APPLICATION NOTE

cadence®

Using Multipliers for Signal Processing

December 2009

OVERVIEW

Multipliers are often used for signal processing applications. In this note, two examples are presented to illustrate the use of a multiplier to make an amplitude modulator and a frequency doubler.

AMPLITUDE AND BALANCED MODULATION

Amplitude modulation is a technique which uses a low-frequency signal to control the amplitude of a high-frequency signal. A simple modulator can be constructed using a multiplier as shown in Figure 1.

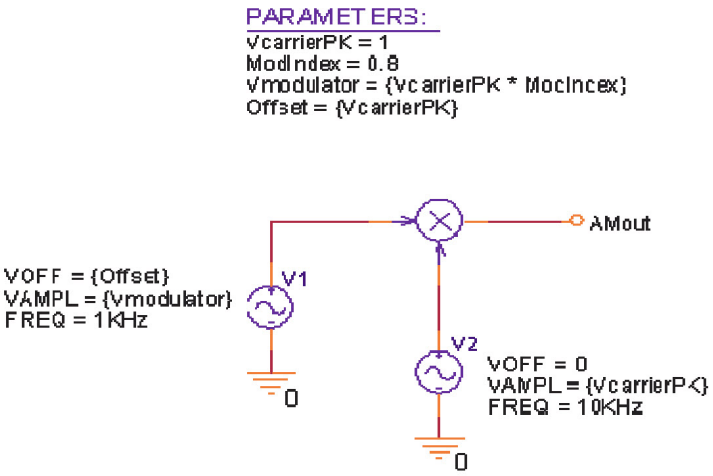

Figure 1: A simple amplitude modulator circuit

One input is the high-frequency or carrier signal, and the other input is the modulating signal. A sinusoidal source at a frequency of 10 kHz is used to represent the carrier signal and a second source at a frequency of 1 kHz is used to represent the modulating signal. Notice that the peak amplitude for the carrier is set to 1 volt using the parameter VcarrierPK. The modulating index is the ratio of the peak of the modulating signal to the peak of the carrier. Here, the index is set to 0.8 or 80% modulation. A typical broadcast AM signal includes the carrier as well as the sidebands in the transmission. To get such a double sideband transmitted carrier signal (DSB-TC) we must bias or offset the modulating signal by a value equal to the carrier's peak voltage.

The amplitude modulated signal and the modulating signal from this simulation are shown in Figure 2.

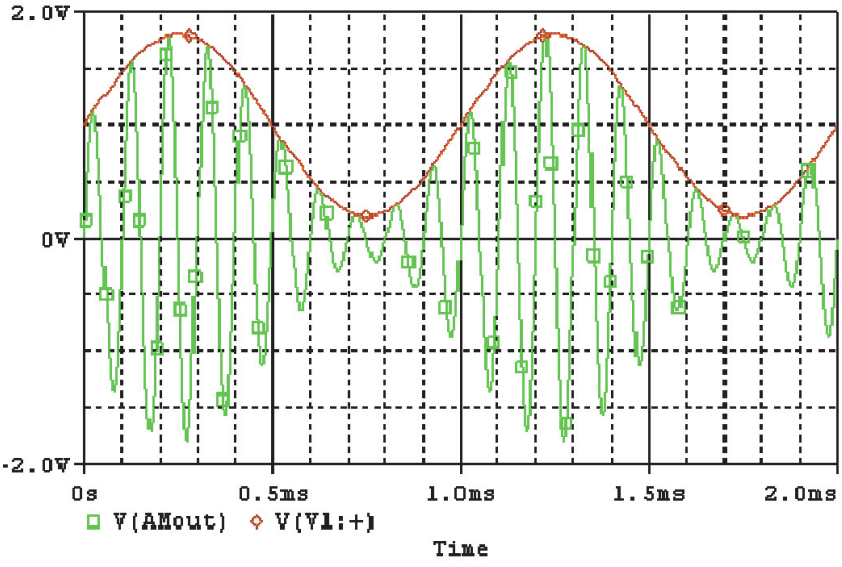

Figure 2: A simple amplitude modulator circuit

A balanced modulator produces a double sideband suppressed carrier signal (DSB-SC). By setting the offset of the modulating signal to be zero in the above circuit, we will suppress the carrier. To do this set VOFF equal to zero for voltage source V1. Notice, the output of this modulator shown in Figure 3; the shape of its upper A balanced modulator output signal envelope resembles a full-wave rectified AC source.

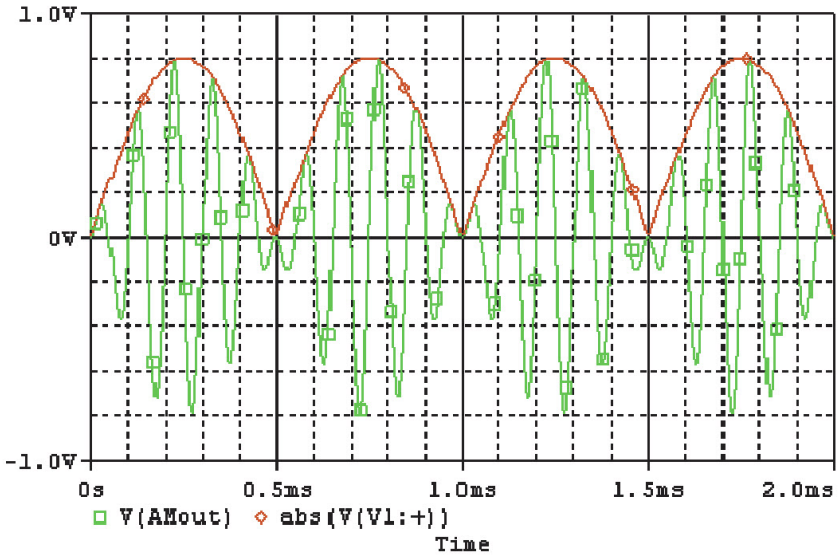

Figure 3: A balanced modulator output signal

FREQUENCY DOUBLING

Another application for a multiplier is as a frequency doubler (see Figure 4). Connecting a sinusoidal source simultaneously to both inputs of a multiplier will yield a signal with double the input frequency. The first multiplier, Xmul, produces a waveform that has one-half the amplitude of the original input signal with a DC offset of one-half the input waveform's peak value. The DC offset is removed with a voltage source called Voffset. The amplitude of the original signal is restored with a second multiplier which doubles the signal.

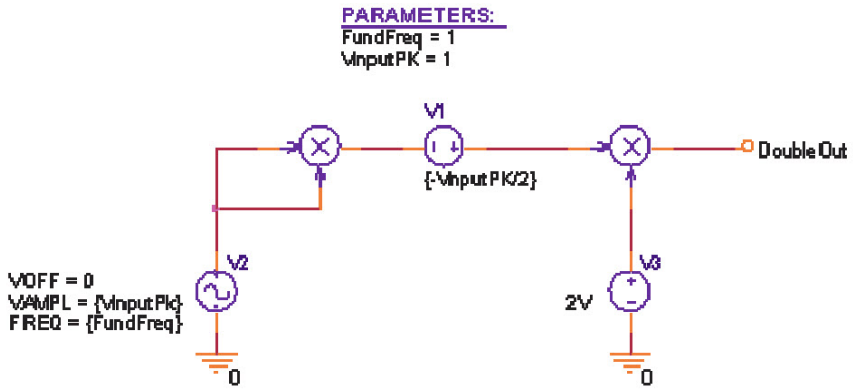

Figure 4: A simple frequency doubler circuit

Figure 5 shows the original input signal, as well as the frequency doubled output signal. These examples have illustrated how a multiplier implemented using the E device in the Cadence® PSpice® environment can be used in signal processing applications such as amplitude modulation and frequency doubling.

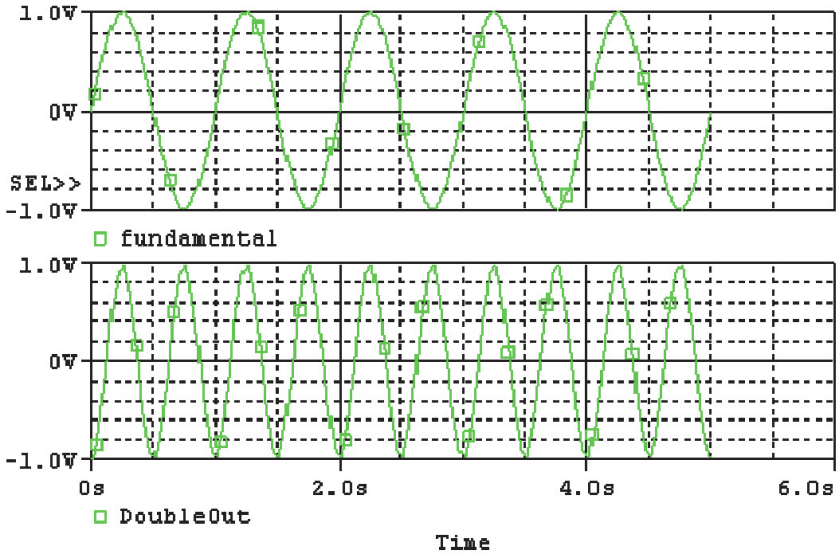

Figure 5: Output results for frequency doubler

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