Experiment 5

Operation of Clipper & Clamper Circuits

OBJECTIVES

- To understand the basic application of clippers and clampers
- To understand the basic circuit of clipper and clamper circuits and check their practical implementation

THEORY

1 Introduction

A semiconductor diode is a non-linear device, which behaves as a small resistance in its forward direction and acts as a large resistance in its reverse direction. This is displayed in the Volt- Ampere (V-I) characteristic which is a graph of current vs. voltage for a diode. By linearizing theV-I characteristic, a diode circuit model is obtained known as a *piecewise linear model*.

2 Diode clipper circuits

A clipper is a circuit in which the output of an input sinusoidal (or any time-dependent signal) waveform can be clipped at different levels. A clipping circuit requires at least two fundamental components, a diode and a resistor. A DC battery, however, is also frequently used. The output waveform can be clipped at different levels simply by interchanging the position of the various elements and changing the magnitude of the DC battery. Generally, ideal diodes are considered and the complete analysis can be based on non-ideal diodes with specific V-I characteristic.

For networks of this type, it is often helpful to consider particular instants of the time-varying input signal to determine the state of the diode (ON or OFF). Keep in mind that even the though input varies, at a specific time instant this time varying signal can be replaced by a DC source of the same value. Figure 1 shows examples of various clipping circuits. Please note that the inputto all circuits is a sinusoidal waveform.

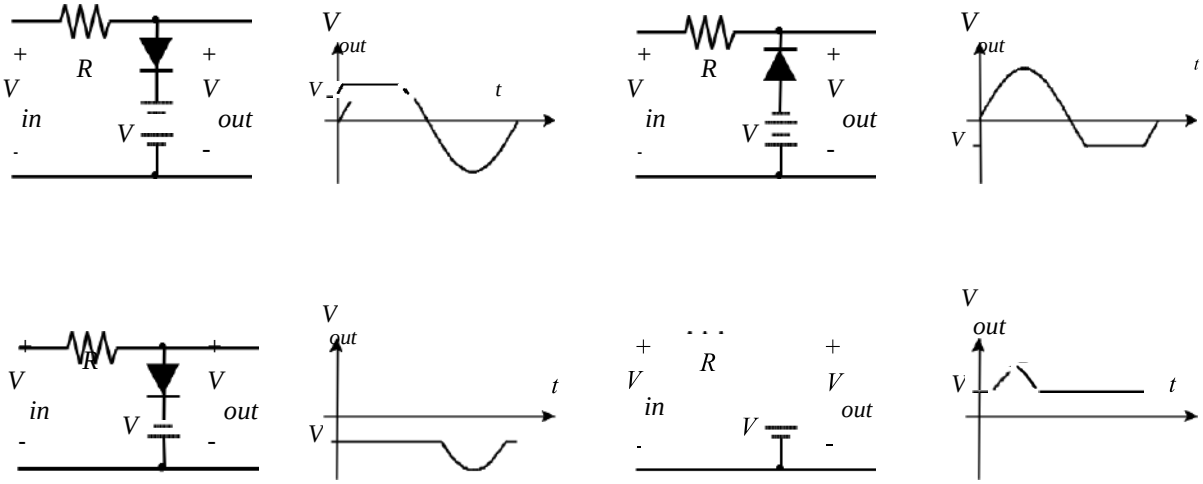
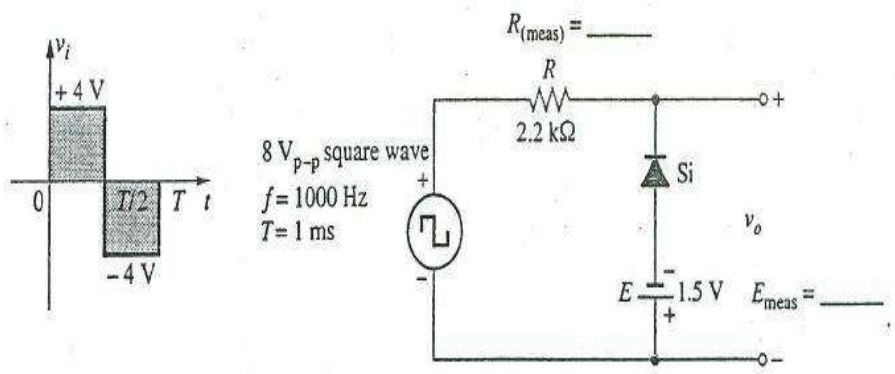


Figure 1: Clipping circuits

For two circuits on the left, the maximum output voltage is clipped at Vout = V. (Ideal diode) For two circuits on the right the minimum output voltage is clipped at Vout= V. (Ideal diode) For a non-ideal diode, maximum or minimum output voltage is Vout = V + Vd, or –V - Vd where Vd is the voltage drop across the diode.

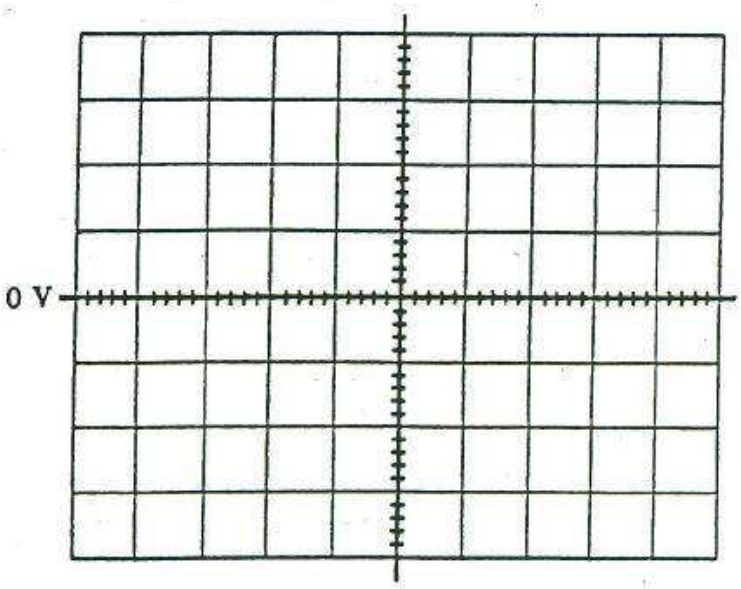
EXPERIMENTAL PROCEDURE

a) Construct the clipping network. Record the measured resistance value and voltage of the D cell. Note that the input is an 8 Vp p Square wave at a frequency of 1000 Hz.



b) Using the measured values of R, E and V_T calculate the voltage V_O when the applied square wave is +4V,that is, for the interval when the input is +4V. what is the level of V_O ? Show all the steps of yours calculations to determine V_O

Sketch of V_o from calculated results:



c) Using the sensitivities set the input square wave and record V_O using oscilloscope. Be sure to preset the V_O = 0 V line using ground position of the coupling switch and the DC position to viewthe waveform.

Diode clamper circuits

A clamper is a circuit which will add or subtract a DC component from any input voltage. The clamping circuit has a minimum requirement of three elements: a diode, a capacitor, and a resistor. The clamping circuit may also include a DC battery. It is usually advantageous when examining clamping circuits to first consider the conditions that exist when the input is such that the diode is forward-biased. Figure 6.1 shows examples of various clamping circuits and their output waveforms. Note that the input is a square wave with peak-to-peak value of 2V. The peak-to-peak value of all the output waveforms is always 2V but the waveforms are shifted depending on the dc-biasing of the circuits.

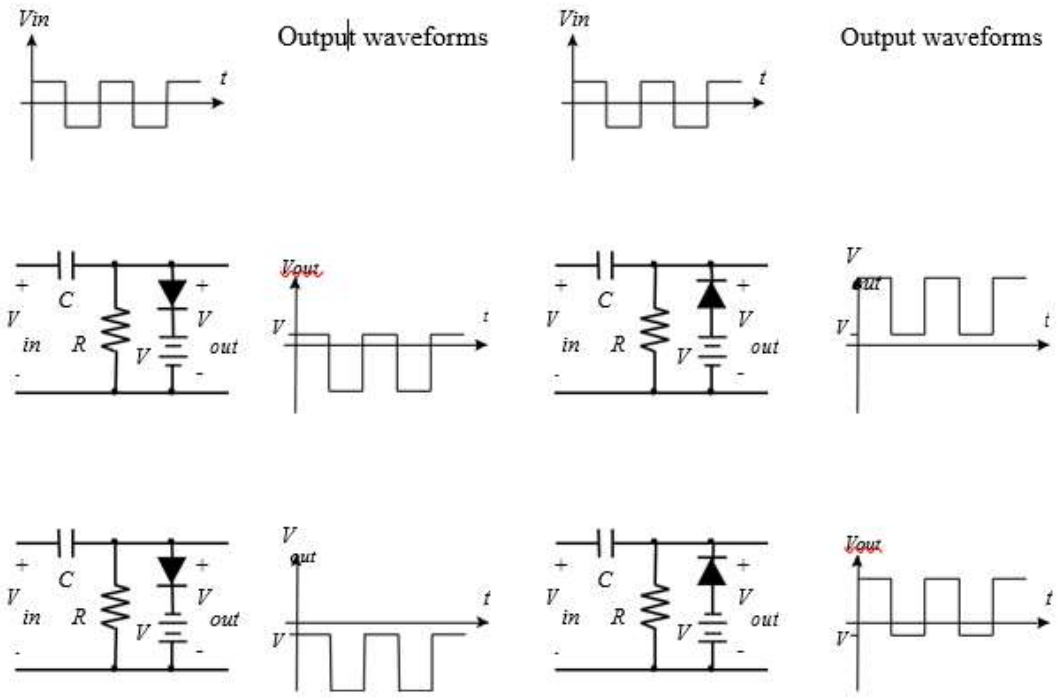


Figure 6.1: Clamping circuits

a) You have a sinusoidal input which is 1 KHz and 16V peak-to-peak. Design a circuit that would limit the output to a maximum of 5V on the positive cycle and a minimum of 3V on the negative cycle. Test your circuit. Sketch the output.

b) Assemble the circuit in Fig. 9 with Vin as a DC source. You need to vary Vin from -8 to 8V in the steps of 2V. Using "5V-fixed" terminals of the other power supply (the black one) make V1=5V. Use the other variable DC terminal to make V2=-3V. Measure the output (Vout). Fill out the table below and draw the relationship between Vin and Vout.

Table 6.1: Voltage limiting circuit result

Vin (V)	-8	-6	-4	-2	0	2	4	6	8
Vout(V)									

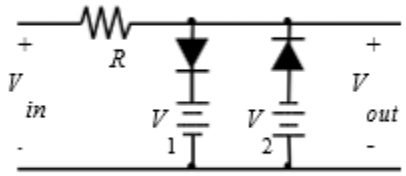


Figure. 6.2: Limiting Circuit

Clamping Circuits

a) Connect the circuit of fig. 10 with C= 22 μF, R=300K **Ω** , and voltage V=0.

b) Apply a square wave input signal of 12 V peak to peak at a frequency of 1 kHz.

c) Use the DC-Coupling on the oscilloscope and sketch the output V_{out} and input V_{in}.

d) Set the value of V to 6 volts and repeat steps a-c. Compare the results of steps c), and d).

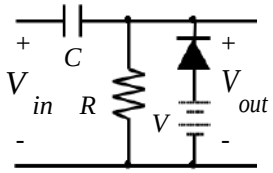


Figure. 6.3: Clamping Circuit

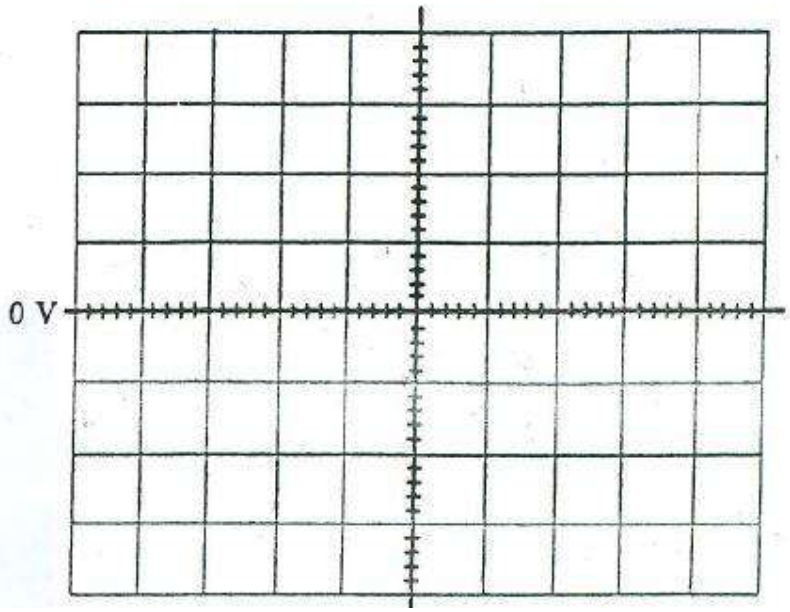
e) If the diode was considered an ideal diode, what would be the clamping voltages for V=0 and V=6V.

QUESTIONS AND DISCUSSION

1. How would you identify the anode of an unmarked diode using a DMM?

2. Under what conditions will a diode turn-on? Explain.

Sketch of V_o from measured results:



Lab Exercise and Summary

Summary should cover Introduction, Procedure, Data Analysis and Evaluation.

Student's Signature:_____ **Date:**_____

LABORATORY SKILLS ASSESSMENT (Psychomotor)

Total Marks: 100

Criteria (Max Marks)	Level 1 0% ≤ S < 50%	Level 2 50% ≤ S< 70%	Level 3 70% ≤ S< 90%	Level 4 90%≤ S ≤100%	Score (S)
Procedural Awareness (20)	Selects inappropriate skills and/or strategies required by the task.	Selects and applies appropriate skills and/or strategies required by the task with major errors.	Selects and applies the appropriate strategies and/or skills specific to the task without significant errors.	Selects and applies appropriate strategies and/or skills specific to the task without any error.	
Practical Implementation (30)	Makes major critical errors in applying procedural knowledge related to operation of clipper circuit	Makes numerous critical errors in applying procedural knowledge related to operation of clipper circuit	Makes some non-critical errors in applying procedural knowledge related to operation of clipper circuit	Applies the procedural knowledge in optimized ways related to operation of clipper circuit	
Participation to Achieve Group Goals (10)	Shows little commitment to achieve group goals and fails to perform assigned roles.	Demonstrates commitment to achieve group goals, but has difficulty in performing assigned roles.	Demonstrates commitment to achieve group goals and carries out assigned roles effectively.	Actively helps to identify, achieve group goals and works effectively to meet them in all roles assumed.	
Interpersonal Skills in Group Work (10)	Rarely interacts positively within a group, even with prompting.	Interacts with other group members if prompted.	Interacts with all group members spontaneously.	Interacts positively with all group members and encourages such interaction in others.	
Use of Tool/Equipment (20)	Uses tools, equipment and materials with limited competence.	Uses tools, equipment and materials with some competence.	Uses tools, equipment and materials with considerable competence.	Uses tools, equipment and materials with a high degree of competence.	
Safety (10)	Requires constant reminders to follow safety procedures.	Requires some reminders to follow safety procedures.	Follows safety procedures with only minimal reminders.	Routinely follows safety procedures.	
				Marks Obtained	

Instructor Name: _____ Sign: _____

LABORATORY SKILLS ASSESSMENT (Affective)

Total Marks: 40

Criteria (Max. Marks)	Level 1 0% ≤ S < 50%	Level 2 50% ≤ S < 70%	Level 3 70% ≤ S < 90%	Level 4 90% ≤ S ≤ 100%	Score
Introduction (5)	Very little background information provided or information is incorrect	Introduction is brief with some minor mistakes	Introduction is nearly complete, missing some minor points	Introduction complete and well-written; provides all necessary background principles for the experiment	
Procedure (5)	Many stages of the procedure are not entered on the lab report.	Many stages of the procedure are entered on the lab report.	The procedure could be more efficiently designed but most stages of the procedure are entered on the lab report.	The procedure is well designed and all stages of the procedure are entered on the lab report.	
Data Record (10)	Data is brief and missing significant pieces of information.	Data provides some significant information and has few critical mistakes.	Data is almost complete but has some minor mistakes.	Data is complete and relevant. Tables with units are provided. Graphs are labeled. All questions are answered correctly.	
Data Analysis (10)	Data is presented in very unclear manner.	Data is presented in ways that are not clear enough.	Data is presented in ways that can be understood and interpreted.	Data is presented in ways that best facilitate understanding and interpretation.	
Report Quality (10)	Report contains many errors.	Report is somewhat organized with some spelling or grammatical errors.	Report is well organized and cohesive but contains some grammatical errors.	Report is well organized and cohesive and contains no grammatical errors. Presentation seems polished.	
				Marks Obtained	

LABORATORY SKILLS ASSESSMENT (Cognitive) Total Marks: 10

(If any) **Marks Obtained**	

Instructor's Signature: _____ **Date: _____**