The AM RF Signal
Xtal Set Society

A radio frequency (RF) amplitude modulated signal (AM) can be generated by multiplying the radio frequency carrier by an audio signal with proper bias, as follows.

(1.1) $$AM = \{1 + m(\cos(\omega_a t)\}\cos(\omega_0 t),$$

where m (≤ 1) is the modulation factor, ω_a, is the angular audio frequency, ω_0 is the angular carrier frequency, and ω equals $2\pi f$, f being frequency.

Carrying out the multiplication, we have

(1.2) $$AM = \cos(\omega_0 t) + \frac{m}{2}\cos(\omega_0 + \omega_a)t + \frac{m}{2}\cos(\omega_0 - \omega_a)t.$$

Clearly, the AM signal consists of three radio frequency signals. For example, if the carrier is 1 MHz and the original audio signal is 1 kHz, the three radio frequency signals are: 1 MHz, 1.001 MHz, and 0.999 MHz. The signals multiplied by m/2 are called the sidebands, one below the carrier and one above in frequency.

AM signals, in actual circuits, are generated by multiplying the carrier by an audio signal. The circuit models itself after equation 1.1. Since the AM RF signal created consists of three radio frequency signals, we can generate a copy in a circuit simulation by simply adding the signals noted in equation 1.2, as shown in Figure 1. Here, the amplitude of the two sidebands are set at 60%/2 or 0.3 that of the carrier. The lower RF sideband becomes 0.3 volts at 999 kHz. The upper sideband becomes 0.3 volts at 1001 kHz. The resulting signal, across R4, is a sum of the three and indeed looks just like an AM signal on an oscilloscope, as noted in Figure 2.

Figure 1: The component parts of an AM Signal

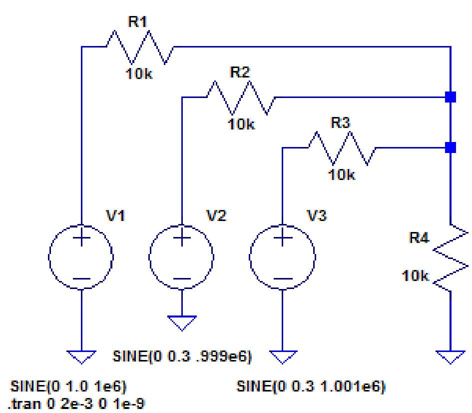
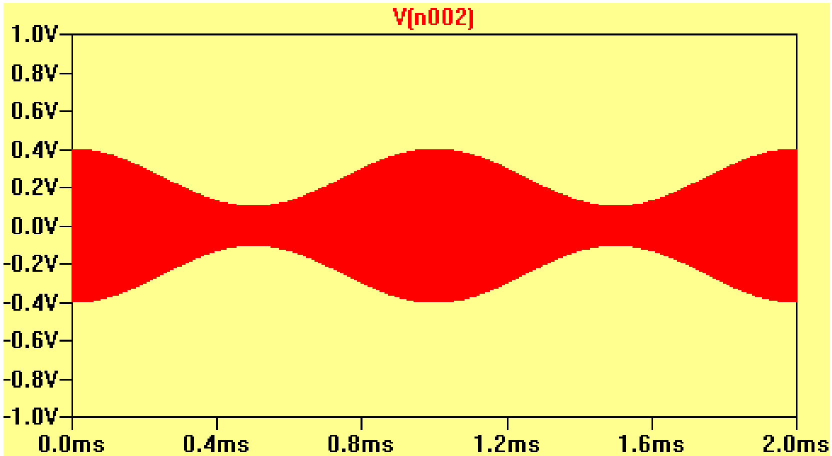


Figure 2: "Scope" View of the full AM Signal



By expanding the "scope" picture above – the waveform if you will – we can see the two sideband traces each peaking at 0.3 volts, noted as V(n003) and V(n004). The 1.0 volt carrier, V(n001), shows its peak of 1 volt.