SNS COLLEGE OF TECHNOLOGY

An Autonomous Institution

Coimbatore-35

Accredited by NBA – AICTE and Accredited by NAAC – UGC with 'A++' Grade(III Cycle)
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DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

19ECB301-ANALOG AND DIGITAL COMMUNICATION

III YEAR/ V SEMESTER

UNIT 4 – DIGITAL MODULATION TECHNIQUES

TOPIC – MSK

MINIMUM SHIFT KEYING

Minimum Shift Keying (MSK) is one of the most spectrally efficient modulation schemes available. Due to its constant envelope, it is resilient to non-linear distortion and was therefore chosen as the modulation technique for the GSM cell phone standard.

MSK is a special case of Continuous-Phase Frequency Shift Keying (CPFSK) which is a special case of a general class of modulation schemes known as Continuous-Phase Modulation (CPM).

It is worth noting that CPM (and hence CPFSK) is a non-linear modulation and hence by extension MSK is a non-linear modulation as well. Nevertheless, it can also be cast as a linear modulation scheme, namely Offset Quadrature Phase Shift Keying (OQPSK), which is a special case of Phase Shift Keying (PSK).

MINIMUM SHIFT KEYING

- Minimum-shift keying (MSK)
  - Consider a continuous-phase frequency-shift keying (CPFSK) signal, which is defined for the interval $0 \le t \le T_b$ as follows:

$$s(t) = \begin{cases} \sqrt{\frac{2E_b}{T_b}} \cos[2\pi f_1 t + \theta(0)] & \text{for symbol 1} \\ \sqrt{\frac{2E_b}{T_b}} \cos[2\pi f_2 t + \theta(0)] & \text{for symbol 0} \end{cases}$$

  - E_b is the transmitted signal energy per bit.
  - T_b is the bit duration.
  - The phase $\theta(0)$, denoting the value of the phase at time $t = 0$, sums up the past history of the modulation process up to time $t = 0$.

MINIMUM SHIFT KEYING

- Minimum-shift keying (MSK)
  - Another useful way of representing the CPFSK signal $s(t)$ is to express it in the conventional form of an angle-modulated signal as follows:

$$s(t) = \sqrt{\frac{2E_b}{T_b}} \cos[2\pi f_c t + \theta(t)] \qquad (*)$$

  - $\theta(t)$ is the phase of $s(t)$.
  - When the phase $\theta(t)$ is a continuous function of time, we find that the modulated signal $s(t)$ itself is also continuous at all times, including the inter-bit switching times.

MINIMUM SHIFT KEYING

- The phase $\theta(t)$ of a CPFSK signal increases or decreases linearly with time during each bit duration of T_b seconds

$$\theta(t) = \theta(0) \pm \frac{\pi h}{T_b} t, \qquad 0 \le t \le T_b$$

The plus (minus) sign corresponds to sending symbol 1 (0).

- We can find that

$$f_c + \frac{h}{2T_b} = f_1 \qquad f_c - \frac{h}{2T_b} = f_2$$

- We thus get

$$f_c = \frac{1}{2}(f_1 + f_2) \qquad h = T_b(f_1 + f_2)$$

MINIMUM SHIFT KEYING

- h is referred to as the *deviation ratio*.
- With h=1/2, the frequency deviation equals half the bit rate. This is the minimum frequency spacing that allows the two FSK signals representing symbols 1 and 0 to be coherently orthogonal.
- At time $t = T_b$:

$$\theta(T_b) - \theta(0) = \begin{cases} \pi h & \text{for symbol 1} \\ -\pi h & \text{for symbol 0} \end{cases}$$

- This is to say, the sending of symbol 1 increases the phase of a CPFSK signal $s(t)$ by πh radians, whereas the sending of symbol 0 reduces it by an equal amount.

MINIMUM SHIFT KEYING

MSK, Minimum Shift Keying is a form of continuous phase frequency shift keying, providing spectrum efficiency & enabling efficient RF power amplifier operation.

Minimum shift keying, MSK, is a form frequency modulation based on a system called continuous-phase frequency-shift keying.

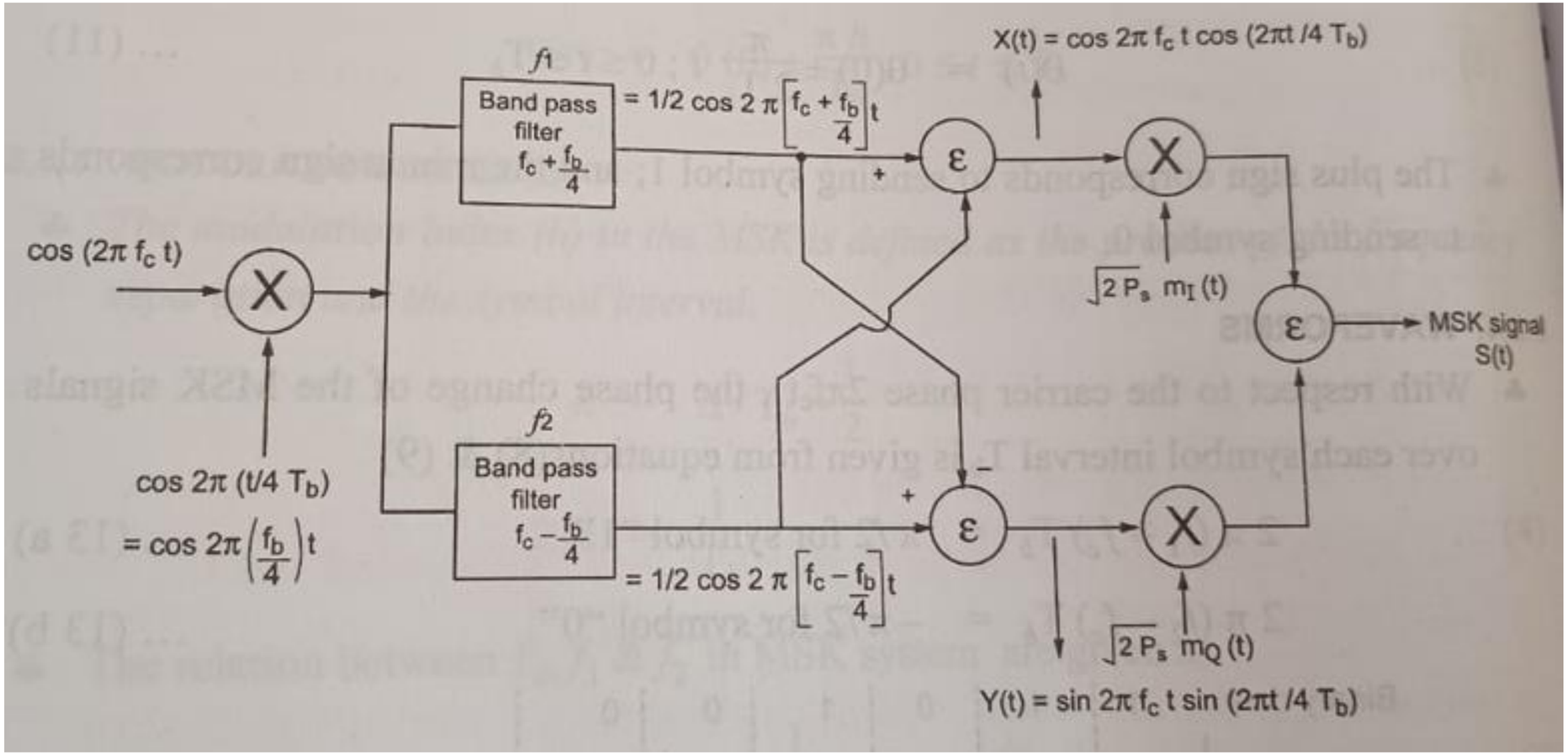
Minimum shift keying, MSK offers advantages in terms of spectral efficiency when compared to other similar modes, and it also enables power amplifiers to operate in saturaton enabling them to provide high levels of efficiency.

NEED OF MINIMUM SHIFT KEYING

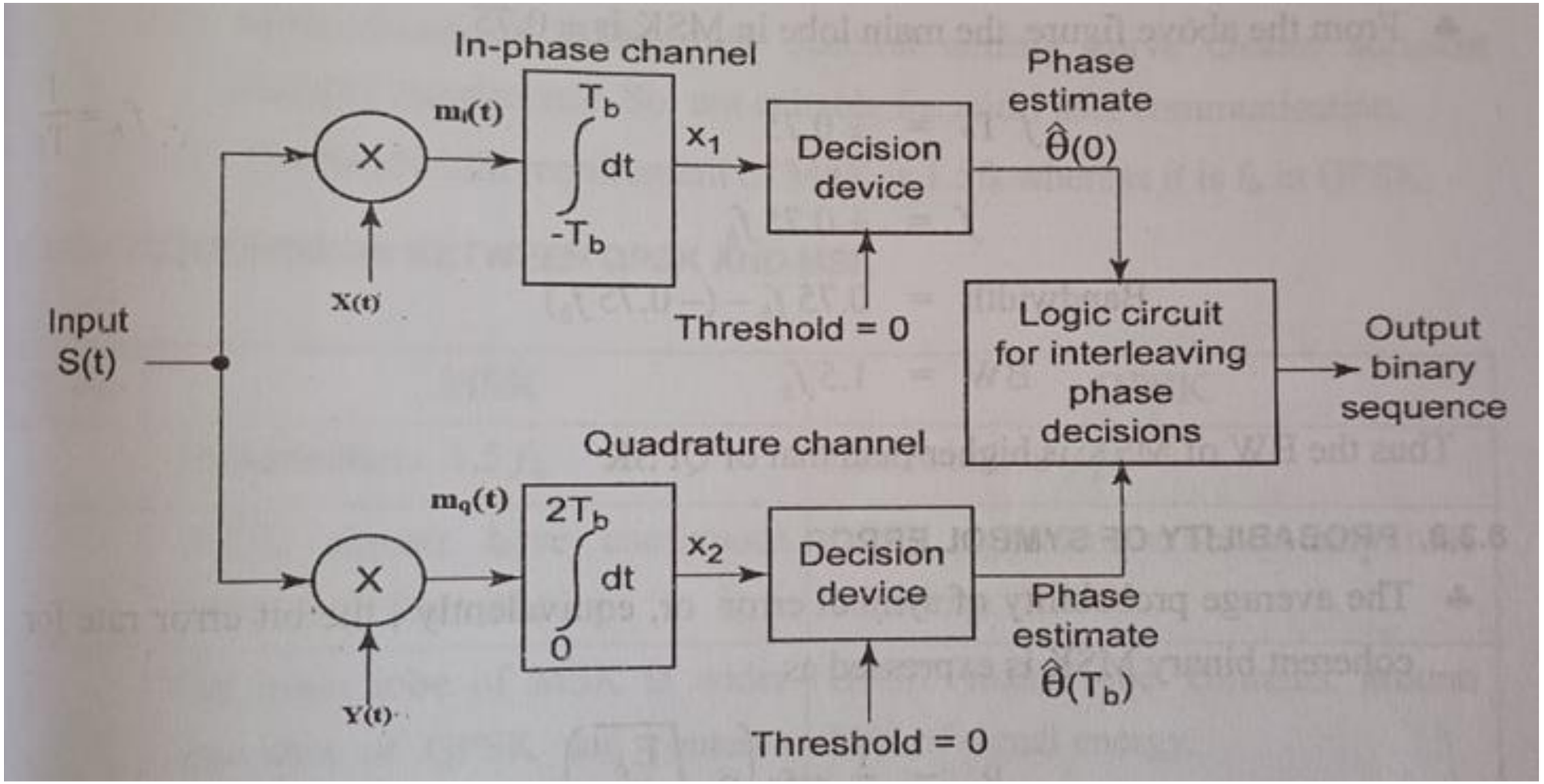
It is found that binary data consisting of sharp transitions between "one" and "zero" states and vice versa potentially creates signals that have sidebands extending out a long way from the carrier, and this creates problems for many radio communications systems, as any sidebands outside the allowed bandwidth cause interference to adjacent channels and any radio communications links that may be using them.

MSK, minimum shift keying has the feature that there are no phase discontinuities and this significantly reduces the bandwidth needed over other forms of phase and frequency shift keying.

MSK TRANSMITTER

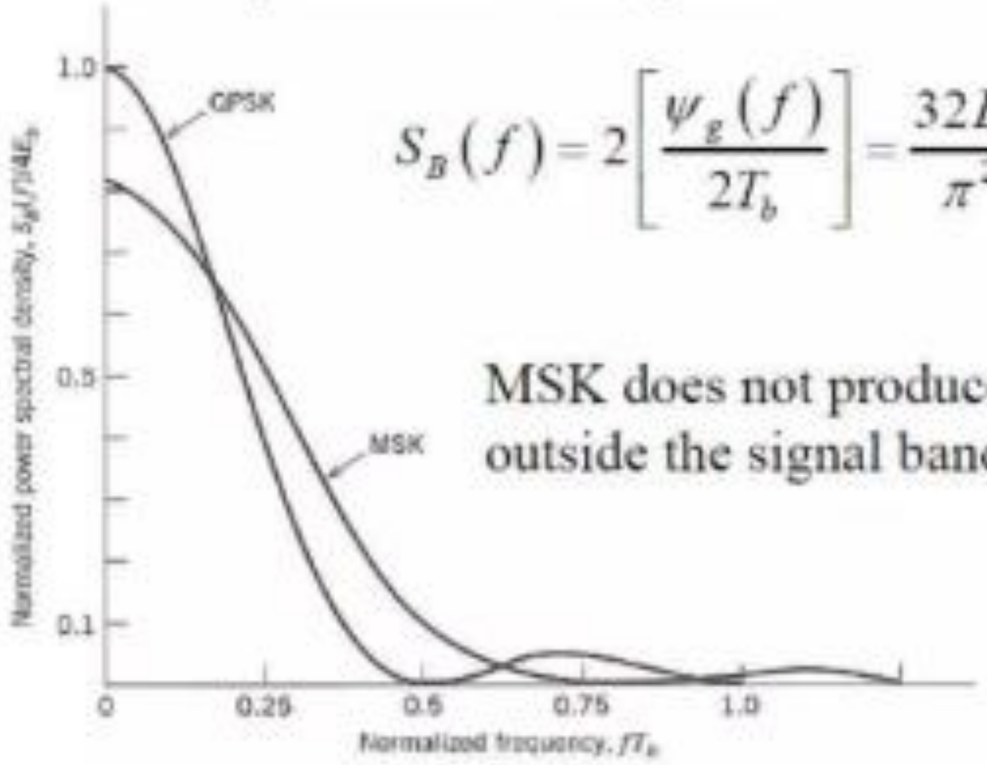


MSK RECEIVER



POWER SPECTRA OF MSK

- Power spectra of MSK signals



$$S_B(f) = 2\left[\frac{\Psi_g(f)}{2T_b}\right] = \frac{32E_b}{\pi^2}\left[\frac{\cos(2\pi T_b f)}{16T_b^2 f^2 - 1}\right]^2$$

MSK does not produce as much interference outside the signal band of interest as QPSK.

ADVANTAGES

- Smoother waveforms
- It has continuous phase in all cases.
- There is no amplitude variations
- Main lobe is wider,contains 99% of signal energy
- Less Interchannel Interference
- Good BER Performance
- Self synchronizing capability.
- MSK is spectrally efficient modulation scheme and is particulary attractive for use in mobile radio communication systems.

DISAVANTAGES

- The generation and detection of MSK signal is slightly complex.
- Because of incorrect synchronization, Phase jitter is present.
- Slow decay of MSK – Power spectral density curve creates adjacent channel interference. So, not suitable for multi user communication.
- The bandwidth requirement of MSK is 1.5fb whereas it is fb in QPSK.

ASSESSMENT

1.Define MSK

2.What is meant by CPFSK.

3.Define Modulation Index.

4.Define the probability of symbol error

THANK YOU