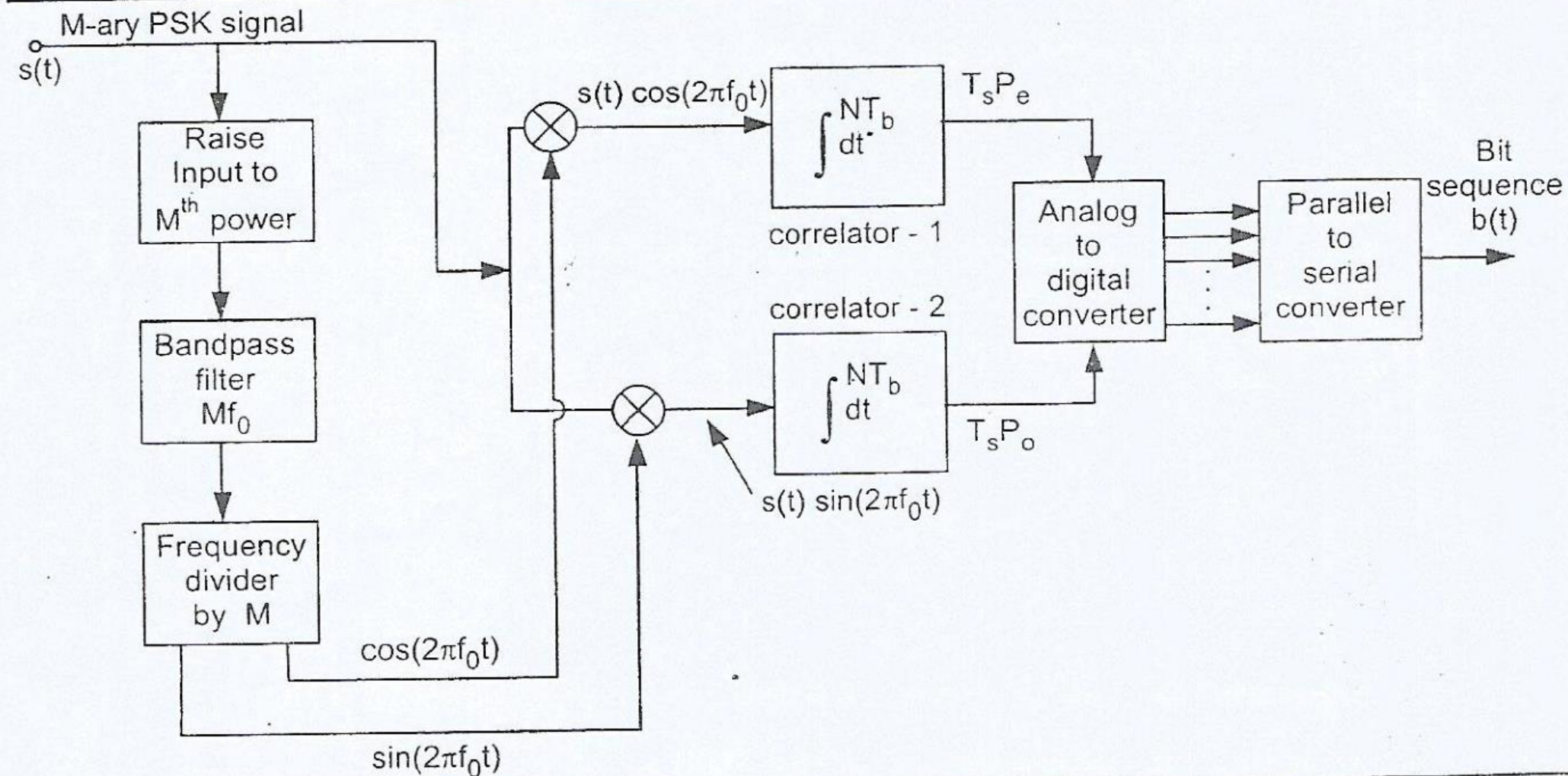


CONTINUE
M-ARY PSK

- M-ary PSK receiver
 - Examples
- 

8.5.5.2 M-ary PSK Receiver

Fig. 8.5.5 shows the receiver of M-ary PSK. It is similar to QPSK receiver. The input signal $s(t)$ is raised to M^{th} power. The bandpass filter extracts the frequency component Mf_0 . This frequency is divided by 'M' to obtain carrier frequency f_0 . The coherent carriers are thus generated and applied to the two multipliers.



The outputs of the multipliers are given to the integrators. The integrators integrate over the period of $T_s = NT_b$. The outputs of the integrators are sampled after the period T_s in every cycle and applied to the analog to digital converter. The integrator outputs are proportional to $T_s P_e$ and $T_s P_o$. These voltages are applied to A/D converter, which reconstructs 'N' bit symbol. This 'N' bit symbol is given to the parallel to serial converter. It then generates the bit sequence $b(t)$.

Ex. 8.5.2 In digital CW communication system, the bit rate of NRZ data stream is 1 Mbps and carrier frequency is 100 MHz. Find the symbol rate of transmission and bandwidth requirement of the channel in the following cases of different techniques used.

i) BPSK system ii) QPSK system iii) 16-ary PSK system [Dec-2001, 6 Marks]

Sol. : Given data

The bit rate is, $f_b = 1 \text{ Mbps} = 1 \times 10^6$

Hence
$$T_b = \frac{1}{f_b} = \frac{1}{1 \times 10^6} = 1 \times 10^{-6} \text{ or } 1 \mu\text{s}.$$

Carrier frequency $f_o = 100 \text{ MHz}$

(i) BPSK system

Bandwidth of BPSK system is given by equation 8.1.21 as,

$$\begin{aligned} \text{BW} &= 2f_b \\ &= 2 \times 1 \times 10^6 = 2 \text{ MHz} \end{aligned}$$

In BPSK, one bit is considered as one symbol.

Hence
$$T_s = T_b = 1 \times 10^{-6}$$

$\therefore$ Symbol rate
$$= \frac{1}{T_s} = \frac{1}{1 \times 10^{-6}} = 1 \times 10^6 \text{ symbols/sec.}$$

Note that this rate is same as bits/sec.

(ii) QPSK system

Bandwidth of QPSK is given by equation 8.4.24 as,

$$BW = f_b = 1 \times 10^6 \text{ i.e. 1 MHz}$$

$$\begin{aligned} \text{In QPSK, } T_s &= 2T_b \\ &= 2 \times 1 \times 10^{-6} \text{ or } 2 \mu\text{sec} \end{aligned}$$

$$\begin{aligned} \text{Hence, symbol rate} &= \frac{1}{T_s} \\ &= \frac{1}{2 \times 10^{-6}} = 500 \times 10^3 \text{ symbols/sec} \end{aligned}$$

(iii) 16-ary PSK system

Equation 8.5.13 gives the bandwidth of M-ary PSK as,

$$BW = \frac{2f_b}{N}$$

Here 'N' is the number of bits used to make one symbol. Here there are total 16 symbols.

$$\therefore N = \log_2 M$$

$$= \log_2 16 = \frac{\log_{10} 16}{\log_{10} 2} = 4$$

Thus 4 bits make 16 symbols. Hence bandwidth of the 16-ary PSK becomes,

$$\text{BW} = \frac{2 \times 1 \times 10^6}{4} = 500 \text{ kHz}$$

Symbol duration and bit duration are related as,

$$T_s = NT_b \quad (\text{From equation 8.5.2})$$

$$= 4 \times 1 \times 10^{-6} = 4 \times 10^{-6}$$

$$\text{Symbol rate} = \frac{1}{T_s}$$

$$= \frac{1}{4 \times 10^{-6}} = 250 \times 10^3 \text{ symbols/sec}$$

Ex. 8.5.3 Assume that you are required to transmit $f_b = 90 \text{ Mb/s}$ data in an authorised bandwidth of 20 MHz. Which modulation techniques would you consider? Explain why?

Sol. : For this transmission, M-ary PSK modulation method can be used. From equation 8.5.12 the minimum bandwidth of M-ary PSK is given as,

$$BW \leq \frac{2f_b}{N}$$

Here $BW = 20 \times 10^6 \text{ Hz}$ and $f_b = 90 \times 10^6 \text{ Hz}$

Putting those values in above equation,

$$20 \times 10^6 \leq \frac{2 \times 90 \times 10^6}{N}$$

$$\therefore N = 9 \text{ bits}$$

$$\therefore M = 2^N = 2^9 = 512$$

This shows that 512-ary PSK can transmit the 90 MHz signal in the bandwidth of 20 MHz.