UNIT - III

WIRELESS TRANSCIEVERS.

Structure of a wireless communication link - Modulation and demodulation - QPSK - π/4 DQPSK - Offset QPSK - BFSK - MSK - GMSK - Power Spectrum and Error Performance in fading channel.

INTRODUCTION:

The purpose of communication system is to Txmit information bearing sgls through a comm channel seperating the Txer from Rxer.

Information Bearing Sgls are called as Bare Band sgls

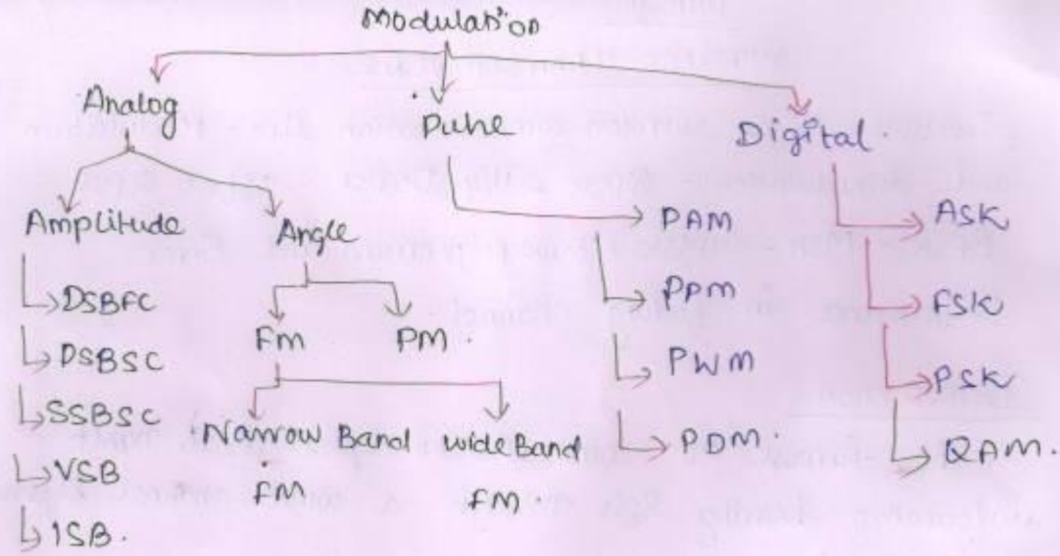
Bare band ⇒ Band of frequencies representing the origi sgl

The Txer modifies the msg sgl to some other format called as Modulation.

∴ It is defined as " The Process of changing the characteristics of the carrier sgl with respect to the Instantaneous change in the original msg sgl (or) modulating sgl.

Depending on the type of carrier, the modulation is classified into.

- Analog
- Pulse
- Digital.



Analog Communication.

The characteristics of the carrier is varied in proportion with the instantaneous value of modulating sgl is called as analog modulation sys.

If the carrier is sinusoidal, then its amp, freq, phase change in accordance with the modulating sgl.

PHASE SHIFT KEYING:

It is a form of angle modulator or constant digital amp modulation.

Here the I/P is a binary digital sel and there are limited number of o/p phases are possible.

It is divided into : BPSK (binary): 0 or 1

QPSK (Quadrature): 00, 01, 10, 11.

Examples Include:

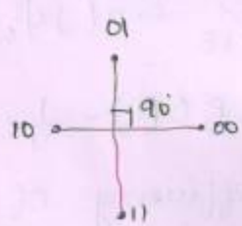
- wireless LAN
- many RFID Systems
- Bluetooth

QPSK:

It is a mthd of Txmiting information across an analog channel.

The data bits are grouped into pairs represented as symbol, that is sent after modulating the carrier.

It Creates 4 diff Symbols one for each pair.



Symbol	phase
00	0
01	90
10	180
11	270

constellation diagram of QPSK

The Original data stream is split into 2 Streams.

b_{1i} , b_{2i} . $b_{1i} = b_{2i}$

$b_{2i} = b_{2i+1}$.

The basic regtangular pulses are $g(t) = g_R(t/T_s)$

first define 2 sequences of pulses.

$$p_{1D}(t) = \sum_{i=-\infty}^{\infty} b_{1i}\, g(t - iT_s) = b_{1i} * g(t)$$

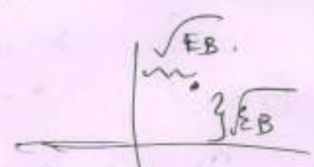
$$p_{2D}(t) = \sum_{i=-\infty}^{\infty} b_{2i}\, g(t - iT_s) = b_{2i} * g(t).$$

when interpreting QPSK as pulse amp modulation, the band pass sgl reads.

$$S_{BP}(t) = \sqrt{\frac{E_B}{T_B}} \left[p_{1D}(t) \cos(2\pi f_c t) - p_{2D}(t) \sin(2\pi f_c t) \right]$$

The Energy within 1 interval is.

$$\int_0^{T_s} S_{BP}(t)^2\, dt = 2E_B.$$



The Base Band Sgl is:

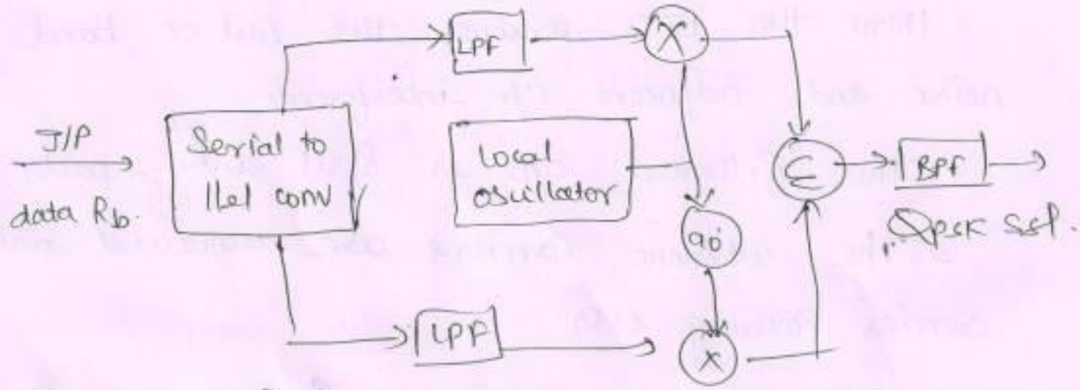
$$S_{LP}(t) = \left[p_{1D}(t) - \tfrac{1}{4}\, p_{1D}(t) \cdot p_{2D}(t) \right].$$

when interpreting QPSK as a phase mod, the low pass sgl is written as.

$$\sqrt{E_B/T_B}\, \exp(j\phi_s(t))$$ with

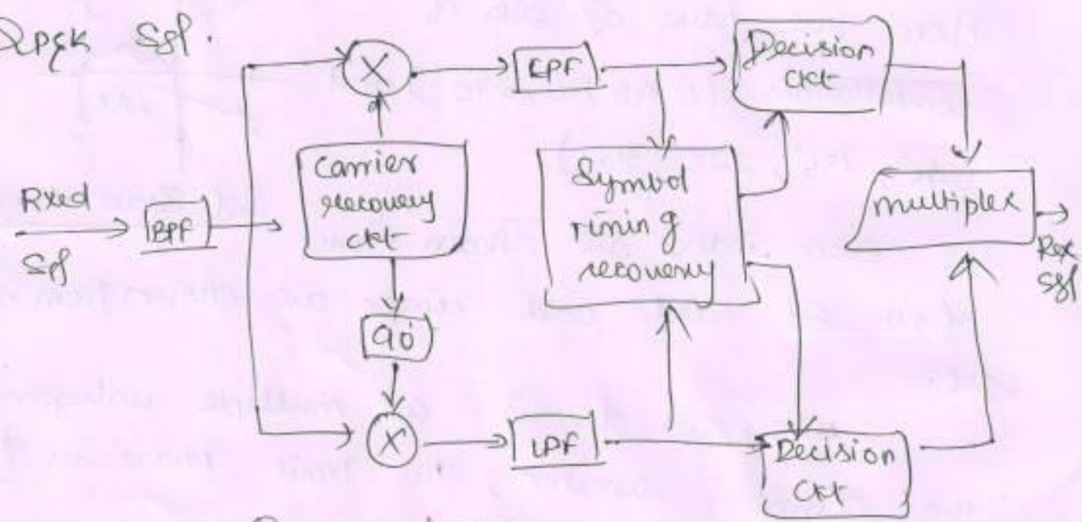
$$\phi_s(t) = \pi \cdot \left[\frac{1}{2} \cdot p_{2D}(t) - \frac{1}{4} \cdot p_{1D}(t) \cdot p_{2D}(t) \right].$$

The spectral efficiency of QPSK is twice the efficiency of BPSK, since both in-phase and the QP have components are exploited for Xion of information.



QPSK Txer

* The unipolar binary msg stream has bit rate R_b is converted into NRZ
* It is splitted into 2 bit streams $m_I(t)$ and $m_Q(t)$ each having $R_S = R_b/2$.
  - → $m_I(t)$ - even stream ⇒ modulated as $\phi_1(t)$
  - → $m_Q(t)$ - odd stream ⇒ modulated as $\phi_2(t)$
* These 2 BPSK Sgl are summed to produce QPSK Sgl.



QPSK Rxer

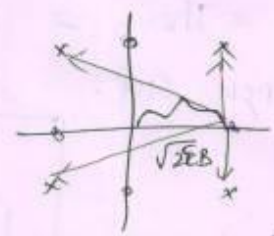
* Here the BPF removes the out of band noise and adjacent Ch interference.
* The filtered o/p is split into 2 parts.
* The coherent carriers are recovered using carrier recovery ckts.
* The spectral efficiency rises to 2.04 @ 1.58 bits/Hz using raised cosine basic pulses.

π/4 DQPSK

Variations of the sgl envelope are undesirable because they make the design of suitable amp more difficult.

It is most important for wireless comm.

Here we have 2 sets of constellations (0°, 90°, 180°, 270°) and (45°, 135°, 225°, 315°).

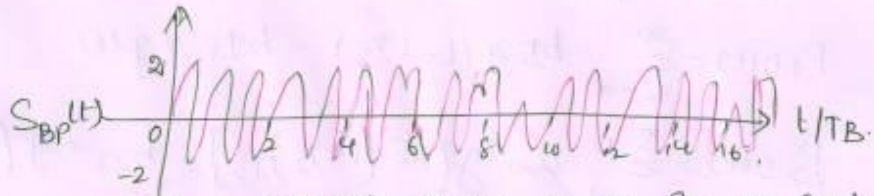


Sgl Space diag

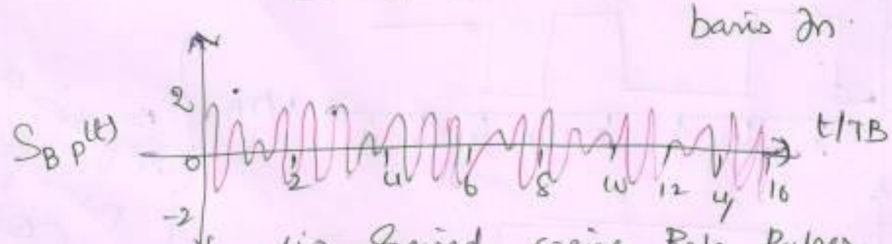
even index are chosen from first set and odd index are chosen from second set.

whenever t is a multiple integer of the symbol duration, the Txmit phase is rxd by π/4.

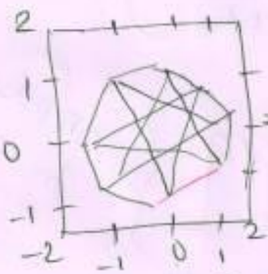
∴ The transitions b/w subsequent sef constellations can never pass through the origin.



(a) π/4 DPSK as a fn of rectangular basis fn



(b) Raised cosine Rolloff Pulses



⟹ IQ diagram of π/4 DQPSK.

The sef phase is given by

$$\phi_s(t) = \pi\left[\frac{1}{2}P_{2D}(t) - \frac{1}{4}P_1D(t)P_2D(t) + \frac{1}{4}\left[\frac{\pm}{T_S}\right]\right]$$

OFFSET - QPSK

Improving the peak to average ratio in QPSK is to make sure that bit txions for the inphase and Quadrature phase components occur at different time instants. ⟹ "OQPSK"

Transitions for inphase component → integer multiples of symbol duration

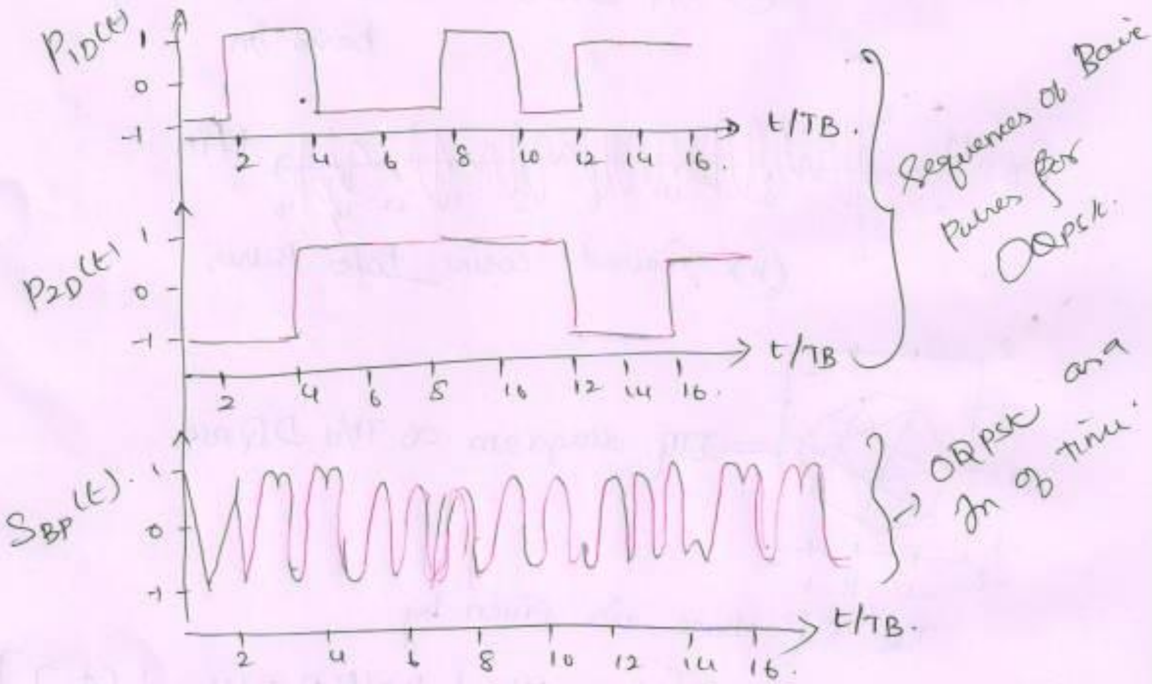
Quadrature component → half a symbol duration.

It helps eliminate Spectrum regrowth after amp.

- The Txmit pulse streams are

$$P_{1D}(t) = \sum_{i=-\infty}^{\infty} b_{1i}\, g(t - iT_S) = b_{1i} * g(t)$$

$$P_{2D}(t) = \sum_{i=-\infty}^{\infty} b_{2i}\, g[t - (i+1/2)T_S] = b_{2i} * g\left(t - \frac{T_s}{2}\right)$$



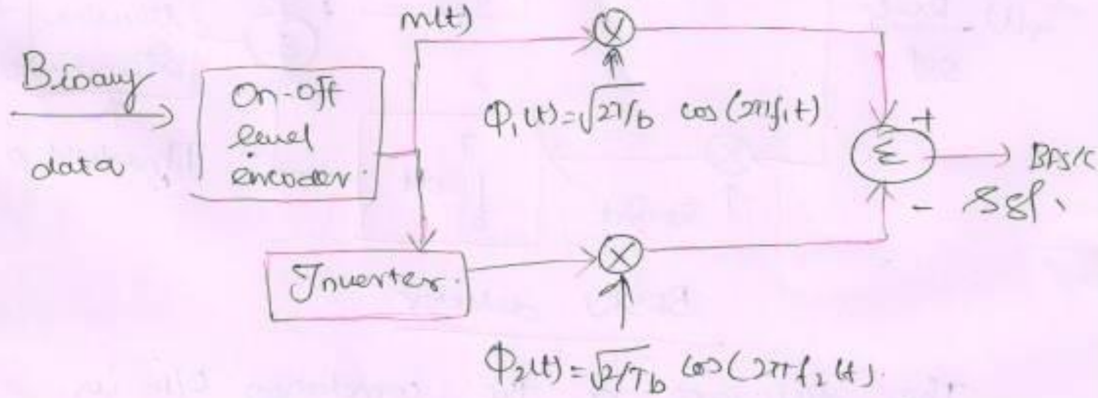
- Here there are no Txtions Passing through the origin, it takes care of envelope fluctuations

BFSK:

The frequency of a constant amp carrier sg is switched b/w 2 values according to the 2 possible msg states (0 and 1).

Here each symbol is represented by Txmiting a sinusoidal sgl, freq depends on the symbol of the txed. FSK cannot be represented as PAM.

$$g_m(t) = \cos\left[(2\pi f_c + b_m 2\pi f_{mod})t / T + \varphi\right].$$

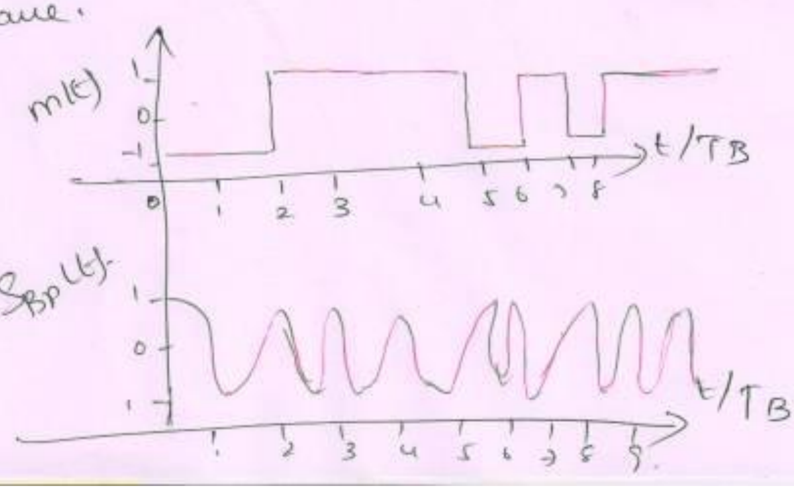


The real & img parts of Base band sgls are.

$$Re(s_{LP}(t)) = \sqrt{2E_B/T_B}\cos\left[2\pi h_{mod}\int_{-\infty}^{t}\tilde{p}_{b,FSK}(t)\,dt\right]$$

$$Im(s_{LP}(t)) = \sqrt{2E_B/T_B}\sin\left[2\pi h_{mod}\int_{-\infty}^{t}\tilde{p}_{b,FSK}(\tau)\,d\tau\right]$$

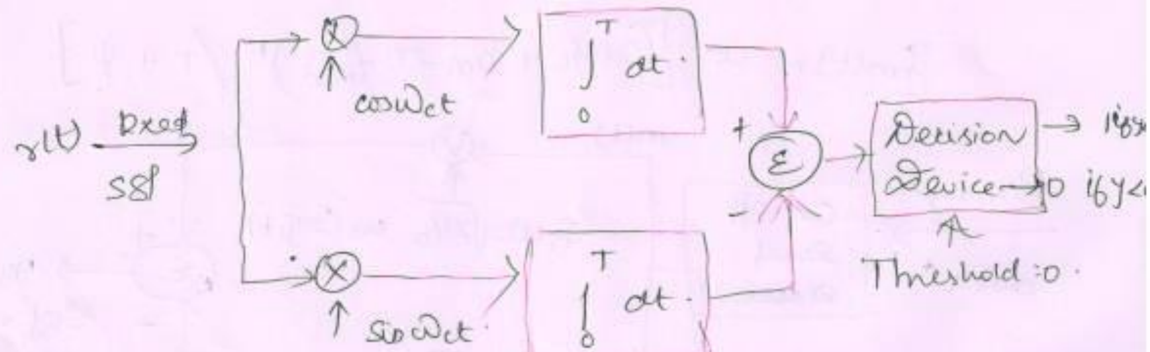
The freq of the modulated wave is shifted with a continous phase in accordance to i/p binary wave.



The Txion Bandwidth of FSK is gn by Carson's rule as:

$B_T = 2\Delta f + 2B$.

$B_T = 2(\Delta f + B)$.

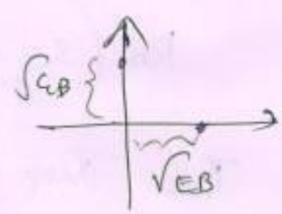


BFSK detector

The difference of the correlation O/P is compared with a threshold comparator.

The probability of error for a coherent FSK Rxer is:

$$P_{e,FSK} = Q\left[\sqrt{\frac{E_b}{N_0}}\right]$$



MSK

It is a continuous phase - frequency shift keying where the peak frequency deviation is 1/4 the bit rate.
The name implies that minimum freq separation that allows orthogonal detection.

Different ways for interpretation:

1. $h_{mod} = 0.5$, $f_{mod} = 1/4T$.

This Implies phase changes by $\pm \pi/2$ at 1 bit durati

2. $g(t) = \sin(2\pi f_{mod}(t+T_B))\, g_R(t, 2T_B)$.

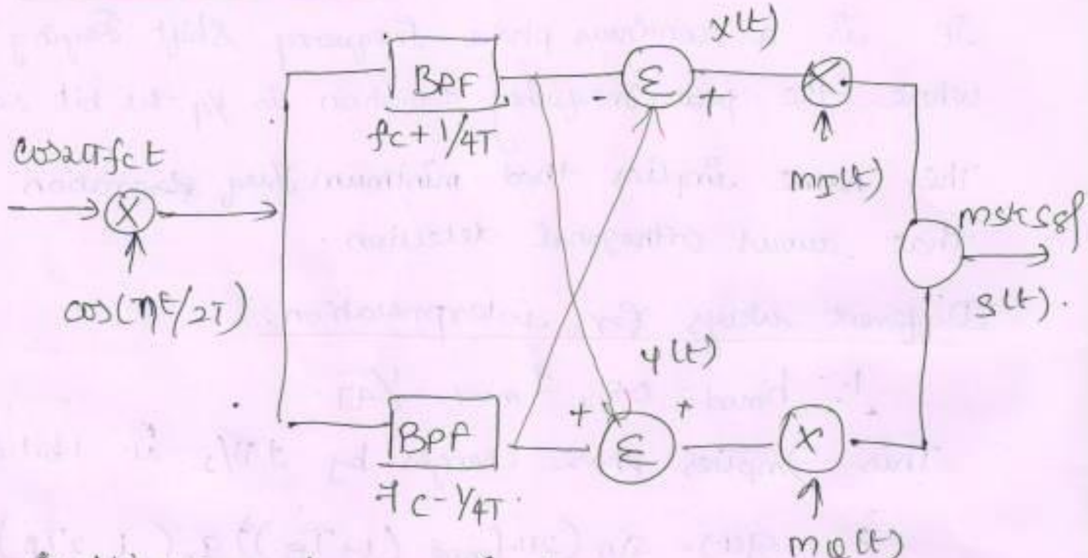
This Implies, basic pulses are sinusoidal halfwave extending over a duration of $2T_B$.

3. $S(f) = \frac{16 T_B}{\pi^2}\left(\frac{\cos(2\pi f T_B)}{1-16 f^2 T_B^2}\right)$.

Properties:
- constant envelope
- Spectral efficiency
- Good BER performance
- Self - Synchronizing capability.

MSK has lower spectral efficiency when the energy Bandwidth is 90% (1.29 bits/s) but still performs better if 99% (0.85 bits/s)

MSK Modulator:

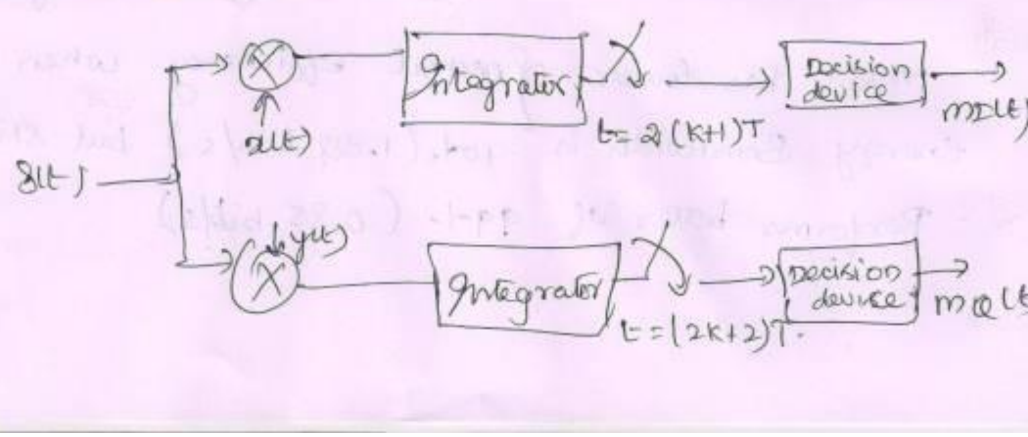


multiplying by $\cos(\pi t/2T)$ Produces 2 phase correlation sgls $f_c + 1/4T$, $f_c - 1/4T$

They are seperated by 2 Band pass filters and combined to form in-phase and quadrature carrier components x(t), y(t).

These are multiplied by odd, even bit streams to produce MSK sgl.

MSK demodulator:



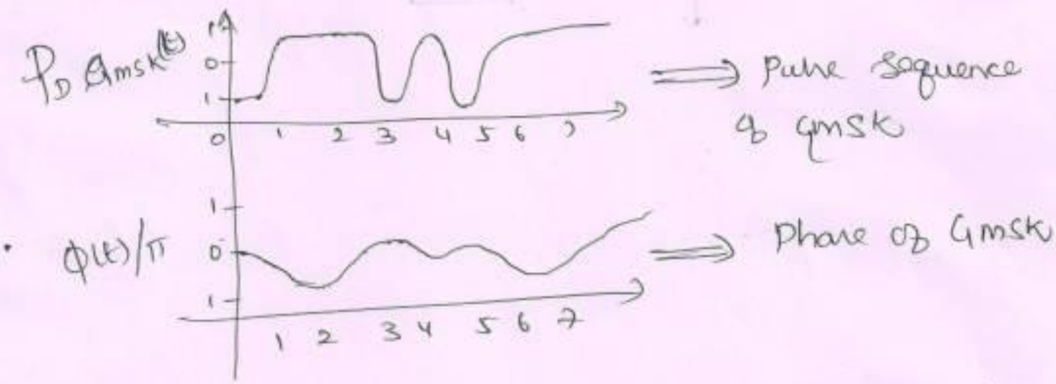
GMSK

The Spectral efficiency of MSK is low. This is eliminated by GMSK.

Its modulation index = 0.5, $\tilde{g}(t) = g_G(t, T_B, B_G T)$.

So, the sequence of Txmit phase pulse is.

$$P_D(t) = \sum_{i=-\infty}^{\infty} b_i \tilde{g}(t - iT_B) = b_i * \tilde{g}(t)$$



The Gmsk has irreducible error rate that is less than produced by the mobile channel,

Has high power efficiency, spectral efficiency.

The Probability of Error of Gmsk is.

$$P_e = Q\left\{\sqrt{\frac{2\gamma E_b}{N_0}}\right\}.$$

Gmsk Txer: