MSK is sometimes referred to as *fast FSK*, as the frequency spacing used is only half as much as that used in conventional noncoherent FSK [Xio94].

MSK is a spectrally efficient modulation scheme and is particularly attractive for use in mobile radio communication systems. It possesses properties such as constant envelope, spectral efficiency, good BER performance, and self-synchronizing capability.

An MSK signal can be thought of as a special form of OQPSK where the baseband rectangular pulses are replaced with half-sinusoidal pulses [Pas79]. These pulses have shapes like the St. Louis arch during a period of $2T_b$. Consider the OQPSK signal with the bit streams offset as shown in Figure 6.30. If half-sinusoidal pulses are used instead of rectangular pulses, the modified signal can be defined as MSK and for an N-bit stream is given by

$$s_{\mathrm{MSK}}(t) = \sum_{i=0}^{N-1} m_{I_i}(t)p(t-2iT_b)\cos 2\pi f_c t + \sum_{i=0}^{N-1} m_{Q_i}(t)p(t-2iT_b-T_b)\sin 2\pi f_c t \tag{6.104}$$

where

$$p(t) = \begin{Bmatrix} \cos\left(\dfrac{\pi t}{2T_b}\right) & 0 \le t \le 2T_b \\ 0 & \text{elsewhere} \end{Bmatrix} \tag{6.105}$$

and where $m_{I_i}(t)$ and $m_{Q_i}(t)$ are the "odd" and "even" bits of the bipolar serial data stream which have values of ±1 and which feed the in-phase and quadrature arms of the modulator at a rate of $R_b/2$. It should be noted that there are a number of variations of MSK that exist in the literature [Sun86]. For example, while one version of MSK uses only positive half-sinusoids as the basic pulse shape, another version uses alternating positive and negative half-sinusoids as the basic pulse shape. However, all variations of MSK are continuous phase FSK employing different techniques to achieve spectral efficiency [Sun86].

The MSK waveform can be seen as a special type of a continuous phase FSK if Equation (6.104) is rewritten using trigonometric identities as

$$s_{\mathrm{MSK}}(t) = \sqrt{\frac{2E_b}{T_b}}\cos\left[2\pi f_c t - m_{I_i}(t)m_{Q_i}(t)\frac{\pi t}{2T_b} + \phi_k\right] \tag{6.106}$$

where ϕ_k is 0 or π depending on whether $m_I(t)$ is 1 or –1. From Equation (6.106), it can be deduced that MSK has a constant amplitude. Phase continuity at the bit transition periods is ensured by choosing the carrier frequency to be an integral multiple of one fourth the bit rate, $1/4T$. Comparing Equation (6.106) with Equation (6.97), it can be concluded that the MSK signal is an FSK signal with binary signaling frequencies of $f_c + 1/4T$ and $f_c - 1/4T$. It can further be seen from Equation (6.106) that the phase of the MSK signal varies linearly during the course of each bit period [Pro94, Chapter 10].