# Study and Analysis of Clipper and Clamper Circuits

MOH MOH KHAING[1], YI LAY NGE[2], KHIN THANDAR OO[3]
[1, 2, 3] Department of Electronic Engineering, Technological University (Myitkyina)

***Abstract -- This paper presents the analysis of diode clipper and clamper circuits that are commonly used in analog television receivers and FM transmitters. Different configurations of diode clipper circuits and clamper circuits are designed and analyzed through simulation results. Ordinary diodes, Zener diodes, resistors and capacitors are used as circuit elements and circuit analyses are performed with the help of Multisim software.***

***Indexed Terms: diode clipper circuits, clamper circuits, Simulation, Multisim Software***

## I. INTRODUCTION

A clipping circuit designed with diodes is an electronic circuit that is used to 'clip' the input voltage to prevent it from attaining a value larger than a predefined one. The basic components required for a clipping circuit are a diode and a resistor. Clipper circuits can be classified depend upon their biasing, configurations, level of clipping. There are two general categories of clippers: series and parallel (or shunt). The series configuration consists of a diode connected in series with a resistor; the other one is the shunt clipper that has the diode in a branch parallel to a resistor. In order to fix the clipping level to the desired amount, a dc battery must also be included. Different levels of clipping can be obtained by varying the amount of voltage of the battery and also interchanging the positions of the diode and resistor. In addition, Zener diode can be used as voltage limiter circuits. It can perform to limit the voltage swings to desired level. A Zener used to limit the positive or negative of the voltage to the selected Zener voltage level.

The clamper circuit is almost similar to the clipper circuit except that contains an extra element called capacitor. A typical clamper circuit consists of a capacitor, a diode, and a resistor. Sometimes, clamper circuits contain an extra dc battery. According to circuit configurations, the clamper circuit can be classified as positive clamper, negative clamper and biased clampers.

## II. BASIC CIRCUITS AND WORKING PRINCIPLE

In electronic circuits, the diode is the simplest and the most fundamental non-linear circuit element. A clipper circuit is one of the simple diode circuits and it has the ability to "clip off" a portion of the input signal without distorting the remaining part of the ac waveform. Figure 1 illustrates the basic clipper circuit that can clipped off the positive or negative part of the input signal depending on the direction of the diode. The half-wave rectifier is an example of the simplest form of diode clipper.

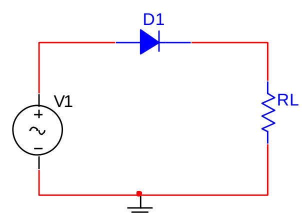



Figure1. A clipper circuit

Figure 2 shows the basic Zener limiter circuit in which ac supply, a Zener diode and a resistor are connected in series. Its function is to limit the ac input voltage swings to the Zener voltage level. For ac input signal, the Zener can act as a forward-biased diode for positive half cycle and limit the voltage to diode voltage drop. During negative half cycle, the negative peak is limited by Zener action to Zener voltage level.

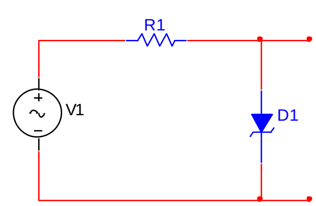



Figure2. A Zener limiter circuit

A clamper circuit is also a simple diode circuit that clamps the positive or negative peak of the signal at a desired dc level. Figure 3 shows a basic clamper circuit that must consist of a capacitor, a diode and a resistive element. The resistor and capacitorare used in the clamper circuits to maintain an altered DC level at the clamper output and the diode is connected in parallel with the output load. The clamper passes the input signal to the output load depend upon the orientation of the diode.

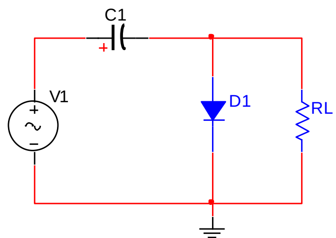



Figure3. A clamper circuit

## III. DESIGNED CIRCUITS AND SIMULATION RESULTS

(i) Positive series clipper: Figure 4 shows the designed positive clipper circuit connecting a diode and a 1KΩ resistor in series. In this circuit, input signal 10Vpp is supplied and output is taken across the resistor. During the input positive cycle, the diode is reverse-biased and clipping the input signal as $V_{out}$=0V. During negative half cycle, the diode acts a closed switch and passes the input signal at the output as $V_R$= $-V_{in}+V_D$=-10+0.7=-9.3V

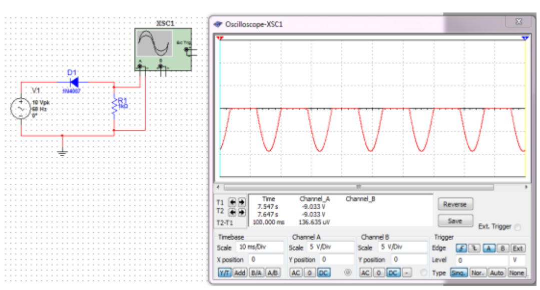


Figure 4: Simulation result of positive clipper

(ii) Negative series clipper: The negative clipper circuit is designed by turning around diode. Therefore, reverse operation occurs for input voltage signal $10V_{pp}$. During positive input half cycle, the diode is forward-biased and the output voltage is $V_R=(V_{in}-V_D)$= 10V-0.7V= 9.3V. During alternation, the diode is reversed-biased and acts as an open switch and the output voltage is $V_{out}$=0V. Designed circuit and clipping output waveform are shown in Figure 5.

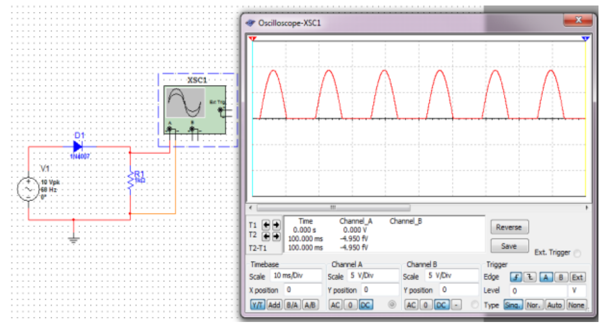


Fig. 5: Simulation result of negative series clipper

(iii) Positive shunt clipper: Figure 6 illustrates the positive shunt clipper circuit and output waveform. During positive cycle of input signal $10V_{pp}$, the diode acts closed switch and limits the voltage to $V_{out}$=0.7V. When negative input goes, the output voltage looks like the negative part of the input voltage, but the magnitude is determined by the voltage divider circuit as follows:

$$Vout = \frac{R_2}{R_1 + R_2} Vin$$

$$Vout = \frac{1K}{1K + 1K} \times -10V = -5V$$

Therefore, the output waveform is limited to positive 0.7V and negative part of -5V.

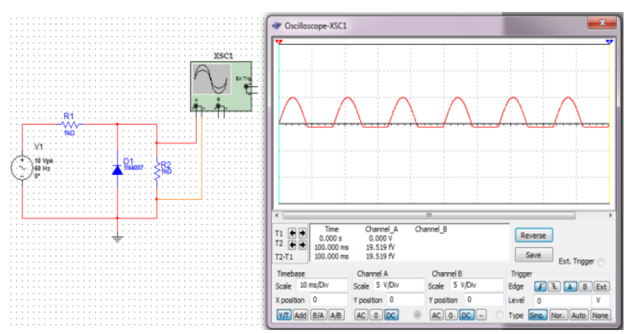


Figure 6.Simulation result of positive shunt clipper

(iv) Negative shunt clipper**:** When the diode is turned around, the circuit is called negative clipper shown in Figure 7. During the negative part of the input voltage, the diode is forward-biased and conducts, $V_{out}$ is held at -0.7V by the diode drop. For the negative limiter, the output voltage is determined by the following equation,

$$Vout = \frac{1K}{1K + 1K} \times 10 = 5V$$

Therefore, the output waveform swings +5V to -0.7V.

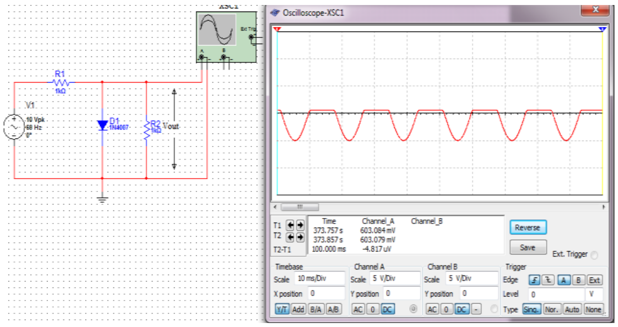



Fig. 7: Simulation result of negative shunt clipper

(v) Biased positive clipper: To produce clipping voltage waveforms at different levels, a bias voltage, $V_{BIAS}$ can be added in series with the diode as shown in Figure 8. For this clipper, $V_{bias}$ is provided 3 V and the input sinusoidal voltage is supplied $10V_{pp}$. During the positive input cycle, the diode is forward-biased allowing the circuit to limit the input voltage to $V_{bias}$+0.7V = 3V+0.7V=3.7 and all input voltage above this level is clipped off. Negative part of input voltage is determined by voltage divider circuit as $V_{out}$= -5V.Therefore the output voltage of 3.7V positive cycle and negative cycle of -5V can be seen on oscilloscope.

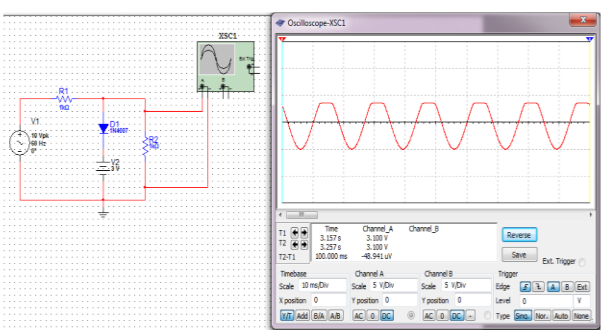



Fig. 8: Simulation result of biased positive clipper

(vi) Biased negative clipper: To limit the voltage at the negative level, the diode and Vbias are connected as shown in Figure 9. In this circuit, the reversed operation of positive clipper circuit is occurred and the negative voltage level is limited to -$V_{bias}$-0.7= -3V-0.7V= -3.7V.

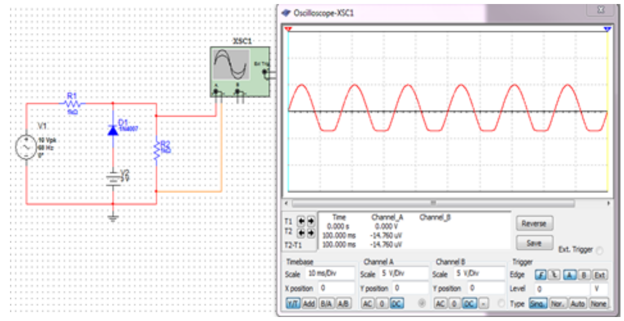



Fig. 9: Simulation result of biased negative clipper

(vii) Zener diode clipper: Zener diode can be used as a voltage limiter to limit the input voltage swings to desired levels. In the circuit shown in Figure 10, a 1N4728A- 3.3V Zener diode and a 1N4733A- 5.1V Zener diode are used back-to-back connection to limit both peaks of the input to the Zener voltage level±0.7V. During the positive alternation, Zener diode $D_1$ is forward- biased and provides 0.7V and Zener diode $D_2$ limits to 5.1 V. there for the input voltage is limited to 0.7+5.1=5.8V and the negative peak is limited to -4V peak of input voltage.

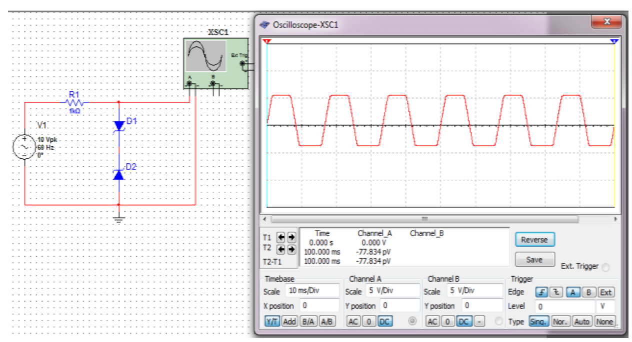



Fig. 10: Simulation result of Zener diode clipper

(viii) Positive clamper circuit: In positive clamper circuit, a 10μF capacitor, a diode and a 10 KΩ resistor are connected as shown in Figure 11. $10V_{pp}$ is supplied to the circuit in series with the capacitor. When the input voltage goes negative, the diode is forward-biased permitting the capacitor to charge 10V-0.7V=9.3V. The DC value is approximately $V_{DC}$= 10V-0.7V= 9.3V. The output waveform goes to approximately -0.7V.

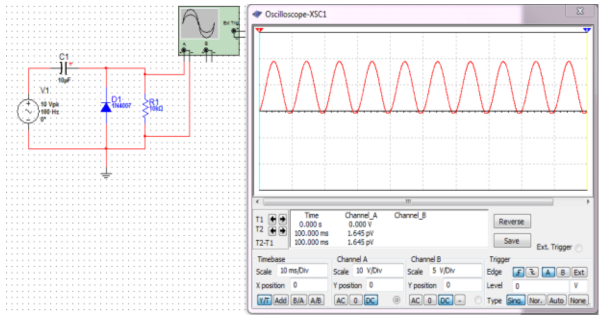
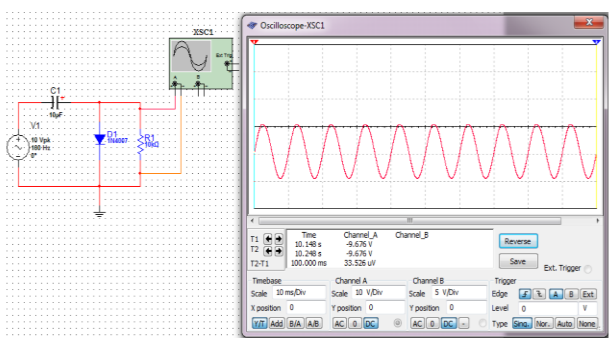


Fig. 11: Simulation result of positive clamper

(ix) Negative clamper circuit**:** By turning around diode, negative clamper circuit is designed as shown in Figure 12. The DC value is approximately $V_{DC}$= -10V+0.7V=-9.3V.

Fig. 12: Simulation result of negative clamper

(x) Biased positive clamper: The circuit of a positively biased clamper circuit is shown in Figure



13.When negative half cycle goes, the diode is forward-biased by both input supply voltage and battery voltage. By applying KVL to determine $V_C$,

$-V_{in}+V_C+0.7-V_{bias}=0$
-10+$V_C$+0.7-5=0
$V_C$=14.3V

During the positive half cycle, the diode is reverse biased and the output voltage can be determined as follows,

$V_{in}+V_C-V_R=0$
10+14.3-$V_R$=0
$V_R$= 24.3V

Therefore the clamping output voltage waveform can be observed in oscilloscope.

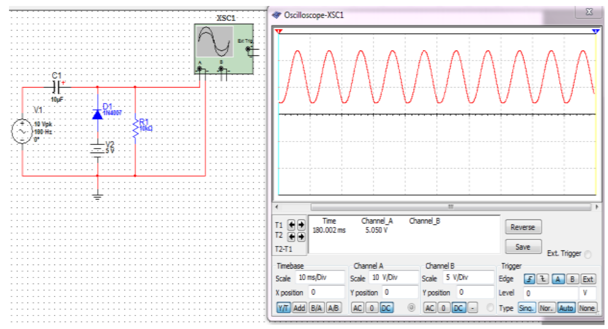


Fig. 13: Simulation result of biased positive clamper

(xi) Biased negative clamper: In biased negative clamper, when positive half cycle goes, the diode is forward-biased by both input supply voltage and battery voltage. By applying KVL to determine $V_C$,

$V_{in}+V_C-0.7+V_{bias}=0$
10+$V_C$-0.7+5=0
$V_C$=-14.3V

During the negative half cycle, the diode is reverse biased and the output voltage as follows,

$-V_{in}+V_C-V_R=0$
-10-14.3-$V_R$=0
$V_R$= -24.3V

Therefore, the clamping output voltage waveform can be seen on oscilloscope as in Figure 14.

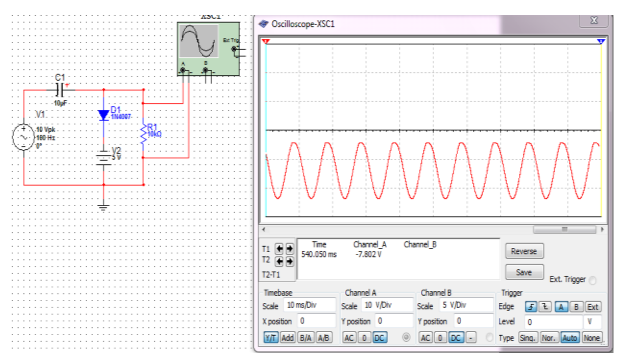


Fig. 14: Simulation result of biased negative clamper

## IV. CONCLUSION

In this paper, positive and negative diode clipper, biased clipper, combinational clipper circuits, Zener diode clipper, positive clamper, negative clamper are designed and simulated using Multisim software. Outputs of each designed circuit are calculated numerically and simulation results have been displayed in oscilloscope through Multisim. The clipping functions and clamping functions of the circuits have been analyzed through the resultant output waveforms. Observed values of limiting and clamping voltage levels are reasonably identical to the theoretical outputs.

## REFERENCES

[1] Thomas L. Floyd, Electronic devices: conventional current version, Ninth Edition

[2] http://www.circuitstoday.com/diode-clippers

[3] http://www.idc-online.com/technical_references/pdfs/electronic_engineering/Diode_Clamping_Circuits.

[4] https://circuitdigest.com/tutorial/diode-clipper-circuits

[5] https://www.physics-and-radio-electronics.com/electronic devices-and-circuits/rectifier/clampercircuits.html

[6] Positive Negative and Biased Clamper: http://www.visionics.a.se

[7] Diode Clipper and Clamper: http://www.uomisan.edu.iq

[8] Clippers and Clamper: https://coefs.uncc.edu

[9] Diodes and Rectifiers: https://www.allaboutcircuits.com

[10] Negative clipper circuits: https://www.tutorialspoint.com