Amplitude Modulator

Amplitude modulation may be achieved in a number of ways, the most common method being to use the modulating signal to vary the otherwise steady voltage on the output electrode of an amplifier.

Vacuum tubes are used for very high power outputs (in the kilowatt and higher ranges), and transistors are used for lower powers. (Pentode vacuum tubes and transistors have similarly shaped output characteristics, although they operate at greatly different voltage and current levels.) The basic circuit for a BJT modulator is shown in Figure.

The transistor is normally operated in the class C mode in which it is biased well beyond cutoff. The carrier input to the base must be sufficient to drive the transistor into conduction over part of the RF cycle, during which the collector current flows in the form of pulses. These pulses are periodic at the carrier frequency and can therefore be analyzed into a trigonometric Fourier series. The tuned circuit in the collector is tuned to resonate at the fundamental component, and thus, to a close approximation, the RF voltage at the collector is sinusoidal.

AM Modulator Circuits

Depending upon the location of modulator in transmitter circuit, there are two types of modulators : i) Low level modulator and ii) Medium power modulator.

Low Level AM Modulator

When modulator is placed before the output element of final stage of the transmitter, it is called level modulator.

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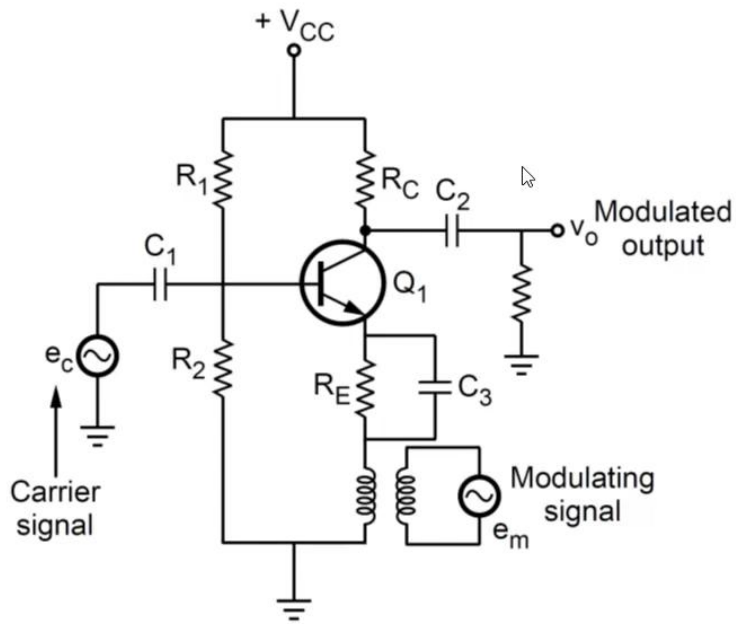
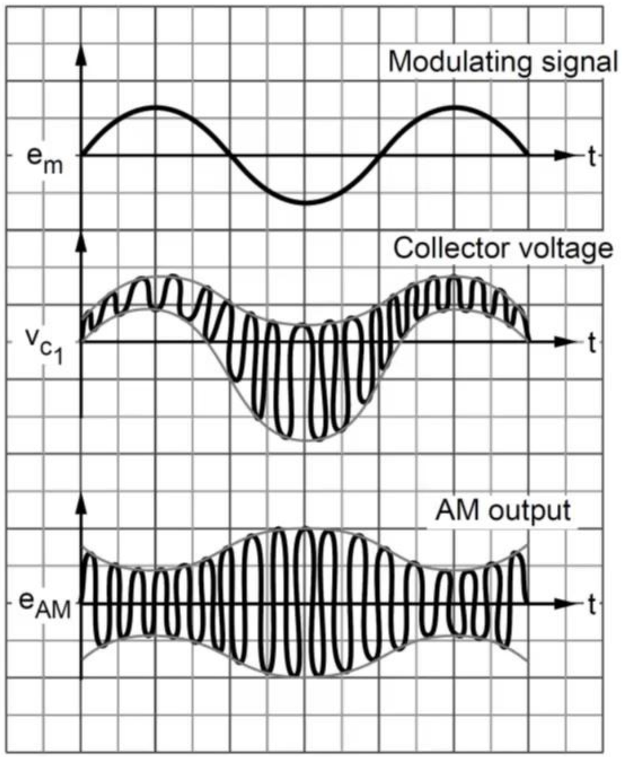
Circuit diagram and waveforms



(a) Circuit diagram of low level AM modulator



(b) Waveforms

Operation

- Carrier signal is given to the base of the amplifier and modulating signal is given to emitter. In absence of modulating signal, the circuit simply operates as linear class A amplifier.
- When modulating signal is applied to an emitter, the gain of the amplifier varies according to voltage of modulating signal.
- Depending upon the gain variations, carrier signal is amplified. Thus amplitude of carrier signal is modulated by modulating signal.
- Voltage gain of emitter modulator is given as,

$$A_v = A_q[1 + m\sin(2\pi f_m t)]$$

where A_v is voltage gain with modulation.

A_q is quiescent voltage gain.

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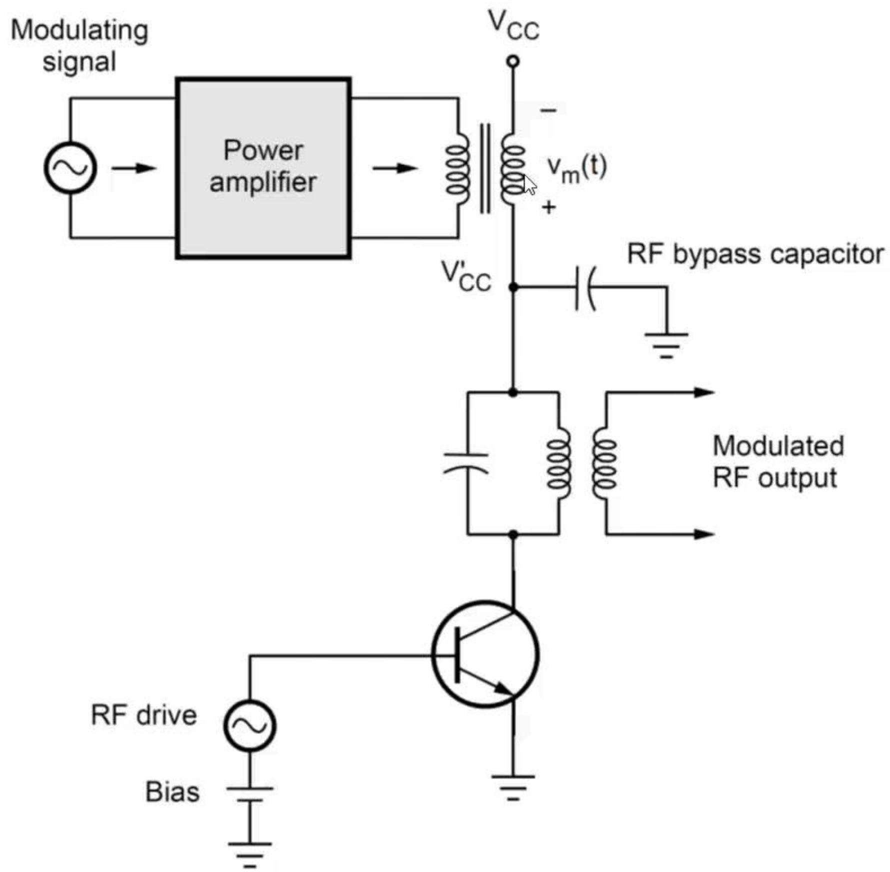
Advantages of low level modulation

i) Less modulating signal power is required to obtain high percentage modulation.

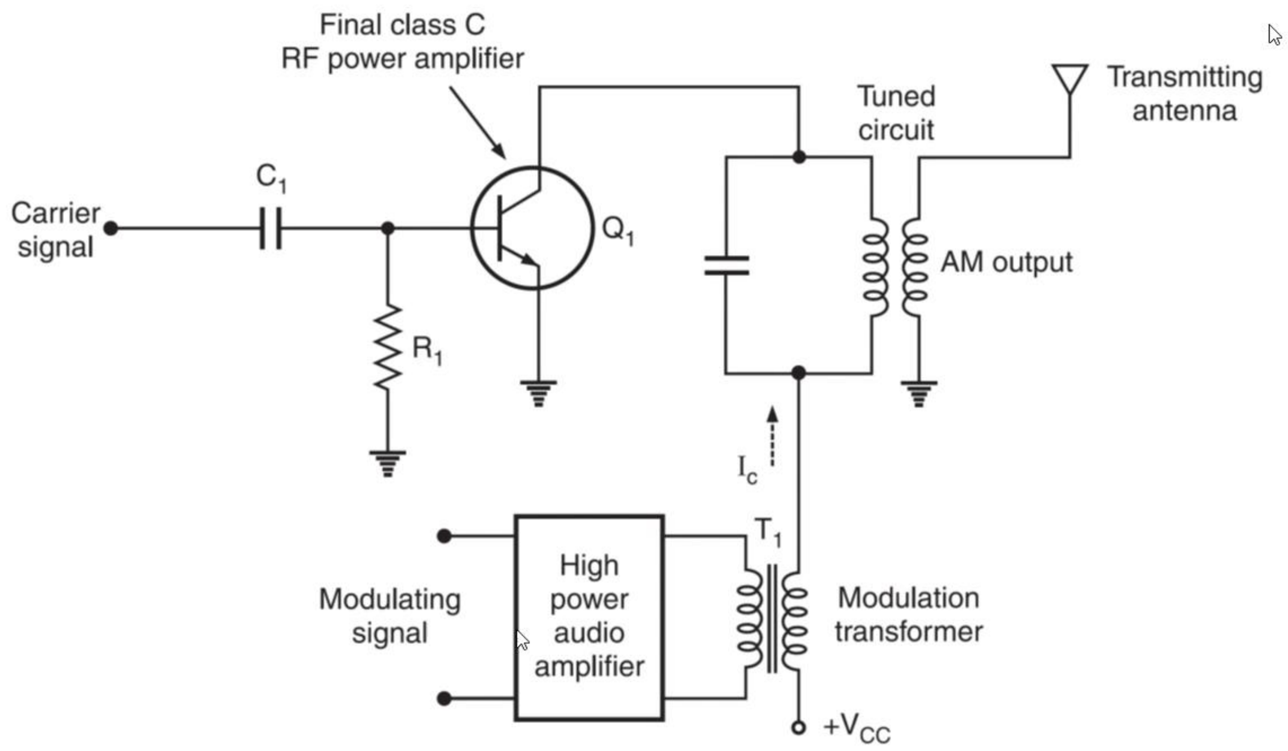
ii) Modulator circuit is to be designed at low power.

Disadvantages of low level modulation

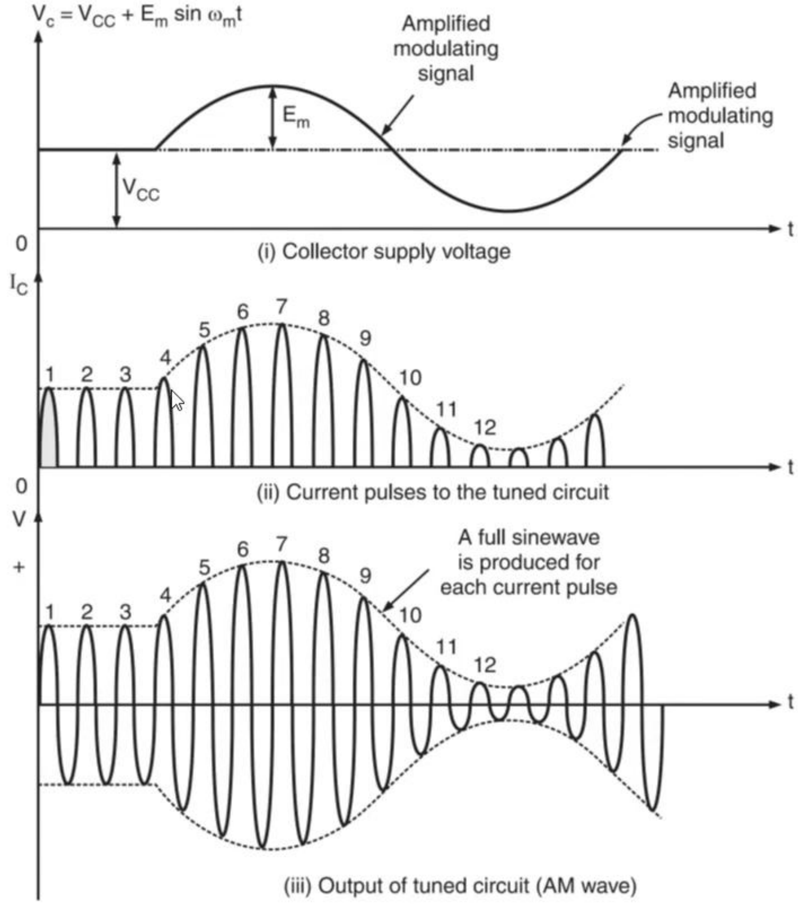
Amplifiers following modulator stage must be linear. At high operating powers linear amplifiers are very inefficient.



BJT collector modulator (class C amplifier)



High level collector modulator



Waveforms of collector modulator circuit

Advantages of high level modulators

i) There is no constraint of linear operation on amplifiers preceding modulator stage.

ii) Power efficiency is good.

Disadvantages of high level modulators

i) High modulating power is required to achieve higher percentage modulation.

ii) Final modulating signal amplifier has to supply all the sideband power, which is around 33 % of total transmitted power.

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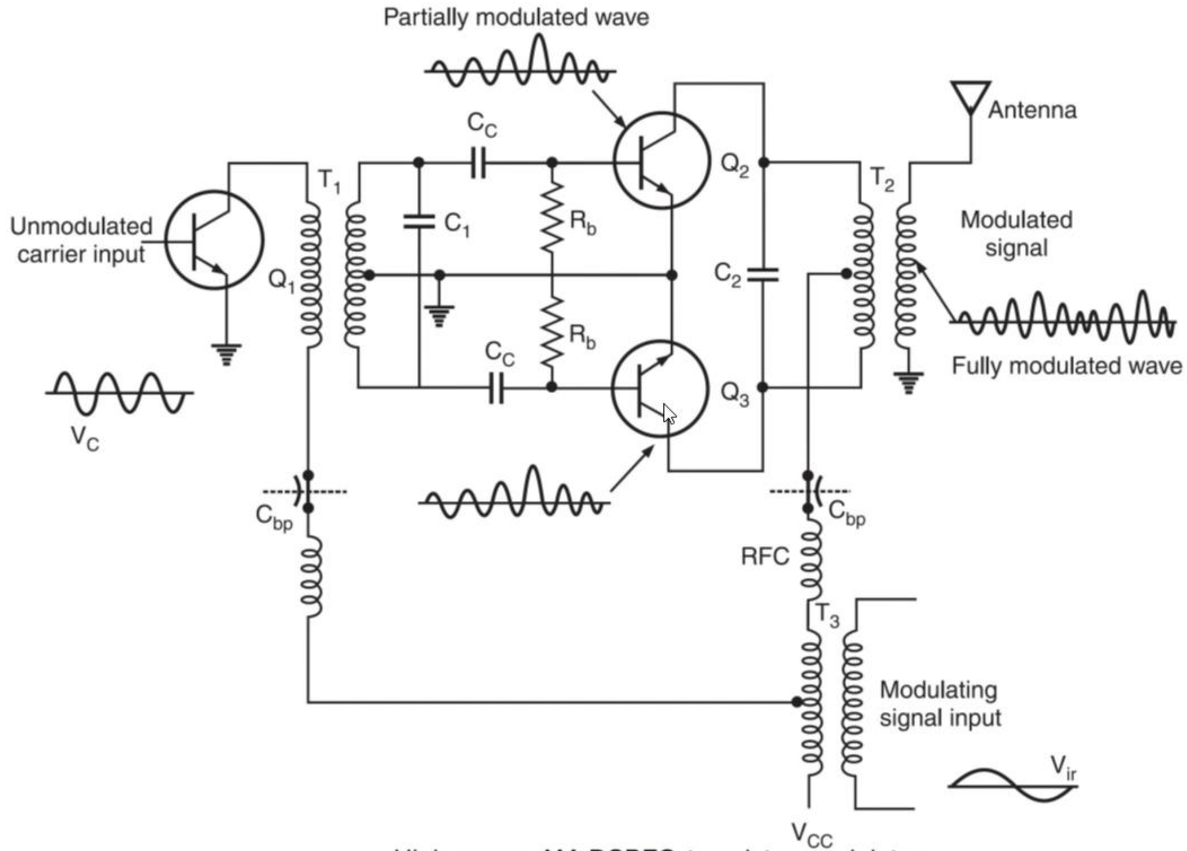
Simultaneous Base and Collector Modulation



High power AM DSBFC transistor modulator

Amplitude Demodulator Circuit

Amplitude Demodulator Circuits

At the receiver, a circuit must be provided that recovers the information signal from the modulated carrier.

The most common circuit in use is the ***Diode Envelope Detector***, which produces an output voltage proportional to the envelope, which is the modulating or information signal. The basic circuit is shown in Fig. (a).

The diode acts as a rectifier and can be considered an ON switch when the input voltage is positive, allowing the capacitor *C* to charge up to the peak of the RF input. During the negative half of the RF cycle, the diode is off, but the capacitor holds the positive charge previously received, so the output voltage remains at the peak positive value of RF. There will, in fact, be some discharge of *C*, producing an RF ripple on the output waveform, which must be filtered out.

As the input voltage rises with the modulating cycle, the capacitor voltage has no difficulty in following this, but during the downward swing in modulation the capacitor may not discharge fast enough unless an additional discharge path is provided by the resistor *R*. The time constant of the *CR* load has to be short enough to allow the output voltage to follow the modulating cycle and yet long enough to maintain a relatively high output voltage.