UNIT1, MODULE4: Generation of AM (Emitter modulation) and Amplitude demodulation(Diode detector)

NOTES:

Introduction:

Transmitters that transmit amplitude modulated signals require an AM modulator circuit to produce the required signal.

There are many ways in which amplitude modulation can be generated and a variety of circuits that can be used.

In early AM transmitters the amplitude modulator circuit was a key element of the transmitter. Today with software processes and multi-mode transmitters, the amplitude modulator is likely be contained within an overall modulator circuit that is able to provide a number of different types of modulation.

Nevertheless, many transmitters still require AM modulators and the concepts and theory behind them is still relevant.

Many AM modulators were used with valve transmitters – AM was widely used for many communications applications when thermionic valve or vacuum tube technology was used. Accordingly, many of the circuits that were developed were for use with these devices. However, the principles are the same for both valve and semiconductor technologies.

High and low level AM modulators

AM modulators may be classed as either high or low level dependent upon their level in the overall signal chain.

High level modulator: A high level modulator is defined as one that modulates a high power section of the circuit, typically the final RF amplifier. It has the advantage that linear amplifiers are not required for the RF amplification stages after AM modulation has been applied. The drawback is that high power audio amplifiers are needed. For broadcast transmitters where very high power levels are used, class D or class E amplifiers may be employed for the audio output.

Low level modulator: A low level AM modulator would be one where the modulation is applied to low power stage of the transmitter, typically in the RF generation stages, or via the digital signal processing areas. The drawback of this approach is that linear amplification is required for the RF stages.

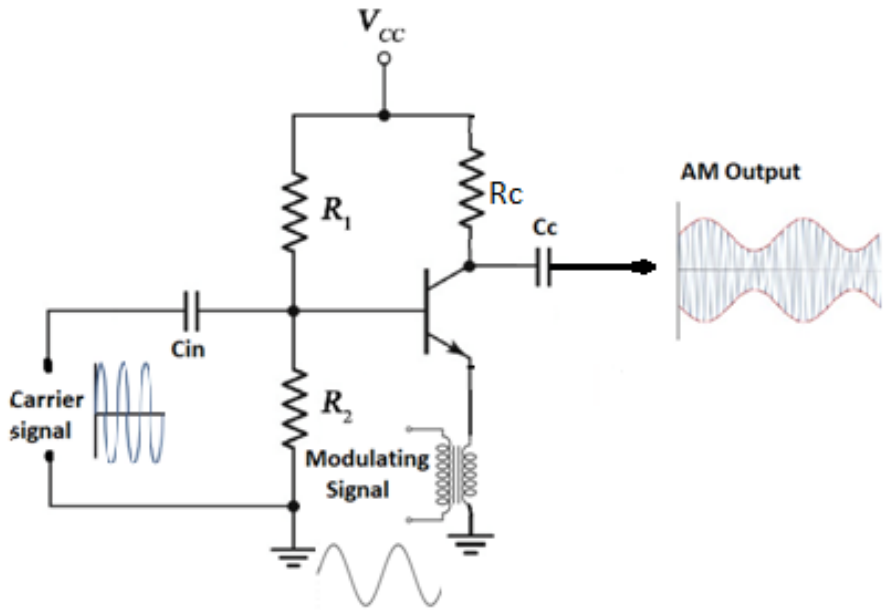
Generation of AM (Emitter Modulation)

In amplitude modulation, the amplitude of the high frequency (carrier) is controlled by the low frequency (modulating) signal.

In order to generate AM, wave a nonlinear device such as Transistor or Diode is used.

A nonlinear device makes it possible to mix up (multiply) the two signals viz. the modulating signal and the carrier signal, thus resulting in a range of frequencies at the output.

The filter circuit at the output attenuates the higher harmonics to produce an output voltage with the waveform of AM wave.



AM- Emitter Modulator Circuit

Circuit Explanation:

1. Modulating signal is applied through isolation transformer to the emitter of transistor and the carrier is applied directly to the base.

2. The modulating signal drives the circuit into both saturation and cut-off states, producing the nonlinear amplification necessary for modulation to occur

3. The collector waveform includes the carrier, upper and lower side frequencies as well as a component at the modulating frequency

4. Coupling capacitor C removes the modulating signal frequency from the waveform, producing a symmetrical AM envelope at Vout

Working of AM emitter modulator circuit

When no modulating signal present, the circuit operates as a linear amplifier. The output is simply the carrier amplified by the quiescent voltage gain

When a modulating signal is applied, the amplifier operates nonlinearly, and signal multiplication occurs

The modulating signal varies the gain of the amplifier at a sinusoidal rate equal to the frequency of the modulating signal and can be expressed as:

$$Av = Aq\ [1 + m\ Sin(2\pi fmt)]$$

where

Av = amplifier voltage gain with modulation

Aq = amplifier quiescent (without modulation)

voltage gain

Characteristics of Emitter modulator circuit

Amplitude of the output signal depends on the amplitude of input carrier and the voltage gain of amplifier

Simple but incapable of producing high-power output waveforms

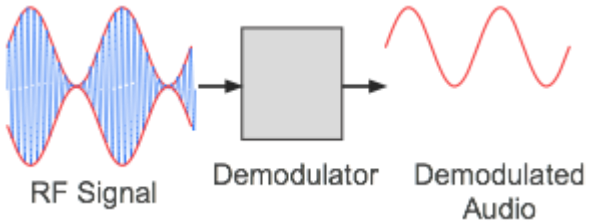
Amplitude Demodulation

Demodulation is a key process in the reception of any amplitude modulated signals whether used for broadcast or two way radio communication systems.

Demodulation is the process by which the original information bearing signal, i.e. the modulation is extracted from the incoming overall received signal.

The process of demodulation for signals using amplitude modulation can be achieved in a number of different techniques, each of which has its own advantage.

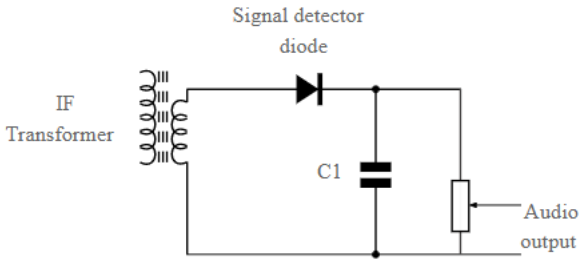
AM demodulators are found in many items of radio equipment: broadcast receivers, professional radio communication equipment, walkie talkies - AM is still used for air-band radio communications.



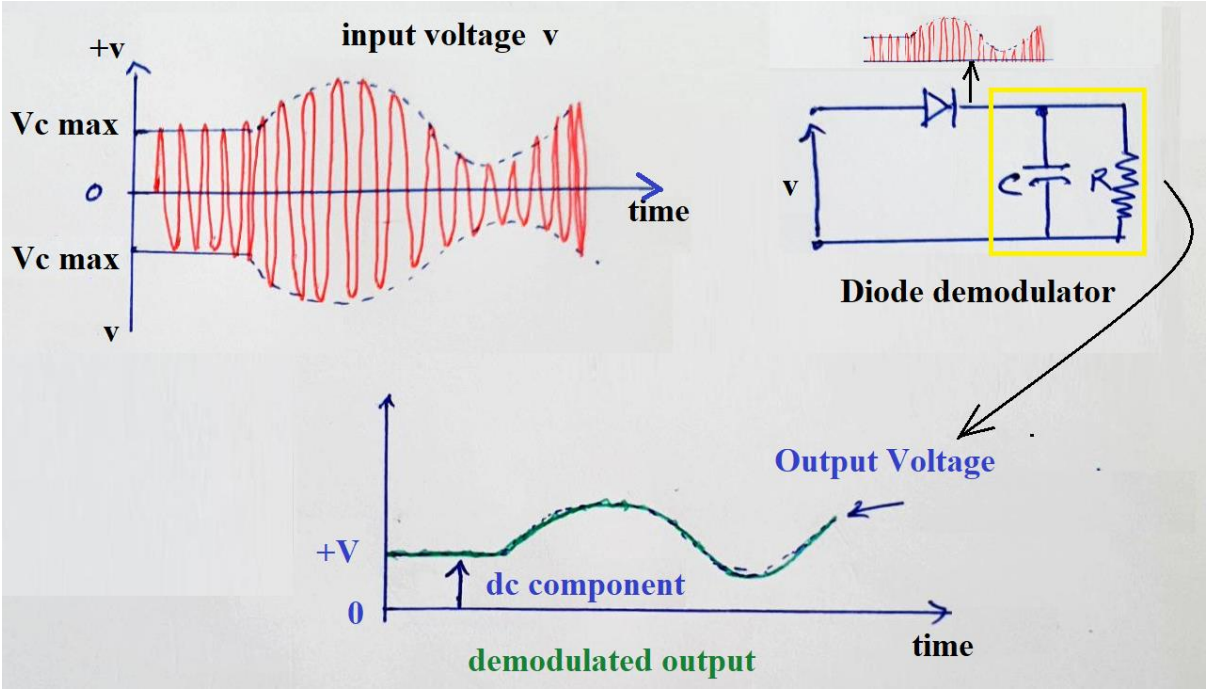
Demodulation

Diode rectifier envelope detector:

This form of detector is the simplest form, only requiring a single diode and a couple of other low-cost components. The performance is adequate for low-cost AM broadcast radios, but it does not meet the standards of other forms of demodulation.



Circuit of an envelope detector as used in an AM radio receiver.



Input and output waveforms of a diode envelope detector demodulator circuit