Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

Electro technology Lab Report

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STUDENT NUMBER: *16323766*

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LAB SESSION: *SESSION 2 (4 – 6PM)*

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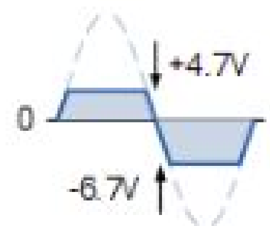
MODULE: *CS 1025*

OBJECTIVE

Observe the input and output graphs using an oscilloscope, of diodes in reverse and forward bias that are connected in a circuit in parallel. Using the graph estimate the cut-in voltage of the diodes. Repeat this for a circuit contain an LED and a D.C. current.

INTRODUCTION

The Diode Clipper, also known as a *Diode Limiter*, is a wave shaping circuit that takes an input waveform and clips or cuts off its top half, bottom half or both halves together.



APPARATUS

1. 2.2KΩ resistor
2. A.C current source
3. D.C current source
4. 2 diodes
5. LED
6. Breadboard
7. Oscilloscope
8. Wire

BACKGROUND INFORMATION

SEMI-CONDUCTORS

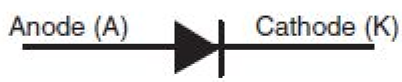
Semiconductors conduct less than metal conductors but more than insulators. Some common semiconductor materials are silicon, germanium, and carbon. Silicon is the most widely used semiconductor material in the electronics industry. Almost all diodes, transistors, and ICs manufactured today are made from silicon. A pentavalent atom is one that has five valence electrons.

Semiconductor Doping

'Doping' is the addition of an 'impurity' element to an intrinsic semiconductor, is used to enhance the conductivity of the semiconductor itself. A semiconductor that has been doped is referred to as an 'extrinsic' semiconductor.

DIODES

A *diode is a* semiconductor and is made by joining *p* - and *n* –type semiconductor materials. It is a 'current valve', allowing current to flow in one direction but not the other

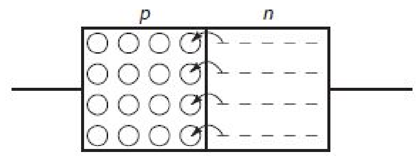


P-Type

A semiconductor doped with a trivalent impurity element (an element that has a valence of three electrons) is known as a p-type semiconductor. The number of 'holes' in a p-type semiconductor exceeds the number of free electrons. Therefore we say that the 'majority carriers' are holes.

N-Type

A semiconductor doped with a pentavalent element (element with five electrons in the outer shell) is known as a p-type conductor. They have an enhanced number of free electrons which gives them better conductivity. They have a greater number of free electrons than holes. Hence, we say that the 'majority carriers' are electrons.



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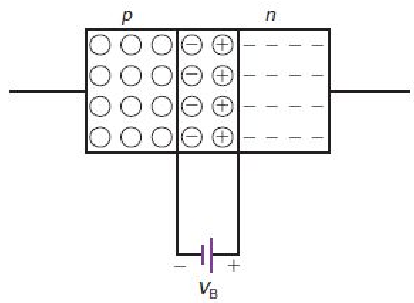
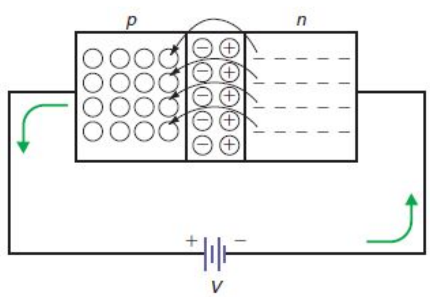


Diode in forward-bias

The term *bias* is defined as a control voltage or current in electronics. Forward-biasing a diode allows current to flow easily through the diode. Forward bias exists when the anode is positive with respect to the cathode. Electrons flow in the opposite direction of the arrow *(diode symbol)* in the direction of the n-side. The arrow on the diode symbol points in the direction of conventional current flow.



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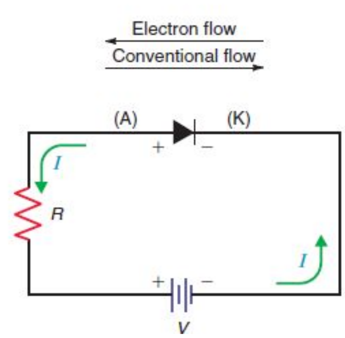
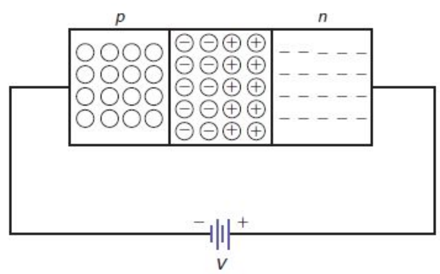


Diode in reverse-bias

The negative terminal of the voltage source, is connected to the p -type semiconductor material and that the positive terminal of the voltage source, is connected to the n –type semiconductor material. This results in the charge carriers in both sections being pulled away from the junction. A diode in reverse bias is in a non - conducting state and acts like an open switch, ideally with infinite resistance. However a reverse-biased diode does conduct a small amount of current, called *leakage current*. The leakage current is mainly due to the minority current carriers in both sections of the diode



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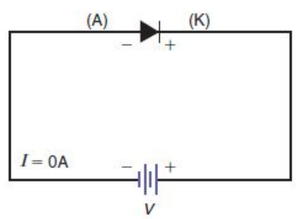
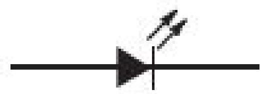


LED (Light Emitting Diode)

When elements such as gallium, arsenic, and phosphorus are used in doping, a manufacturer can make diodes that emit different colors of light. These diodes are called light-emitting diodes (LEDs). For any diode that is forward-biased, free electrons and holes combine at the junction. When free electrons from the n side cross over into the p side, they fall into a hole. When an electron falls, it releases energy. This energy is mainly heat or light. The color of the light emitted from the LED depends on the type of element used in the manufacture of the LED.

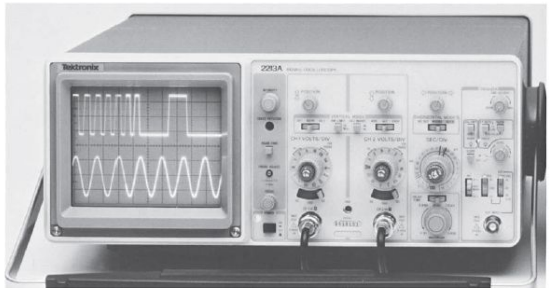


Depletion Region
When the p - n junction is formed, free electrons on the n side diffuse across the junction to the p side. When these free electrons are on the p side, they become minority current carriers. The area where the positive and negative ions are located is called the depletion zone. Other names commonly used *are depletion region* and *depletion layer.* The word depletion is used because the area has been depleted of all charge carriers.

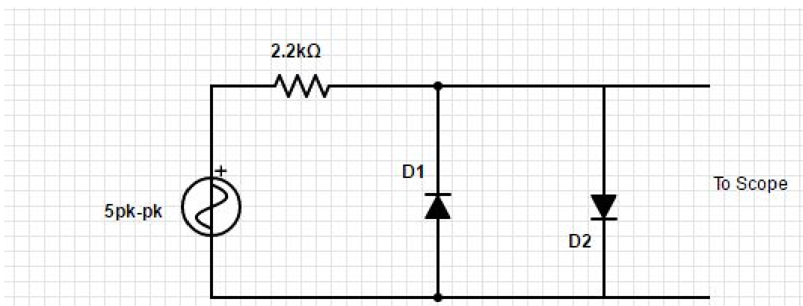
METHOD

HOW TO USE AN OSSILOSCOPE

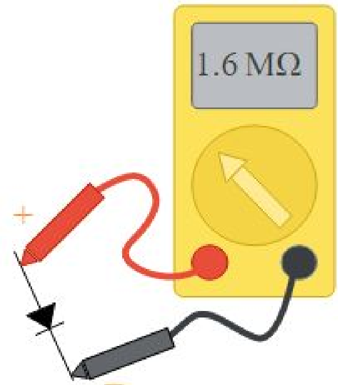
Oscilloscopes have the ability to measure the time, frequency, and voltage level of a signal, view rapidly changing waveforms, and determine if an output signal is distorted. An analog oscilloscope displays the instantaneous amplitude of an AC voltage waveform versus time on the screen of a cathode-ray tube (CRT). The oscilloscope is a graph-displaying device. The vertical axis (Y) represents voltage and the horizontal axis (X) represents time. Inside the cathode-ray tube is an electron gun assembly, vertical and horizontal deflection plates, and a phosphorous screen. The electron gun emits a high-velocity beam of electrons that strike the chemical coating on the inside face of the CRT, causing it to emit light. The intensity of light can be varied by a control located on the oscilloscope front panel. In general, an oscilloscope is normally used to make two basic measurements; amplitude and time. Oscilloscope probes (*LOW-CAPACITANCE PROBE (LCP) & DIRECT PROBE)* are the test leads used for connecting the vertical input signal to the oscilloscope.

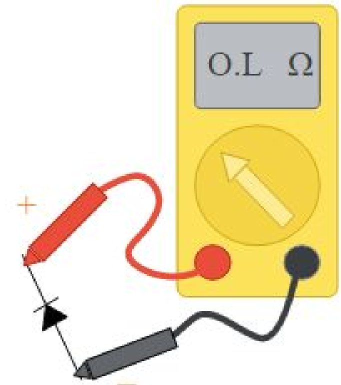


Circuit 1



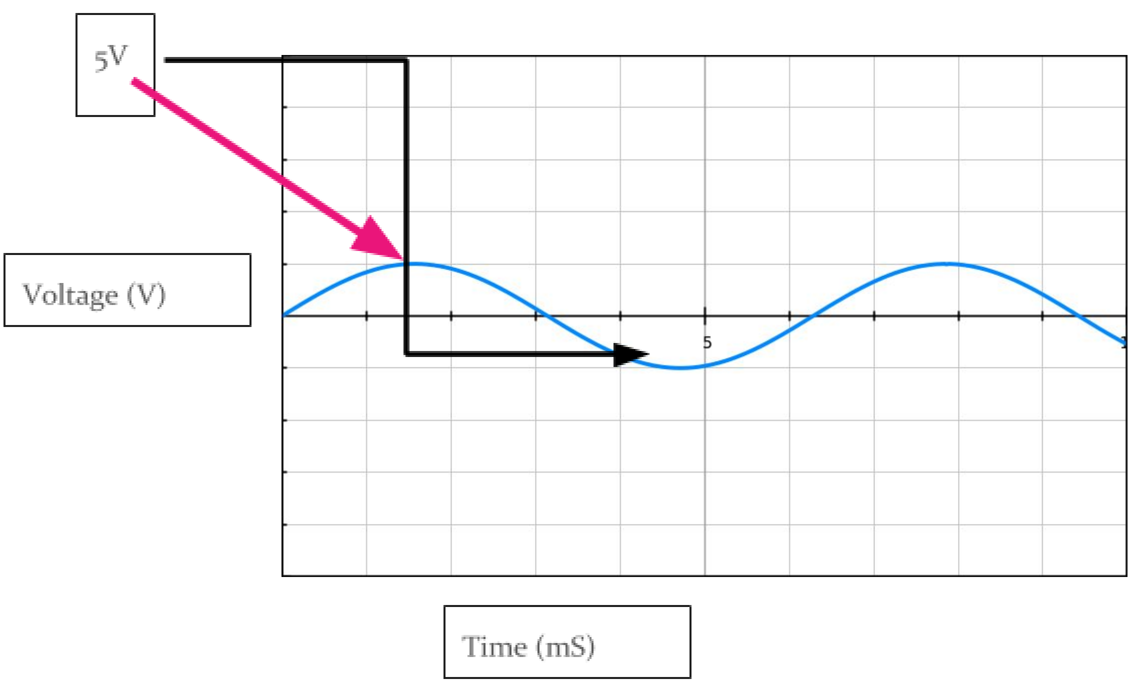
1. Before beginning the experiment we had to verify the identity of the terminals of the diode using the ohm-meter. We needed this to figure out the forward current direction. On the resistance setting, the meter puts a small voltage on its test leads. You use that small voltage to see which way current flows. If the ohm-meter reads a finite resistance, that means the diode is conducting a small current in the forward direction, and the red ++plus lead from the meter is touching the anode. If the resistance reads O.L (for overload), the diode is not conducting current. That means the red ++plus test lead is touching the cathode.



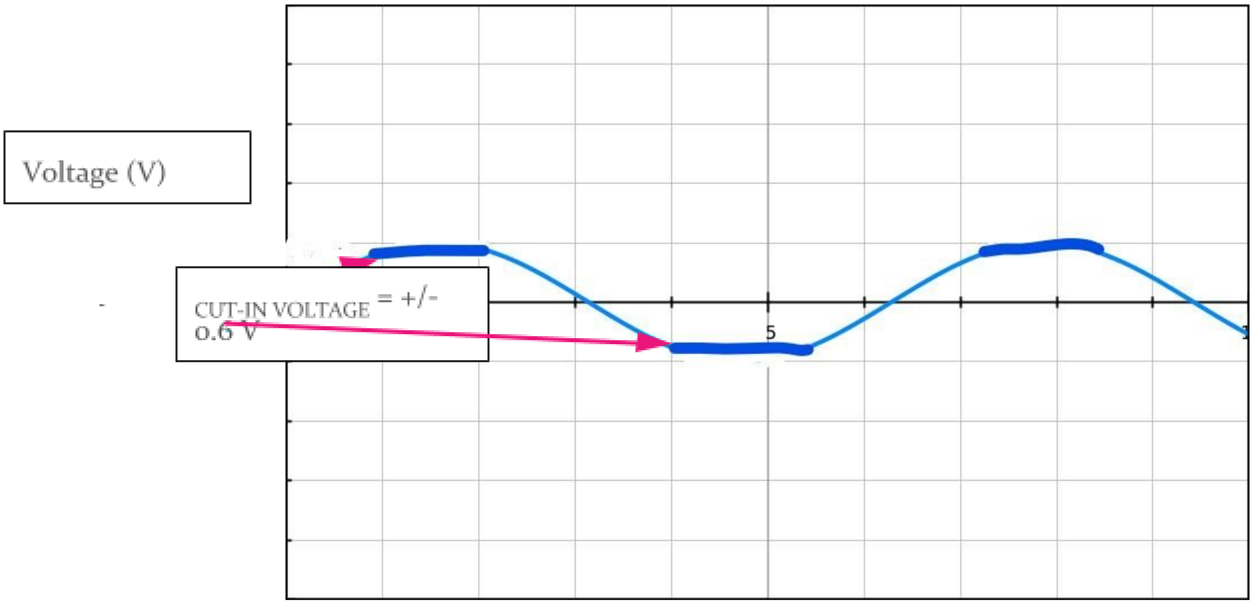


2. Place the sinusoidal waveform voltage source, the resistor and the diodes in the breadboard.
3. Place the diodes in forward and reverse bias and connect them in parallel
4. Connect the function generator to the resistor and channel 1 of oscilloscope to the circuit output.
5. Connect function generator, oscilloscope ground terminal to the common ground of the breadboard.
6. Set the frequency and amplitude of the input signal.

INPUT GRAPH



OUTPUT GRAPH



ANALYSIS OF GRAPHS

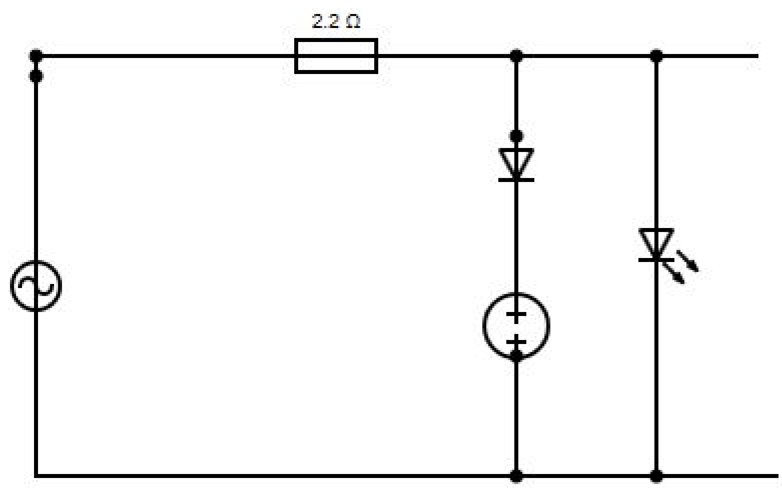
When the diode is in forward bias its increase in its voltage the forward current increases slowly. When the forward voltage is equal to the threshing voltage the forward voltage increases rapidly. When the diode is in reverse bias voltage there is a small reverse current that flows which is almost constant. When the voltage is equal to the reverse breakdown voltage the reverse current increases to a high value.

For the diode to become forward biased, it must have the input voltage greater than +0.6 volts. When this happens the diodes begins to conduct and holds the voltage across itself constant at 0.6V until the sinusoidal waveform falls below this value. Then the output voltage which is taken across the diode cannot be greater than 0.6 volts during the positive half cycle

For a diode in reverse bias the opposite is true. The diode is forward biased during the negative half cycle of the sinusoidal waveform and limits or clips it to -0.6 volts while allowing the positive half cycle to pass unchanged when reverse biased. As the diode limits the negative half cycle of the input voltage it is called a negative clipper circuit.

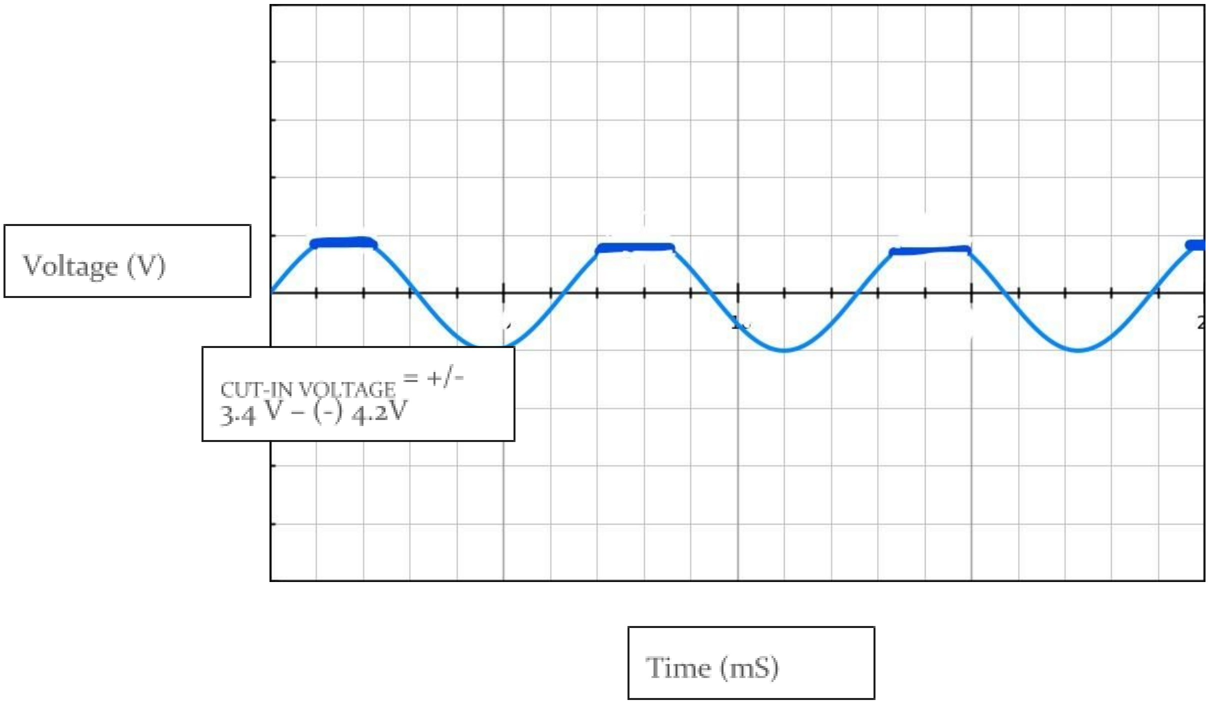
For ideal diodes the output waveform above would be zero. However, due to the forward bias voltage drop across the diodes the actual clipping point occurs at +0.6 volts and -0.6 volts respectively.

CIRCIUT 2



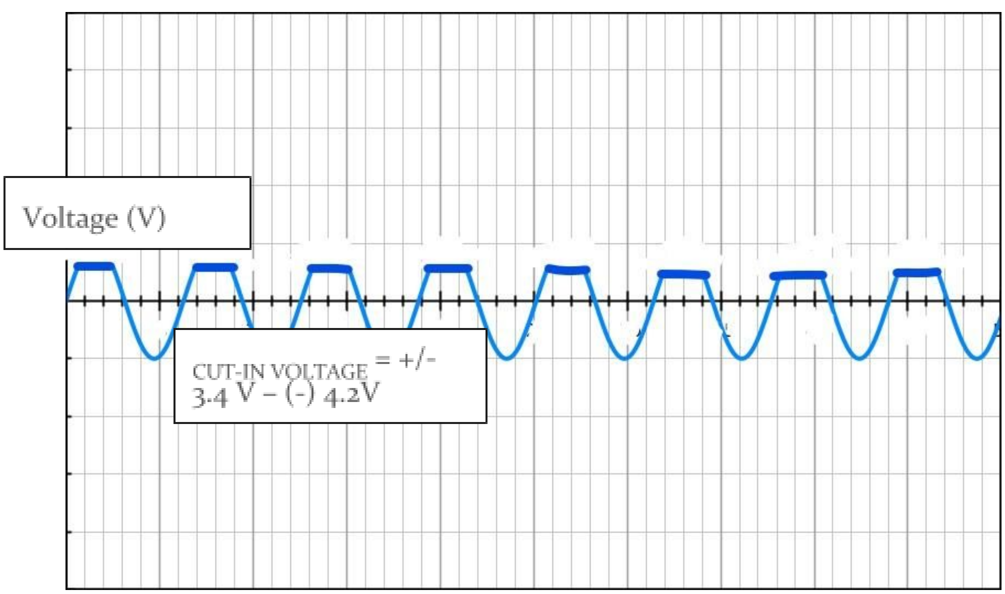
1. Follow the same procedure as the demonstration above
2. Repeat this experiment twice, for the first case without an LED, then the second case with the LED in parallel.

WITH LED



NOTE: The distance between the nodes are wider than the graph without the LED. The LED blinks to indicate the circuit is closed at low frequencies.

WITHOUT LED



Time (mS)

ANALYSIS OF GRAPH

Both graphs have the same form. The only difference is that the graph with the LED has broader spaces between the nodes of the wave. This is because LED's have a very low breakdown voltage rating. Due to their low breakdown voltage, accidentally applying even a small value of reverse voltage can destroy the LED or degrade its performance. By connecting an LED with a diode in parallel protects it from this damage. The parallel connection ensures that the LED cannot accidentally receive a reverse-bias voltage greater than its breakdown voltage rating. In for our experiment the LED has a maximum reverse voltage of 0.6V, equal to the forward voltage of 0.6 V across D 1. That is why we get that graph because the voltage flows into the LED due to its low breakdown voltage.

CONCLUSION

The diode limiter also called a 'Clipper' as it is used to limit the input voltage. A basic diode limiter circuit can be assembled using diode, a resistor and or an LED. Depending upon the circuit configuration and bias, the circuit may clip or eliminate all or part of an input waveform. The wave can be viewed on the oscilloscope screen.

SOURCES

http://evalidate.freehostia.com/diode/Diode_Limiter/diodeLimiterTheory.html

http://www.electronics-tutorials.ws/diode/diode-clipping-circuits.html

https://www.youtube.com/watch?v=pieY6wUEGbU