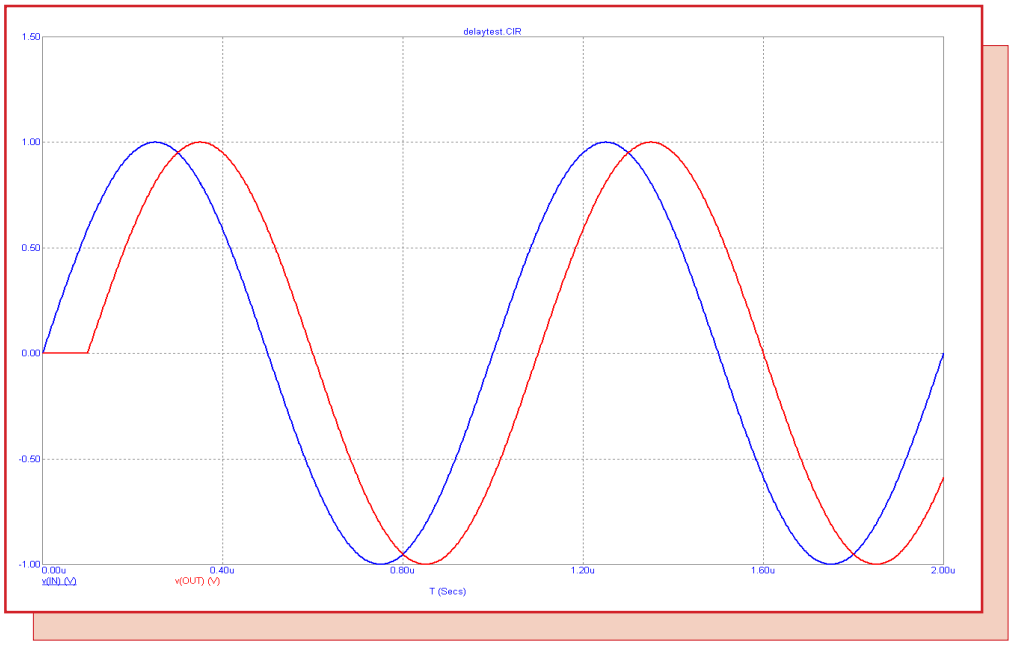

Fig. 2 - Delay transient analysis results

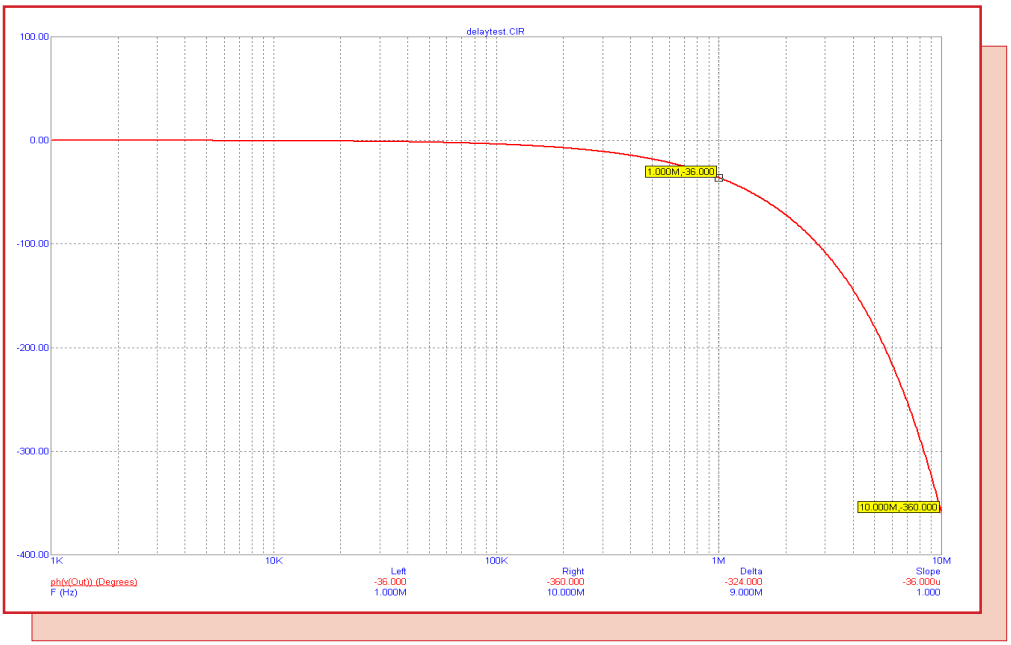

Fig. 3 - Delay AC analysis results