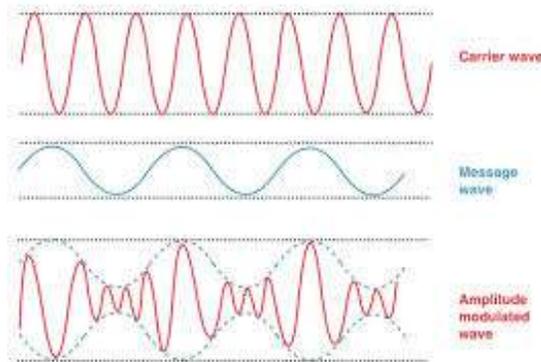


AM, PM and FM modulation

What is amplitude modulation

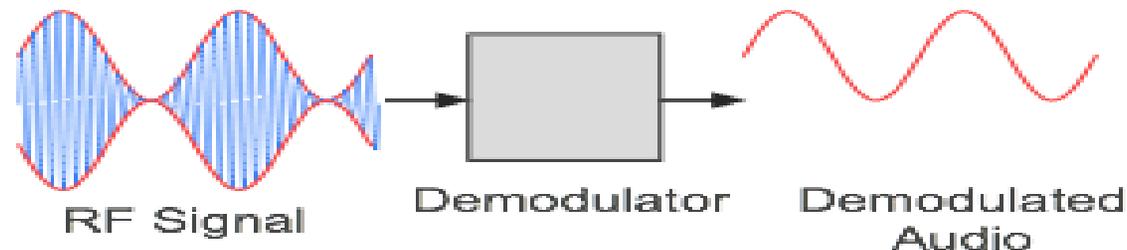
- In order that a radio signal can carry audio or other information for broadcasting or for two way radio communication, it must be modulated or changed in some way. Although there are a number of ways in which a radio signal may be modulated, one of the easiest is to change its amplitude in line with variations of the sound.



Amplitude modulation

Amplitude demodulation

- Amplitude modulation, AM, is one of the most straightforward ways of modulating a radio signal or carrier. It can be achieved in a number of ways, but the simplest uses a single diode rectifier circuit.
- Other methods of demodulating an AM signal use synchronous techniques and provide much lower levels of distortion and improved reception where selective fading is present.
- One of the main reasons for the popularity of amplitude modulation has been the simplicity of the demodulation. It enables costs to be kept low - a significant advantage in producing vast quantities of very low cost AM radios.



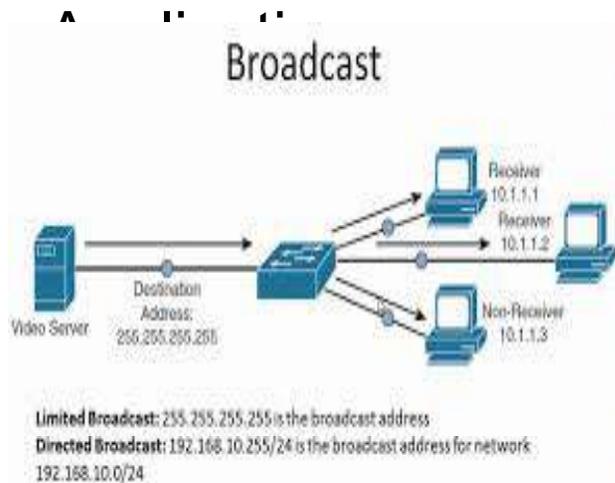
Advantages & disadvantages of AM

Advantages

- It is simple to implement
- it can be demodulated using a circuit consisting of very few components
- AM receivers are very cheap as no specialised components are needed.

Disadvantages

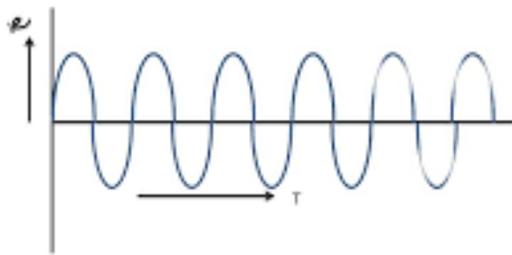
- It is not efficient in terms of its power usage
- It is not efficient in terms of its use of bandwidth, requiring a bandwidth equal to twice that of the highest audio frequency
- It is prone to high levels of noise because most noise is amplitude based and obviously AM detectors are sensitive to it.



- **Broadcast transmissions:** AM is still widely used for broadcasting on the long, medium and short wave bands. It is simple to demodulate and this means that radio receivers capable of demodulating amplitude modulation are cheap and simple to manufacture. Nevertheless many people are moving to high quality forms of transmission like frequency modulation, FM or digital transmissions.

- **Air band radio:** VHF transmissions for many airborne applications still use AM. It is used for ground to air radio communications as well as two way radio links for ground staff as well.

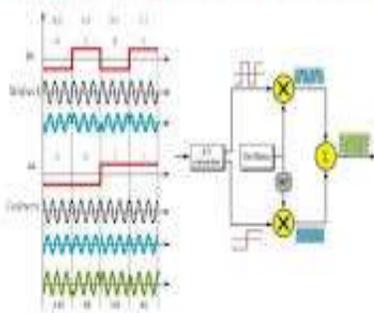
SINGLE SIDE BAND SUPPRESSED CARRIER SIGNAL SSBSC



A = AMPLITUDE
T = TIME

- **Single sideband:** Amplitude modulation in the form of single sideband is still used for HF radio links. Using a lower bandwidth and providing more effective use of the transmitted power this form of modulation is still used for many point to point HF links.

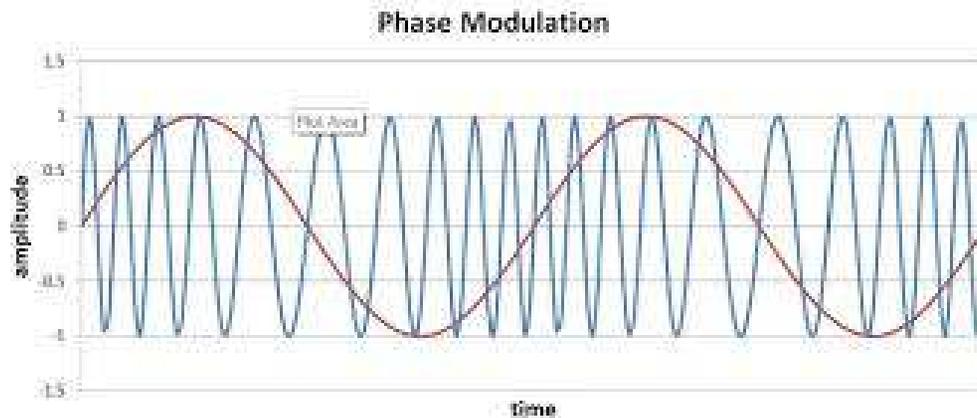
BLOCK DIAGRAM OF QAM MODULATION



- **Quadrature amplitude modulation:** AM is widely used for the transmission of data in everything from short range wireless links such as Wi-Fi to cellular telecommunications and much more. Effectively it is formed by having two carriers 90° out of phase.

What is Phase Modulation

- Phase modulation, PM is sometimes used for analogue transmission, but it has become the basis for modulation schemes used for carrying data. Phase shift keying, PSK is widely used for data communication. Phase modulation is also the basis of a form of modulation known as quadrature amplitude modulation, where both phase and amplitude are varied to provide additional capabilities.



Phase modulation basics

- A radio frequency signal consists of an oscillating carrier in the form of a sine wave is the basis of the signal. The instantaneous amplitude follows this curve moving positive and then negative, returning to the start point after one complete cycle - it follows the curve of the sine wave.

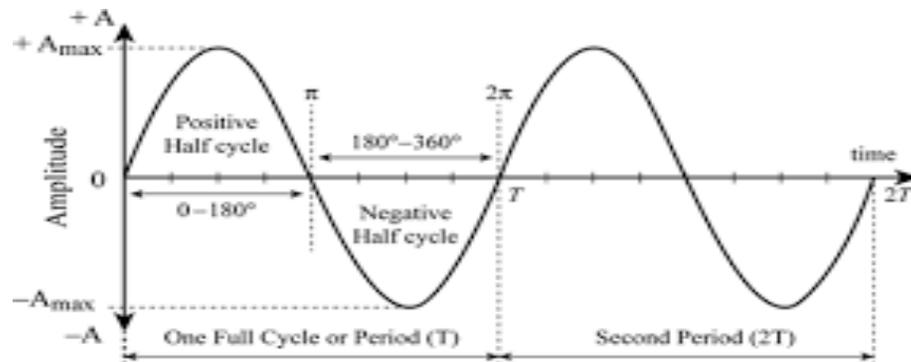
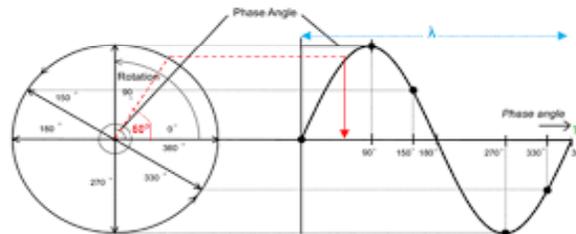


Figure 1

Cont..

- The sine wave can also be represented by the movement of a point around a circle, the phase at any given point being the angle between the start point and the point on the waveform as shown.

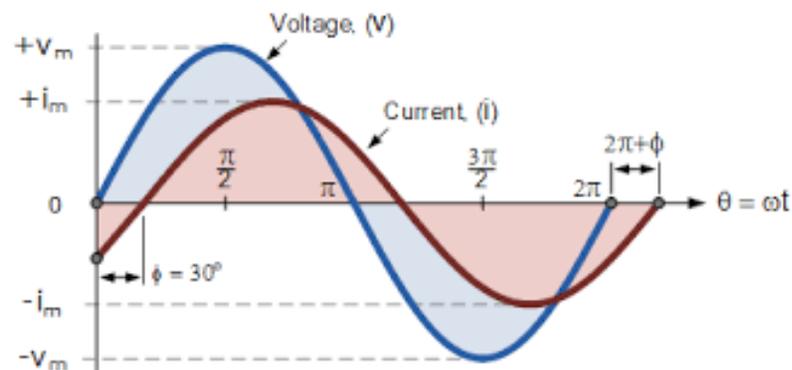


- Phase angle of point as time progresses have a phase difference

Phase advances can be said to

Cont..

- Phase modulation works by modulating the phase of the signal, i.e. changing the rate at which the point moves around the circle. This changes the phase of the signal from what it would have been if no modulation was applied. In other words the speed of rotation around the circle is modulated about the mean value.

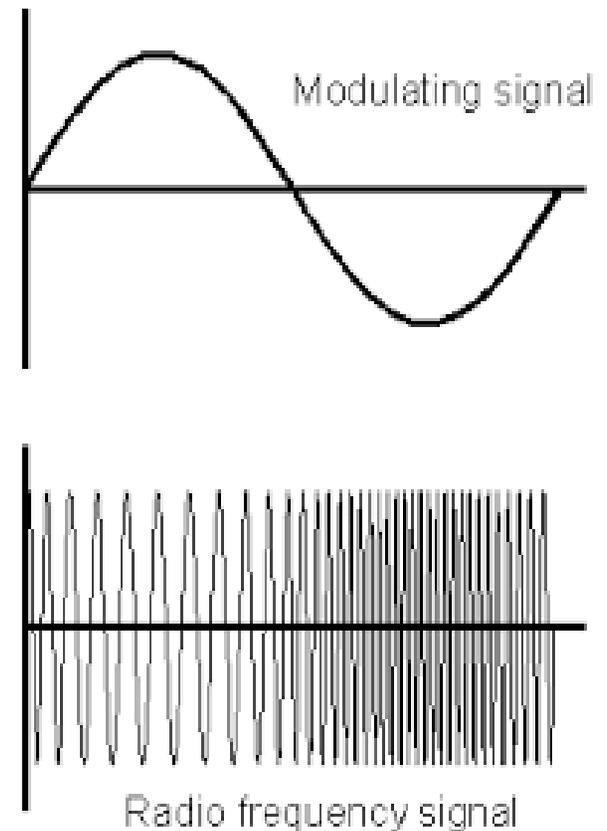


Forms of phase modulation

Although phase modulation is used for some analogue transmissions, it is far more widely used as a digital form of modulation where it switches between different phases. This is known as phase shift keying, PSK, and there are many flavours of this. It is even possible to combine phase shift keying and amplitude keying in a form of modulation known as quadrature amplitude modulation, QAM.

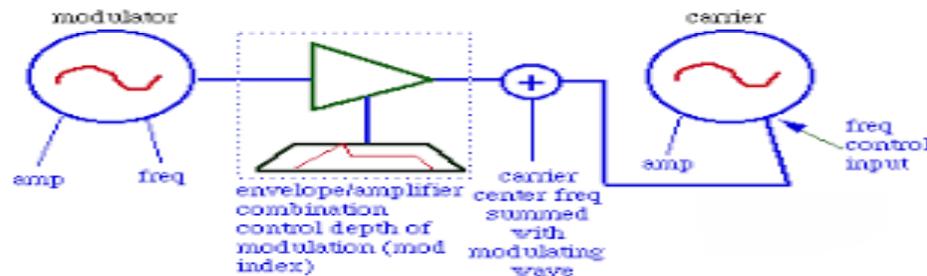
What is frequency modulation, FM

- As with any form of modulation, it is necessary to be able to successfully demodulate it and recover the original signal. The FM demodulator may be called a variety of names including FM demodulator, FM detector or an FM discriminator.
- There are a number of different types of FM demodulator, but all of them enable the frequency variations of the incoming signal to be converted into amplitude variations on the output. These are typically fed into an audio amplifier, or possibly a digital interface if data is being passed over the system.



FM modulators

- Varactor diode oscillator:** This method simply requires the use of a varactor diode placed within the tuned circuit of an oscillator circuit. It is even possible to use a varactor diode within a crystal oscillator circuit. Typically when crystal oscillators are used the signal needs to be multiplied in frequency, and only narrow band FM is attainable.

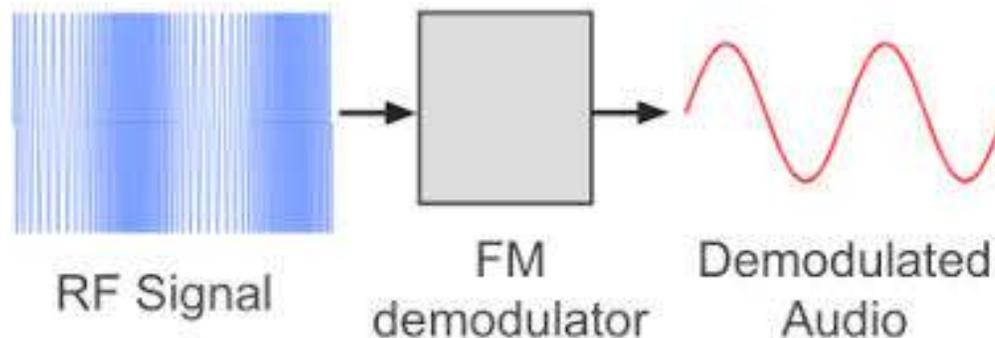


- Phase locked** generating frequency with constraints with an excellent solution.

excellent method of frequency control to manage the carrier frequency it provides and

Frequency demodulation

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CONT..

The list below gives some of the forms of phase shift keying that are used:

- PM - Phase Modulation
- PSK - Phase Shift Keying
- BPSK - Binary Phase Shift Keying
- QPSK - Quadrature Phase Shift Keying
- 8 PSK - 8 Point Phase Shift Keying
- 16 PSK - 16 Point Phase Shift Keying
- OPSK - Offset Phase Shift Keying

Advantages of frequency modulation, FM:

- ***Resilience to noise:*** One particular advantage of frequency modulation is its resilience to signal level variations. The modulation is carried only as variations in frequency.
- ***Easy to apply modulation at a low power stage of the transmitter:*** Another advantage of frequency modulation is associated with the transmitters.
- ***It is possible to use efficient RF amplifiers with frequency modulated signals:*** It is possible to use non-linear RF amplifiers to amplify FM signals in a transmitter and these are more efficient than the linear ones required for signals with any amplitude variations (e.g. AM and SSB).

disadvantages of frequency modulation, FM

- ***FM has poorer spectral efficiency than some other modulation formats:*** Some phase modulation and quadrature amplitude modulation formats have a higher spectral efficiency for data transmission than frequency shift keying, a form of frequency modulation.
- ***Requires more complicated demodulator:*** One of the minor disadvantages of frequency modulation is that the demodulator is a little more complicated, and hence slightly more expensive than the very simple diode detectors used for AM.

CONT..

- ***Some other modes have higher data spectral efficiency:*** Some phase modulation and quadrature amplitude modulation formats have a higher spectral efficiency for data transmission than frequency shift keying, a form of frequency modulation.
- ***Sidebands extend to infinity either side:*** The sidebands for an FM transmission theoretically extend out to infinity. They are normally significant for wideband frequency modulation transmissions, although small for narrow band FM.