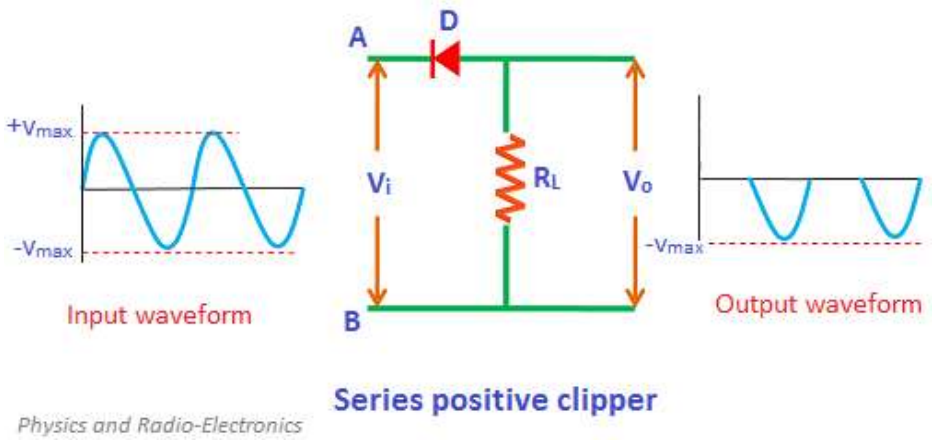
Clipper Circuits

Electronic devices are very sensitive to voltage. If a large amplitude voltage is applied, it may permanently destroy the device. So, it is essential to protect the electronics devices.

The protection of the electronic devices can be achieved by using the clipper circuits.

A clipper is a device that removes either the positive half (top half) or negative half (bottom half), or both positive and negative halves of the input AC signal. In other words, a clipper is a device that limits the positive amplitude or negative amplitude or both positive and negative amplitudes of the input AC signal. In some cases, a clipper removes a small portion of the positive half cycle or negative half cycle or both positive and negative half cycles. In the below circuit diagram, the positive half cycles are removed by using the series positive clipper.



Series positive clipper

The clipper circuit does not contain energy storage elements such as capacitor but contains both linear and no-linear elements. The linear elements used in the clippers include resistors and the non-linear elements used in the clippers include diodes or transistors.

One of the basic clipping device is the half wave rectifier. A half wave rectifier removes either the positive half cycle or negative half cycle of the input AC signal and allows the remaining half cycle of the input AC signal. Thus, a half wave rectifier acts as a clipper circuit.

The half wave rectifier (clipper circuit) is made up of one diode and a resistor. Depending on the orientation of the diode, either the positive or the negative half cycle is removed.

The resistor is mainly used to limit the current flowing through the diode when it is forward biased.

The clipping (removal) of the input AC signal is done in such a way that the remaining part of the input AC signal will not be distorted.

Clippers are often referred to as voltage limiters, current limiters, slicers, or amplitude selectors. Clipper circuits are extensively used in digital computers, radars, television receivers, radio receivers and other electronic systems for removing unwanted portion of the input AC signal.

Types of clippers

The clipper circuits are generally categorized into three types: series clippers, shunt clippers and dual (combination) clippers. In series clippers, the diode is connected in series with the output load resistance. In shunt clippers, the diode is connected in parallel with the output load resistance.

The series clippers are again classified into four types: series positive clipper, series positive clipper with bias, series negative clipper and series negative clipper with bias. The shunt (parallel) clippers are again classified into four types: shunt positive clipper, shunt positive clipper with bias, shunt negative clipper, and shunt negative clipper with bias.

The various types of clippers are as follows:

- Series positive clipper
- Series positive clipper with bias
- Series negative clipper
- Series negative clipper with bias
- Shunt positive clipper
- Shunt positive clipper with bias
- Shunt negative clipper
- Shunt negative clipper with bias
- Dual (combination) clipper

- Series positive clipper

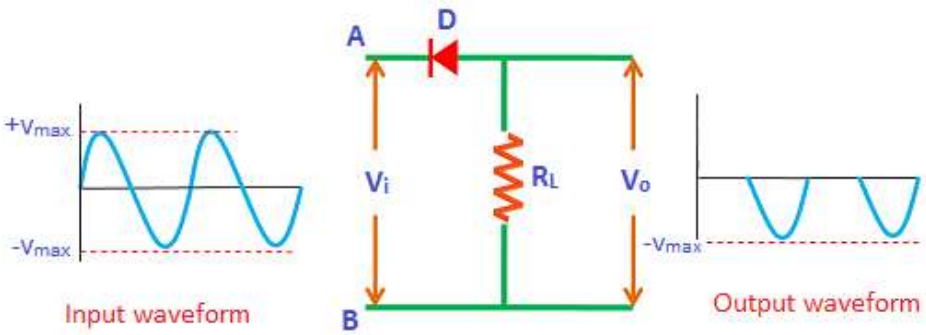
In series positive clipper, the positive half cycles of the input AC signal is removed.

If the diode is arranged in such a way that the arrowhead of the diode points towards the input and the diode is in series with the output load resistance, then the clipper is said to be a series positive clipper.

In the circuit diagram, the diode D is connected in series with the output load resistance R_L and the arrowhead of the diode is pointing towards the input. So the circuit is said to be a series positive clipper.

The vertical line in the diode symbol represents the cathode (n-side) and the opposite end represents the anode (p-side).

During positive half cycle:



Series positive clipper

During the positive half cycle, terminal A is positive and terminal B is negative. That means the positive terminal A is connected to n-side and the negative terminal B is connected to p-side of the diode. As we already know that if the positive terminal is connected to n-side and the negative terminal is connected to p-side then the diode is said to be reverse

biased. Therefore, the diode D is reverse biased during the positive half cycle.

During reverse biased condition, no current flows through the diode. So the positive half cycle is blocked or removed at the output.

During negative half cycle:

During the negative half cycle, terminal A is negative and terminal B is positive. That means the negative terminal A is connected to n-side and the positive terminal B is connected to p-side of the diode. As we already know that if the negative terminal is connected to n-side and the positive terminal is connected to p-side then the diode is said to be forward biased. Therefore, the diode D is forward biased during the negative half cycle.

During forward biased condition, electric current flows through the diode. So the negative half cycle is allowed at the output.

Thus, a series of positive half cycles are completely removed at the output.

We know that a clipper either clips a portion of half cycle or clips a complete half cycle. In this case, complete half cycles are removed.

Thus, a series positive clipper removes the series of positive half cycles.

- Series positive clipper with bias

Sometimes it is desired to remove a small portion of positive or negative half cycles. In such cases, the biased clippers are

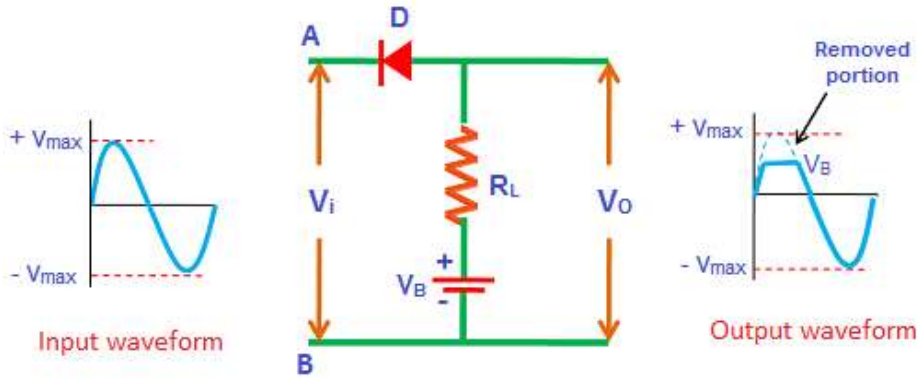
used.

The construction of the series positive clipper with bias is almost similar to the series positive clipper. The only difference is an extra element called battery is used in series positive clipper with bias.

Series positive clipper with positive bias

During positive half cycle:

During the positive half cycle, terminal A is positive and terminal B is negative. That means the positive terminal is connected to n-side and the negative terminal is connected to p-side. As we already know that if the positive terminal is connected to n-side and the negative terminal is connected to p-side then the diode is said to be reverse biased. Therefore, the diode is reverse biased by the input supply voltage V_i.



Series positive clipper with positive bias

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However, we are supplying the voltage from another source called battery. As shown in the figure, the positive terminal of the battery is connected to p-side and the negative terminal of the battery is connected to n-side of the diode. Therefore, the diode is forward biased by the battery voltage V_B.

That means the diode is reverse biased by the input supply voltage (V_i) and forward biased by the battery voltage (V_B).

Initially, the input supply voltage V_i is less than the battery voltage V_B ($V_i < V_B$). So the battery voltage dominates the input supply voltage. Hence, the diode is forward biased by the battery voltage and allows electric current through it. As a result, the signal appears at the output.

When the input supply voltage V_i becomes greater than the battery voltage V_B, the diode D is reverse biased. So no current flows through the diode. As a result, input signal does not appear at the output.

Thus, the clipping (removal of a signal) takes place during the positive half cycle only when the input supply voltage becomes greater than the battery voltage.

During negative half cycle:

During the negative half cycle, terminal A is negative and terminal B is positive. That means the diode D is forward biased due to the input supply voltage. Furthermore, the battery is also connected in such a way that the positive terminal is connected to p-side and the negative terminal is connected to n-side. So the diode is forward biased by both battery voltage V_B and input supply voltage V_i.

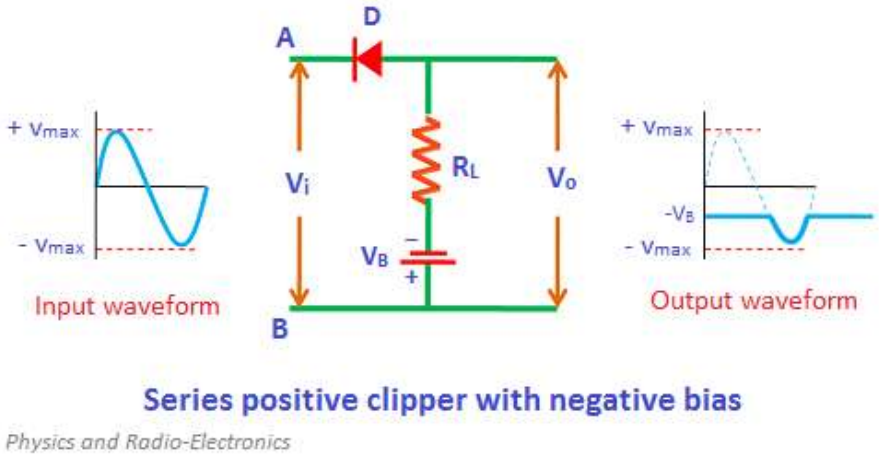
That means, during the negative half cycle, it doesn't matter whether the input supply voltage is greater or less than the battery voltage, the diode always remains forward biased. So the complete negative half cycle appears at the output.

Thus, the series positive clipper with positive bias removes a small portion of positive half cycles.

Series positive clipper with negative bias

During positive half cycle:

During the positive half cycle, the diode D is reverse biased by both input supply voltage V_i and battery voltage V_B. So no signal appears at the output during the positive half cycle. Therefore, the complete positive half cycle is removed.



Series positive clipper with negative bias

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During negative half cycle:

During the negative half cycle, the diode is forward biased by the input supply voltage V_i and reverse biased by the battery voltage V_B. However, initially, the battery voltage V_B dominates the input supply voltage V_i. So the diode remains to be reverse biased until the V_i becomes greater than V_B. When the input supply voltage V_i becomes greater than the battery voltage V_B, the diode is forward biased by the input supply voltage V_i. So the signal appears at the output.

- Series negative clipper

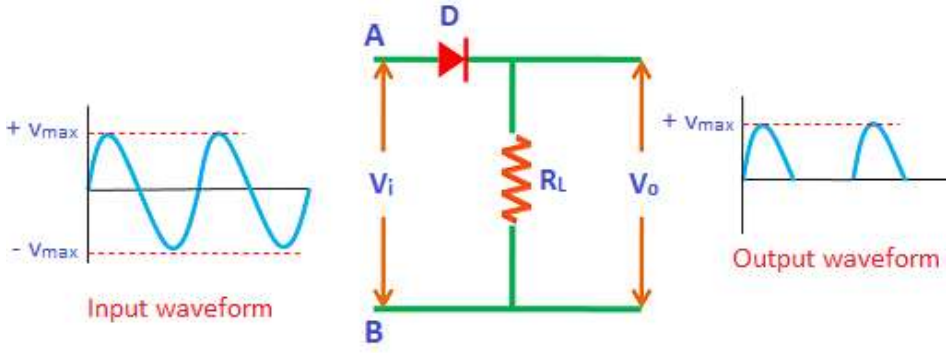
In series negative clipper, the negative half cycles of the input AC signal is removed at the output. The circuit construction of the series negative clipper is shown in the figure.

If the diode is arranged in such a way that the arrowhead of the diode points towards the output and the diode is in series with the output load resistance, then the clipper is said to be a series negative clipper. In simple words, in a series negative clipper, the diode is connected in a direction opposite to that of the series positive clipper.

The vertical line in the diode symbol represents the cathode (n-side) and the opposite end represents the anode (p-side).

During positive half cycle:

During the positive half cycle, terminal A is positive and terminal B is negative. That means the positive terminal A is connected to p-side and the negative terminal B is connected to n-side of the diode. As we already know that if the positive terminal is connected to p-side and the negative terminal is connected to n-side then the diode is said to be forward biased. Therefore, the diode D is forward biased during the positive half cycle.



During forward biased condition, electric current flows through the diode. So the positive half cycle is allowed at the output. Therefore, a series of positive half cycles appears at the output.

During negative half cycle:

During the negative half cycle, the terminal A is negative and the terminal B is positive. That means the negative terminal A is connected to p-side and the positive terminal B is connected to n-side of the diode. As we already know that if the negative terminal is connected to p-side and the positive terminal is connected to n-side then the diode is said to be reverse biased. Therefore, the diode D is reverse biased during the negative half cycle.

During reverse biased condition, no current flows through the diode. So the negative half cycle is completely blocked or removed at the output. In other words, a series of negative half cycles are removed at the output.

Thus, the series negative clipper removes the series of negative half cycles.

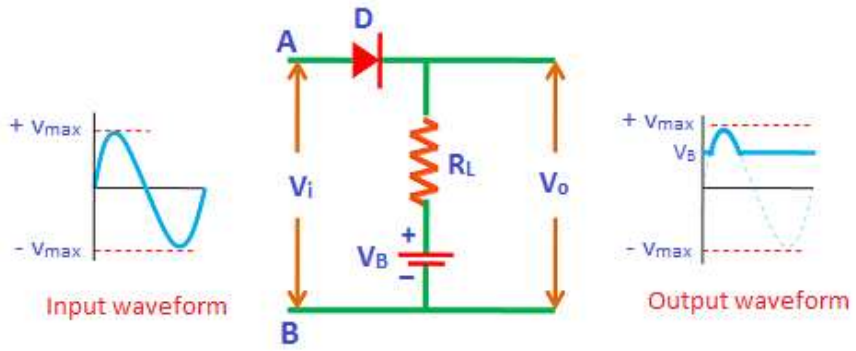
- Series negative clipper with bias

Sometimes it is desired to remove a small portion of positive or negative half cycles of the input AC signal. In such cases, the biased clippers are used.

The construction of the series negative clipper with bias is almost similar to the series negative clipper. The only difference is an extra element called battery is used in series negative clipper with bias.

Series negative clipper with positive bias

During positive half cycle:



Series negative clipper with positive bias

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During the positive half cycle, terminal A is positive and terminal B is negative. That means the positive terminal A is connected to p-side and the negative terminal B is connected to n-side. As we already know that if the positive terminal is connected to p-side and the negative terminal is connected to n-side then the diode is said to be forward biased. However, we are also supplying the voltage from another source called battery. As shown in the figure, the positive terminal of the battery is connected to n-side and the negative terminal of the battery is connected to p-side of the diode.

That means the diode is forward biased by input supply voltage V_i and reverse biased by battery voltage V_B. Initially, the battery voltage is greater than the input supply voltage. Hence, the diode is reverse biased and does not allow electric current. Therefore, no signal appears at the output.

When the input supply voltage V_i becomes greater than the battery voltage V_B, the diode is forward biased and allows electric current. As a result, the signal appears at the output.

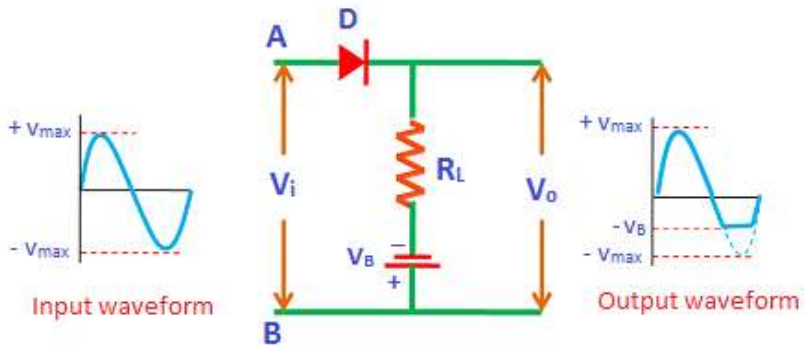
During negative half cycle:

During the negative half cycle, the diode is reverse biased by both input supply voltage V_i and battery voltage V_B. So it doesn't matter whether the input supply voltage is greater or less than the battery voltage V_B, the diode always remains reverse biased. Therefore, during the negative half cycle, no signal appears at the output.

Series negative clipper with negative bias

During positive half cycle:

During the positive half cycle, the diode D is forward biased by both input supply voltage V_i and the battery voltage V_B. So it doesn't matter whether the input supply voltage is greater or less than battery voltage V_B, the diode always remains forward biased. Therefore, during the positive half cycle, the signal appears at the output.



Series negative clipper with negative bias

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During negative half cycle:

During the negative half cycle, the diode D is reverse biased by the input supply voltage V_i and forward biased by the battery voltage V_B. Initially, the input supply voltage V_i is less

than the battery voltage V_B. So the diode is forward biased by the battery voltage V_B. As a result, the signal appears at the output.

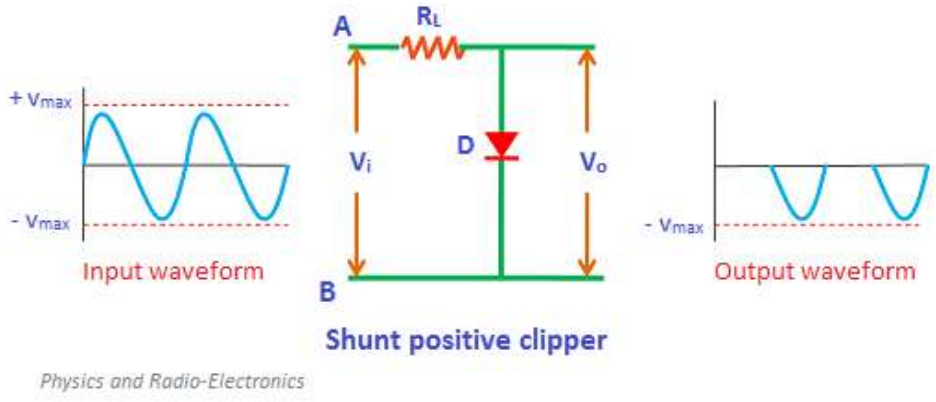
When the input supply voltage V_i becomes greater than the battery voltage V_B, the diode will become reverse biased. As a result, no signal appears at the output.

- Shunt positive clipper

In shunt clipper, the diode is connected in parallel with the output load resistance. The operating principles of the shunt clipper are nearly opposite to the series clipper.

The series clipper passes the input signal to the output load when the diode is forward biased and blocks the input signal when the diode is reverse biased.

The shunt clipper on the other hand passes the input signal to the output load when the diode is reverse biased and blocks the input signal when the diode is forward biased.



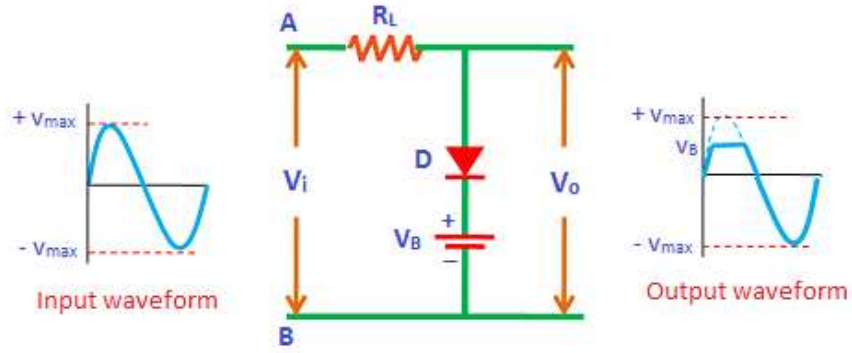
In shunt positive clipper, during the positive half cycle the diode is forward biased and hence no output is generated. On the other hand, during the negative half cycle the diode is

reverse biased and hence the entire negative half cycle appears at the output.

- Shunt positive clipper with bias

Shunt positive clipper with positive bias

During the positive half cycle, the diode is forward biased by the input supply voltage V_i and reverse biased by the battery voltage V_B. However, initially, the input supply voltage V_i is less than the battery voltage V_B. Hence, the battery voltage V_B makes the diode to be reverse biased. Therefore, the signal appears at the output. However, when the input supply voltage V_i becomes greater than the battery voltage V_B, the diode D is forward biased by the input supply voltage V_i. As a result, no signal appears at the output.



Shunt positive clipper with positive bias

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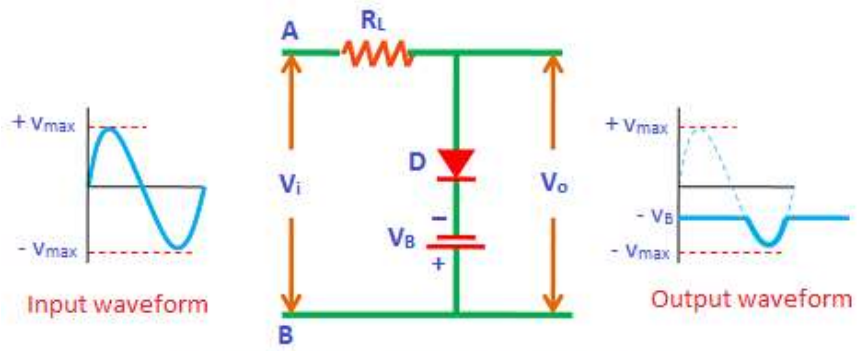
During the negative half cycle, the diode is reverse biased by both input supply voltage and battery voltage. So it doesn't matter whether the input supply voltage is greater or lesser than the battery voltage, the diode always remains reverse biased. As a result, a complete negative half cycle appears at the output.

Shunt positive clipper with negative bias

During the positive half cycle, the diode is forward biased by both input supply voltage V_i and battery voltage V_B. Therefore, no signal appears at the output during the positive half cycle.



Shunt positive clipper with negative bias

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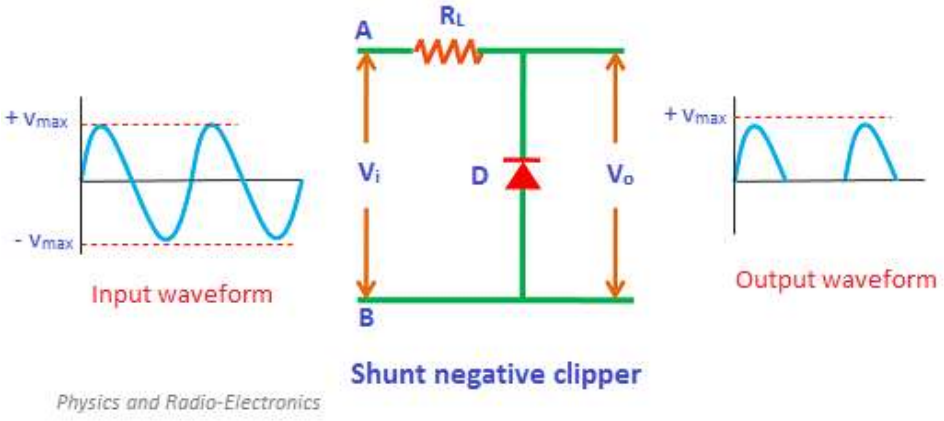
During the negative half cycle, the diode is reverse biased by the input supply voltage and forward biased by the battery voltage. However, initially, the input supply voltage V_i is less than the battery voltage V_B. So the battery voltage makes the diode to be forward biased. As a result, no signal appears at the output. However, when the input supply voltage V_i becomes greater than the battery voltage V_B, the diode is reverse biased by the input supply voltage V_i. As a result, the signal appears at the output.

- Shunt negative clipper

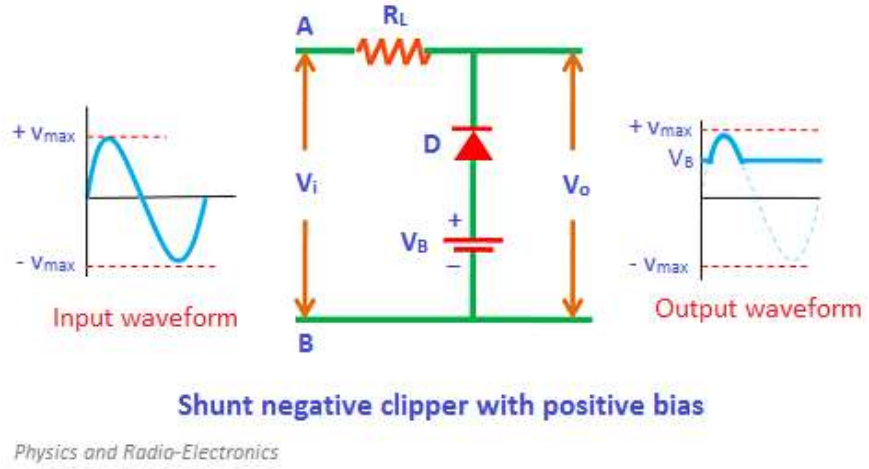
In shunt negative clipper, during the positive half cycle the diode is reverse biased and hence the entire positive half cycle appears at the output. On the other hand, during the negative half cycle the diode is forward biased and hence no output signal is generated.



- Shunt negative clipper with bias

Shunt negative clipper with positive bias

During the positive half cycle, the diode is reverse biased by the input supply voltage V_i and forward biased by the battery voltage V_B. However, initially, the input supply voltage is less than the battery voltage. So the diode is forward biased by the battery voltage. As a result, no signal appears at the output. However, when the input supply voltage becomes greater than the battery voltage then the diode is reverse biased by the input supply voltage. As a result, the signal appears at the output.

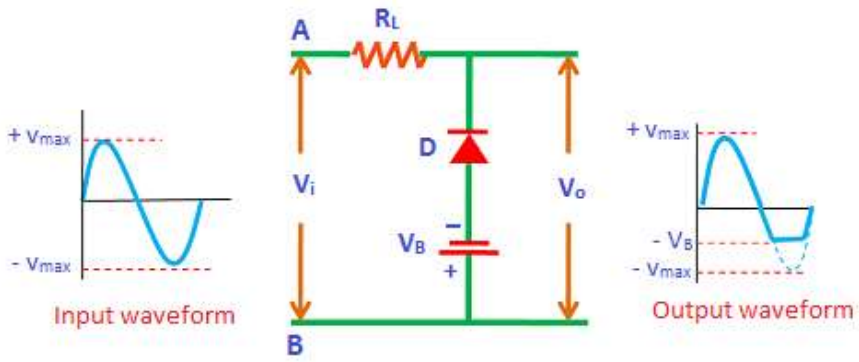


During the negative half cycle, the diode is forward biased by both input supply voltage V_i and battery voltage V_B. So the

complete negative half cycle is removed at the output.

Shunt negative clipper with negative bias

During the positive half cycle, the diode is reverse biased by both input supply voltage V_i and battery voltage V_B. As a result, the complete positive half cycle appears at the output.



Shunt negative clipper with negative bias

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During the negative half cycle, the diode is forward biased by the input supply voltage V_i and reverse biased by the battery voltage V_B. However, initially, the input supply voltage is less than the battery voltage. So the diode is reverse biased by the battery voltage. As a result, the signal appears at the output. However, when the input supply voltage becomes greater than the battery voltage, the diode is forward biased by the input supply voltage. As a result, the signal does not appear at the output.

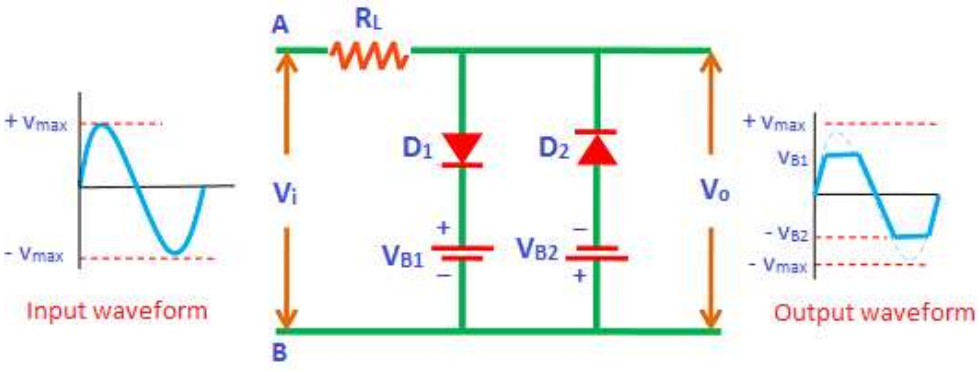
- Dual (combination) clipper

Sometimes it is desired to remove a small portion of both positive and negative half cycles. In such cases, the dual clippers are used.

The dual clippers are made by combining the biased shunt positive clipper and biased shunt negative clipper.

Let us consider a dual clipper circuit in which a sinusoidal ac voltage is applied to the input terminals of the circuit.

During positive half cycle:



Dual (Combination) clipper

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During the positive half cycle, the diode D_1 is forward biased by the input supply voltage V_i and reverse biased by the battery voltage V_{B1}. On the other hand, the diode D_2 is reverse biased by both input supply voltage V_i and battery voltage V_{B2}.

Initially, the input supply voltage is less than the battery voltage. So the diode D_1 is reverse biased by the battery voltage V_{B1}. Similarly, the diode D_2 is reverse biased by the battery voltage V_{B2}. As a result, the signal appears at the output. However, when the input supply voltage V_i becomes greater than the battery voltage V_{B1}, the diode D_1 is forward biased by the input supply voltage. As a result, no signal appears at the output.

During negative half cycle:

During the negative half cycle, the diode D_1 is reverse biased by both input supply voltage V_i and battery voltage V_{B1}. On the other hand, the diode D_2 is forward biased by the input supply voltage V_i and reverse biased by the battery voltage V_{B2}.

Initially, the battery voltage is greater than the input supply voltage. Therefore, the diode D_1 and diode D_2 are reverse biased by the battery voltage. As a result, the signal appears at the output.

When the input supply voltage becomes greater than the battery voltage V_{B2}, the diode D_2 is forward biased. As a result, no signal appears at the output.

Applications of clippers

- Clippers are commonly used in power supplies.
- Used in TV transmitters and Receivers
- They are employed for different wave generation such as square, rectangular, or trapezoidal waves.
- Series clippers are used as noise limiters in FM transmitters.

PREV NEXT

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