# THE DESIGN OF A SERIAL MSK MODEM

by

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# CHAPTER I

# INTRODUCTION

The spectral congestion in the radio frequency (RF) band as a result of increased demand for digital transmission channels has inspired a search for more efficient signaling techniques. The goal is to use as little transmitter power and channel bandwidth as possible without sacrificing error rate performance. The efforts to realize this goal have led to the development of several spectrally efficient digital transmission schemes. These schemes include quadrature phase-shift keying (QPSK), offset QPSK (OQPSK), and minimum shift keying (MSK) [1].

MSK represents a special case of frequency shift keying (FSK) because the frequency separation between the two signaling frequencies is only half that of conventional orthogonal FSK [1], [3]. For this reason, MSK is often referred to as fast FSK. MSK sometimes goes by the name of continuous phase FSK (CPFSK) because of its continuous phase characteristic. This phase continuity and a constant envelope make MSK attractive [1].

This report will consider the MSK signaling scheme, and the primary focus will be on the design of a serial MSK (SMSK) modulator and demodulator (modem). This type of MSK was first described by Amoroso and Kivett [2].

# CHAPTER II

# DESCRIPTION OF MSK

## MSK in General

It has been shown that MSK conceptually resembles OQPSK [1]. Instead of rectangular pulses modulating the in-phase and quadrature channels of a carrier as in OQPSK, sinusoidal pulses modulate the two channels in MSK. First, OQPSK will be reviewed; then, its relationship to MSK will be shown.

As shown in Figure 1, a binary bit stream at a rate of $\frac{1}{T}$ where T is the bit time, has been split into two binary bit streams: one containing only even bits, $b_i(t)$; and one containing only odd bits, $b_q(t)$. When the even bit stream is offset from the odd bit stream by T seconds and these offset bit streams, $b_{io}(t)$ and $b_{qo}(t)$, modulate the in-phase and quadrature channels of a carrier, the sum of the two modulated signals is OQPSK. Figure 2 illustrates this process. Now, if $b_{io}(t)$ and $b_{qo}(t)$ are shaped into sinusoidal pulses, as seen in Figure 3, then the resulting waveform at the output of the summer in Figure 2 will be MSK [1]. The mathematical description of MSK is then

$$s_{MSK}(t) = b_{io}(t)\cos(2\pi f_c t)\cos(\frac{\pi t}{2T}) + b_{qo}(t)\sin(2\pi f_c t)\sin(\frac{\pi t}{2T}) \qquad (1)$$

Recalling that

$$\cos\alpha \cos\beta = \frac{1}{2}\cos(\alpha-\beta) + \frac{1}{2}\cos(\alpha+\beta)$$

$$\sin\alpha \sin\alpha = \frac{1}{2}\cos(\alpha-\beta) - \frac{1}{2}\cos(\alpha+\beta)$$

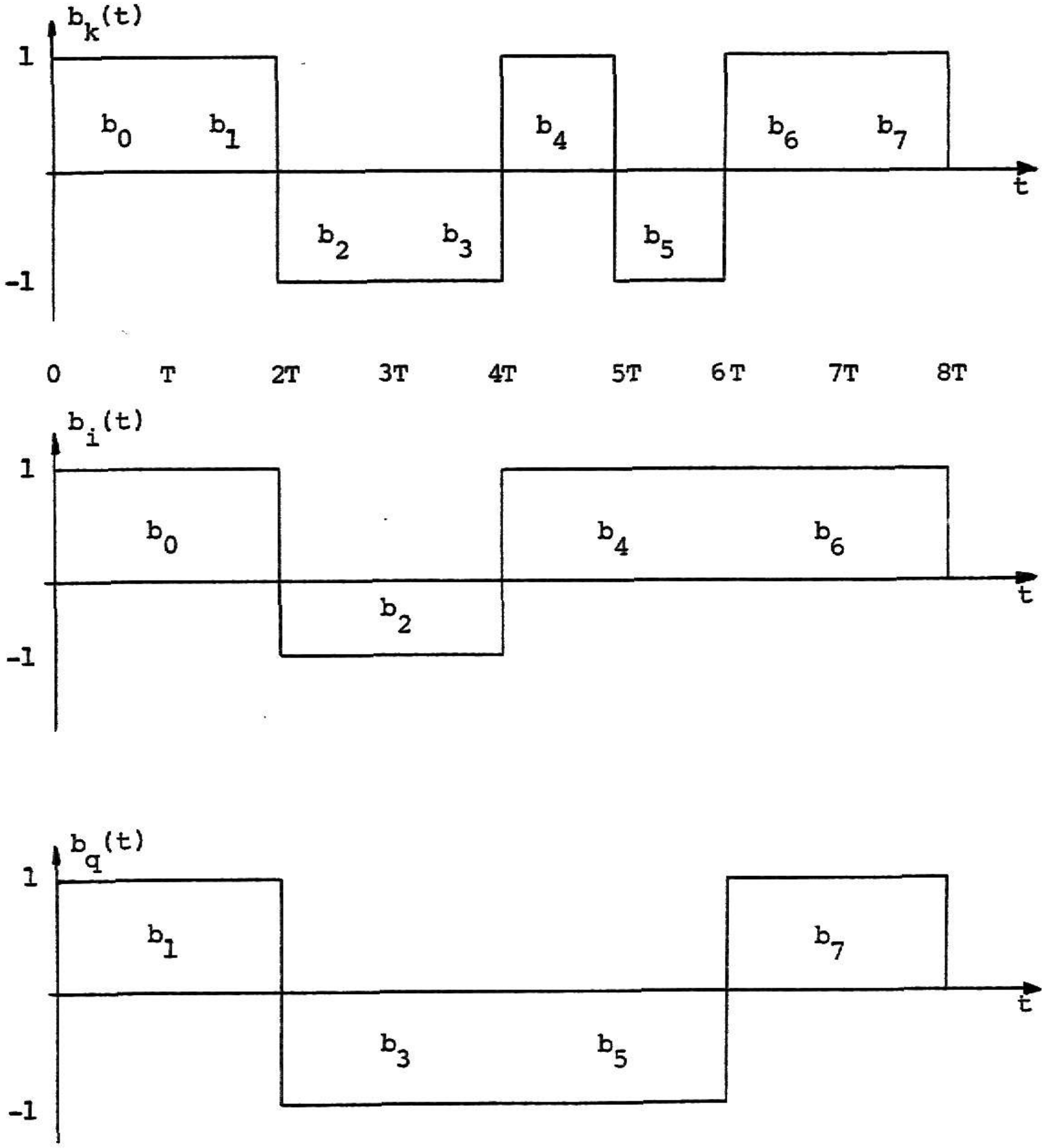

Figure 1. Binary Bit Stream Split into Even and Odd Bit Streams.