Analog and Digital Communication

Part - 3

Data Encoding and Communication Technique

We know that data (information) may be of analog or digital type and the signal that is transmitted through the channel, whether guided or unguided, are also of Analog and Digital type. Now data needs to be encoded into signal, before they are actually transmitted through the channel. Based on this data and signal types, there are four encoding techniques.

1. Analog Data to Analog Signal
2. Analog Data to Digital Signal
3. Digital Data to Analog Signal
4. Digital Data to Digital Signal

To send a signal over a physical medium, we need to encode or transform the signal in some way so that the transmission medium can transmit it. The sender and receiver must agree on what kind of transmission has been done so that the signal may be received properly and the information may be recovered without error.

The information content in a signal is based upon having some changes in it, i.e. having some variation in the signal. Thus the signal needs to be modified in some way to carry the information we want to convey. This is called modulation. Thus the act of changing or encoding the information in the signal is known as **modulation**.

Analog - to - Analog Modulation

A good example of analog-to-analog modulation is radio broadcasting. Here we want to send sound in some form over the atmosphere to the receiving radio sets. The sound is converted to analog electrical signal at the source and is used to encode the signal which is the base frequency at which the transmission is being done, also known as the carrier wave. The reverse process is performed at the radio set to recover the information in electrical form, which is then converted back to sound so that, we hear what is being sent at the radio station.

There are three different ways in which this encoding of the analog signal with the analog information is performed:

- Amplitude Modulation (AM) – the amplitude of the Radio Frequency Carrier wave is changed depending on the amplitude of the audio information to be sent.
- Frequency Modulation (FM) – The frequency of the Radio Frequency Carrier wave is changed depending on the frequency variation of the audio information to be sent.
- Phase Modulation (PM) – The phase of the signal is changed according to the information to be sent.

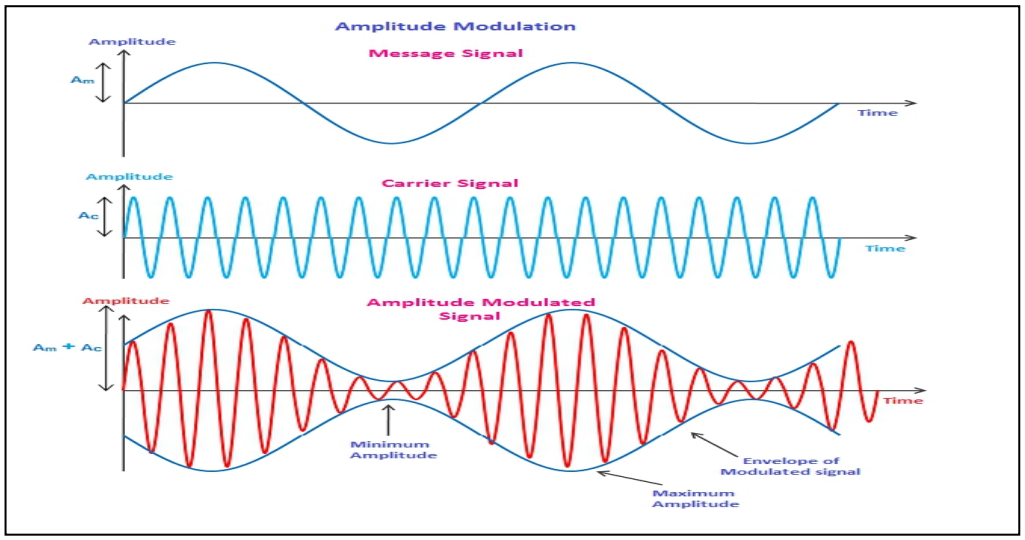
Amplitude Modulation (AM)

In this type of modulation, the frequency and phase of the carrier signal is not altered. Only the amplitude changes and we can see that the information is contained in the envelope of the carrier signal. The bandwidth of the composite signal is twice that of the highest frequency in the information signal that modulates the carrier.

By International agreement, for radio transmission using AM, 9 KHz is allowed as the bandwidth. So if a radio station transmits at 618 KHz, the next station can only transmit at 609 or 627 KHz. Thus it clear that the highest audio frequency that can be carried over AM radio is 4.5 KHz, which is sufficient for most voice and musical pieces. (Note that the audio frequency range lies in between 300 Hz to 3.4 KHz).

Actually the modulating signal is centered around the carrier frequency and extends the composite signal both ways in equal measure. Each of these is called a sideband and therefore AM radio transmission is dual sideband.

AM radio transmission has been assigned the frequency range of 530 KHz to 1700 KHz. The quality of AM transmission is not very good as noise in the channel can easily creep into the signal and alter its amplitude.

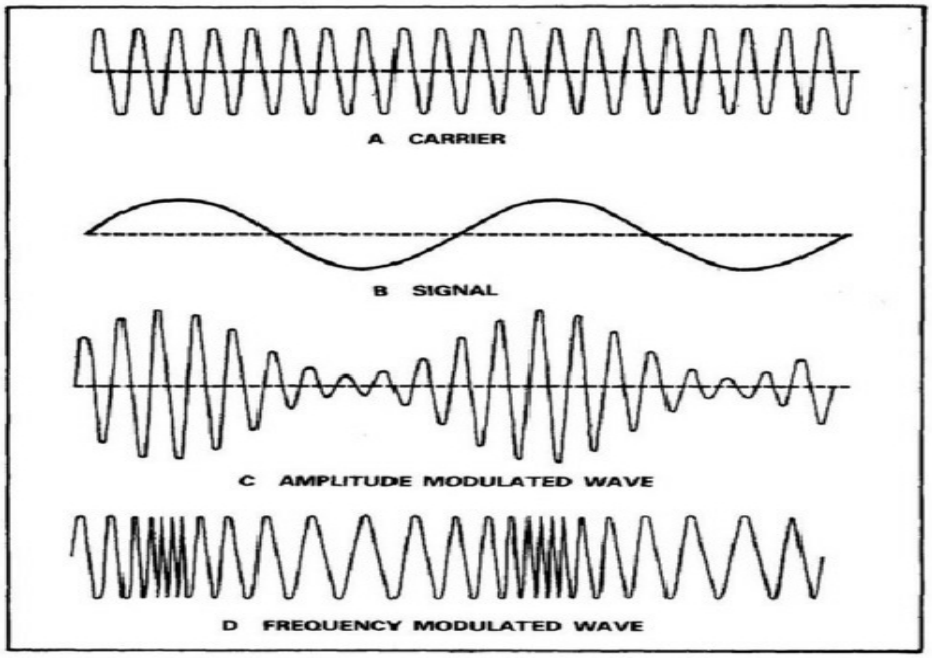


Frequency Modulation (FM)

Here the frequency of the base signal is altered depending on the information that is to be sent. The amplitude and phase of the carrier signal are not changed. It can be shown that this results in a bandwidth requirement of 10 times the modulating signal, centered on the carrier frequency.

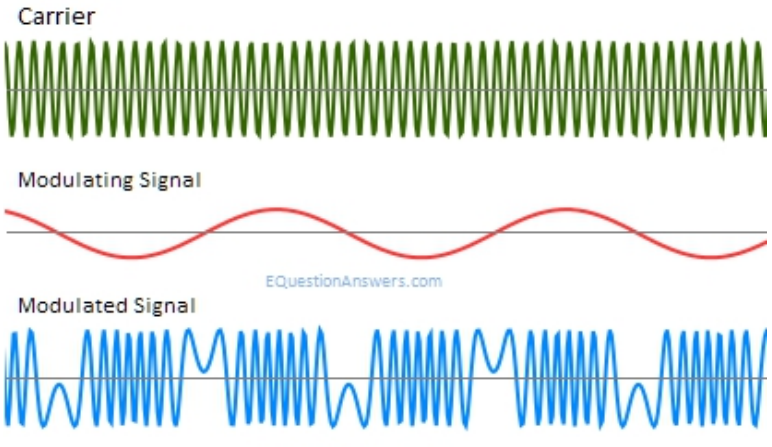
This method is less susceptible to noise and gives the best performance as far as single hop transmission goes.

FM radio transmission has been allocated the spectrum range 88 MHz to 108 MHz. As a good stereo sound signal needs 15 KHz of bandwidth, this means that FM transmission has a bandwidth of 150 KHz. To be safe from interference from neighbouring stations, 200 KHz is the minimum separation needed. As a further safety measure, in any given area, only alternate stations are allowed and the neighbouring frequencies are kept empty. We can therefore, have at most 50 FM stereo radio stations in a given geographical area.



Phase Modulation (PM)

In this case the modulating signal leaves the frequency and amplitude of the carrier signal unchanged but alters its phase. The characteristics of this encoding technique are similar to FM, but the advantage is that of reduced complexity of equipment. However this method is not used in commercial broadcasting.



Phase Modulation