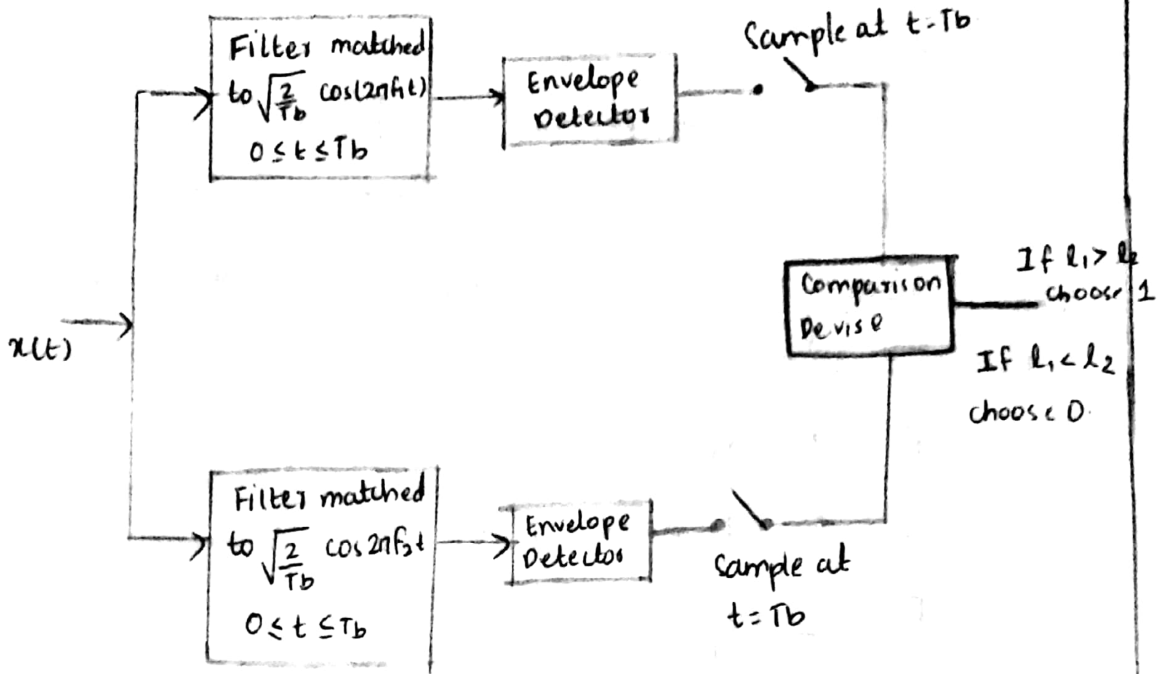
Non-Coherent Binary FSK :-



Non coherent Rx for Detection of binary FSK signals

In the binary FSK system, the transmitted signal is

$$s_i(t) = \begin{cases} \sqrt{2E_b/T_b}\cos 2\pi f_i t & 0 \le t \le T_b \\ 0 & \text{else.} \end{cases}$$

where the carrier frequency f_i equals one of two possible values f_1 & f_2.

f_1 Transmitted signal frequency f_1 represents symbol 1

f_2 represents symbol 0

For non coherent detection the Rx consists of two matched filters followed by two envelope detectors.

Upper path filter matched to $\sqrt{\frac{2}{T_b}}\cos 2\pi f_1 t$ $\quad 0 \le t \le T_b$

lower path filter matched to $\sqrt{\frac{2}{T_b}}\cos 2\pi f_2 t$ $\quad 0 \le t \le T_b$

The o/p of the envelope detectors are sampled at t=Tb. The sampled values l_1 & l_2 are compared.

If $l_1 > l_2$, the Rx decides in favour of '1'

if $l_1 < l_2$ the Rx decides in favour of '0'

The probablity of error for non-coherent modulation scheme is given by

$$P_e = \frac{1}{2} \exp\left(-\frac{E}{2N_0}\right)$$

For non-coherent BFSK $E = E_b$ & $T = T_b$.

$$P_e = \frac{1}{2} \exp\left(-\frac{E_b}{2N_0}\right)$$

DPSK [Differential Phase Shift Keying]

DPSK is the non-coherent orthogonal version of PSK.

It eliminates the need for a coherent reference signal at the Rx by combining 2 basic operations at the transmitter.

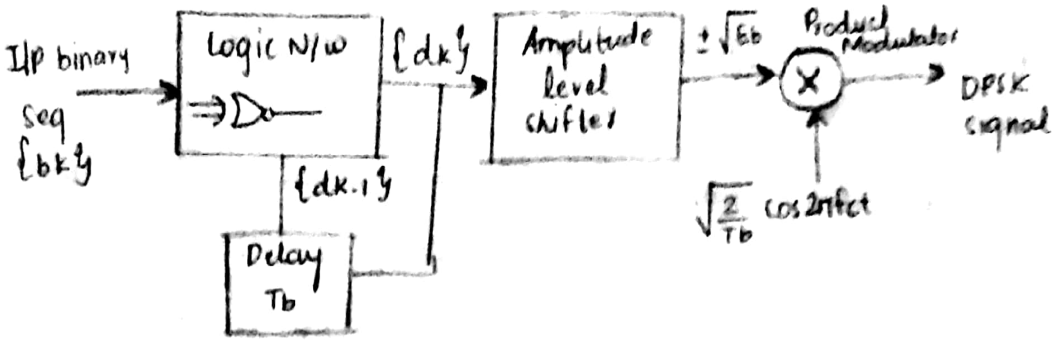
i) differential encoding of i/p binary wave.

ii) phase shift keying.

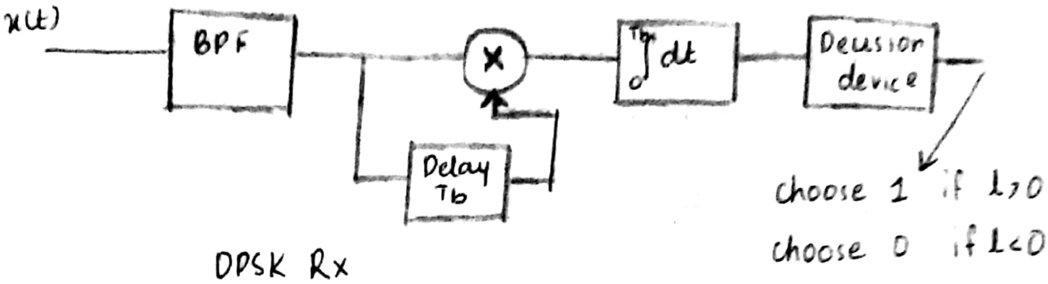
To send symbol '0', phase advance the current signal by 180°

To send symbol '1' phase of current signal is unchanged.

Rx consists of storage elements to measure the relative phase difference b/w the waveforms received in the two successive bit intervals.



DPSK Tx



DPSK Rx

Consider a signal $s_1(t)$ transmitted over two bit intervals $0 \le t \le 2T_b$.

$$s_1(t) = \begin{cases} \sqrt{\frac{E_b}{2T_b}} \cos 2\pi f_c t & 0 \le t \le T_b \\ \sqrt{\frac{E_b}{2T_b}} \cos 2\pi f_c t & T_b \le t \le 2T_b. \end{cases}$$

Since in the second bit interval the phase of the transmitted signal is unaltered wrt that of first $\therefore$ the transmitted bit during second bit interval is 1

Consider signal $s_2(t)$ transmitted over two bit intervals

$$s_2(t) = \begin{cases} \sqrt{\frac{E_b}{2T_b}} \cos 2\pi f_c t & 0 \le t \le T_b \\ \sqrt{\frac{E_b}{2T_b}} \cos (2\pi f_c t + \pi) & T_b \le t \le 2T_b \end{cases}$$

In the signal transmitted during second interval, the phase is advanced by 180° ∴ the transmitted bit is '0'

Observe the expression of $s_1(t)$ & $s_2(t)$ for 2 bit intervals $(0 \le t \le 2T_b)$ indeed they are orthogonal.

In other words, DPSK is a special case of noncoherent orthogonal modulation with

$$T = 2T_b \quad \& \quad E = 2E_b$$

Average probablity of error for non-coherent orthogonal modulation is given by

$$P_e = \frac{1}{2} \exp\left(-\frac{E}{2N_0}\right)$$

$$P_e = \frac{1}{2} \exp\left(-\frac{E_b}{N_0}\right)$$

The first step in DPSK Tx is differential encoding. We take an arbitrary initial bit & we use the following logic eq (XNOR)

$$d_k = b_k \oplus d_{k-1}$$

$$d_k = d_{k-1} \cdot b_k + \bar{d}_{k-1} \bar{b}_k$$

d_k - present o/p bit (at $t = kT_b$)

d_{k-1} - previous o/p bit (at $t = (k-1)T_b$)

b_k - present i/p bit

Consider an i/p binary message sequence

1 0 0 1 0 0 1 1

$\{b_K\}$		1	0	0	1	0	0	1	1
$\{\bar{b}_K\}$		0	1	1	0	1	1	0	0
$\{d_{K-1}\}$		1	1	0	1	1	0	1	1
$\{\bar{d}_{K-1}\}$		0	0	1	0	0	1	0	0
$\{b_K d_{K-1}\}$		1	0	0	1	0	0	1	1
$\{\bar{b}_K \bar{d}_{K-1}\}$		0	0	1	0	0	1	0	0
Differentially encoded sequence $\{d_K\}$	1	1	0	1	1	0	1	1	1
Transmitted phase (radians)	0	0	π	0	0	π	0	0	0

Volt threshold.

There by decision is made in favour of symbol 0 or 1. If o/p is +ve, the phase diff is b/w $-\pi/2$ to $\pi/2$ & the decision is favour of '1'

If o/p is −ve, the phase diff lies outside the range $-\pi/2$ to $\pi/2$ & decision is in favour of 0