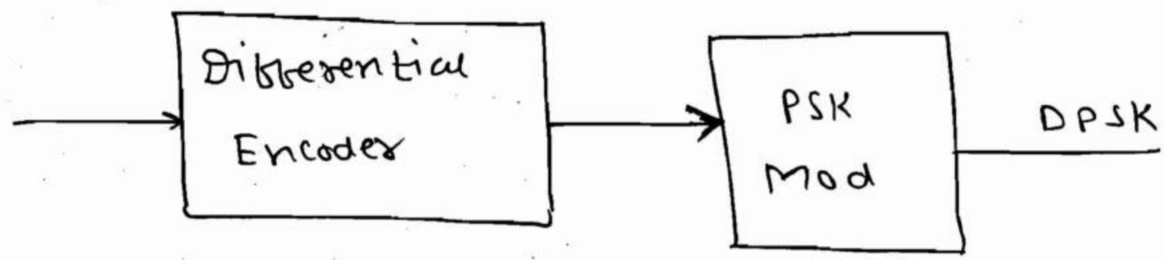
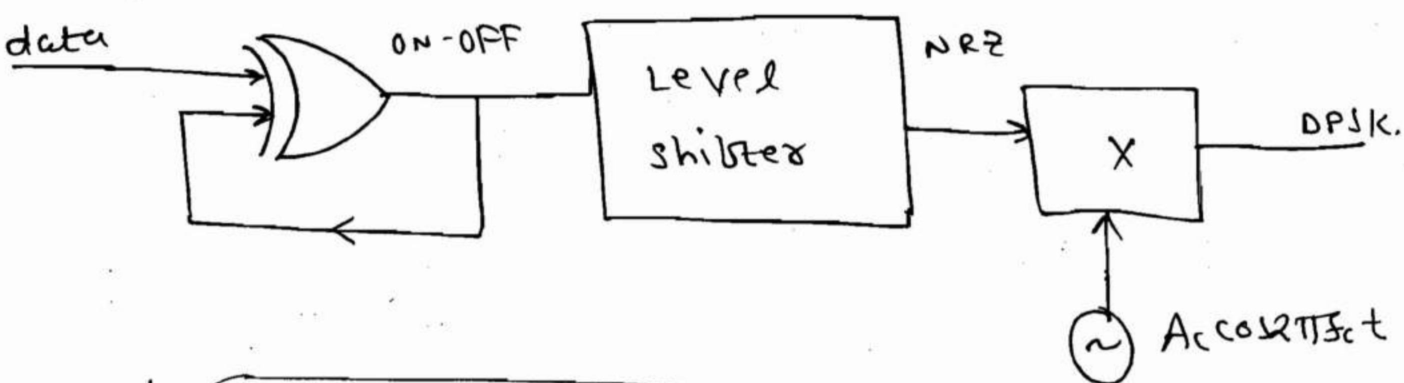
Differential PSK:

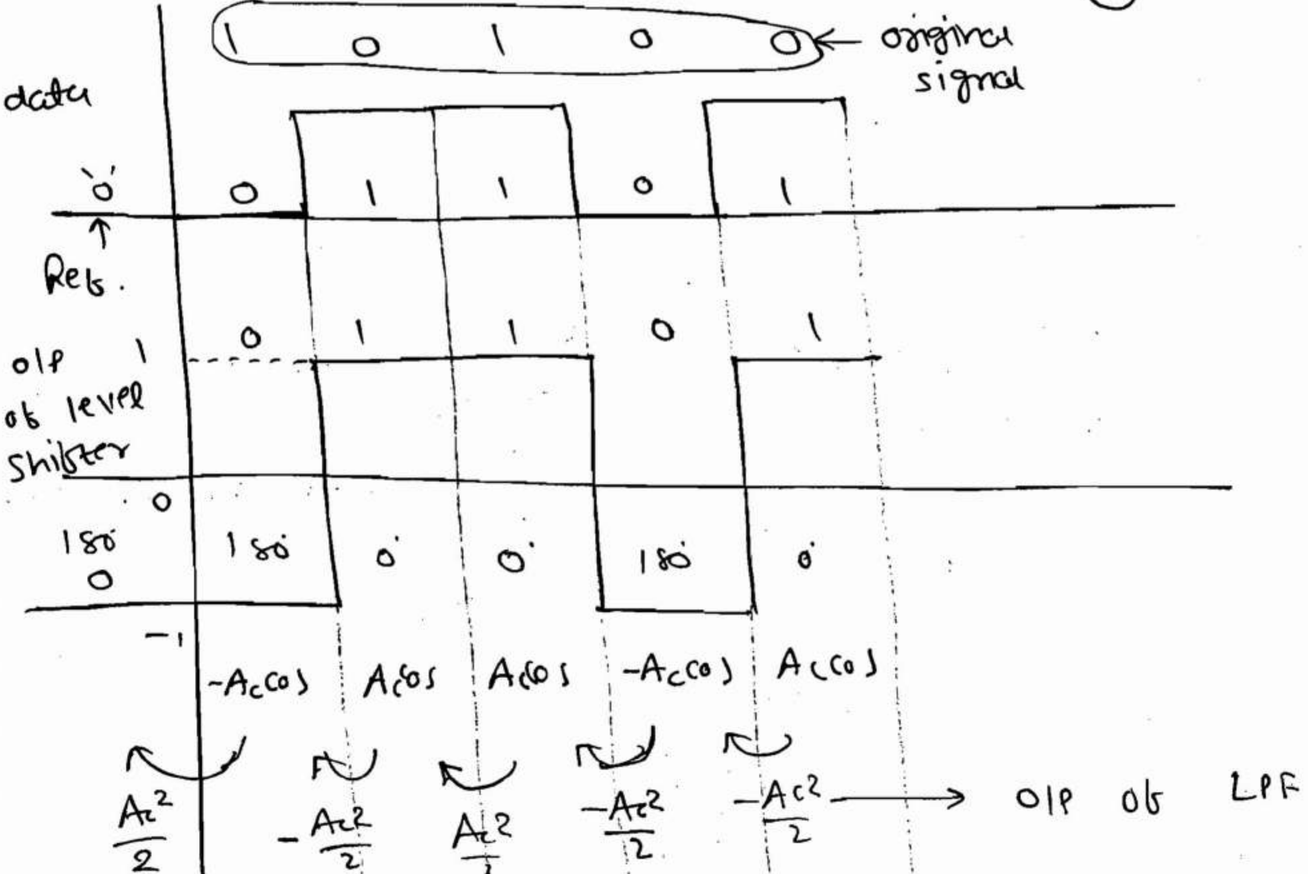
⇒ The binary data is differentially encoded and applied to a PSK modulator to generate the DPSK signal.

⇒



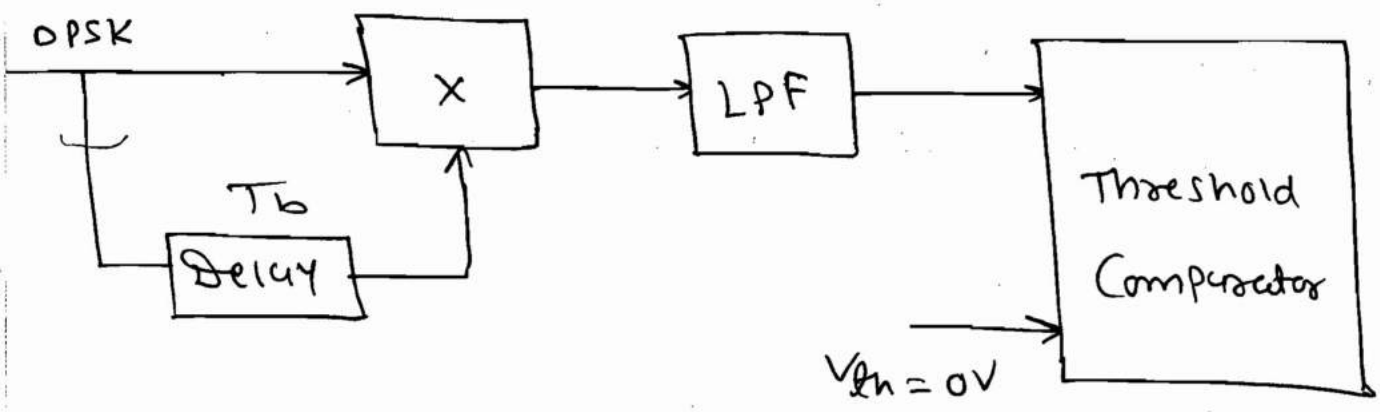
⇒





* Demodulation of DPSK:

=>



=> Local oscillator is not required in DPSK, so, synchronization is not required betn the Tx & Rx.

=>

0 0 1 0 0 1	0 0 1 0 0 1
'1' → 0 1 1 0 1 1	'0' → 1 0 0 1 0 0
π 0 0 π 0 0	0 π π 0 π π.

☆ M-ary Signaling:

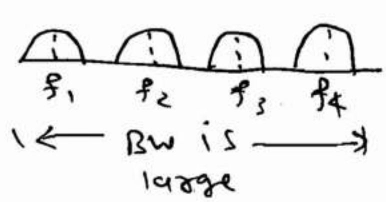
=> Binary signaling

M=2 → 1 → f_1 BFSK → M=4 — f_1, — f_2, — f_3, — f_4 QFSK

0 → f_2

→ 1 → ϕ_1 BPSK

0 → ϕ_2



→ M=4 QPSK

— ϕ_1

— ϕ_2

M=8 → 8PSK

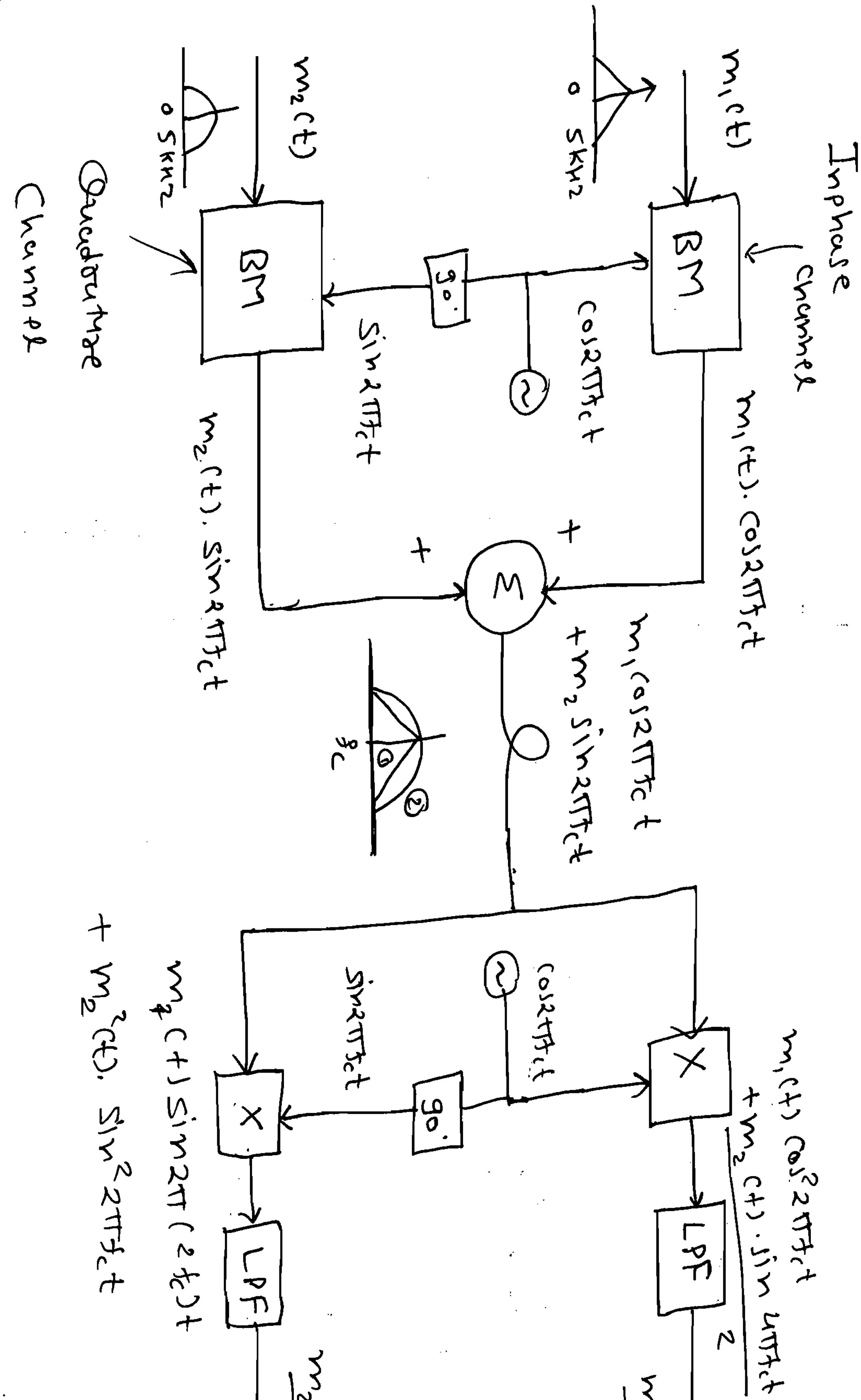
ϕ_1

ϕ_2

⋮

⇒ In M-ary signalling M-descrete voltage levels are transmitted into free space using digital communication.

* <u>Quadrature</u> <u>Carrier</u> <u>Multiplexing:</u>



⇒ It is also called as orthogonal freq. division multiplexing.

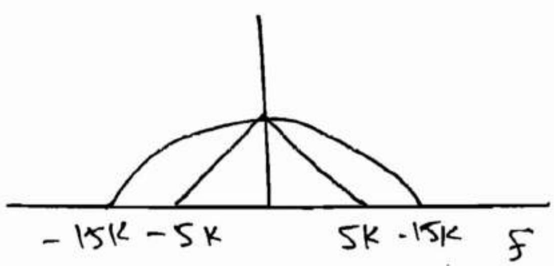
$$\int f_1(t) \cdot f_2(t)\, dt = 0.$$

⇒ It is used in CDMA mobile phone.

$\boxed{Q}$ Consider a multiplexed signal $m_1(t)\cos 2\pi f_c t + m_2(t) \cdot \sin 2\pi f_c t$. $m_1(t)$ is band-limited to 10KHZ and $m_2(t)$ is band-limited to 15 KHZ. Determine BW of the multiplexed signal:

Sol^n:

⇒

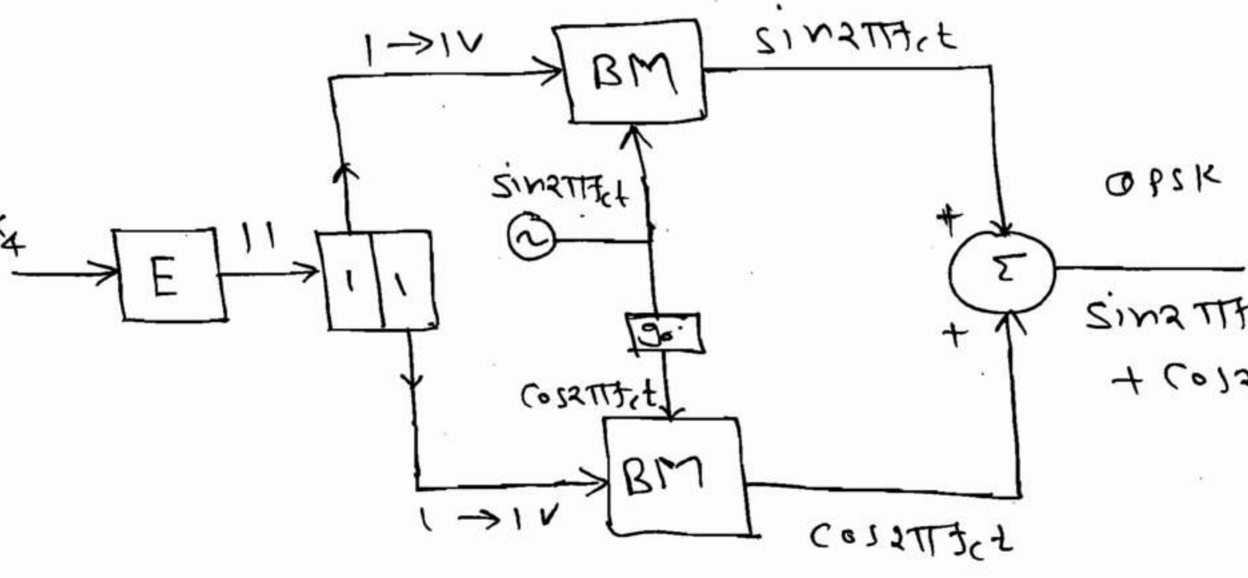


⇒ BW = 2 x highest freq.

$\boxed{BW = 30\,KHZ}$

* Quadrature phase shift keying: (QPSK).

⇒



$\Rightarrow$ X_1 —— 00 $\rightarrow$ $\phi_1 = -135°$.

X_2 —— 01 $\rightarrow$ $\phi_2 = 135°$.

X_3 —— 10 $\rightarrow$ $\phi_3 = -45°$.

X_4 —— 11 $\rightarrow$ $\phi_4 = 45°$.

$\Rightarrow$ $X_1 \rightarrow 00 \rightarrow -\sin 2\pi f_c t - \cos 2\pi f_c t$

$= \sqrt{2}\left(\sin(2\pi f_c t + 225°)\right)$

$= \sqrt{2}\left(\sin(2\pi f_c t - 135°)\right).$

$\Rightarrow$ $X_2 \rightarrow 01 \rightarrow -\sin 2\pi f_c t + \cos 2\pi f_c t$

$= \sqrt{2}\sin(2\pi f_c t + 135°).$

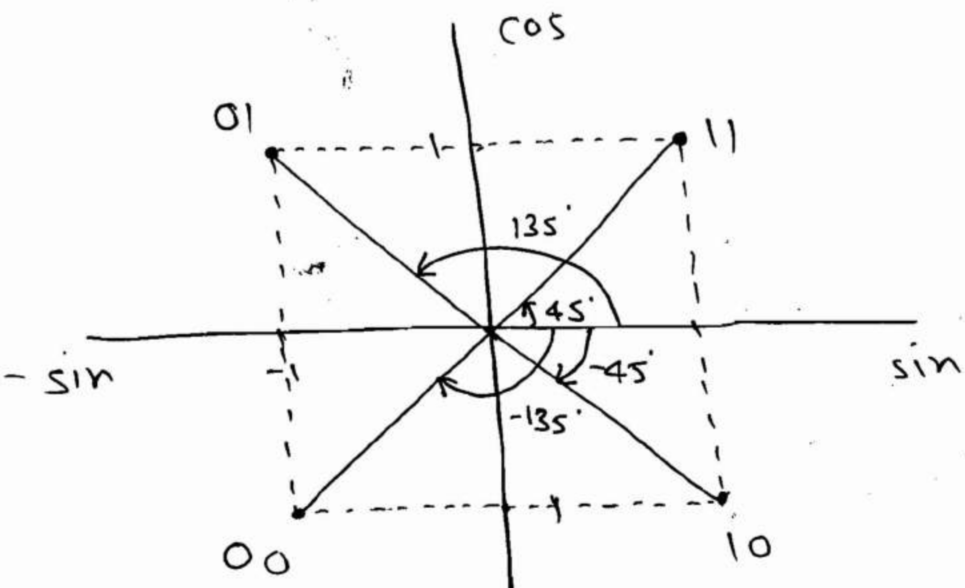
$\Rightarrow$ $X_3 \rightarrow 10 \rightarrow \sin 2\pi f_c t - \cos 2\pi f_c t$

$= \sqrt{2}\sin(2\pi f_c t - 45°)$

$\Rightarrow$ $X_4 \rightarrow 11 \rightarrow \sin 2\pi f_c t + \cos 2\pi f_c t$

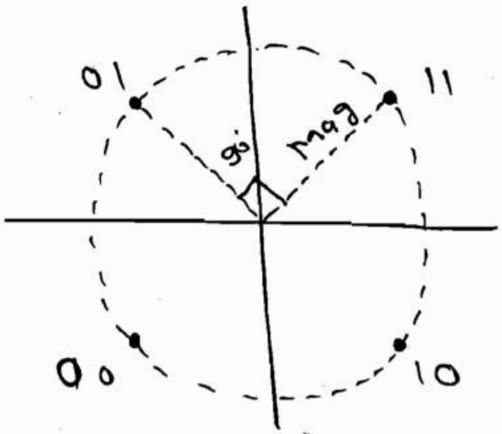
$= \sqrt{2}\sin(2\pi f_c t + 45°).$

* <u>Phasor Diagram:</u>

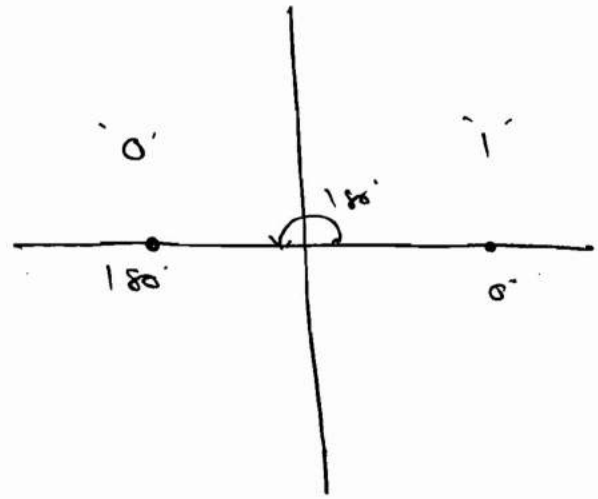


* Constellation Diagram:

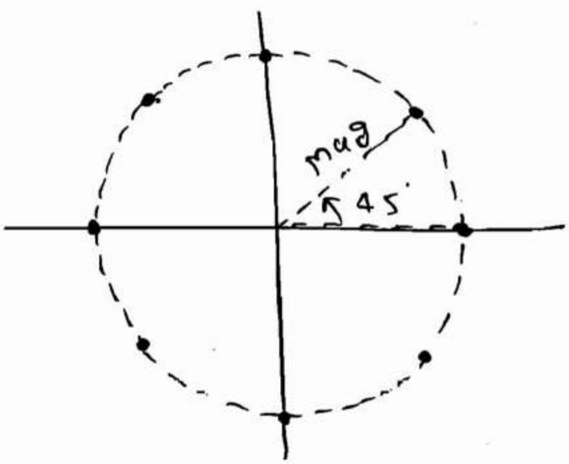
① QPSK:

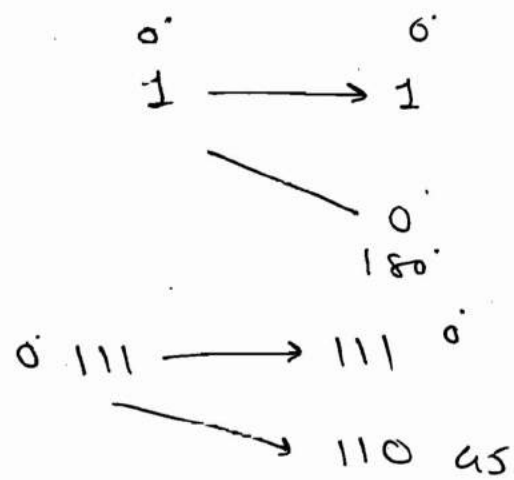


② BPSK:



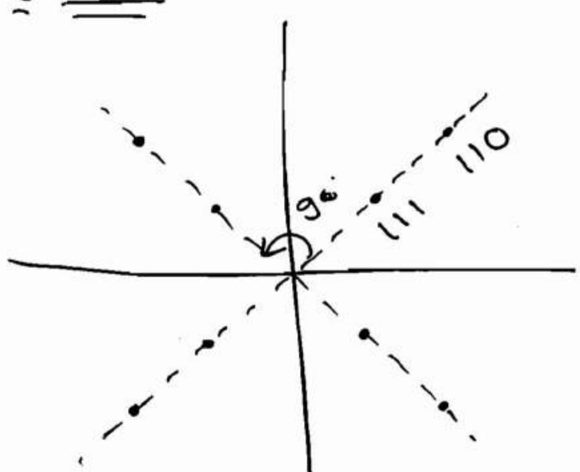
③ 8PSK:





⇒ As M increases angular suppression decreases (or) probability of error increases.

④ 8 QAM

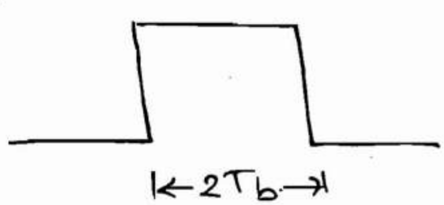


⇒ The input to the QPSK modulator is 2 bits at a time. The duration of this two bits is $2T_b$ sec. one bit is applied to the inphase channel and the other bit is applied to the Quadrature channel. at the same time.

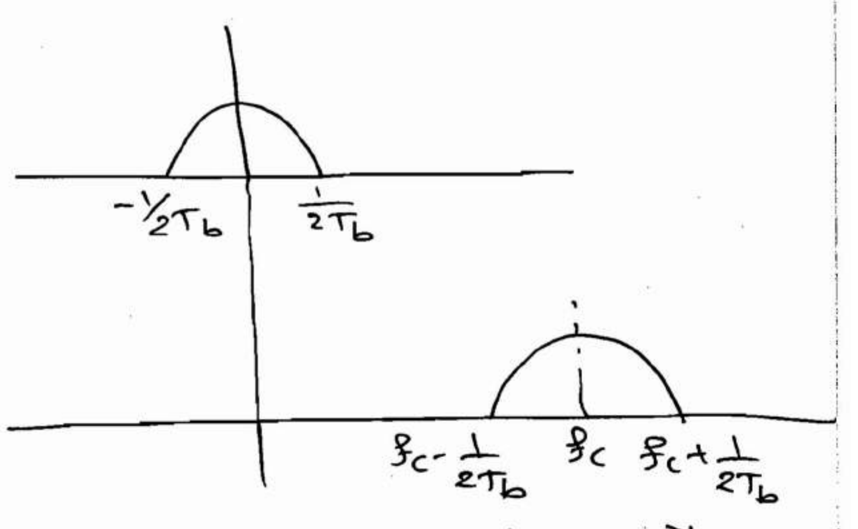
⇒ The i/p to the Balanced Modulator is a rectangular pulse but the pulse width is $2T_b$ sec.

⇒ one pulse is multiplied with the $\cos 2\pi f_c t$ and one pulse is multiplied by $\sin 2\pi f_c t$. So, both occupy the same freq. range but interference not occure as the carriers are ortho-gonal to each other.

⇒



$\longleftrightarrow$



$$\boxed{BW = \frac{1}{T_b} = R_b}$$

* Generalized formula to determine BW of M-ary signaling:

$$\Rightarrow \quad \boxed{BW = \frac{2R_b}{\log_2 M}} \quad \text{IMP}$$

① BPSK → $M = 2$

$$BW = \frac{2R_b}{\log_2 2} = 2R_b$$

② QPSK → $M = 4$
(QAM)

$$BW = \frac{2R_b}{\log_2 2^2} = \frac{2R_b}{2\log_2 2} = R_b.$$

③ 8-PSK → $M = 8$

$$BW = \frac{2R_b}{\log_2 2^3} = \frac{2}{3}R_b.$$

* Baud rate:

Bit rate		Baud rate
110110 6 bits/sec	→ [BPSK] →	0° 0° 180° 0° 0° 180° 6 phase/sec
110110 6 bits/sec	→ [QPSK] →	45° 135° −45° 3 phase/sec.

$$\Rightarrow \therefore \boxed{\text{Baud rate} = \frac{\text{Bit rate}}{\log_2 M} = \frac{R_b}{\log_2 M} = \frac{BW}{2}}$$

$\Rightarrow$ Band width efficiency :-

$$\boxed{\eta = \frac{R_b}{BW}}$$

$$BPSK \rightarrow \eta = \frac{R_b}{2R_b} = 50\%$$

$$QPSK \longrightarrow \eta = \frac{R_b}{2R_b} = 100\%$$