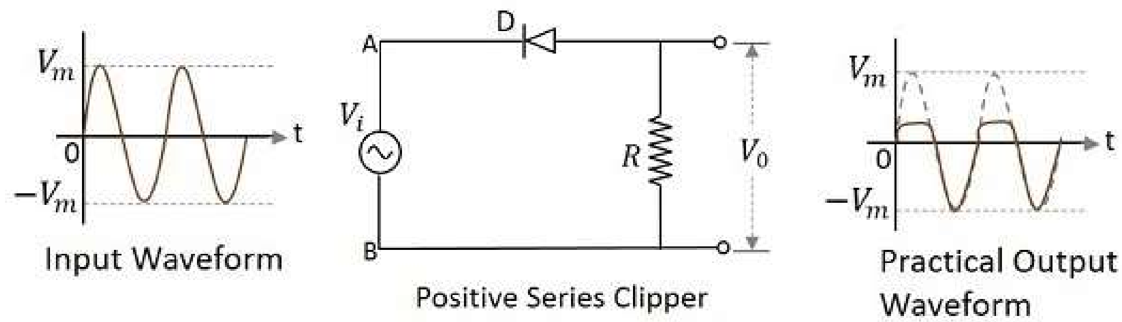
MODULE 1: CLIPPERS AND CLAMPERS

Positive Series Clipper

Clipper circuit in which the diode is connected in series to the input signal and that attenuates the positive portions of the waveform, is termed as **Positive Series Clipper**. The following figure represents the circuit diagram for positive series clipper.

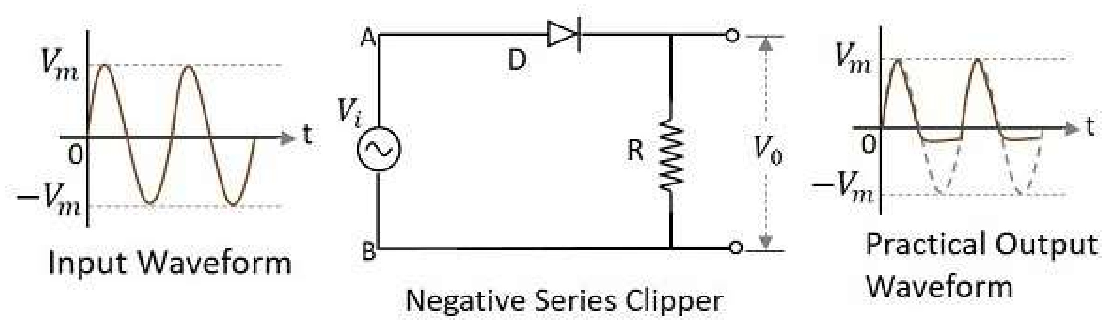


Positive Cycle of the Input − When the input voltage is applied, the positive cycle of the input makes the point A in the circuit positive with respect to the point B. This makes the diode reverse biased and hence it behaves like an open switch. Thus the voltage across the load resistor becomes zero as no current flows through it and hence V_0V0 will be zero.

Negative Cycle of the Input − The negative cycle of the input makes the point A in the circuit negative with respect to the point B. This makes the diode forward biased and hence it conducts like a closed switch. Thus the voltage across the load resistor will be equal to the applied input voltage as it completely appears at the output V_0V0

Negative Series Clipper

A Clipper circuit in which the diode is connected in series to the input signal and that attenuates the negative portions of the waveform, is termed as **Negative Series Clipper**. The following figure represents the circuit diagram for negative series clipper.



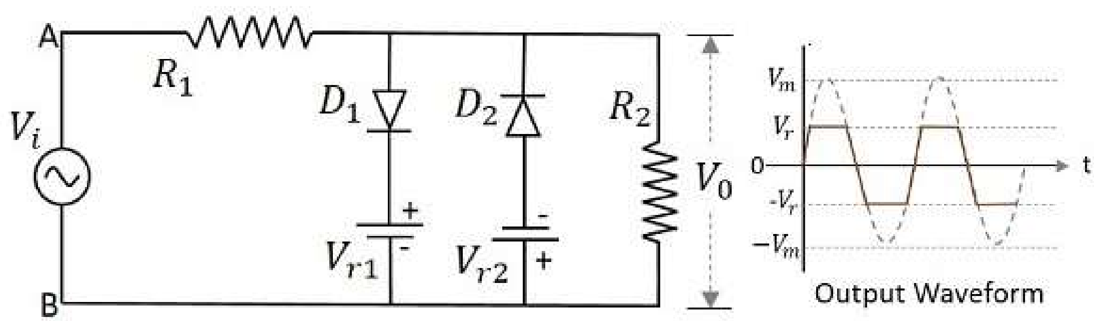
Positive Cycle of the Input − When the input voltage is applied, the positive cycle of the input makes the point A in the circuit positive with respect to the point B. This makes the diode forward biased and hence it acts like a closed switch. Thus the input voltage completely appears across the load resistor to produce the output V_0.

Negative Cycle of the Input − The negative cycle of the input makes the point A in the circuit negative with respect to the point B. This makes the diode reverse biased and hence it acts like an open switch. Thus, the voltage across the load resistor will be zero making V_0 zero.

Two-way Clipper or Double Ended Shunt clipper

This is a positive and negative clipper with a reference voltage V_r. The input voltage is clipped two-way both positive and negative portions of the input waveform with two reference voltages. For this, two diodes D_1 and D_2 along with two reference voltages V_{r1} and V_{r2} are connected in the circuit.

This circuit is also called as a **Combinational Clipper** circuit. The figure below shows the circuit arrangement for a two-way or a combinational clipper circuit along with its output waveform.



During the positive half of the input signal, the diode D_1 conducts making the reference voltage V_{r1} appear at the output.

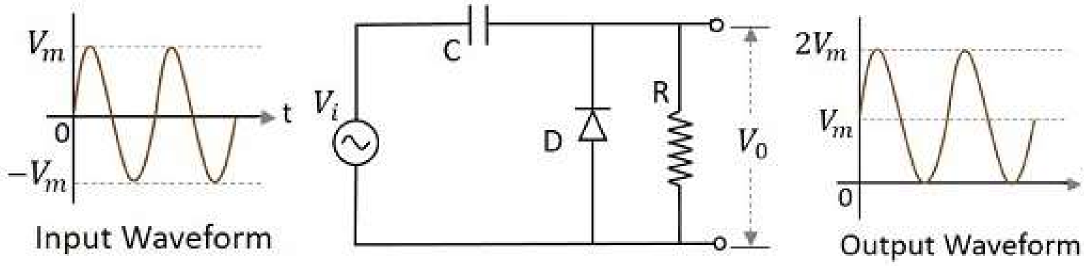
During the negative half of the input signal, the diode D_2 conducts making the reference voltage V_{r1} appear at the output.

Hence both the diodes conduct alternatively to clip the output during both the cycles. The output is taken across the load resistor.

Positive Clamper Circuit

A Clamping circuit restores the DC level. When a negative peak of the signal is raised above to the zero level, then the signal is said to be **positively clamped**.

A Positive Clamper circuit is one that consists of a diode, a resistor and a capacitor and that shifts the output signal to the positive portion of the input signal. The figure below explains the construction of a positive clamper circuit.



Positive Clamper circuit

Initially when the input is given, the capacitor is not yet charged and the diode is reverse biased. The output is not considered at this point of time. During the negative half cycle, at the peak value, the capacitor gets charged with negative on one plate and positive on the other. The capacitor is now charged to its peak value V_m. The diode is forward biased and conducts heavily.

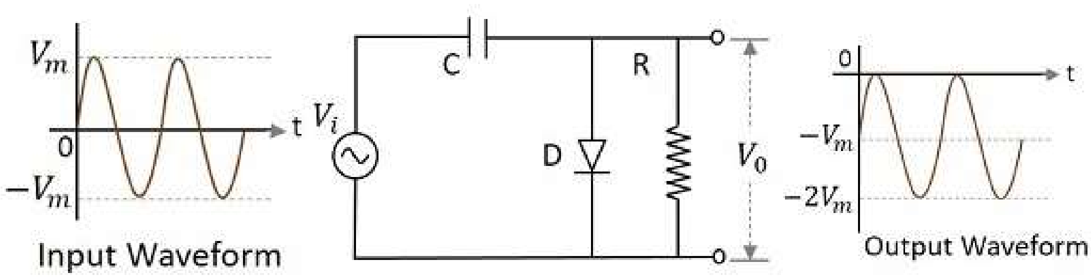
During the next positive half cycle, the capacitor is charged to positive V_m while the diode gets reverse biased and gets open circuited. The output of the circuit at this moment will be

$$V_0=V_i+V_m V0=Vi+Vm$$

Hence the signal is positively clamped as shown in the above figure. The output signal changes according to the changes in the input, but shifts the level according to the charge on the capacitor, as it adds the input voltage.

Negative Clamper

A Negative Clamper circuit is one that consists of a diode, a resistor and a capacitor and that shifts the output signal to the negative portion of the input signal. The figure below explains the construction of a negative clamper circuit.



Negative Clamper circuit

During the positive half cycle, the capacitor gets charged to its peak value v_m. The diode is forward biased and conducts. During the negative half cycle, the diode gets reverse biased and gets open circuited. The output of the circuit at this moment will be

$$V_0=V_i+V_m V0=Vi+Vm$$

Hence the signal is negatively clamped as shown in the above figure. The output signal changes according to the changes in the input, but shifts the level according to the charge on the capacitor, as it adds the input voltage.

Applications

There are many applications for both Clippers and Clampers such as

Clippers

- Used for the generation and shaping of waveforms
- Used for the protection of circuits from spikes
- Used for amplitude restorers
- Used as voltage limiters
- Used in television circuits
- Used in FM transmitters

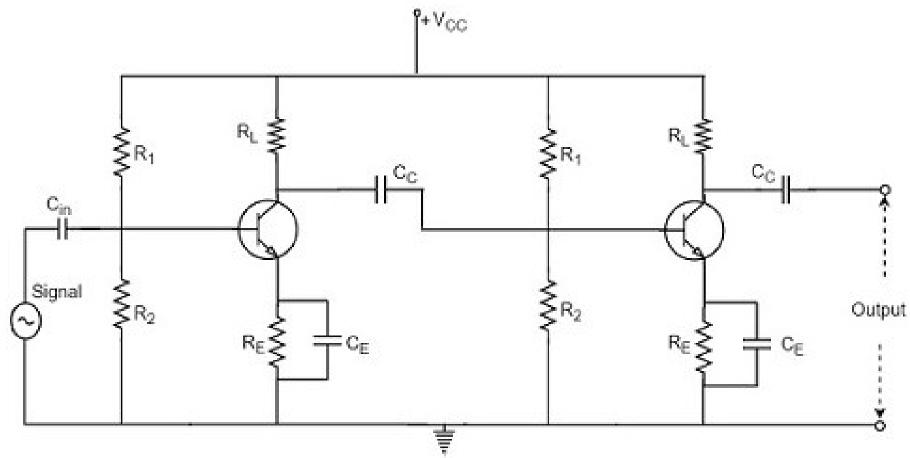
Clampers

- Used as direct current restorers
- Used to remove distortions
- Used as voltage multipliers
- Used for the protection of amplifiers
- Used as test equipment
- Used as base-line stabilizer

RC Coupled BJT Amplifier

The constructional details of a two-stage RC coupled transistor amplifier circuit are as follows. The two stage amplifier circuit has two transistors, connected in CE configuration and a common power supply V_{CC} is used. The potential divider network R_1 and R_2 and the resistor R_e form the biasing and stabilization network. The emitter by-pass capacitor C_e offers a low reactance path to the signal.

The resistor R_L is used as a load impedance. The input capacitor C_{in} present at the initial stage of the amplifier couples AC signal to the base of the transistor. The capacitor C_C is the coupling capacitor that connects two stages and prevents DC interference between the stages and controls the shift of operating point. The figure below shows the circuit diagram of RC coupled amplifier.



Operation of RC Coupled Amplifier

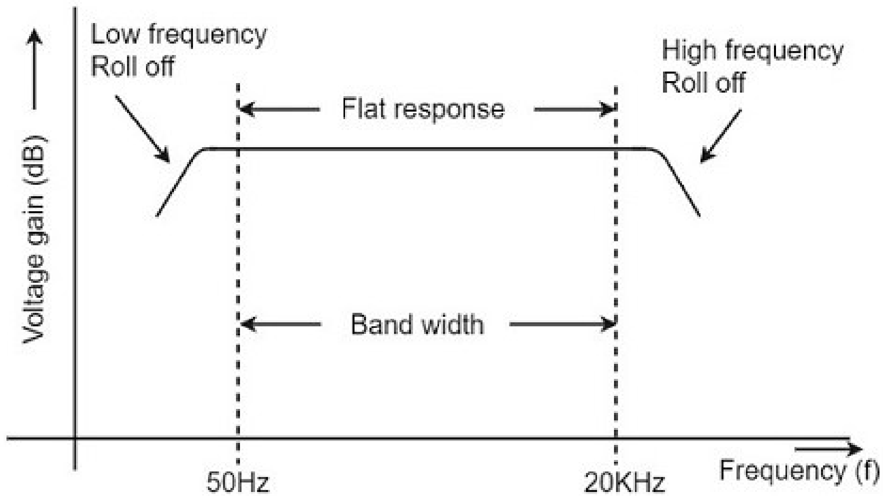
When an AC input signal is applied to the base of first transistor, it gets amplified and appears at the collector load R_L which is then passed through the coupling capacitor C_C to the next stage. This becomes the input of the next stage, whose amplified output again appears across its collector load. Thus the signal is amplified in stage by stage action.

The important point that has to be noted here is that the total gain is less than the product of the gains of individual stages. This is because when a second stage is made to follow the first stage, the **effective load resistance** of the first stage is reduced due to the shunting effect of the input resistance of the second stage. Hence, in a multistage amplifier, only the gain of the last stage remains unchanged.

As we consider a two stage amplifier here, the output phase is same as input. Because the phase reversal is done two times by the two stage CE configured amplifier circuit.

Frequency Response of RC Coupled Amplifier

Frequency response curve is a graph that indicates the relationship between voltage gain and function of frequency. The frequency response of a RC coupled amplifier is as shown in the following graph.



From the above graph, it is understood that the frequency rolls off or decreases for the frequencies below 50Hz and for the frequencies above 20 KHz. whereas the voltage gain for the range of frequencies between 50Hz and 20 KHz is constant.

We know that,

$$X_C=12\pi f_C XC=12\pi fc$$

It means that the capacitive reactance is inversely proportional to the frequency.

At Low frequencies (i.e. below 50 Hz)

The capacitive reactance is inversely proportional to the frequency. At low frequencies, the reactance is quite high.

At High frequencies (i.e. above 20 KHz)

Again considering the same point, we know that the capacitive reactance is low at high frequencies. So, a capacitor behaves as a short circuit, at high frequencies

At Mid-frequencies (i.e. 50 Hz to 20 KHz)

The voltage gain of the capacitors is maintained constant in this range of frequencies, as shown in figure. If the frequency increases, the reactance of the capacitor C_C decreases which tends to increase the gain. But this lower capacitance reactive increases the loading effect of the next stage by which there is a reduction in gain.

Due to these two factors, the gain is maintained constant

Advantages of RC Coupled Amplifier

The following are the advantages of RC coupled amplifier.

- The frequency response of RC amplifier provides constant gain over a wide frequency range, hence most suitable for audio applications.
- The circuit is simple and has lower cost because it employs resistors and capacitors which are cheap.
- It becomes more compact with the upgrading technology.

Disadvantages of RC Coupled Amplifier

The following are the disadvantages of RC coupled amplifier.

- The voltage and power gain are low because of the effective load resistance.
- They become noisy with age.
- Due to poor impedance matching, power transfer will be low.

Applications of RC Coupled Amplifier

The following are the applications of RC coupled amplifier.

- They have excellent audio fidelity over a wide range of frequency.
- Widely used as Voltage amplifiers
- Due to poor impedance matching, RC coupling is rarely used in the final stages.