Modulation Method

Modulation is the process of converting data into electrical signals optimized for transmission. Modulation techniques are roughly divided into four types: Analog modulation, Digital modulation, Pulse modulation , and Spread spectrum method.

Advantages of Modulation

- By implementing Modulation, the antenna size gets reduced. Before modulation technology, the antenna used for transmission had to be very large. The range of communication gets limited as the wave cannot travel to a distance without getting modulated.
- The range of communication has increased.
- The reception quality is immensely improved.
- Receivers are allowed to adjust to the bandwidth.
- Multiplexing of signals occurs.
- No signal mixing occurs.

Types of Modulation

Primarily Modulation can be classified into two types:

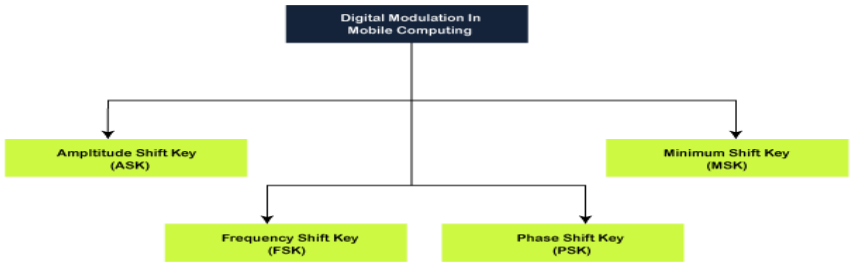
- Digital Modulation
- Analog Modulation

Digital Modulation

Digital Modulation is a technique in which digital signals/data can be converted into analog signals. For example, Base band signals.

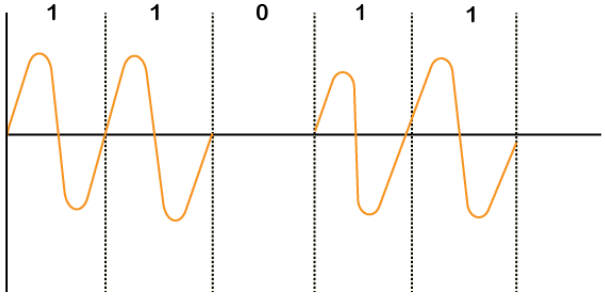
Digital Modulation can further be classified into four types:

- Amplitude Shift Key(ASK) Modulation
- Minimum Shift Key (MSK) Modulation
- Frequency Shift Key (FSK) Modulation
- Phase Shift Key (PSK) Modulation



Amplitude Shift Key (ASK) Modulation

- As the name suggests, in Amplitude Shift Key or ASKS Modulation, the amplitude is represented by "1," and if the amplitude does not exist, it is represented by "0".
- Using Amplitude Shift Key Modulation is very simple, and it requires a very low bandwidth.
- Amplitude Shift Key Modulation is vulnerable to inference or deduction.

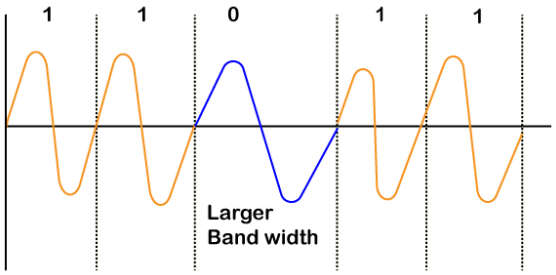


Minimum Shift Key (MSK) Modulation

- The Minimum Shift Key or MSK Modulation is the most effective technique of Modulation and can be implemented for almost every stream of bits. It is easy and effective than Amplitude Shift Key, Frequency Shift Key and Phase Shift Key.
- MSK is mostly used because of its ability and flexibility to handle "One(1)" and "Zero(0)" transition of binary bits.

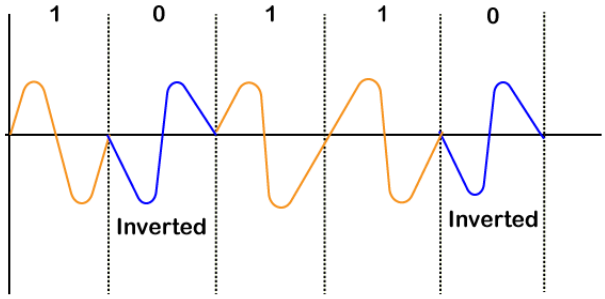
Frequency Shift Key (FSK) Modulation

- In Frequency Shift Key or FSK Modulation, different notations f1 and f2 are used for different frequencies.
- Here, f1 is used to represent bit "1," and f2 represents bit "0".
- It is also a simple modulation technique but uses different frequencies for different bits; bandwidth requirement becomes high.



Phase Shift Key (PSK) Modulation

- In Phase Shift Key or PSK Modulation, the phase difference is used to differentiate between the "1" and "0" bits.
- If the bit is "1", a simple wave is drawn, and if the bit becomes "0", the phase of the wave is shifted by "180 or π".
- PSK Modulation is more complicated than ASK and FSK Modulation, but it is robust too.



Analog Modulation in Mobile Computing

Analog modulation is a process of transferring analog low-frequency baseband signal such as **an audio or TV signal over a higher frequency carrier signal such as a radio frequency** band. Baseband signals are always analog to this modulation.

In other words, you can say that "Analog Modulation is a technique which is used in analog data signals transmission into digital signals."

An example of Analog Modulation is Broadband Signals.

There are three properties of a carrier signal in analog modulation i.e., amplitude, frequency and phase. So, the analog modulation can further be classified as:

- Amplitude Modulation (AM)
- Frequency Modulation (FM)
- Phase Modulation (PM)

Difference between Digital and Analog Modulation

Both digital and analog modulation are used to vary or transform signals from one for to another, but the difference is that an analog-modulated signal is demodulated into an analog baseband waveform. On the other hand, in digital modulation, a digitally modulated signal contains discrete modulation units, called symbols, that are interpreted as digital data.

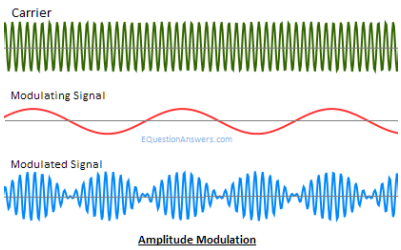
Amplitude Modulation

Amplitude modulation or AM is a modulation technique that is used in electronic communication. It is most commonly used for transmitting messages with a radio carrier wave. It varies the instantaneous amplitude of the carrier signal or waves according to the message signal's instantaneous amplitude.

If we denote the message signal as **m(t)** and **c(t)= Acosw$_c$t,** then **amplitude modulation signal F(t)** will be written as:

$F(t)= A\cos w_c t+m(t)\cos w_c t$

$F(t)=[A+m(t)]\cos w_c t$



History of Amplitude modulation

Amplitude modulation was the earliest modulation technique used for transmitting audio in radio broadcasting. It was developed during the first quarter of the 20th century and was based on the **Roberto Landell De Moura** and **Reginald Fessenden's** radiotelephone experiments proposed in 1900.

Advantages of Amplitude Modulation

- Amplitude Modulation is easy to implement. It is the simplest type of modulation.
- Amplitude Modulation, we can easily do Demodulation by using few components and a circuit.
- The hardware design of both the transmitter and receiver is very simple, that's why it is cost-effective.
- The receiver used for Amplitude Modulation is very cheap.

Disadvantages of Amplitude Modulation

- Amplitude Modulation is not a very power efficient technique.
- Amplitude Modulation requires a very high bandwidth that is equivalent to that of the highest audio frequency.
- Amplitude Modulation is very susceptible to noise. You can easily notice the noise.

Usage of Amplitude Modulation

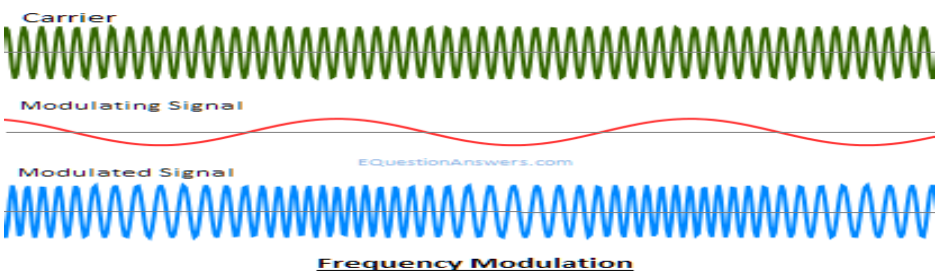
Amplitude Modulation is used in AM radio communication. AM radio broadcast is an example of Amplitude Modulation.

Frequency Modulation

Frequency Modulation or FM is the process of encoding the information in a carrier wave by varying the instantaneous frequency of the wave. It varies the instantaneous frequency of the carrier signal according to the instantaneous amplitude of the message signal.

If we denote the message signal as **m(t)** and **c(t)= Acosw$_c$t,** then **Frequency modulation signal F(t)** will be written as:

$F(t)= A\cos(w_c\, t+k_f \int m(\alpha)d\alpha)$



Advantages of Frequency Modulation

- Frequency Modulation is widely used for FM radio broadcasting.
- It is also used in telemetry, sound synthesis, seismic prospecting, radar, and monitoring newborns for seizures via EEG, two-way radio systems, magnetic tape-recording systems and some video-transmission systems.
- The main advantage of using frequency modulation in radio transmission is that it has a larger signal-to-noise ratio. That's why it rejects radio frequency interference better than an equal power amplitude modulation (AM) signal. This is the main reason why most music radio channels prefer to broadcast over FM radio.
- In FM, Modulation and Demodulation do not receive any channel noise.

Disadvantages of Frequency Modulation

- FM consists of a complicated circuit than AM for modulation and Demodulation.

Usage of Frequency Modulation

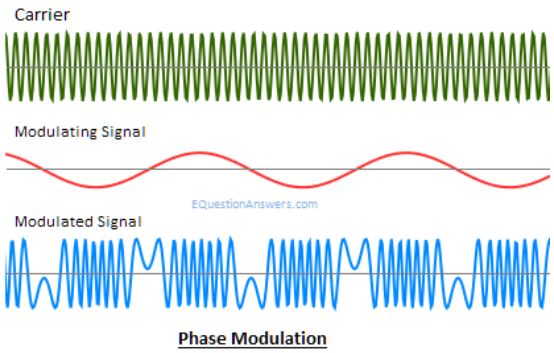
The main example of Frequency Modulation is FM radio broadcasting.

Phase modulation (PM)

Phase modulation or PM is the technique of varying the carrier signal's instantaneous phase according to the instantaneous amplitude of the message signal. It encodes the message signal as changes occurred in the instantaneous phase of a carrier signal.

If we denote the message signal as **m(t)** and **$c(t)= A\cos w_c t$,** then **Phase modulation signal F(t)** will be written as:

$F(t)= A\cos(w_c t+k_p m(t))$



Advantages of Phase modulation

- Phase Modulation is mainly used for transmitting radio waves. It is also used in many digital transmission coding schemes and technologies such as Wi-Fi, GSM and satellite television.
- In PM, Modulation and Demodulation do not receive any channel noise.

Disadvantages of Phase modulation

- The PM modulation and Demodulation consists of a complicated circuit than AM and FM.

Usage of Phase modulation

Phase Modulation is mainly used in Wi-Fi, GSM and satellite television.