BITT POLYTECHNIC

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BRANCH: E.C.E SEMESTER: 4TH

Communication

We convey our messages to someone and to the outside world through voice, facial expressions, gestures. These are the communication methods between human beings. However in technological point of view these messages can be base-band audio, video and even digital bits from computer. Telecommunication is the core subject for sending messages from one place to another place. Here we are discussing various types of modulations which are the core mechanisms for any telecommunication devices. Before we start this subject let us go back in the history of telecommunication. Telephone was the first device to send analog audio signals over long distance through copper wire. Telegraph was on the other way to send messages in the forms of dash-dots. Telephone and telegraph remains the base of all modern day's communication. Present days we send audio, video, bitstreams from computes through copper wires, co-axial cable, even through wireless radio waves, microwaves, infrared, and in the form visual lights through optical fibre. Baseband signals can be sent to some distance through copper wire but sending those to a long distance has many challenges. Letus discuss these problems and how modulation came in to picture.

Modulation needs

Electronic devices produce messages like analog baseband signals in the form of audio, video or even messages can be in the form of digital bits from computer. To send these messages we must have some communication channel like wires, co-axial cable, even wireless radio waves, microwaves or infrared. We can easily transmit messages through wires or cables. Voice, Video, bit streams from computer are having lower frequency band and can travel few distance with wires but cannot be sent through wireless media. Voice signal has lower Bandwidth therefore it will not propagate through space and will be attenuated. To transmit voice signal a large size antenna is required as antenna length is proportional to half of wavelength. The size of the antenna will be more than the distance between transmitter and receiver. Again when more than one transmitter is involved all station will overlap in one frequency band. For those above reasons we choose a carrier, which is a high frequency radio wave, can travel long distance without attenuation and as the frequency is high smaller antenna is required. Selecting different carrier frequency for different transmitting stations can eliminate overlapping of frequency band.

Problem:

1. Voice, Video, bit streams from computer are having lower frequency band
2. They canntravel few distance with wires but not cannot propagate through space
3. Antenna size is half of wavelength thus antenna length for Voice, Video, bit streams would be impractical

4. Assume we transmit Voice, Video, bit streams over an imaginary antenna but being in the same frequency range all channels will overlap

Solution:

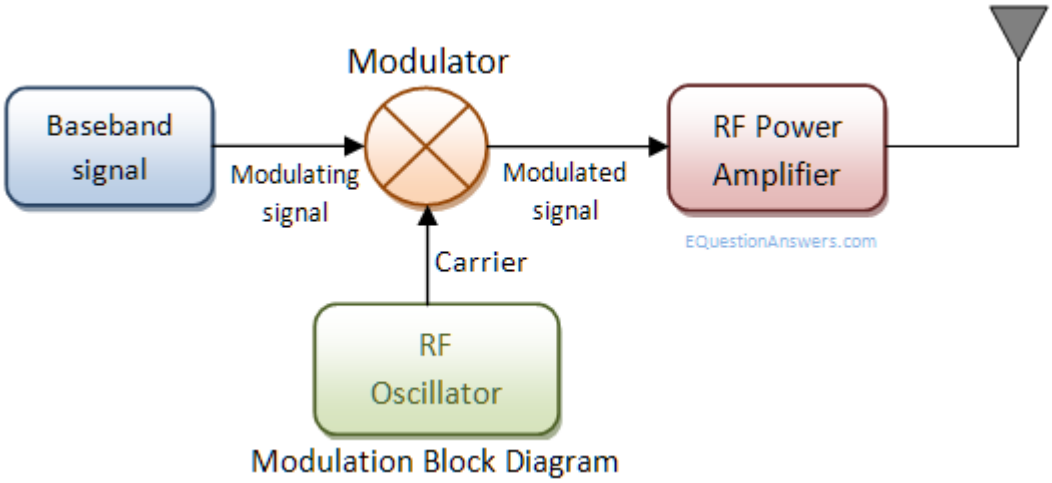
1. carrier signal is used to carry signal to long distance
2. Modulation is used with a selected carrier frequency signal to mix baseband with carrier
3. carrier frequency is in higher frequency radio wave length and thus antenna size would be smaller
4. Radio waves can travel longer distance with very less att
5. Radio wave has a wide range of frequencies to select individual non-overlapping channels

Modulation:

Now we have to develop some way to send the information of message signal via this carrier signal. The carrier signal is a high frequency sinusoidal signal represented by amplitude, frequency and phase. We can vary one of this parameter accordingly with the message information.

What is Modulation?

Modulation is an operation of varying amplitude or frequency or phase of carrier signal according to the instantaneous amplitude of the baseband signal/modulating signal.



Modulation Block Diagram

Here baseband signals comes from a audio/video or computer. Baseband signals are also called modulating signal as it modulates carrir signal. Carrier signals are high frequecy radio waves it generally comes from a radio frequency oscillators. These two signls are combined in modulator. Modulator takes the instantenious amplitute of baseband signal and varies amplitute/frequency/phase of carrier signal. Resultant signal is a modulated signal. It goes to an RF-amplifier for signal power boosting and then feed to antenna or a co-axial cable.

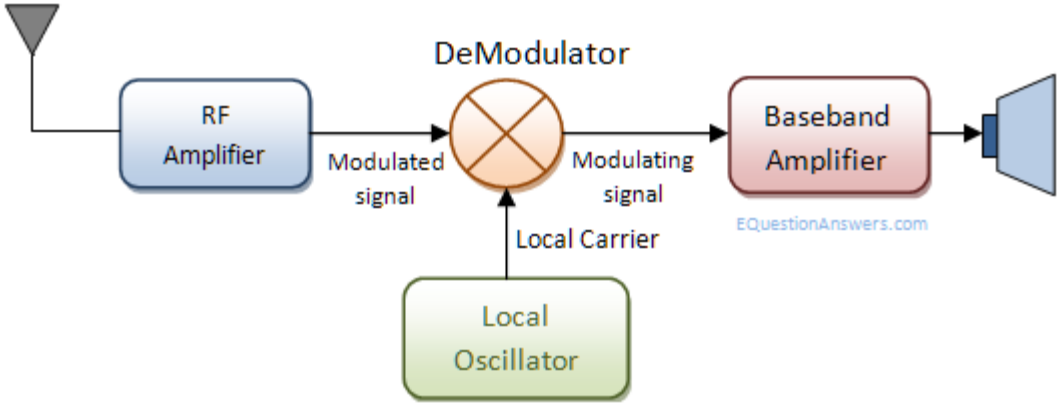
There are two types of modulation analog and digital. Analog modulation delas with the voice, video and regular waves of base band signals. Where as digital modulations are with bit streams or symbols from computing vevices as base band signals.

DeModulation:

Demodulation is the opposite process of modulation. Modulator is a part of signal transmitter where as demodulator is the receiving side. In broadcast system radio tranmitting station does to modulation part. A radio receiver acts as a demodulator. A modem receives signals and also transmits signals thus it does modulation and demodulation at the same time. Thus the name modem has been given. A radio antenna receives low power signal. A co-axial cable end point can also taken as an signal input. An RF amplifer boosts the signal amplitude. Then the signal goes to a demodulator. demodulator does the reverse of modulation and extracts the backband signal from carrier. Then the base band signal is amplified to feed a audio speaker or video moitor or TTL/CMOS signal levels to match computer inpts.

What is De-modulation?

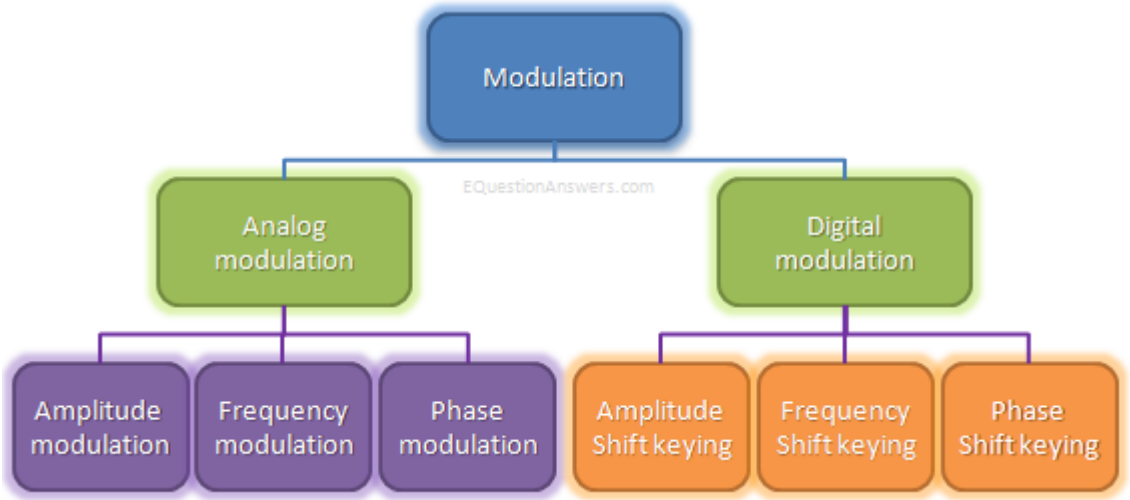
Demodulation is the opposite process of modulation where the varying amplitude, frequency or phase of carrier signal is extracted to construct the original the message signal.



Demodulation Block Diagram

What are the different types of modulations?

There are mainly two categories of modulations: analog and digital. Here is a diagram showing the types of modulations and further the sub types of analog and digital modulations.



Analog Modulation:

Analog modulation refers to the process of transferring analog low frequency baseband signal, like an audio or TV signal over a higher frequency carrier signal such as a radio frequency band. Baseband signal is always analog for this modulation.

There are three properties of a carrier signal amplitute, frequency and phase thus there are three basic types of analog modulations.

1. **Amplitude Modulation (AM)**
2. **Frequency Modulation (FM)**
3. **Phase modulation (PM)**

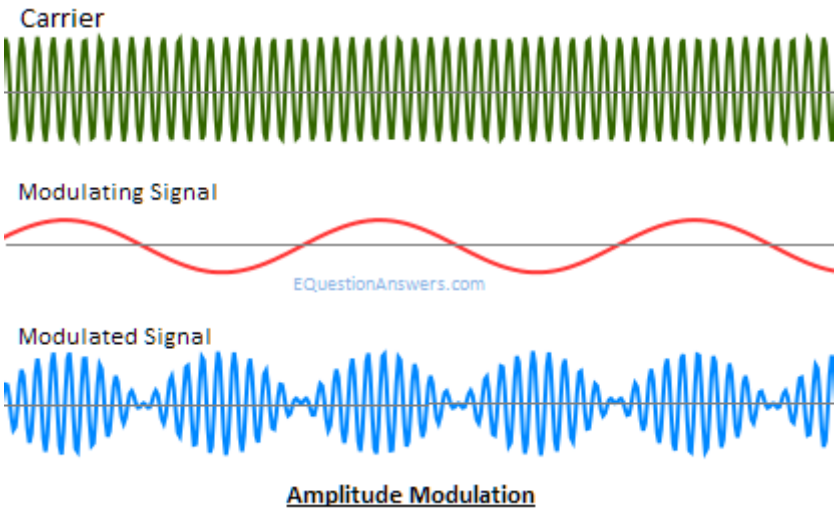
Amplitute Modulation

Amplitude modulation or AM is the process of varying the instantaneous amplitude of carrier signal accordingly with instantaneous amplitude of message signal.

Thus, if m(t) is the message signal and $c(t)=A\cos w_c t$ then AM signal F(t) is written as

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

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



Amplitude Modulation

AM Advantage

AM is the simplest type of modulation. Hardware design of both transmitter and receiver is very simple and less cost effective.

AM Disadvange:

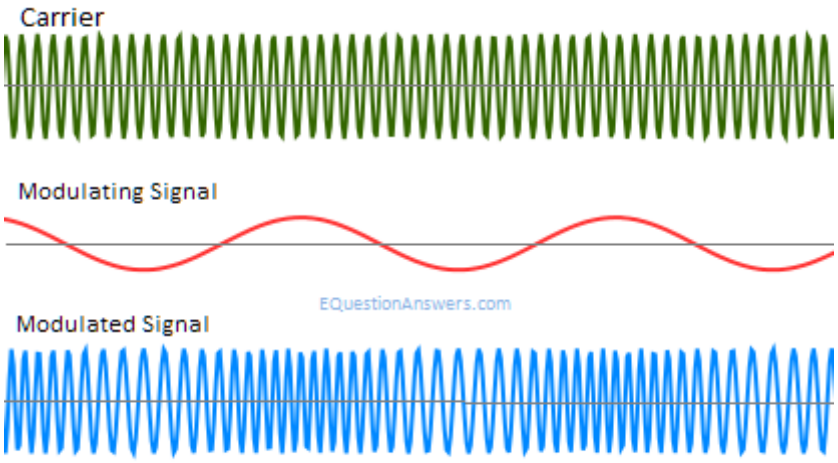
AM is very susceptible to noise.

Application:

1) AM radio broad cast is an example

Frequency modulation

FM or Frequency modulation is the process of varying the in instantaneous frequency of Carrier signal accordingly with instantaneous amplitude of message signal. Thus, if m(t) is the message signal and $c(t)=A\cos w_c t$ then FM signal will be $F(t)= A\cos(w_c t+k_f \int m(\alpha)d\alpha)$



Frequency Modulation

FM Advantage

Modulation and demodulation does not catch any channel noise.

FM Disadvange:

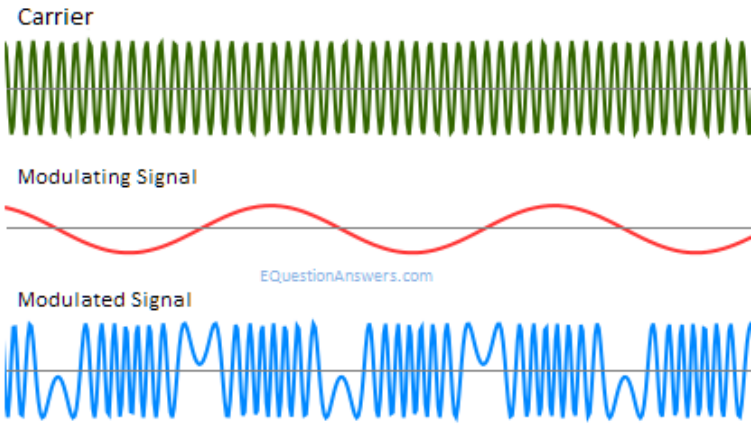
Circuit needed for FM modulation and demodulation is bit complicated than AM

Application:

1) FM radio broad cast is an example

Phase modulation (PM)

PM or Phase modulation is the process of varying the instantaneous phase of Carrier signal accordingly with instantaneous amplitude of message signal. Thus if m(t) is the message signal and c(t)=Acoswct then PM signal will be $F(t)= A\cos(w_c t+k_p m(t))$



Phase Modulation

PM Advantage

Modulation and demodulation does not catch any channel noise.

PM Disadvange:

Circuit needed for PM modulation and demodulation is bit complicated than AM and FM

Application:

1) Satellite communication.

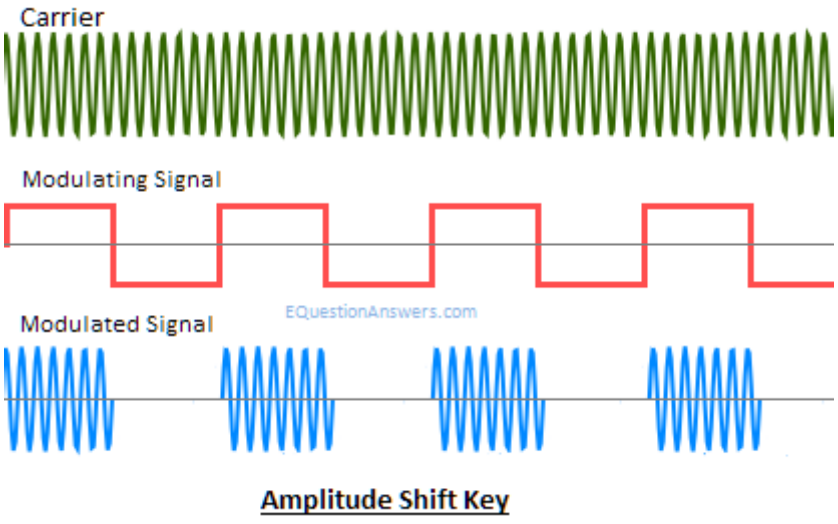
Digital modulation:

Analog modulation refers to the process of transferring digital low frequency baseband signal, like digital bitstream from computers over a higher frequency carrier signal such as a radio frequency band. Digital modulation in somewhat similar to the analog modulation except base band signal is of discrete amplitude level. For binary signal it has only two level, either high or logic 1 or low or logic 0. The modulation scheme is mainly three types.

1. ASK or Amplitude shift Key
2. FSK or Frequency shift key
3. PSK or Phase shift key

ASK or Amplitude shift Key:

When the carrier signal's instantaneous amplitude is varied in proportion to message signal m(t). We have the modulated carrier $m(t)\cos w_c t$ where $\cos w_c t$ is the carrier signal. As the information is an on-off signal the output is also an on-off signal where the carrier is present when information is 1 and carrier is absent when information is 0. Thus this modulation scheme is known as on-off keying (OOK) or amplitude shift key.



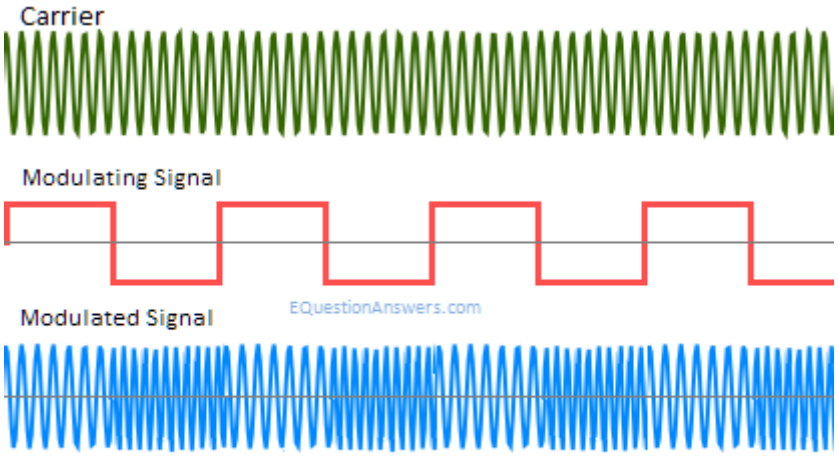
Amplitude Shift Key

Application:

1. Used in our infrared remote controls
2. Used in fibre optical tranmitter and receiver.

FSK or Frequency shift key:

When Data are transmitted by varying instantaneous frequency of the carrier, we have the case of frequency shift key. In this modulation carrier has two predefined frequency w_{c1} and w_{c2}. When information bit is 1 carrier with w_{c1} is transmitted i.e. $\cos w_{c1}$ and When information bit is 0 carrier with w_{c0} is transmitted i.e. $\cos w_{c0}$



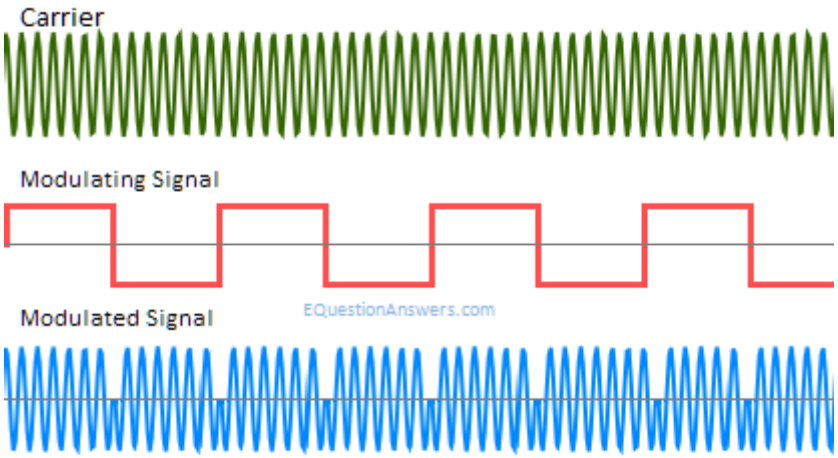
Frequency Shift Key

Application:

1. Many modems used FSK in telemetry systems

PSK or Phase shift key:

The instantaneous phase of the carrier is shifted for this modulation. If the base band signal m(t) =1 carrier in phase is transmitted. If m(t)=0 carrier with out of phase is transmitted i.e. $\cos(w_c t+\Pi)$. If phase shift is done in 4 different quadrants then 2bit of information can be sent at a time. This scheme is a special case of PSK modulation known as QPSK or Quadrature Phase Shift Key.



Phase Shift Key

Application:

1. Used in our ADSL broadband modem
2. Used in satellite communication
3. Used in our mobile phones