Concept of Bit Rate 'R_b' and Baud Rate 'N_b'

Bit Rate R_b = No. of bits transmitted / sec

Baud Rate N_b = No. of symbols/levels transmitted / sec

if each symbol consists of TWO bits : $N_b = \frac{R_b}{2}$

" " THREE " : $N_b = \frac{R_b}{3}$

In General, Baud Rate, $\boxed{N_b = \frac{R_b}{M}}$

M = No. of bits/symbol

0	1	1	0	0	1	0	1

1 symbol = 1 bit $N_b = R_b$

or 1 bit/symbol

0	1	1	0	0	1	0	1

1 symbol = 2 bits $N_b = \frac{R_b}{2}$

2 bits/symbol

Note:· In ASK

$R_b = N_b$.

$B_T = (1+\alpha) R_b$

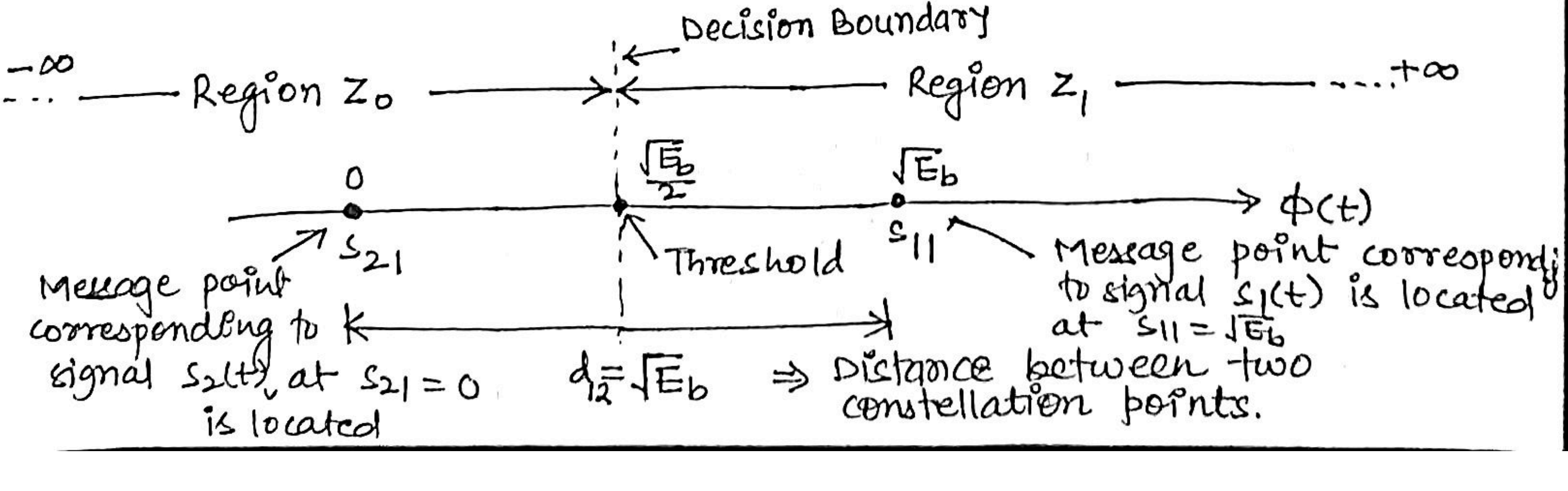
$B_T = (1+\alpha) N_b$.

It refers to a set of possible message points.

Constellation Diagram (signal-space Diagram) :– Constellation diagram is a graphical representation of the complex envelope of each possible symbol state.

Symbol 1 : $s_{11} = \sqrt{E_b}$

Symbol 0 : $s_{21} = 0$

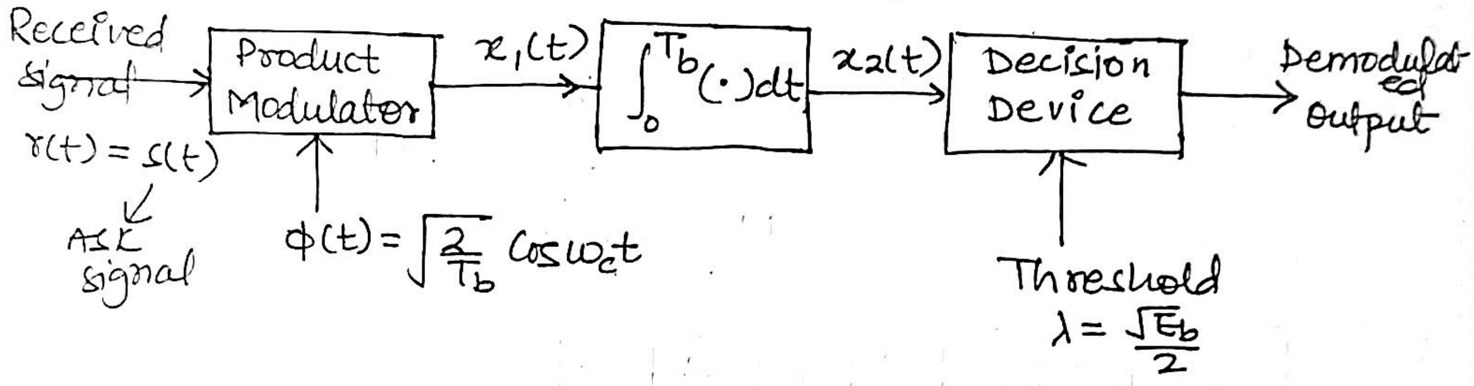


Decision region $Z_1 \approx$ symbol $1 \approx \left(\frac{\sqrt{E_b}}{2} \text{ to } +\infty\right)$

Decision region $Z_0 \approx$ symbol $0 \approx \left(-\infty \text{ to } \frac{\sqrt{E_b}}{2}\right)$

Threshold value $= \frac{\sqrt{E_b}}{2}$

Demodulation of ASK :- (Coherent Demodulator)



$r(t) = s(t) = \sqrt{E_b}\, \phi(t)$ → (Absence of Noise)

$$x_1(t) = s(t)\phi(t)$$
$$= \sqrt{E_b}\, \phi^2(t)$$

$$x_2(t) = \int_0^{T_b} x_1(t)\, dt = \int_0^{T_b} \sqrt{E_b}\, \phi^2(t)\, dt = \sqrt{E_b} \underbrace{\int_0^{T_b} \phi^2(t)\, dt}_{1}$$

Unit energy basis fun^n

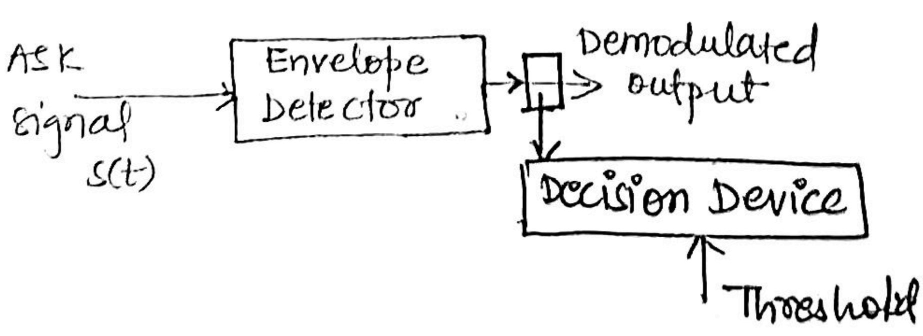
$$x_2(t) = \sqrt{E_b}$$

if $x_2(t) > \lambda$ bit 1 is received

$x_2(t) \leq \lambda$ bit 0 is received

$$\lambda = \frac{\sqrt{E_b}}{2}$$

Non-Coherent Demodulator



Binary Frequency shift Keying (BFSK)

- The frequency of carrier signal (Analog carrier) is varied in accordance with the instantaneous values of the modulating signal (Binary Data).
- In FSK, it is the frequency of the carrier signal that is switched between two values, one representing bit '1' and other representing bit '0'.

$$s(t) = \begin{cases} A_c \cos \omega_{c1} t, & \text{for bit '1'} \\ A_c \cos \omega_{c2} t, & \text{for bit '0'} \end{cases}$$

Mark Frequency, $\omega_{c1} = \omega_c + \Omega$

space Frequency, $\omega_{c2} = \omega_c - \Omega$

$$s(t) = \begin{cases} \sqrt{\dfrac{2E_b}{T_b}} \cos 2\pi f_{c1} t, & \text{for bit '1'} \\ \sqrt{\dfrac{2E_b}{T_b}} \cos 2\pi f_{c2} t, & \text{for bit '0'} \end{cases}$$

$$\left.\begin{aligned} s_1(t) &= \sqrt{\frac{2E_b}{T_b}} \cos 2\pi f_{c1} t \\ s_2(t) &= \sqrt{\frac{2E_b}{T_b}} \cos 2\pi f_{c2} t \end{aligned}\right\} \quad \text{let } f_{c1} = f_1, \; f_{c2} = f_2$$

$0 \leq t \leq T_b$

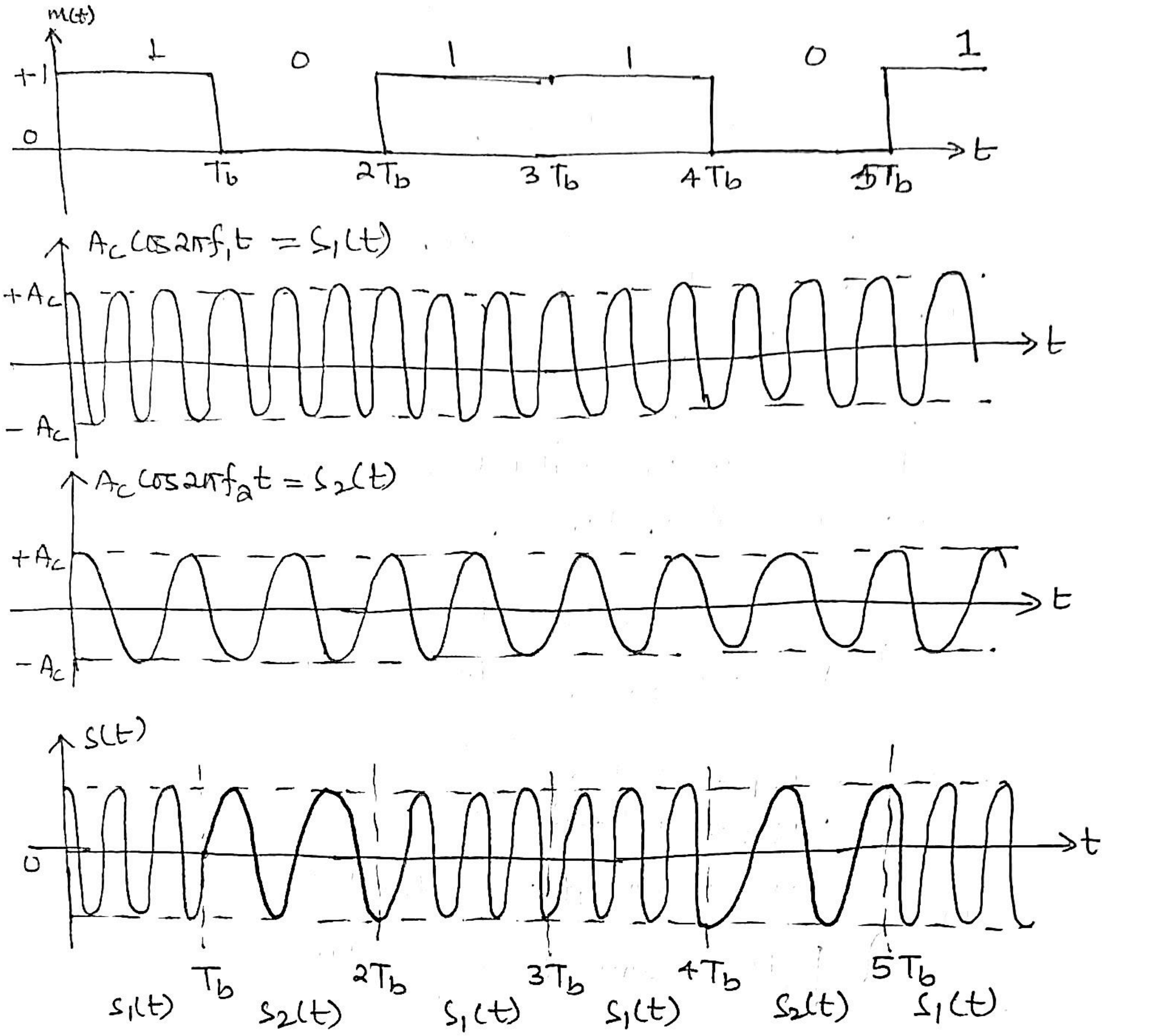
MF $\Rightarrow f_1 = f_c + \Delta f$

SF $\Rightarrow f_2 = f_c - \underbrace{\Delta f}_{\text{freq. deviation}}$

$f_1 = \frac{n_1}{T_b}$ & $f_2 = \frac{n_2}{T_b}$

$\Rightarrow n_1$ and n_2 are integers.

Applications:- In telephone line modem ~~to~~ FSK is used to transmit 300 bps at two frequencies 1070 Hz and 1270 Hz.



<u>Here,</u> $i = 1, 2$
$j = 1, 2$

$s_1(t)$ & $s_2(t)$ are linearly independent

$N = M$.

No. of orthonormal basis functions

$$\phi_1(t) = \frac{s_1(t)}{\sqrt{E_b}} \Rightarrow s_1(t) = \sqrt{E_b}\,\phi_1(t)$$

$$\phi_2(t) = \frac{s_2(t)}{\sqrt{E_b}} \Rightarrow s_2(t) = \sqrt{E_b}\,\phi_2(t)$$

Projection $s_i(t)$ on $\phi_j(t) \Rightarrow$

$$s_{ij} = \int_0^{T_b} s_i(t)\,\phi_j(t)$$

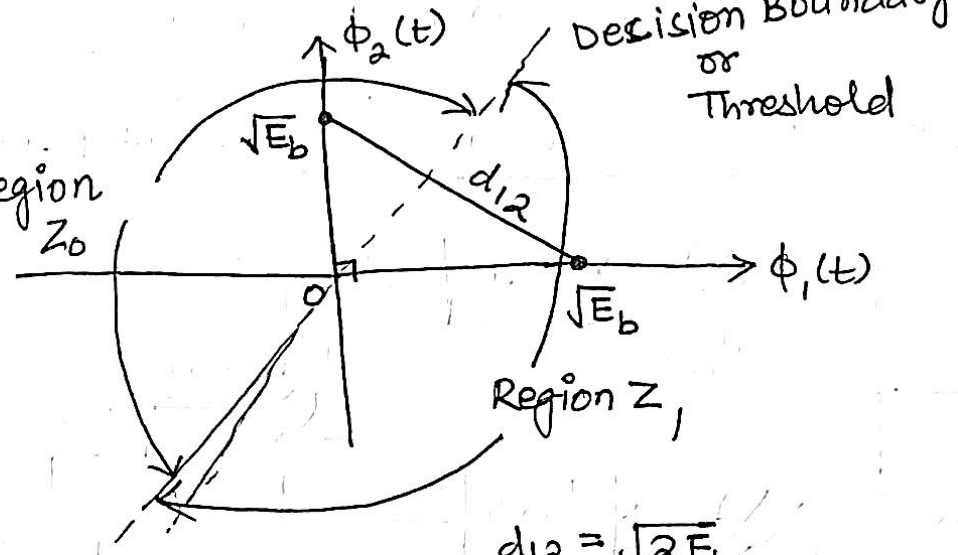
$$s_{11} = \int_0^{T_b} s_1(t)\,\phi_1(t)\,dt = \sqrt{E_b}$$

$$s_{12} = \int_0^{T_b} s_1(t)\,\phi_2(t)\,dt = 0$$

$$s_{22} = \int_0^{T_b} s_2(t)\,\phi_2(t)\,dt = \sqrt{E_b}$$

$$s_{21} = \int_0^{T_b} s_2(t)\,\phi_1(t)\,dt = 0$$

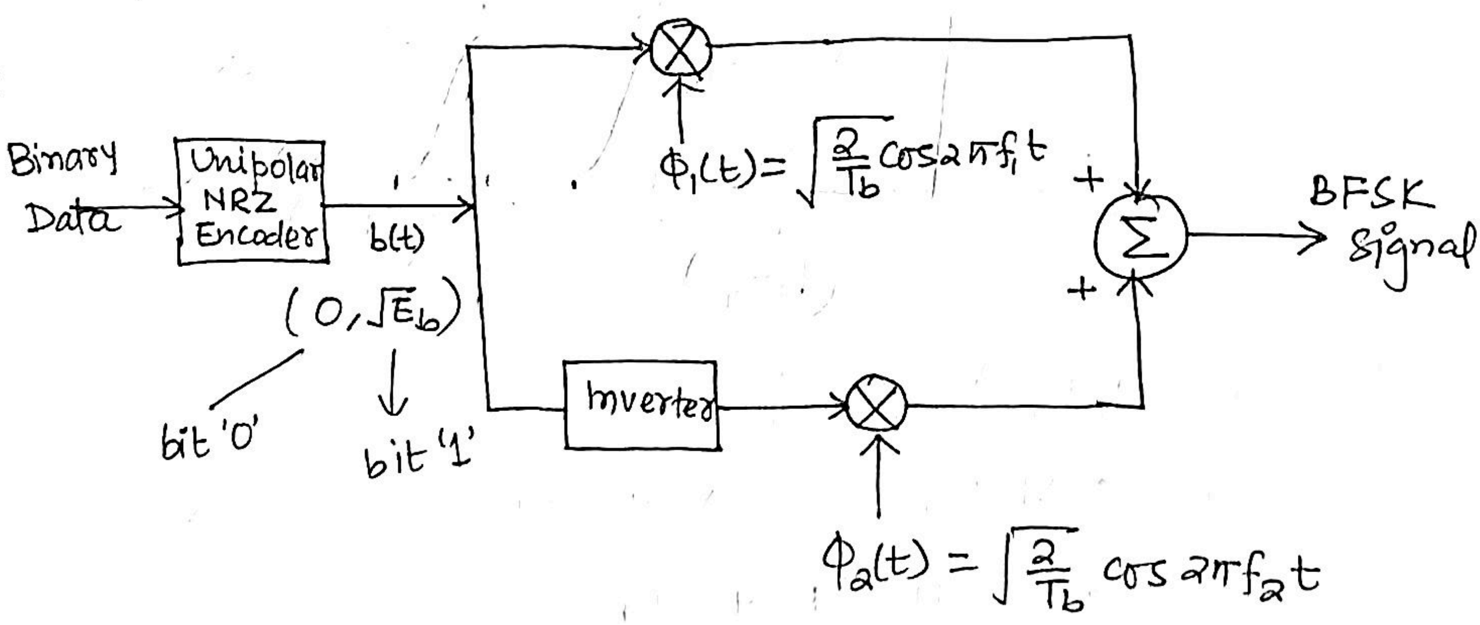
$$s_{ij} = \begin{cases} \sqrt{E_b}, & i=j \\ 0, & i \neq j \end{cases}$$



$d_{12} = \sqrt{2E_b}$ → Euclidean distance

Constellation Diagram

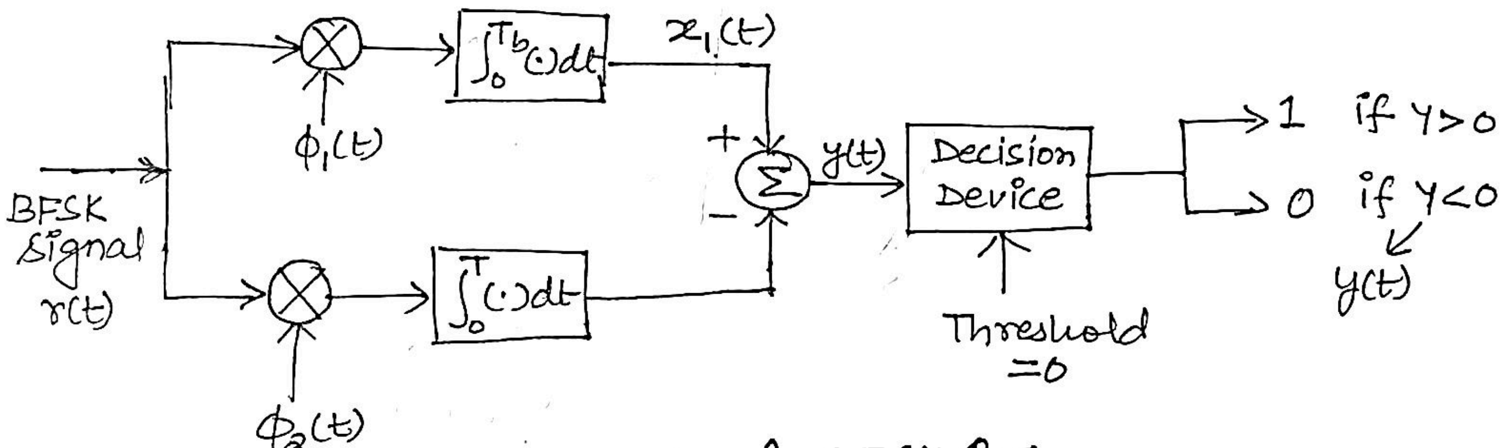
BFSK Modulation



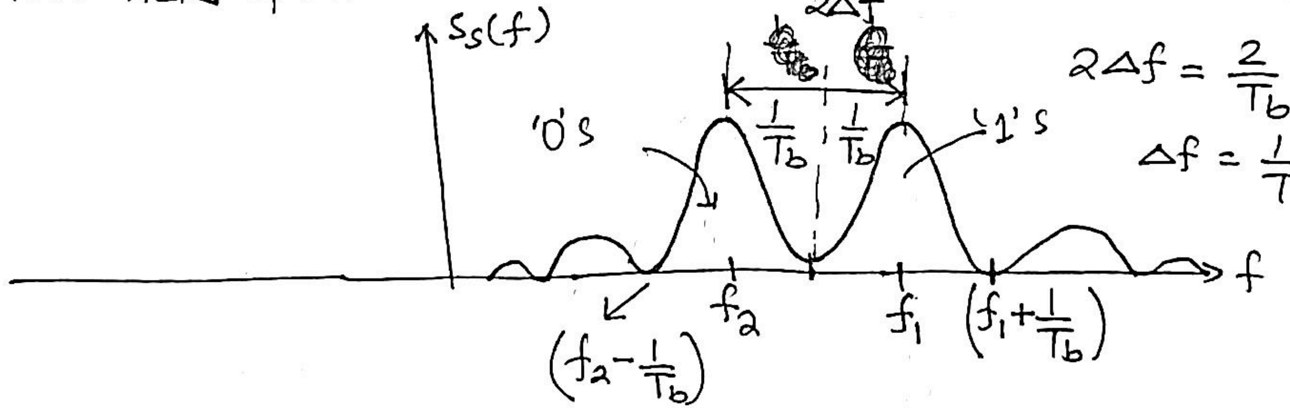
- When in a signalling interval, the input symbol is '1', the upper local oscillator with frequency f_1 is switched ON and signal $s_1(t)$ is transmitted, while lower local oscillator is OFF.

- On the other hand, when the input symbol is '0', the upper LO is OFF while the lower LO is switched ON and signal $s_2(t)$ is transmitted.

BFSK Demodulation (Coherent Demodutor)



Transmission Bandwidth of BFSK :-
The spectrum of BFSK may be viewed as the sum of two ASK spectra.



$$2\Delta f = \frac{2}{T_b}$$
$$\Delta f = \frac{1}{T_b} = R_b$$

Ideal :- $B_T = \left(f_1+\frac{1}{T_b}\right) - \left(f_2-\frac{1}{T_b}\right) = f_1 - f_2 + \frac{2}{T_b}$

$$B_T = 2\Delta f + \frac{2}{T_b} = 2\Delta f + 2R_b \qquad 2\Delta f = f_1 - f_2$$

Practical :- $B_T = (1+\alpha)R_b + 2R_b$

For $\alpha = 0 \Rightarrow (B_T)_{min} = 3R_b$ and for $\alpha = 1 \Rightarrow (B_T)_{max} = 4R_b$