Amplitude Shift Keying

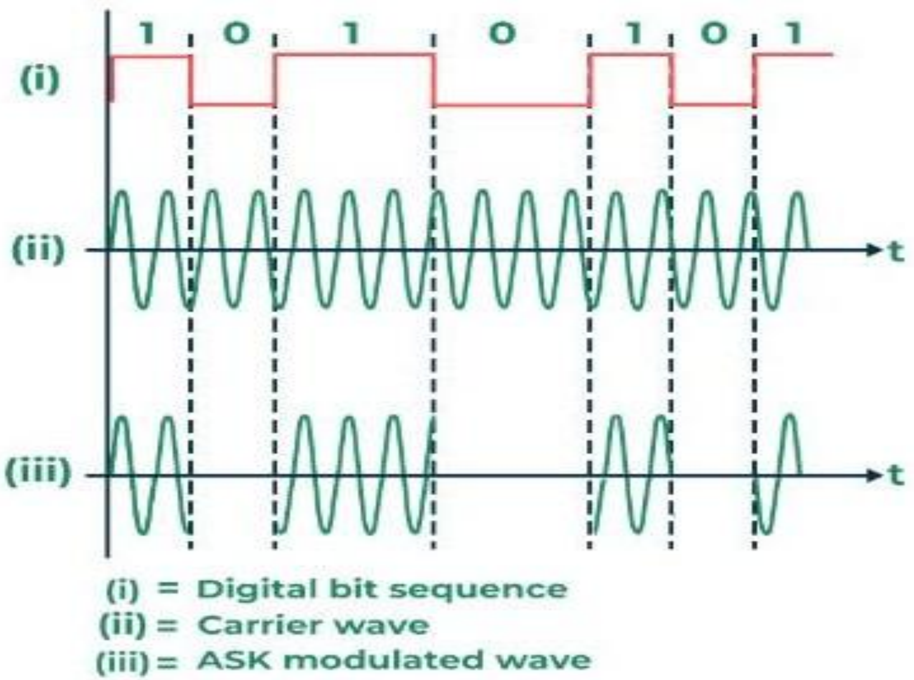
Experiment 6: Binary-ASK And M-ary ASK using MATLAB

Exercise 6

1. Perform Binary Amplitude Shift Keying, on a given binary message sequence and verify the same with the decoded bits at the receiving end. Plot the message bit sequence, carrier signal, modulated signal, demodulated signal and the decoded bit sequence.
2. Repeat question 1, for M-ary ASK for values M = 4 and M=8.

Amplitude Shift Keying(ASK)

- It involves varying the amplitude of a carrier signal in accordance with the digital data being transmitted. The phase and frequency of the carrier remain constant, while the amplitude is modified based on the data.
- In ASK, the carrier signal is turned on and off or varied between two different amplitude levels to represent binary data. Typically, a higher amplitude represents a binary '1', and a lower amplitude (often zero) represents a binary '0’.



Amplitude Shift Keying

Image Courtesy: GeeksforGeeks (https://www.geeksforgeeks.org/amplitude-shift-keying/)

Binary Amplitude Shift Keying

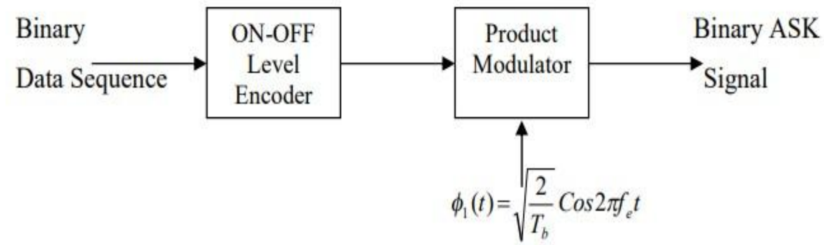
- Binary Amplitude Shift Keying (BASK) or On Off Keying (OOK) is one of the digital modulation techniques in which the amplitude of carrier is switched according to the binary data. This digital modulation scheme is used to transmit digital data over optical fiber, point to point military communication applications, etc. Binary 1 is represented by a short pulse of light and binary 0 by the absence of light.
- For BASK, consider a binary data stream b(t) defined by,

$$b(t) = \begin{cases} \sqrt{E_b}, & \text{for binary symbol 1} \\ 0, & \text{for binary symbol 0} \end{cases}$$

Formulas

Basis function,

$$\phi(t) = \sqrt{\frac{2}{T_b}} \cos(2\pi f_c t)$$



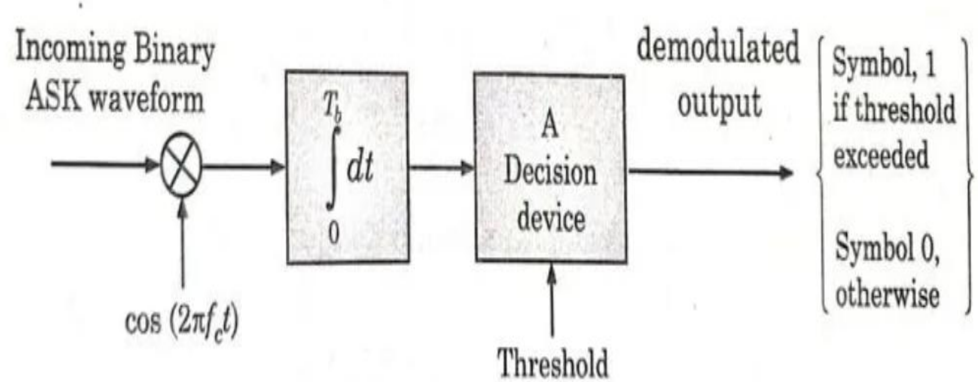
The BASK wave,

$$s(t) = \begin{cases} \sqrt{\frac{2E_b}{T_b}} \cos(2\pi f_c t), & \text{for symbol 1} \\ 0, & \text{for symbol 0} \end{cases}$$

The co-ordinates of message points,

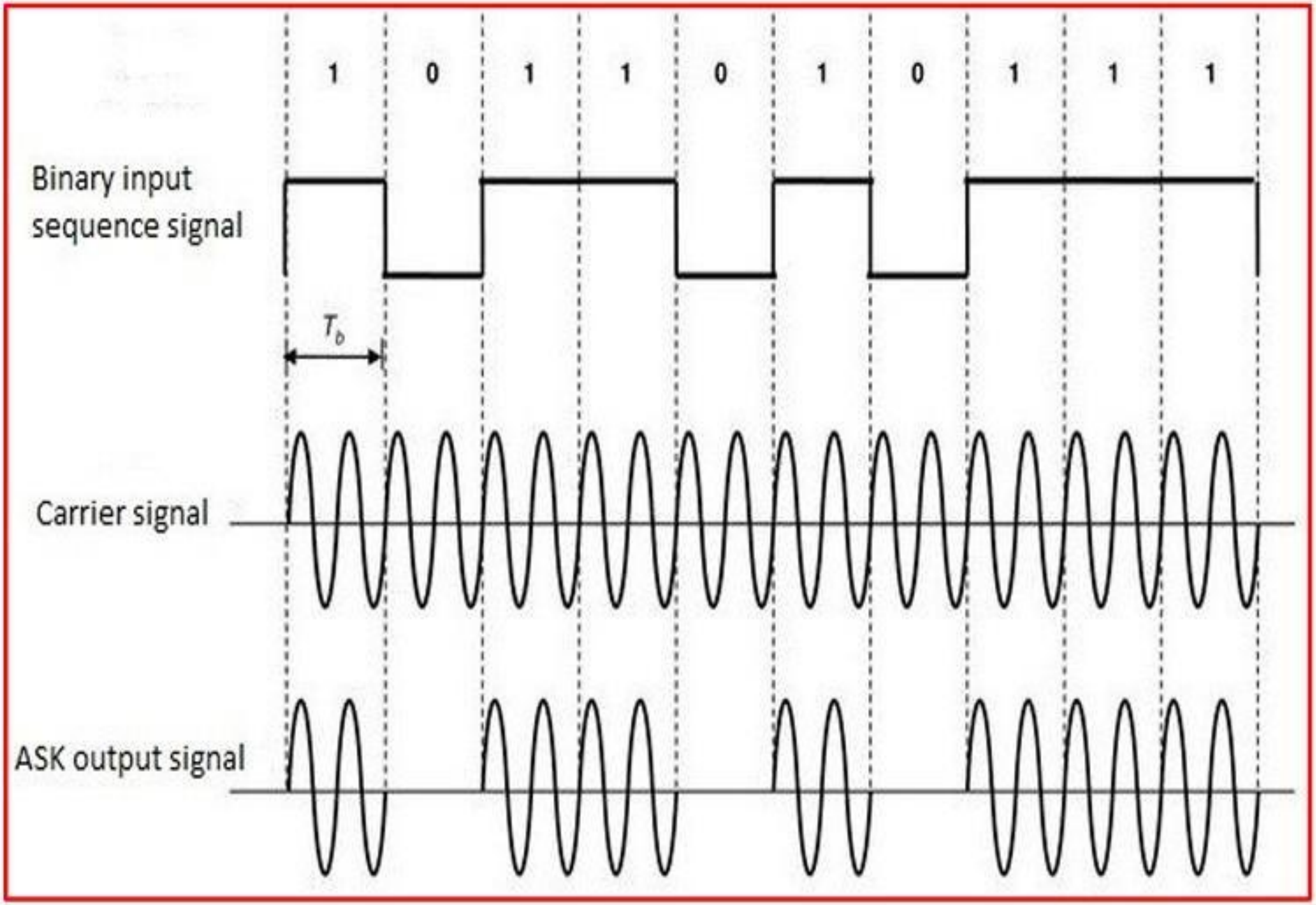
$$s_{11} = \int_0^{T_b} s_1(t)\phi_1(t)\ dt$$
$$= +\sqrt{E_b}$$

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



Coherent detection of binary ASK signals.

BASK-WAVEFORMS



M-ary Amplitude Shift Keying

- In **M-ary ASK (M-ASK)**, the carrier signal can assume M different amplitude levels, where $M=2^k$ and k is the number of bits per symbol. Each unique amplitude level represents a distinct combination of bits.
- For example:

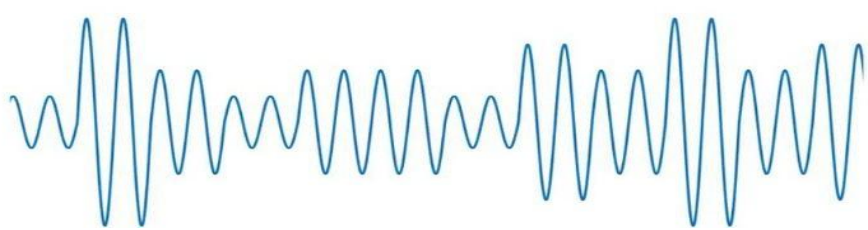
4-ASK uses 4 distinct amplitude levels to represent 2 bits per symbol.

8-ASK uses 8 amplitude levels to represent 3 bits per symbol.

- **Signal Representation:** The M-ASK signal can be expressed as:

$$s_i(t) = A_i \cos(2\pi f_c t), \quad 0 \le t \le T_b, \quad i = 0, 1, 2, \ldots, M-1$$

► ASK schemes with more than two levels (M-ary ASK)



M-ASK

- **Advantages of M-ASK:**

1. Higher Data Rates: Transmits multiple bits per symbol, increasing the data rate.
2. Bandwidth Efficiency : For a fixed symbol rate, M-ASK achieves higher data throughput.

- **Disadvantages of M-ASK:**

1. Complexity: Requires more complex hardware for generation and demodulation.
2. Noise Susceptibility: As M increases, the amplitude levels become closer, making the system more prone to errors in noisy environments.

Formulas

- **Symbol Rate and Bandwidth:** The symbol rate *Rs* for M-ASK is:

$$R_s = \frac{R_b}{\log_2 M}$$

- The bandwidth required remains: $BW = 2R_b$

- Even though the bandwidth requirement is the same as B-ASK, M-ASK improves the data rate by transmitting more bits per symbol

BER for M-ASK

$$P_{se} \approx 2\left(1 - \frac{1}{M}\right) Q\left(\sqrt{\frac{3\log_2 M \cdot E_b}{(M^2-1)N_0}}\right)$$

The bit error rate (BER) is related to the symbol error rate as:

$$P_e = \frac{P_{se}}{\log_2 M}$$