Amplitude Shift Keying (ASK)

The simplest digital modulation technique

A binary information signal is directly modulates the amplitude of an analog carrier.

Similar to standard AM except there are only two output amplitudes possible.

Amplitude Shift Keying (ASK)

Changes in amplitude of the carrier signal

- A **binary information signal** directly modulates the amplitude of an analog carrier.
- Sometimes called *Digital Amplitude Modulation (DAM)*

$$v_{ask}(t) = [1 + v_m(t)]\frac{A}{2}\cos(\omega_c t)$$

Where $v_{ask}(t)$ = amplitude shift keying wave

$v_m(t)$ = digital information signal (volt)

A/2 = unmodulated carrier amplitude (volt)

ω_c = analog carrier radian frequency (rad/s)

The modulating signal is the normalized binary waveform

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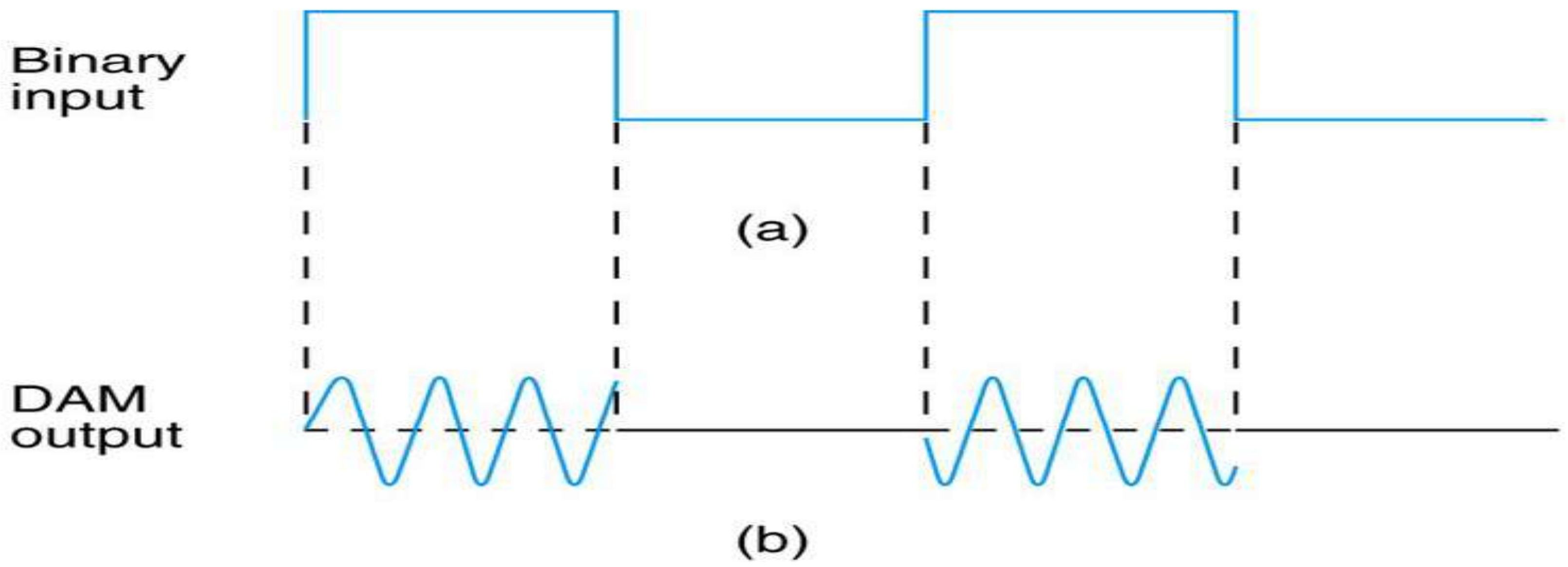


Digital Amplitude Modulation

$$v_{ask}(t) = \begin{cases} A\cos(\omega_c t) \ \ for \quad \text{logic'1'}, v_m(t) = +1V \\ 0 \qquad for \quad \text{logic'0'}, v_m(t) = -1V \end{cases}$$

Frequency Shift Keying (FSK)

Also the relatively **simple digital modulation technique**

Similar to standard FM except the modulating signal is the **binary signal that varies between 2 discrete voltage levels** rather than a continuously changing analog waveform.

Sometimes called as ***Binary Frequency Shift Keying (BFSK)***

Frequency Shift Keying (FSK)

Changes in the freq of the carrier signal

- The phase shift in carrier frequency **(Δf) is proportional to the amplitude of the binary input signal ($v_m(t)$)** and the direction of the shift is determined by the polarity

$$v_{fsk}(t) = V_c \cos\{2\pi[f_c + v_m(t)\Delta f]t\}$$

Where $v_{fsk}(t)$ = binary FSK waveform

V_c = peak analog carrier amplitude (volt)

f_c = analog carrier center frequency (Hz)

Δf = peak shift in analog carrier frequency (Hz)

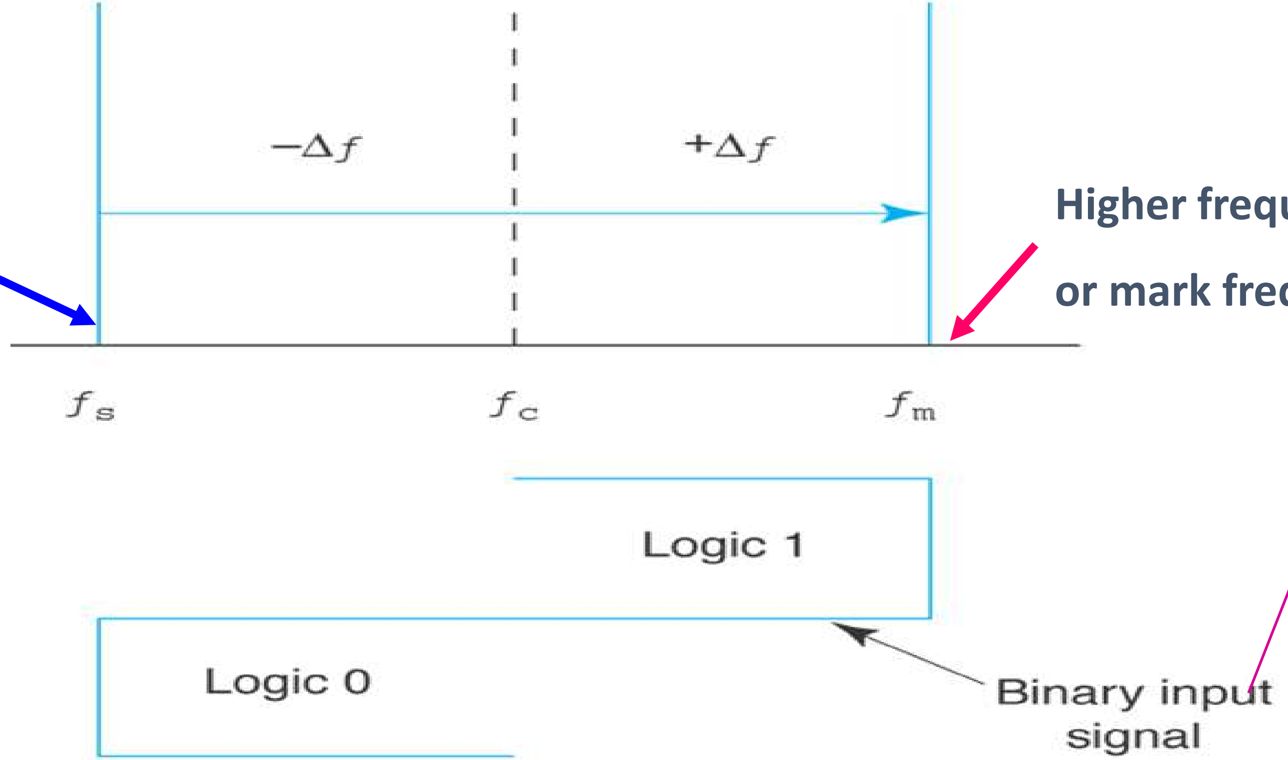
$v_m(t)$ = binary input signal (volt)

The modulating signal is a normalized binary waveform

$$v_{fsk}(t) = \begin{cases} V_c \cos\{2\pi[f_c + \Delta f]t\} \ for \quad \text{logic'1'}, v_m(t) = +1 \\ V_c \cos\{2\pi[f_c - \Delta f]t\} \ for \quad \text{logic'0'}, v_m(t) = -1 \end{cases}$$

lower frequency

or space frequency



Higher frequency

or mark frequency

$$\Delta f = \frac{|f_m - f_s|}{2},$$

where

$$\Delta f = \text{frequency deviation (Hz)}$$

$$|f_m - f_s| = \text{absolute difference between mark \& space frequency (Hz)}$$

Exercise

Prove the following equations to represent binary 1 and 0 respectively.

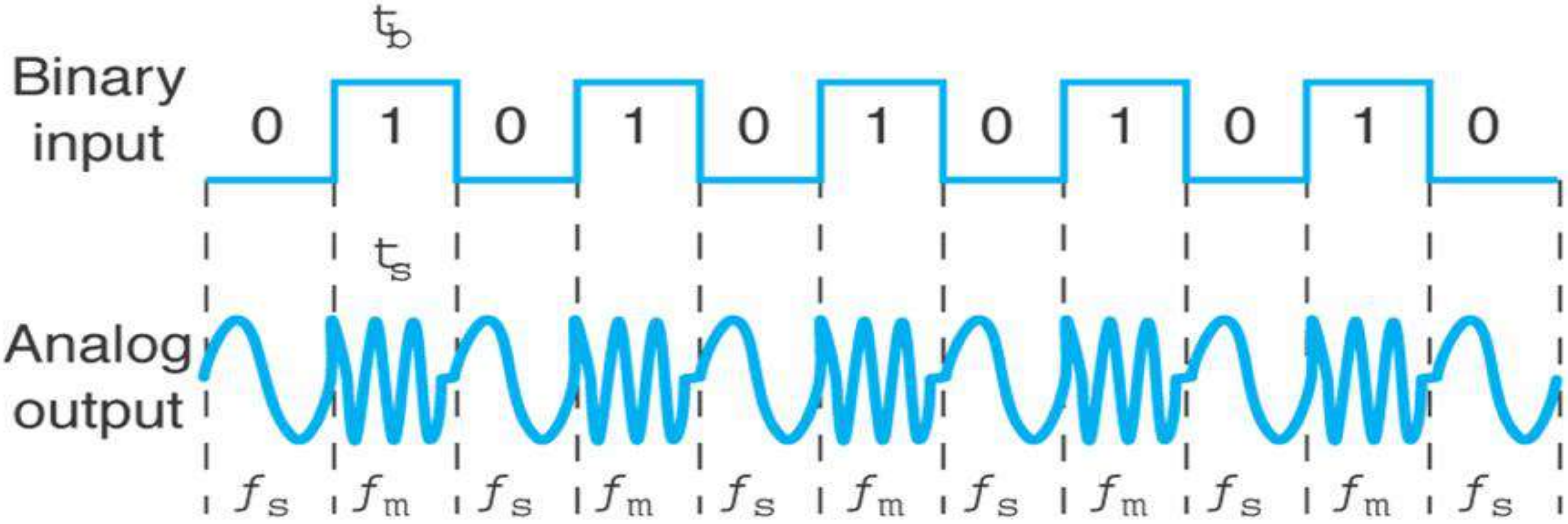
a) $$v_{ask}(t) = [1 + v_m(t)]\frac{A}{2}\cos(\omega_c t)$$

5 marks

b) $$v_{fsk}(t) = V_c \cos\{2\pi[f_c + v_m(t)\Delta f]t\}$$

5 marks

$$B = |(f_m - f_b) - (f_s - f_b)| = |f_m - f_s| + 2f_b = 2(\Delta f + f_b)$$



f_m, mark frequency; f_s space frequency

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Binary Input	Frequency Output
0	Space (f_s)
1	Mark (f_m)

- **Baud for FSK determined by setting N=1**

$$baud = \frac{f_b}{1} = f_b$$

Example 3

For an FSK signal, given a mark frequency = 49kHz, a space frequency = 51kHz and input bit rate =2kbps.

Determine

(a) The peak frequency deviation
(b) Minimum bandwidth
(c) Baud for a binary FSK signal

Ans: 1kHZ,6kHz,2000