Sairam INSTITUTIONS

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YEAR	SEM
II	III

EC 8394

UNIT No. 3 DIGITAL MODULATION

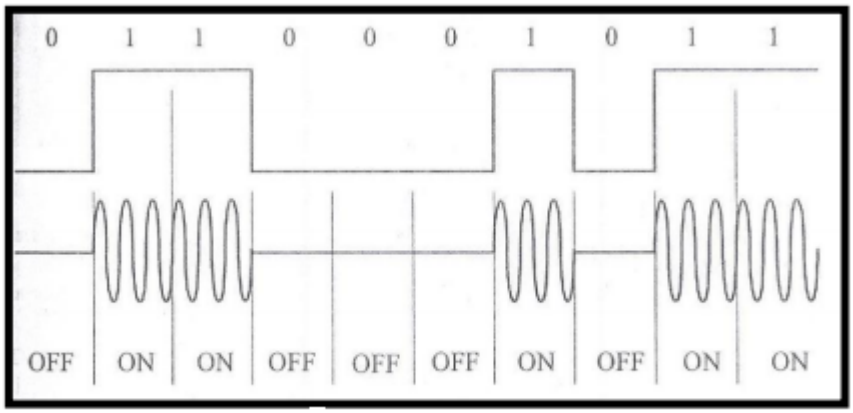
3.1.1 AMPLITUDE SHIFT KEYING (ASK)

Version: 1.XX

AMPLITUDE SHIFT KEYING (ASK)

The simplest digital modulation technique is amplitude-shift keying (ASK), where a binary information signal directly modulates the amplitude of the analog carrier. ASK is similar to standard amplitude modulation except there are only two output amplitudes possible. Amplitude-shift keying is sometimes called digital amplitude modulation (DAM)

In ASK, the carrier is switched on when binary 1 is to be transmitted and it is switched off when binary 0 is to be transmitted ASK is also called on-off keying.



ASK modulation signal waveform.

MATHEMATICAL EXPRESSION FOR ASK:

$V_{(ASK)}(t) = [1 + V_m(t)]\left[\frac{A}{2}\cos(\omega_c t)\right]$

$V_{(ASK)}(t)$ **= amplitude-shift keying wave**

$V_m(t)$ **= digital information (modulating) signal (volts)**

A/2 = unmodulated carrier amplitude (volts)

ω_c **= analog carrier radian frequency (radians per second, 2πfct)**

In the above equation, the modulating signal is a normalized binary waveform.

Where,

+1 V=logic 1

-1 V=logic 0

Therefore, for a logic 1 input, $V_m(t) = +1$ **V, equation reduces to**

$$V_{(ask)}(t) = [1+1]\left[\frac{A}{2}\cos(w_c t)\right]$$

$$V_{(ask)}(t) = A\cos(w_c t)$$

Similarly for a logic 0 input, $V_m(t) = -1$ V, equation reduces to

$$V_{(ask)}(t) = [1-1]\left[\frac{A}{2}\cos(w_c t)\right] = 0$$

Thus the modulated wave $V_{(ask)}(t)$ is either $A\cos(w_c t)$ or 0. Hence the carrier is either "on" or "off" which is why Amplitude shift keying is sometimes referred to as On-Off keying (OOK).

Baud rate

For every change in input bit there is one change in ASK

Time of 1 bit (t_b) equals the time of one signaling element (t_s)

Bit rate = Baud rate

$$\frac{1}{t_b} = \frac{1}{t_s}$$

Bit rate hence equals minimum Nyquist bandwidth.

ASK Modulator:

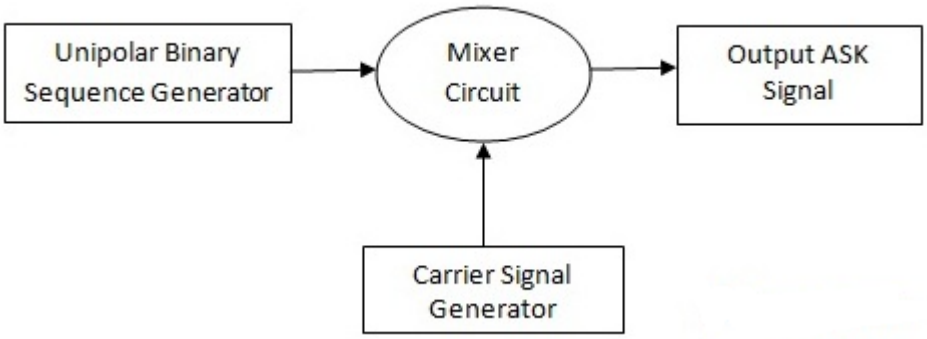


Figure 1 ASK MODULATOR

In ASK, the input binary signal is multiplied with the carrier signal along with its time intervals. Between the first time interval of input binary signal multiplied with the first time interval of carrier signal voltage and the same process continues for all time intervals. If the input binary signal is logic HIGH for a certain time interval, then the same should be delivered at the output ports with increment in voltage level. So the main aim of the amplitude shift keying modulation is to change or improve the voltage characteristics of the input binary signal concerning the carrier signal.

At Mixer Circuit Level

When the switch is closed – for all the logic HIGH time intervals i.e. when the input signal having logic 1 during those intervals the switch is closed and it is multiplied with the carrier signal which is generated from the function generator for the same duration.

When the switch is opened – when the input signal having logic 0, the switch is opened and there is no output signal will be generated. Because the input binary signal logic 0 has no voltage, so during these intervals when the carrier signal multiples with

it, zero output will come. The output is zero for all logic 0 intervals of the input binary signal.

Mixer circuit having the pulse shaping filters and band-limited filters for shaping the ASK output signal.

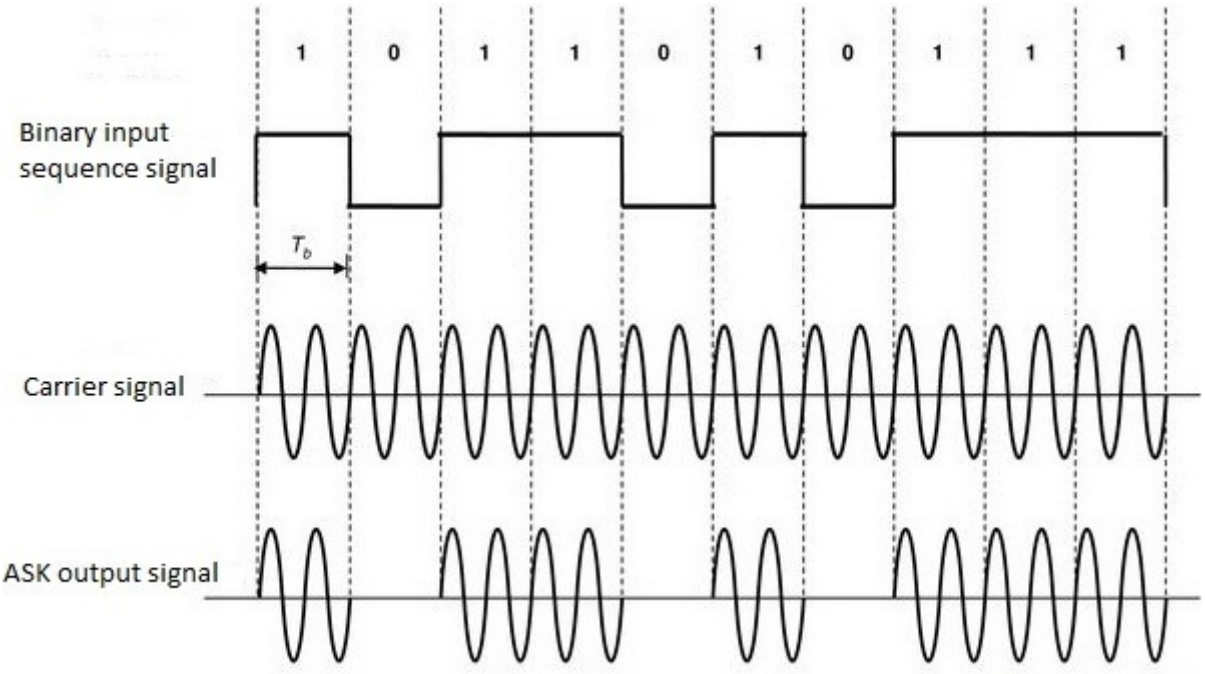


Figure 2 ASK MODULATION WAVEFORM

ASK Demodulator:

Demodulation is the process of reconstructing the original signal at the receiver level. And it is defined as, whatever the modulated signal received from the channel at the receiver side by implementing the proper demodulated techniques to recover/reproduce the original input signal at the output stage of the receiver.

ASK demodulation can be done in two ways. They are,

- Coherent detection (Synchronous demodulation)
- Noncoherent Detection (Asynchronous demodulation)

Coherent ASK Detection

In this way of demodulation process, the carrier signal which is used at the receiver stage is in the same phase with the carrier signal used at the transmitter stage. It means the carrier signal at transmitter and receiver stages are the same values. This type of demodulation is called Synchronous ASK detection or coherent ASK detection.

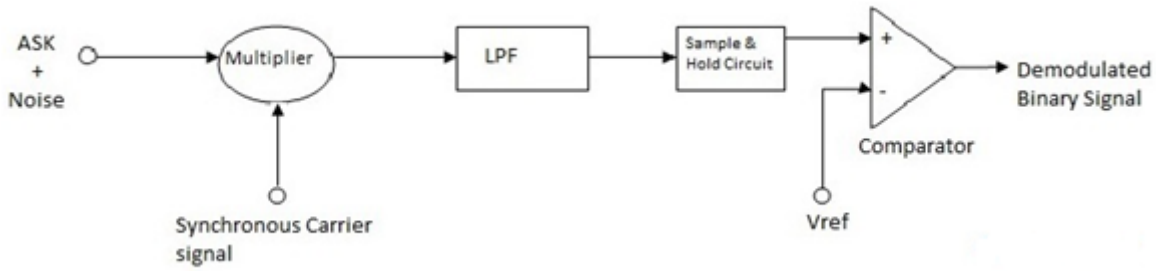


Figure 3 COHERENT ASK DETECTION

The receiver receives the ASK modulated waveform from the channel but is affected with noise signal because it is forwarded from the free space channel. Hence, noise can be eliminated after the multiplier stage by the help of a low pass filter. Then it is forwarded from the sample and hold circuit for converting it into discrete signal form. At each interval, the discrete signal voltage is compared with the reference voltage (Vref) to reconstruct the original binary signal.

Non-coherent ASK Detection

In this, the only difference is the carrier signal which is used at the transmitter side and receiver side are not in the same phase with each other. By this reason, this detection is called Non-coherent ASK detection (Asynchronous ASK detection). This demodulation process can be completed by using a square law device. The output signal which is generated from the square-law device can be forwarded through a low pass filter to reconstruct the original binary signal.

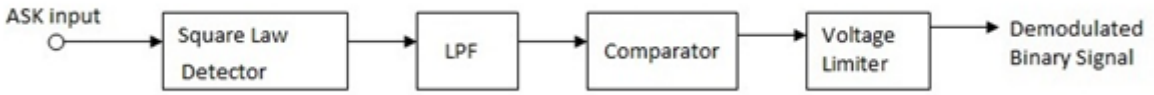


Figure 4 NON-COHERENT ASK DETECTION

Amplitude shift keying is an effective technique to increase the input amplitude characteristics in communications. But these ASK modulated waveforms are easily affected by noise. And this leads to amplitude variations. Due to this, there will be voltage fluctuations in the output waveforms. The second drawback of the ASK modulation technique is, it has low power efficiency. Because ASK requires excessive bandwidth. It leads to power loss in the spectrum of ASK.

Whenever to modulate two input binary signals, amplitude shift keying modulation is not preferable. Because it has to take only one input only. So, to overcome this Quadrature Amplitude Shift Keying (ASK) is preferred. In this modulation technique, we can modulate two binary signals with two different carrier signals. Here, these two carrier signals are in opposite phases with 90degrees difference. Sin and cosine signals are used as carriers in quadrature amplitude shift keying. The advantage of this is, it effectively uses the bandwidth of the spectrum. It offers more power efficiency than the amplitude shift keying.

Advantages of ASK

1. Simple technique
2. Easy to generate and detect

Disadvantages of ASK

1. It is very sensitive to noise
2. It is used at very low bit rates up to 100bits/sec
3. Because ASK requires excessive bandwidth. It leads to power loss in the spectrum of ASK.
4. ASK modulated waveforms are easily affected by noise. And this leads to amplitude variations.

ASK Applications

1. Low-frequency RF applications
2. Home automation devices
3. Industrial networks devices
4. Wireless base stations
5. Tire pressuring monitoring systems