SNS COLLEGE OF ENGINEERING

Kurumbapalayam (Po), Coimbatore – 641 107

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DEPARTMENT OF COMPUTER SCIENCE AND DESIGN

COURSE NAME : 19EE01 BASIC ELECTRICAL AND ELECTRONICS ENGINEERING

I YEAR /II SEMESTER - COMPUTER SCIENCE AND DESIGN

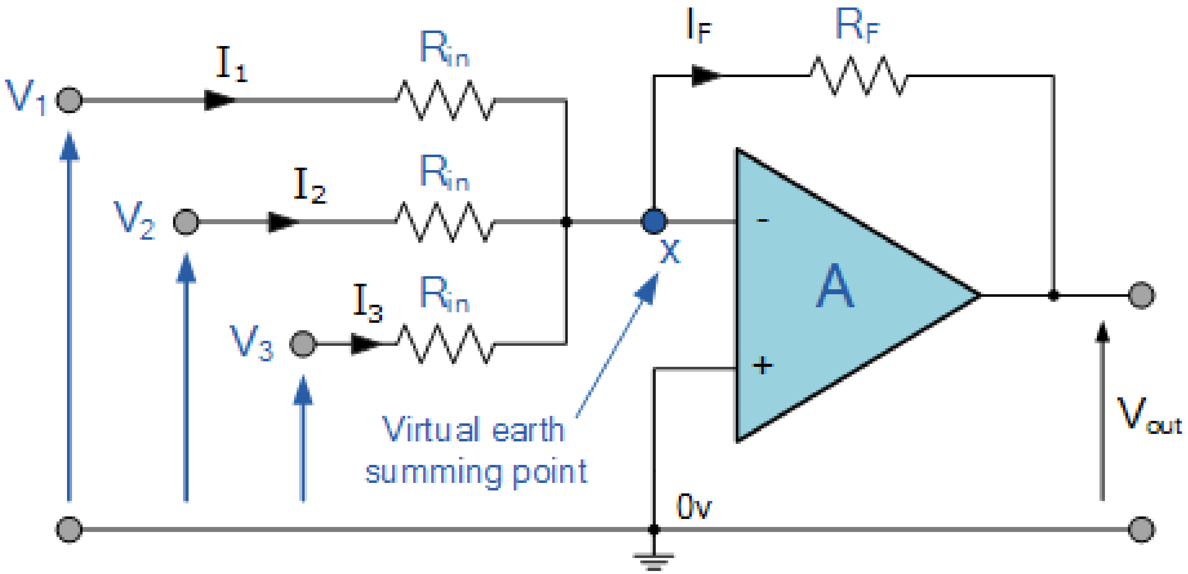
Unit 5 – LINEAR AND DIGITAL ELECTRONICS

Topic 3 : Applications: Summer, Clipper and clamper

The Summing Amplifier

The inverting operational amplifier that the inverting amplifier has a single input voltage, (Vin) applied to the inverting input terminal. If we add more input resistors to the input, each equal in value to the original input resistor, (Rin) we end up with another operational amplifier circuit called a **Summing Amplifier**, "*summing inverter*" or even a "*voltage adder*" circuit as shown below.

Summing Amplifier Circuit



In this simple summing amplifier circuit, the output voltage, (Vout) now becomes proportional to the sum of the input voltages, V_1, V_2, V_3, etc. Then we can modify the original equation for the inverting amplifier to take account of these new inputs thus:

$$I_F = I_1 + I_2 + I_3 = -\left[\frac{V1}{Rin} + \frac{V2}{Rin} + \frac{V3}{Rin}\right]$$

$$\text{Inverting Equation: } Vout = -\frac{Rf}{Rin} \times Vin$$

$$\text{then, } -Vout = \left[\frac{R_F}{Rin}V1 + \frac{R_F}{Rin}V2 + \frac{R_F}{Rin}V3\right]$$

However, if all the input impedances, (R_{IN}) are equal in value, we can simplify the above equation to give an output voltage of:

Summing Amplifier Equation

$$-Vout = \frac{R_F}{R_{IN}}\left(V1 + V2 + V3 \ldots.etc\right)$$

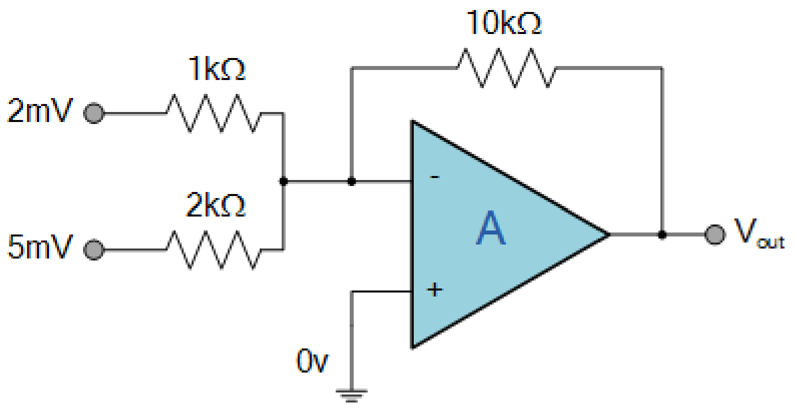
A **Scaling Summing Amplifier** can be made if the individual input resistors are "NOT" equal. Then the equation would have to be modified to:

$$-V_{OUT} = V_1\left(\frac{R_f}{R_1}\right) + V_2\left(\frac{R_f}{R_2}\right) + V_3\left(\frac{R_f}{R_3}\right) \ldots\text{etc}$$

To make the math's a little easier, we can rearrange the above formula to make the feedback resistor Rƒ the subject of the equation giving the output voltage as:

$$-V_{OUT} = R_f\left(\frac{V_1}{R_1} + \frac{V_2}{R_2} + \frac{V_3}{R_3}\right) \ldots\text{etc}$$

Summing Amplifier



Using the previously found formula for the gain of the circuit:

$$\text{Gain (Av)} = \frac{V_{out}}{V_{in}} = -\frac{R_f}{R_{in}}$$

We can now substitute the values of the resistors in the circuit as follows:

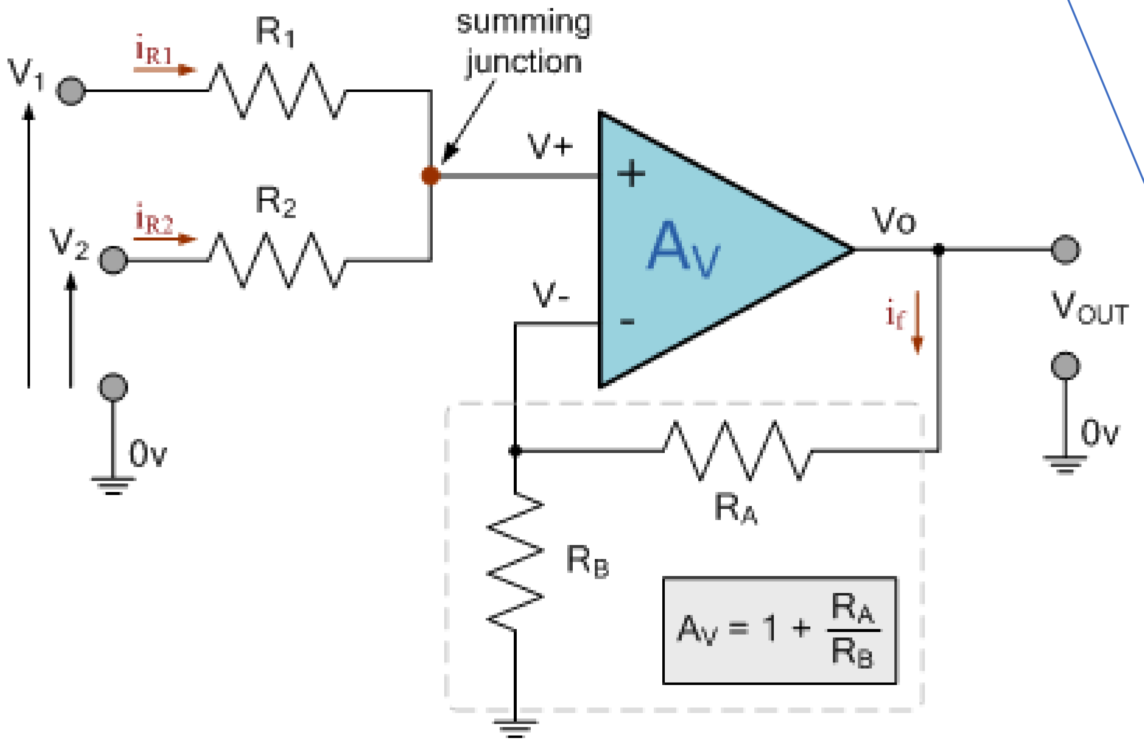
$$A_1 = \frac{10k\Omega}{1k\Omega} = -10 \qquad A_2 = \frac{10k\Omega}{2k\Omega} = -5$$

We know that the output voltage is the sum of the two amplified input signals and is calculated as:

$$Vout = (A_1 \times V_1) + (A_2 \times V_2)$$

$$Vout = (-10(2mV)) + (-5(5mV)) = -45mV$$

Non-inverting Summing Amplifier



So for a 2-input non-inverting summing amplifier the currents flowing into the input terminals can be defined as:

$$I_{R1} + I_{R2} = 0 \quad (\text{KCL})$$

$$\frac{V_1 - V+}{R_1} + \frac{V_2 - V+}{R_2} = 0$$

$$\therefore \left(\frac{V_1}{R_1} - \frac{V+}{R_1}\right) + \left(\frac{V_2}{R_2} - \frac{V+}{R_2}\right) = 0$$

If we make the two input resistances equal in value, then $R_1 = R_2 = R$.

$$V+ = \frac{\frac{V_1}{R} + \frac{V_2}{R}}{\frac{1}{R} + \frac{1}{R}} = \frac{\frac{V_1 + V_2}{R}}{\frac{2}{R}}$$

$$\text{Thus} \quad V+ = \frac{V_1 + V_2}{2}$$

The standard equation for the voltage gain of a non-inverting summing amplifier circuit is given as:

$$A_V = \frac{V_{OUT}}{V_{IN}} = \frac{V_{OUT}}{V+} = 1 + \frac{R_A}{R_B}$$

$$\therefore \quad V_{OUT} = \left[1 + \frac{R_A}{R_B}\right] V+$$

$$\text{Thus:} \quad V_{OUT} = \left[1 + \frac{R_A}{R_B}\right] \frac{V_1 + V_2}{2}$$

Non-inverting Output Voltage

$$V_{OUT} = \left[1 + \frac{R_A}{R_B}\right] \frac{V_1 + V_2}{2}$$

$$\text{If} \quad R_A = R_B$$

$$V_{OUT} = [1 + 1] \frac{V_1 + V_2}{2} = \cancel{2} \frac{V_1 + V_2}{\cancel{2}}$$

$$\therefore V_{OUT} = V_1 + V_2$$

Clipper and Clamper

Clippers and Clampers are very important for changing waveforms into different shapes. They are important parts of handling signals, helping engineers to manage and change electrical messages. A clipper is a simple electric system made to change the shape of an incoming sound wave. It controls or "clips" how loud it can be, so we don't need full strength from start to finish. A clipper's job is to take out or handle certain parts of a signal when it goes above or below a set limit. On the other hand, a clamper is an electronic part made to put DC (steady current) into AC (changing current). A clamper's job is to move the whole waveform higher or lower without changing its shape.

What is Clipper?
A Clipper is a special circuit in electronics that cuts or stops the size of sound waves. It lets signals go through at a certain distance, getting rid of any parts that are beyond the set rules. Clippers are used in audio editing, phone systems, and many types of electronic gadgets.

Working of Clipper
Using a Clipper means picking out parts of the input waveform and removing them. This is done by using diodes to make a small drop in voltage. This stops the signal's strength from being too high. Here is a general explanation of the working of a clipper:

- **Diode Operation**: Clippers often use diodes to manage electricity flow. Diodes let current flow in one way only. In simple terms, a clipper uses this feature to control the size of waveform peaks.
- **Series and Shunt Configurations:** Clippers can be set up in line or side by side (parallel) with the input signal. In a series clipper, the diode is linked with the signal path in line. This lets it chop up waveform when power gets over some limit value. In a type of clipper called a shunt, the diode is linked to help with how electricity flows if there's too much voltage.
- **Threshold Voltage:** The main thing in a clipper is the voltage limit. This is the amount of electricity needed for the diode to begin letting it move, which helps control how big or small a signal can be. The starting voltage decides when the cutting action happens.
- **Clipping Action:** When the waveform of input gets bigger than a certain point, it causes the diode to start flowing. This makes going from one side to another in low resistance easy for that signal. This makes the high-voltage part of the waveform smaller by directing it away through a special type of electronic device called a diode.

Types of Clipper

There are some Types of Clipper given below :

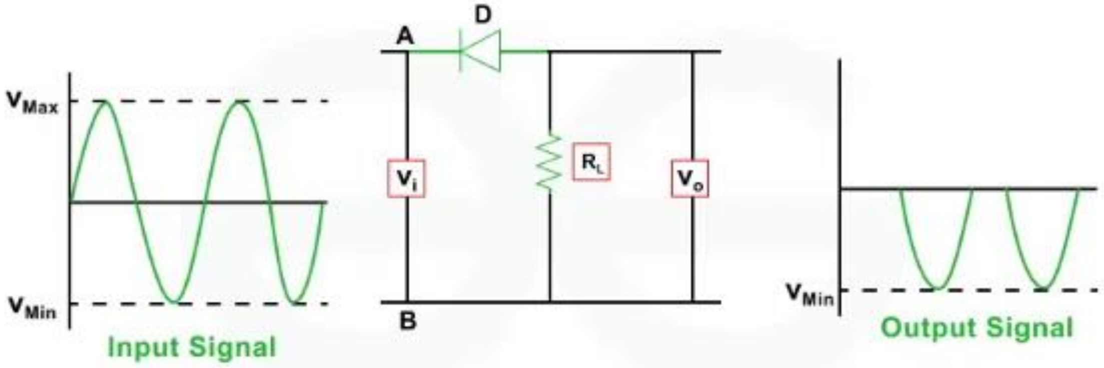
Series Clippers

In series clippers, the diode is connected in series with the input signal. When the voltage of the input waveform exceeds a certain threshold, the diode conducts and clips the waveform.

Series Positive Clippers

Operation: It uses a diode put in series with the incoming signal. The diode works during the up half-cycle, limiting the amplitude of positive waves.

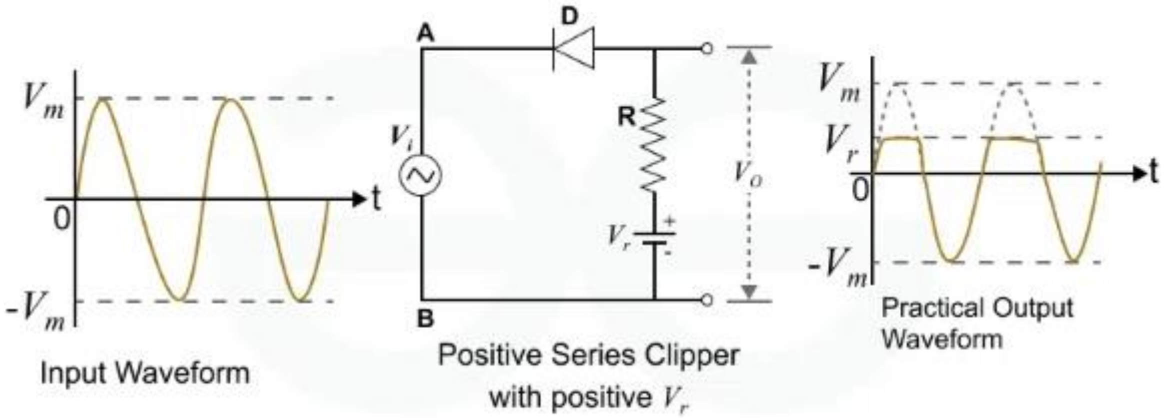
Effect: Limits the positive portion of the signal, which clips and molds it into a wave shape.



Series Positive Clipper with Bias

Operation: Adds a DC bias voltage to the diode in series with it on a positive clipper. This bias affects when the diode starts to work, giving better control over the positive clipping level.

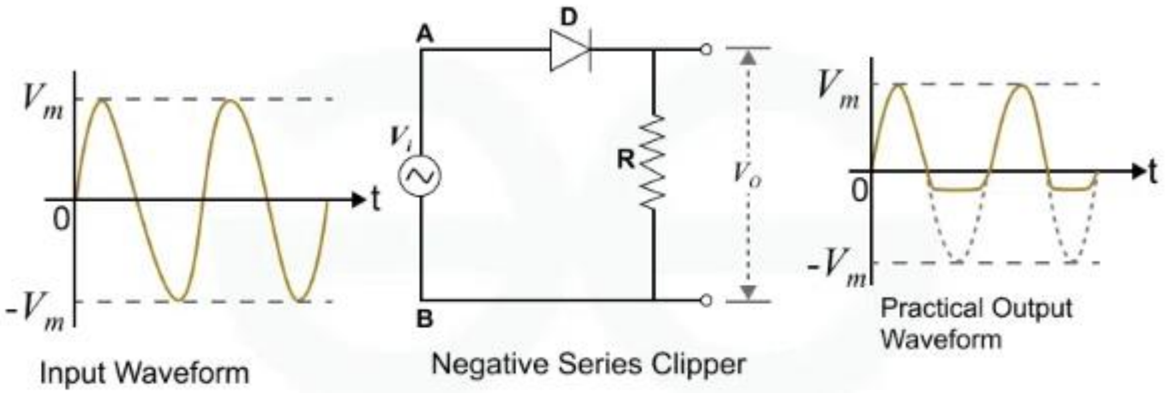
Effect: Makes the clipper better by letting engineers carefully adjust the positive clipping point.



Series Negative Clipper

Operation: Uses a diode in series with the incoming signal to clip the negative half of the waveform. The diode allows current to flow during the negative part, reducing the amplitude.

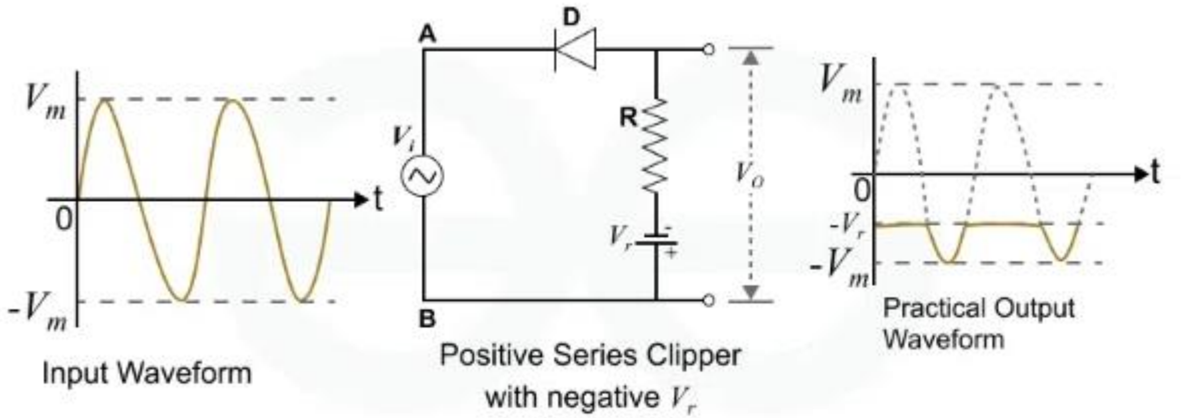
Effect: Reduces the negative portion of the signal, shaping the waveform by clipping its amplitude.



Series Negative Clipper with Bias

Operation: Uses a DC voltage in series with the diode for negative clipping. The bias changes how the diode works during negative half-cycle, giving exact control over over the negative clipping level.

Effect: Gives extra power over the negative clipping point, allowing for more customization.



What is Clamper?

A clamper, also called a DC restorer or level shifter, is an electronic device made to add in a steady current part with the twisty electric wave pattern. The job of a clamper is to move the whole wave up or down without changing its shape. This is done by adding a capacitor and a diode to the circuit, making it possible for energy storage or release.

Working of Clamper

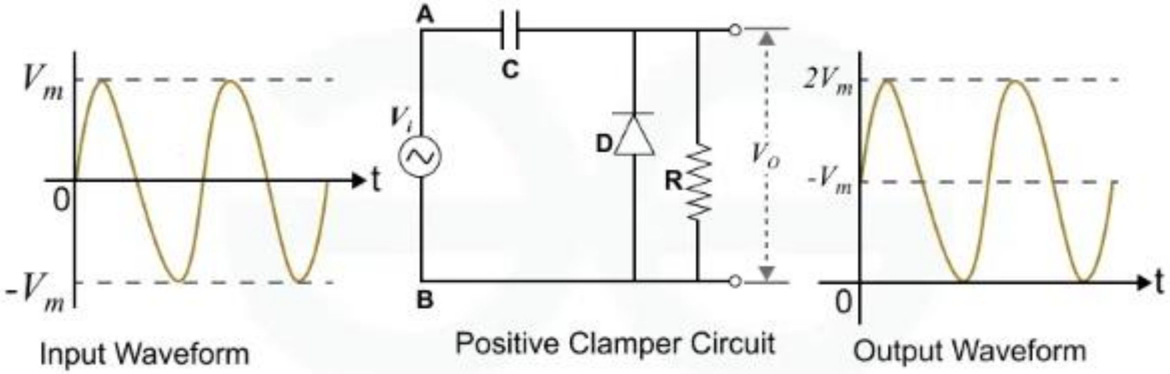
Here's a general overview of the working of a clamper:

- **Basic Components:** A clamper circuit usually has a capacitor (C), a diode (D) and a resistor (R). The capacitor is linked to the input wave with a series connection. Meanwhile, the diode sits side by side (in parallel) with this capacitor.
- **Charging Phase**: When the input AC waveform is positive, it charges through a diode. The diode lets the current move only when the input power is more than what's stored in the capacitor.
- **Discharging Phase**: When the AC input signal is dropping, the diode blocks more charging because it works against current flow. But, the capacitor starts to lose its energy through the resistor. It still keeps a voltage level between its ends.
- **DC Level Adjustment**: The loading and releasing of the capacitor change its whole pattern up or down, depending on which way the diode is pointing. You can change how strong the output waveform is by controlling when it gets more power and less power. This depends on the size of the capacitor and resistor used.

Types of Clamper

Positive Clamper

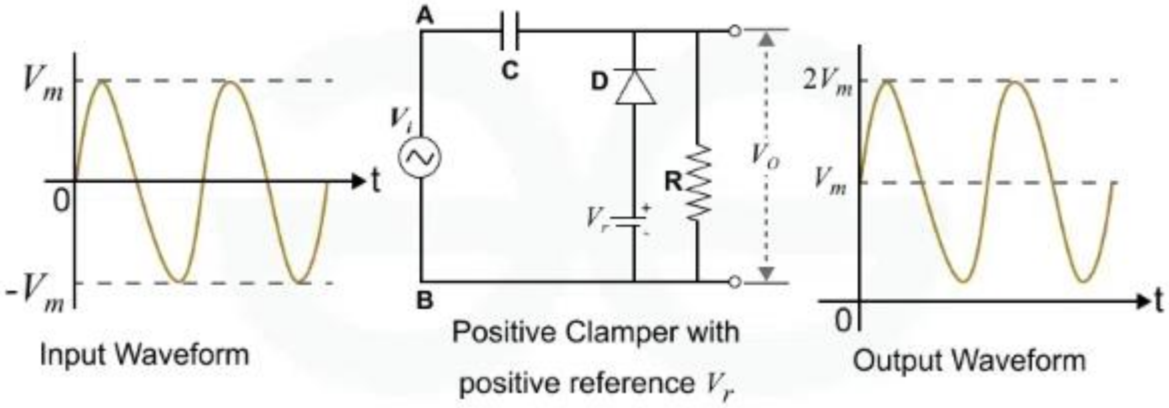
A positive clamper is a type of clamper circuit that shifts the entire waveform in the positive direction. It adds a positive DC component to the input signal during the charging phase, resulting in an upward shift of the waveform.



Positive clamper with positive Vr

Operation: Adding a positive voltage changes the amount of DC. When the charging capacitor and positive voltage are put together, they cause a stronger upwards shift in the output pattern.

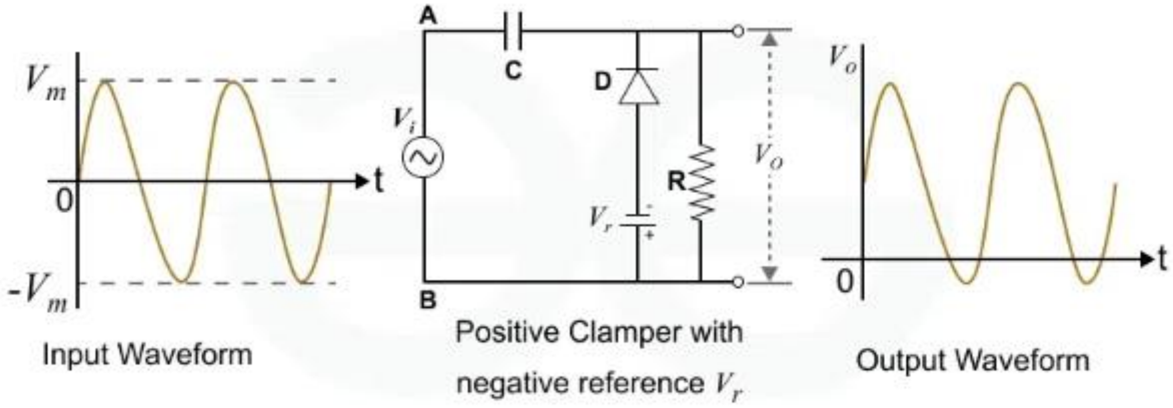
Effect: The entire waveform moves higher by a value chosen from the positive voltage.



Positive Clamper with Negative Vr

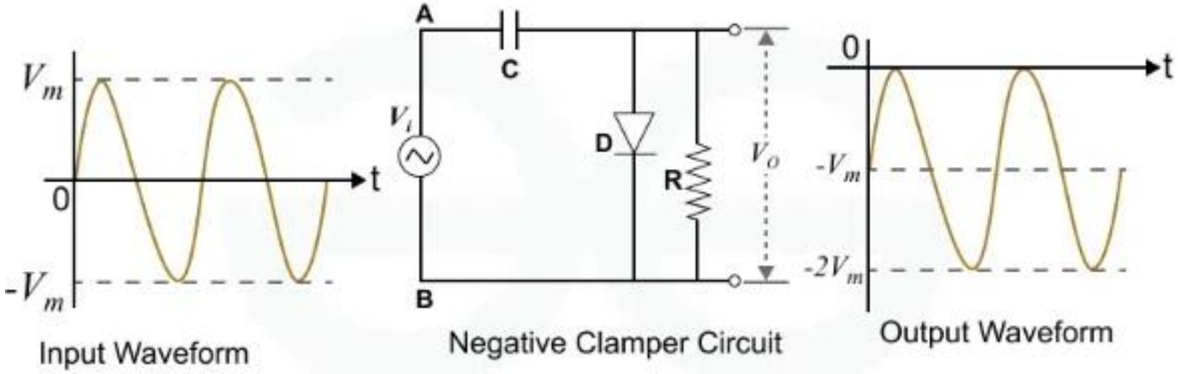
Operation: A negative bias voltage in a positive clamper changes the DC level. This happens because of downward shift caused by the negative side. This makes the negative change in the output waveform more noticeable.

Effect: The entire waveform is moved down lower by an amount decided by the negative voltage.



Negative Clamper

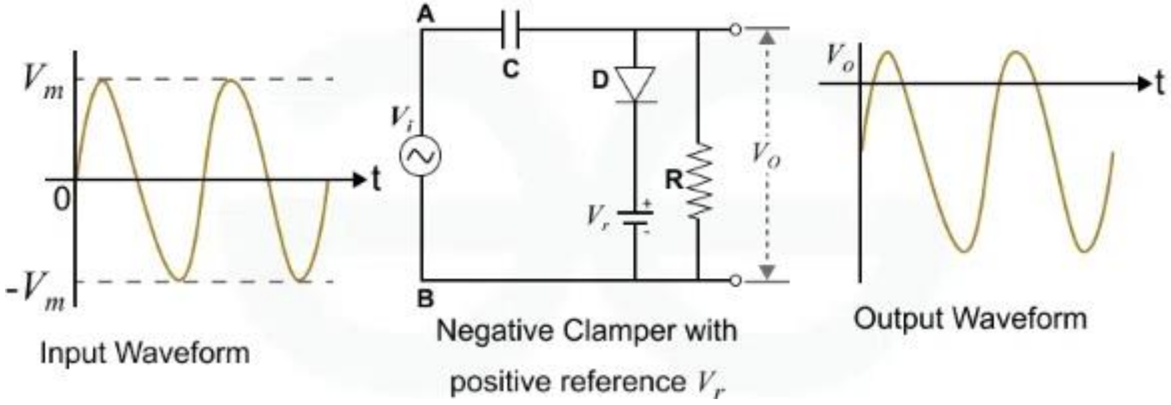
In contrast, a negative clamper shifts the entire waveform in the negative direction. It adds a negative DC component to the input signal during the charging phase, leading to a downward shift of the waveform.



Negative clamper with positive Vr

Operation: Adding a good extra electricity in a negative clamper affects the level that doesn't change. The use of a charging battery and a strong positive pressure leads to an increased shift towards the positive side in the output pattern.

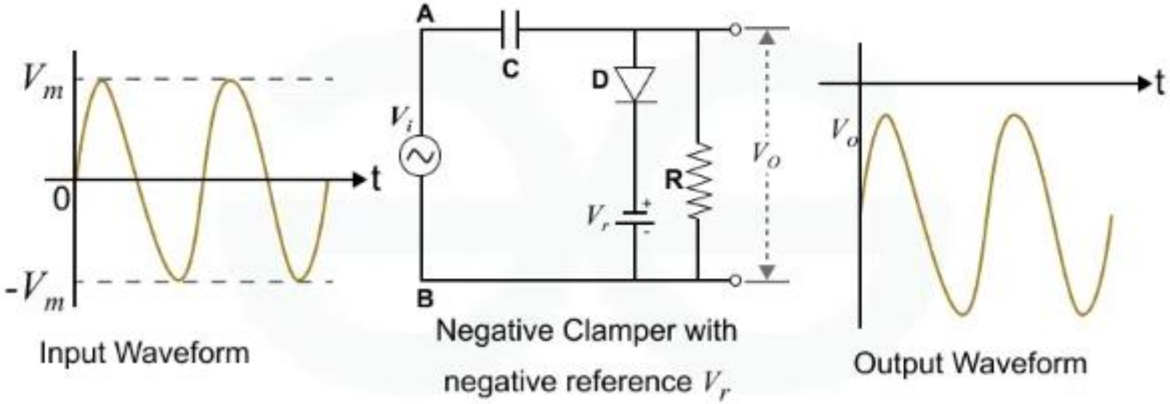
Effect: The entire waveform is moved higher by a measure decided by the positive battery voltage.



Negative Clamper with Negative Vr

Operation: Adding a negative voltage in a clamper causes it to lower the DC level by moving down. This happens because of the negativity from that extra charge you add on. This makes the downward change in the output waveform more noticeable.

Effect: The entire waveform is moved down by an amount set by the negative battery voltage



Difference Between Clipper and Clamper

Clipper	Clamper
Limit or clip the amplitude of a waveform.	Add a DC component to shift the waveform.
Basic Components include Diodes, resistors, and sometimes Op-Amps.	Basic Components includes Diodes, capacitors, resistors, and Op-Amps.
Eliminate unwanted signal components.	Adjust the DC level of waveforms.
Series and shunt configurations.	Positive, negative, and biased configurations.
Diodes selectively conduct at the threshold.	Capacitors charge and discharge to shift the waveform.
Commonly used for precision and versatility in certain types.	They are frequently used to enhance stability and precision.

Applications of Clipper and Clamper

some of the Applications of Clipper and Clamper

Applications of Clipper

- Audio signal processing.
- Communication systems.
- Television and radio broadcasting.
- Electronic devices with amplitude limitations.
- Signal peak control in power amplifiers.

Applications of Clamper

- DC level setting in waveforms.
- Biasing in amplifiers.
- Power supply regulation.
- Pulse generators.
- Cathode ray oscilloscope calibration.

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