Frequency Shift Keying

Version 2.10: Apr 18, 2005 3:42 pm GMT-5

Don Johnson

Abstract

Frequency Shift Keying uses the bit to affect the frequency of a carrier sinusoid.

Frequency Shift Keying

In **frequency-shift keying** (FSK), the bit affects the frequency of a carrier sinusoid.

$$s_0(t) = Ap_T(t)\sin(2\pi f_0 t) \tag{1}$$
$$s_1(t) = Ap_T(t)\sin(2\pi f_1 t)$$

The frequencies f_0, f_1 are usually harmonically related to the bit interval. In the depicted example, $f_0 = \frac{3}{T}$ and $f_1 = \frac{4}{T}$. As can be seen from the transmitted signal for our example bit stream (Figure 2), the transitions at bit interval boundaries are smoother than those of BPSK[1].

To determine the bandwidth required by this signal set, we again consider the alternating bit stream. Think of it as two signals added together: The first comprised of the signal $s_0(t)$, the zero signal, $s_0(t)$, zero, *etc.*, and the second having the same structure but interleaved with the first (Figure 3).

Each component can be thought of as a fixed-frequency sinusoid multiplied by a square wave of period $2T$ that alternates between one and zero. This baseband square wave has the same Fourier spectrum as our BPSK example, but with the addition of the constant

[1]http://cnx.rice.edu/content/m0543/latest/#fig1001

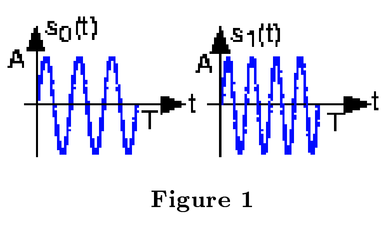

Figure 1

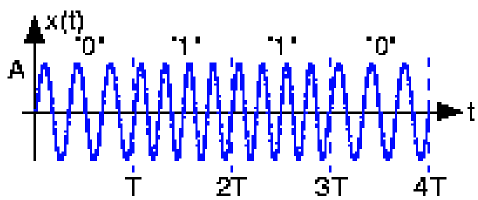

Figure 2: This plot shows the FSK waveform for same bitstream used in the BPSK example[2].

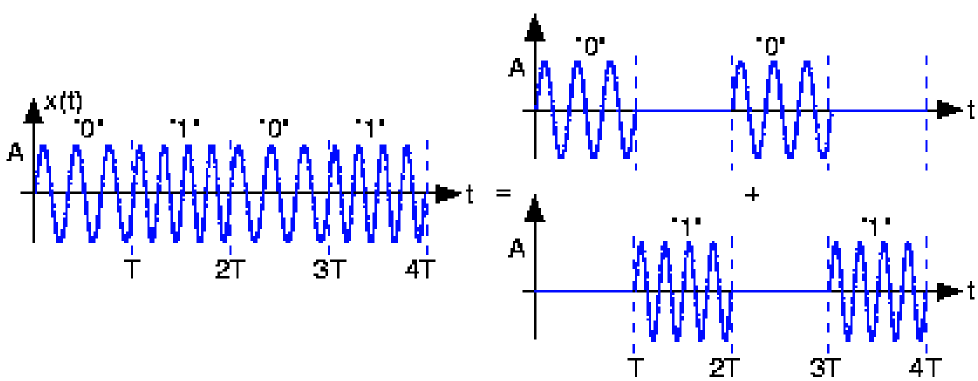

Figure 3: The depicted decomposition of the FSK-modulated alternating bit stream into its frequency components simplifies the calculation of its bandwidth.

term c_0. This quantity's presence changes the number of Fourier series terms required for the 90% bandwidth: Now we need only include the zero and first harmonics to achieve it. The bandwidth thus equals, with $f_0 < f_1$, $f_1 + \frac{1}{2T} - \left(f_0 - \frac{1}{2T}\right) = f_1 - f_0 + \frac{1}{T}$. If the two frequencies are harmonics of the bit-interval duration, $f_0 = \frac{k_0}{T}$ and $f_1 = \frac{k_1}{T}$ with $k_1 > k_0$, the bandwidth equals $\frac{k_1 + (-k_0) + 1}{T}$. If the difference between harmonic numbers is 1, then the FSK bandwidth is *smaller* than the BPSK bandwidth. If the difference is 2, the bandwidths are equal and larger differences produce a transmission bandwidth larger than that resulting from using a BPSK signal set.