MPIT HATHRAS

CHAPTER : 5
Amplitude Modulation - Generation Methods

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LECTURER ELECTRONICS

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Types of modulators

There are two types of amplitude modulators.

1) High level modulation

- High-level modulators produce AM at high power levels, usually in the final amplifier stage of a transmitter.

2) Low level modulation

- Low-level modulators generate AM with small signals and must be amplified before transmission.

Block Diagram of High level AM Transmitters

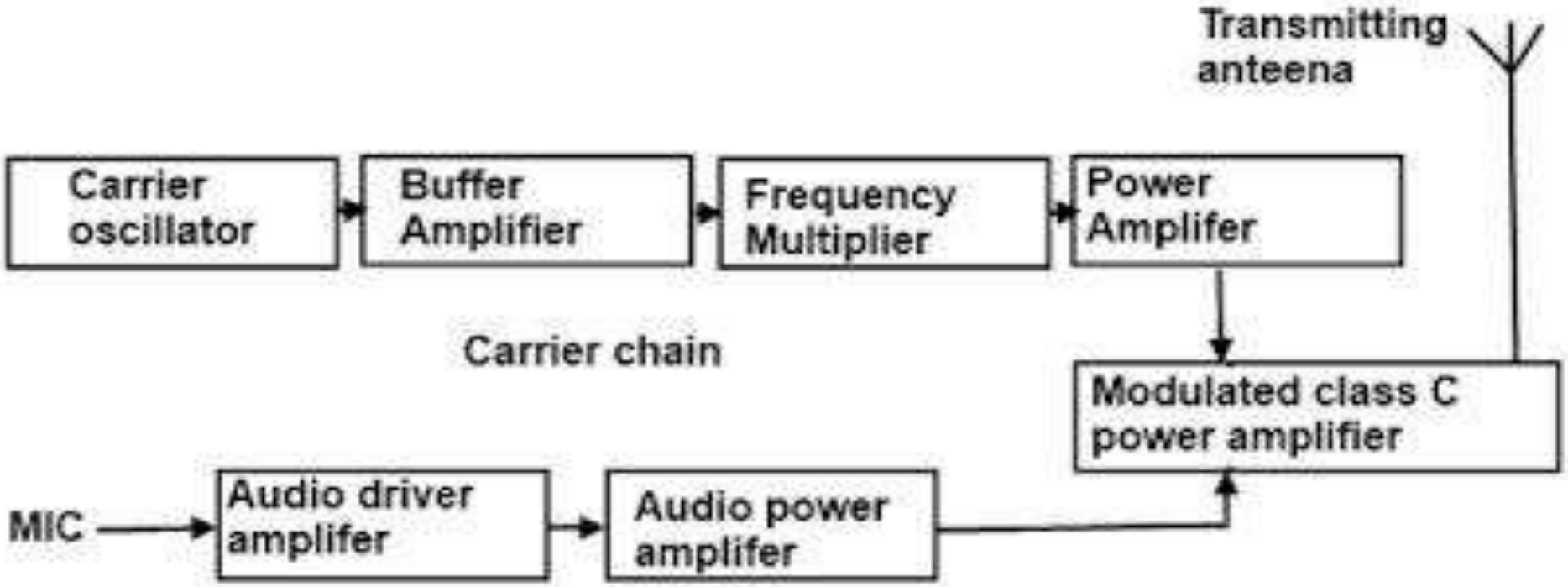


Figure (a) Block diagram of high level AM transmitter

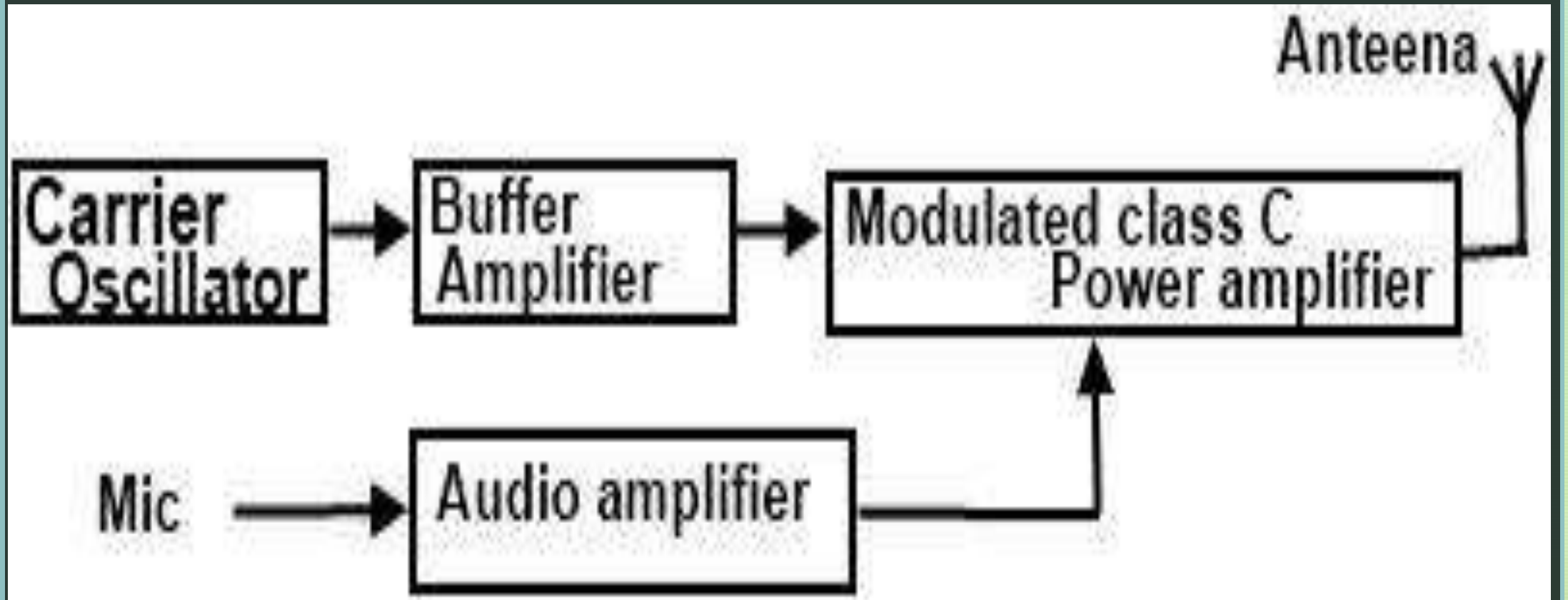
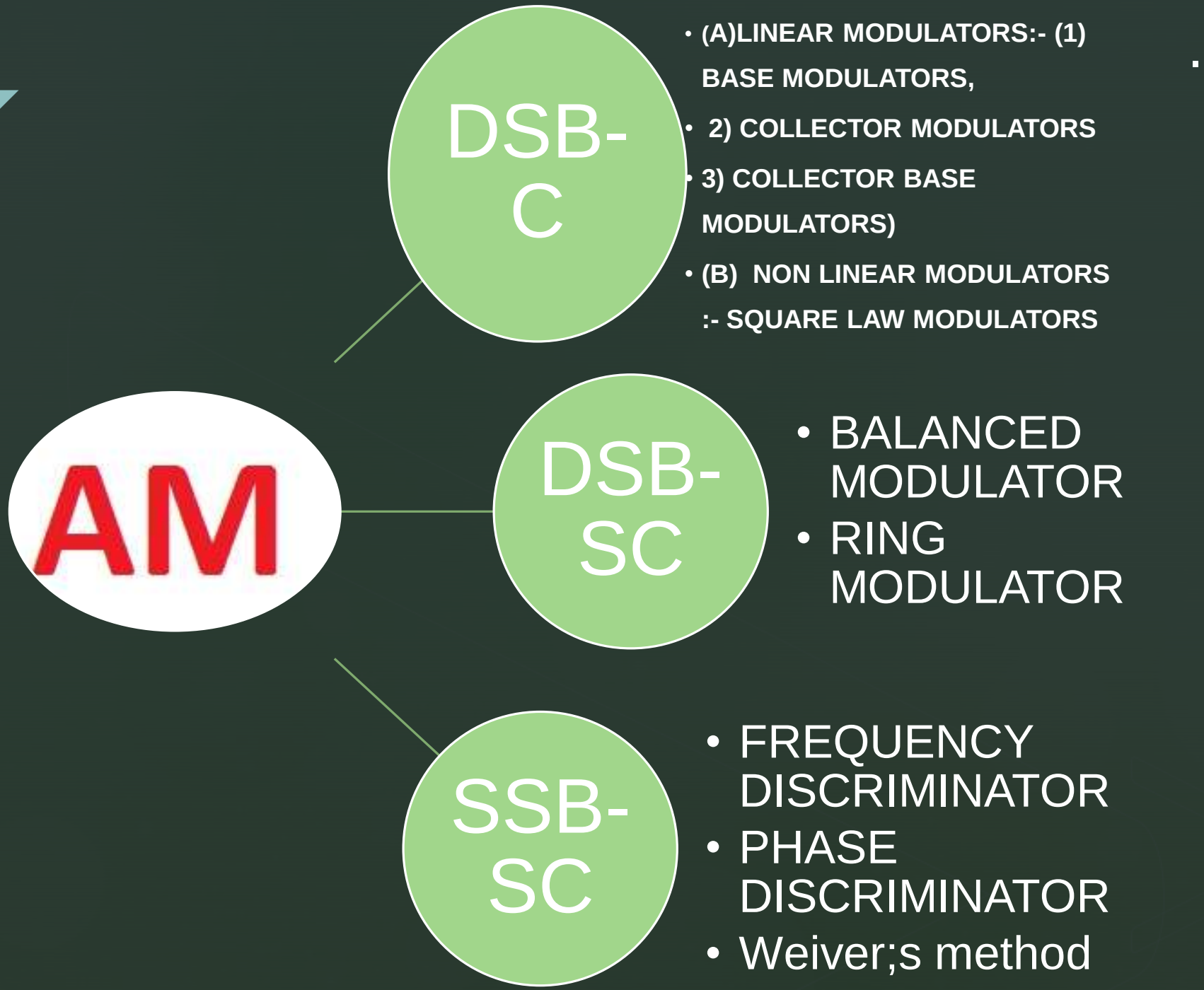
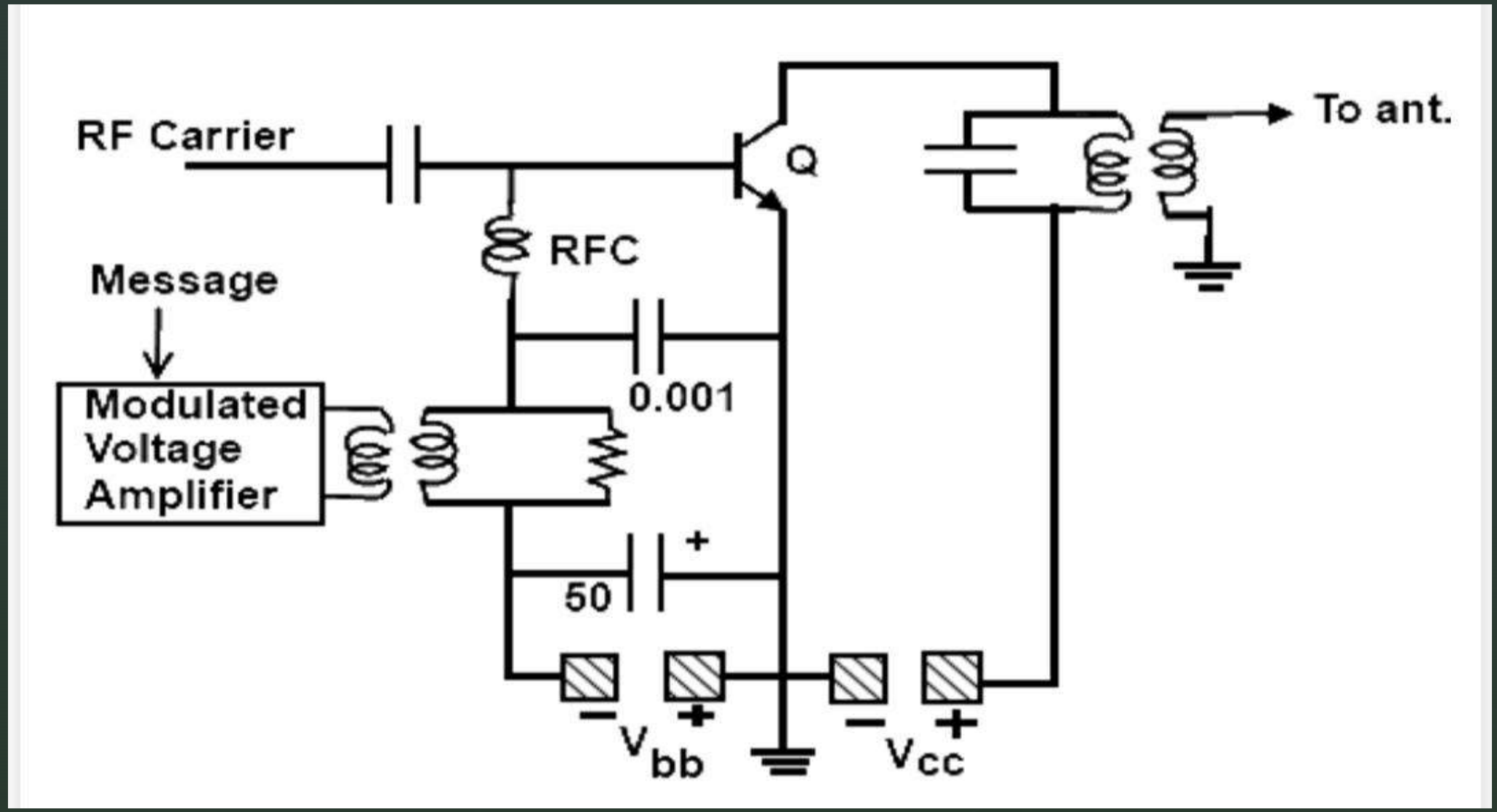


Figure (b) Block diagram of Low-level AM transmitter



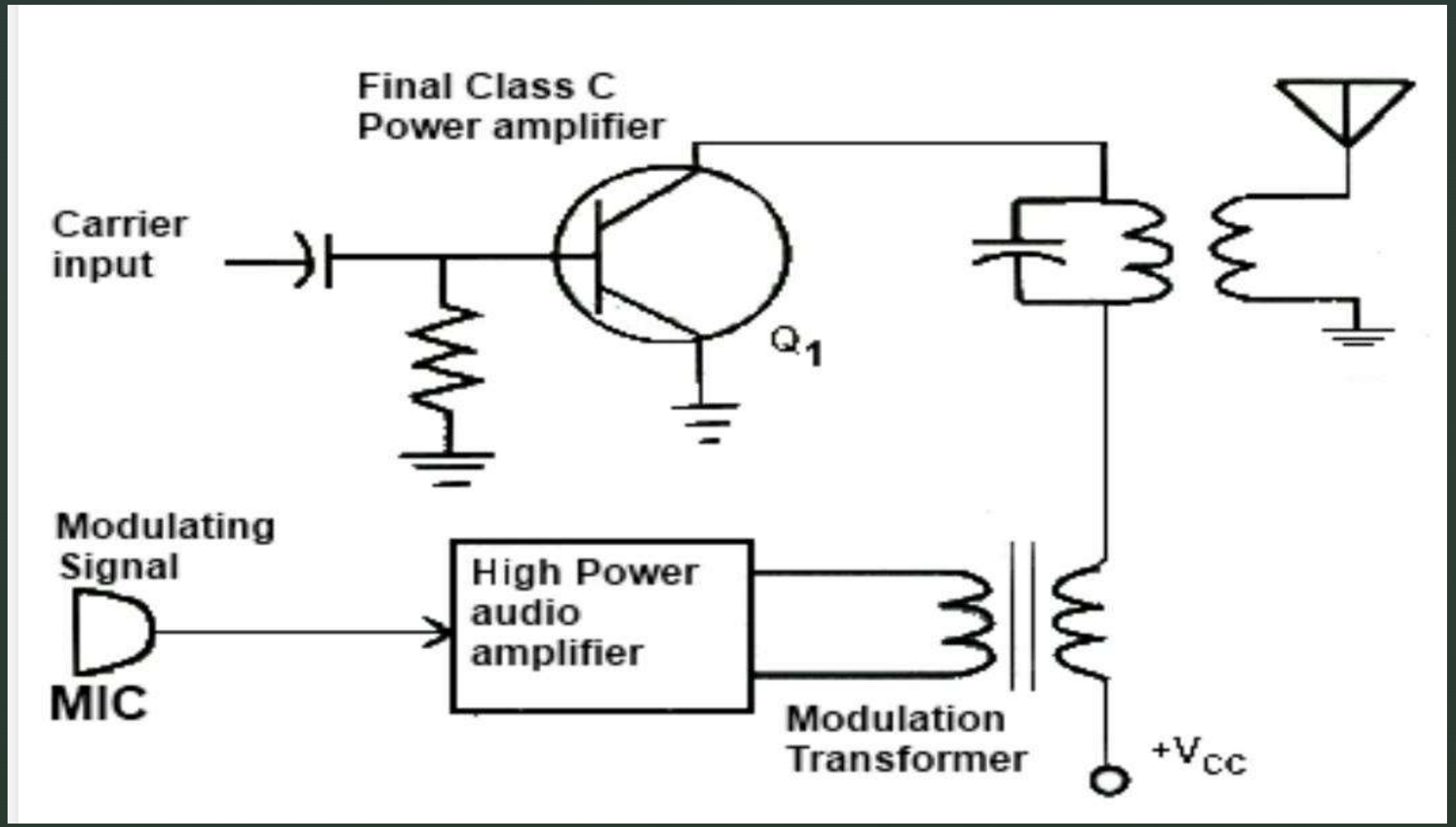
Base modulator



Base Modulator

- It is so named because RF carrier and the message signal both are given to base terminal
- Message signal is amplified and then superimposed on the fixed bias V_{bb} which varies in accordance to the message signal and given to base terminal through RFC.
- The RF carrier is also given to base through coupling capacitor which is then superimposed with the message signal bias .
- This superimposed bias voltage control the collector current which is proportional to the amplitude of the message signal hence this modulated waveform is coupled to the secondary of the transformer
- It is a low level modulator technique.

Collector Modulator



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- The output stage of the transmitter is a high power frequency class C amplifier . Class C amplifiers conduct for only a portion of the positive half cycle of their input signal.

- The collector current pulses cause the tuned circuit to oscillate or ring at the desired output frequency . The tuned circuit, then reproduce the negative portion of the carrier signal.

- The modulator is a linear power amplifier that takes the low level modulating signal and amplifies it to a high power level. So it is a high level modulator technique.

- The modulating output signal is coupled through modulation transformer T1 to the class C amplifier . The secondary winding of the modulation transformer is connected in series with the collector supply voltage Vcc of the class C amplifier.

- With zero modulation input signal, there will be zero modulation voltage across the secondary of T1. Therefore, the collector supply voltage will be applied directly to the class C amplifier and the output carrier will be a steady sine wave.

- When the modulation signal occurs, the AC voltage across the secondary of the modulation transformer will be added to and substracted from the collector supply voltage. This varying supply voltage is applied to the class C amplifier . Naturally, the amplitude of the current pulses through transistor Q1 will vary. As a result , the amplitude of the carrier sine wave varies in accordance with the modulated signal.

- when the modulating signal goes positive , it adds to the collector supply voltage thereby increasing its value and causing higher current pulses and a higher amplitude carrier.

- When the modulating signal goes negative , it substract from the collector supply voltage making it less. For that reason , the class C amplifier current pulses are smaller thereby causing a lower amplitude carrier output.

- Hence amplitude modulated wave is obtained which is then transmitted through antenna.

DSB-SC SIGNAL GENERATION

- A **balanced modulator is a circuit that generates a DSB signal, suppressing the carrier and leaving only the sum and difference frequencies at the output.**

- The output of a balanced modulator can be further processed by filters or phase-shifting circuitry to eliminate one of the sidebands, resulting in a SSB signal.

A balanced modulator consists of two standard amplitude modulators arranged in a balanced configuration so as to suppress the carrier wave as shown in the following block diagram.

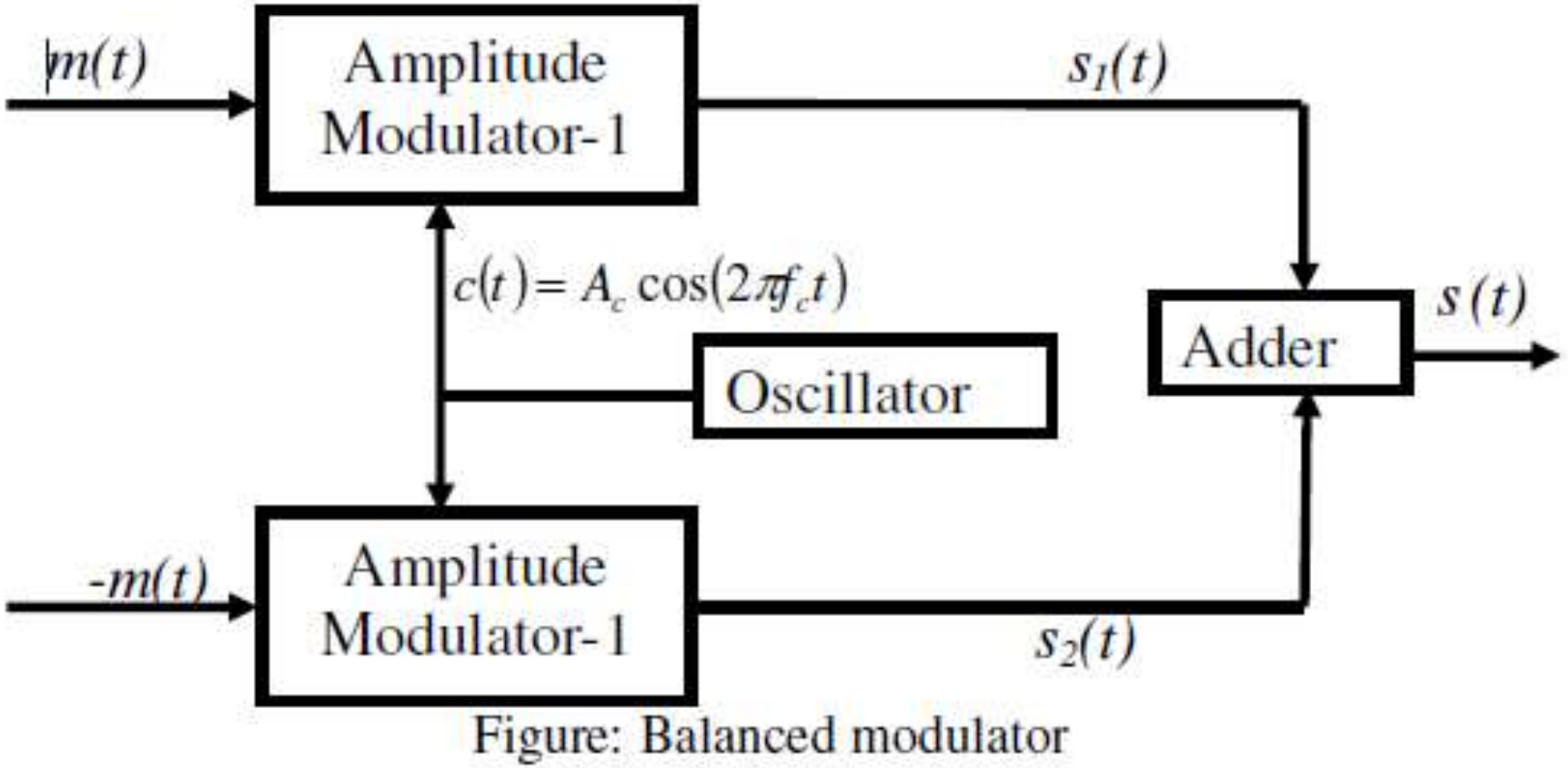


Figure: Balanced modulator

Balanced modulator

$$s_1(t) = A_c[1 + k_a m(t)]\cos(2\pi f_c t)$$
$$s_2(t) = A_c[1 - k_a m(t)]\cos(2\pi f_c t)$$

$$s(t) = s_1(t) - s_2(t)$$
$$s(t) = 2k_a m(t) A_c \cos(2\pi f_c t)$$

- **Hence, except for the scaling factor *2ka, the balanced modulator output is equal to* the product of the modulating wave and the carrier.**

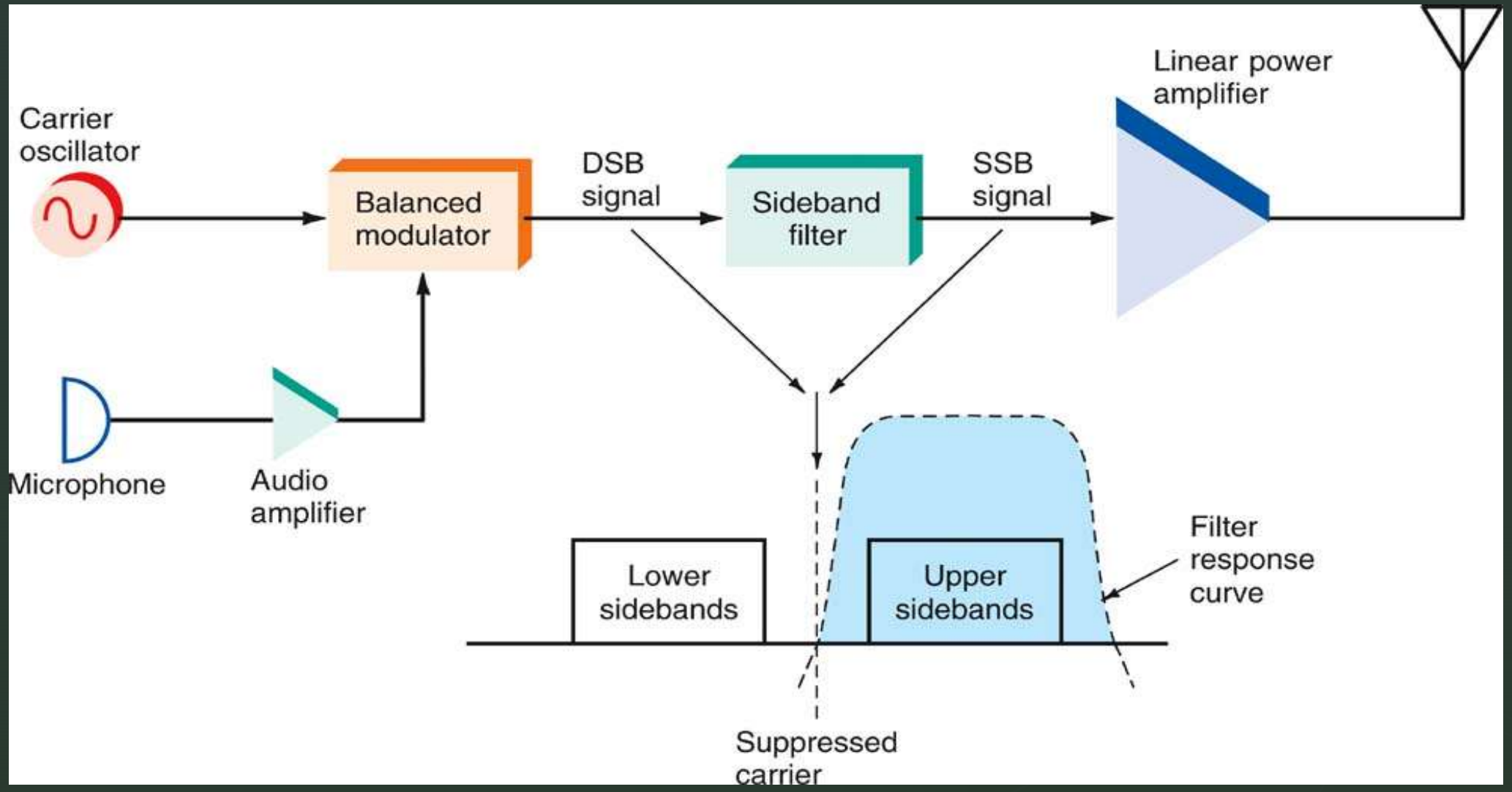
Generating SSB-SC Signals

- The filter method is the simplest and most widely used method of generating SSB signals.
- The modulating signal is applied to the audio amplifier.
- The amplifier's output is fed to one input of a balanced modulator.
- A crystal oscillator provides the carrier signal which is also applied to the balanced modulator

The Filter Method (FREQUENCY DISCRIMINATOR)

- **The output of the balanced modulator is a double-sideband (DSB) signal.**
- **An SSB signal is produced by passing the DSB signal through a highly selective bandpass filter.**
- **With the filter method, it is necessary to select either the upper or the lower sideband.**

SSB transmitter using the filter method



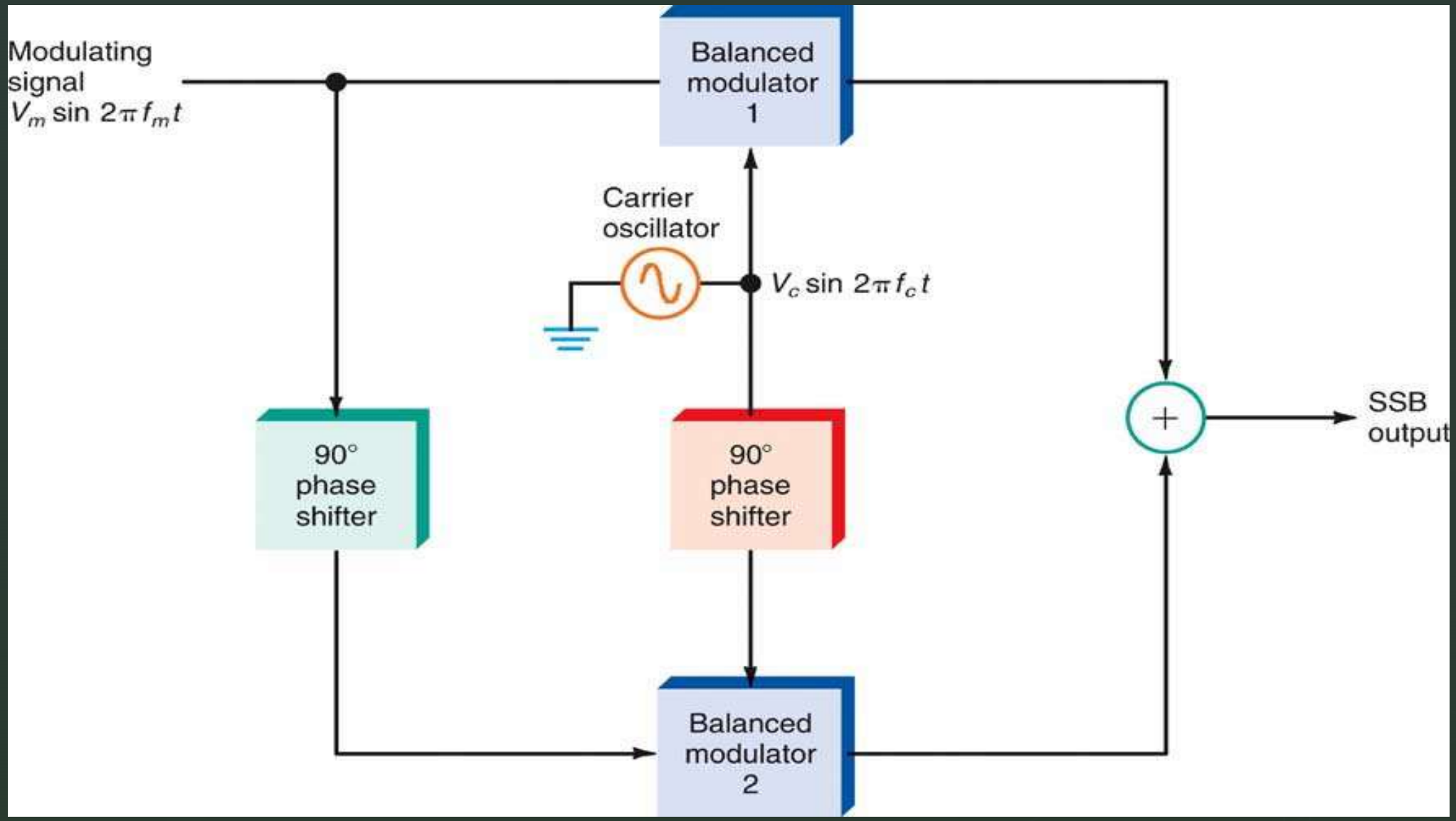
Phasing Method (PHASE DISCRIMINATOR)

- **The phasing method of SSB generation uses a phase-shift technique that causes one of the sidebands to be cancelled out.**
- **The phasing method uses two balanced modulators which eliminate the carrier.**
- **The carrier oscillator is applied to the upper balanced modulator along with the modulating signal.**

Generating SSB Signals: Phasing Method

- **The carrier and modulating signals are both shifted in phase by 90 degrees and applied to another balanced modulator.**
- **Phase-shifting causes one sideband to be cancelled out when the two modulator outputs are added together.**

SSB generator using the phasing method



THANK YOU

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