Experiment No.1

Diode Characteristics

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PART I.

Objective :

To study and plot the V-I characteristics of a diode. (Relationship between V_{AK} and I_A).

Apparatus used:

1. ST2712 board. 2. (2)DC Voltmeter. 3. DC Ammeter. 4. Diode 1N4007 (on board) 5. Potentiometer 5K(1/4W) 6. Resistance 1K(1/4W).

Theory

A diode is the simplest sort of semiconductor device. Broadly speaking, a semiconductor is a material with a varying ability to conduct electrical current. Most semiconductors are made of a poor conductor that has had impurities (atoms of another material) added to it. The process of adding impurities is called doping. If the doping is increased the diode can be considered as a zener diode which cause the decreasing of zener voltage.

Semiconductor diode theory is at the very centre of much of today's electronics industry. In fact semiconductor technology is present in almost every area of modern day technology and as such semiconductor theory is a very important element of electronics.

One of the fundamental structures within semiconductor technology is the PN junction. It is the fundamental building block of semiconductor diodes and transistors and a number of other electronic components.

The semiconductor diode has the valuable property that electrons only flow in one direction across it and as a result it acts as a rectifier. As it has two electrodes it receives its name - diode. In view of this, it is one of the most fundamental structures in semiconductor technology. Vast numbers of diodes are manufactured each year, and of course the semiconductor diode is the basis of many other devices apart from diodes. The bipolar junction transistor, junction FET and many more all rely on the PN junction for their operation. This makes the semiconductor PN junction diode one of the key enablers in today's electronics technology.

PN junction characteristics

The PN junction is not an ideal rectifier diode having infinite resistance in the reverse direction and no resistance in the forward direction.

Referring to figure (1) , in the forward direction (forward biased) it can be seen that very little current flows until a certain voltage has been reached. This represents the work that is required to enable the charge carriers to cross the depletion layer. This voltage varies from one type of semiconductor to another. For germanium it is around 0.2 or 0.3 volts and for silicon it is about 0.6-0.7 volts. In fact it is possible to measure a voltage of about 0.6-0.7 volts across most small current diodes when they are forward biased. Power rectifier diodes normally have a larger voltage across them but this is partly due to the fact that there is some resistance in the silicon, and partly due to the fact that higher currents are flowing and they are operating further up the curve.

From the diagram it can be seen that a small amount of current flows in the reverse direction (reverse biased). It has been exaggerated to show it on the diagram, and in normal circumstances it is very much smaller than the forward current. Typically it may be a pico amps or micro amps at the most. However it is worse at higher temperatures and it is also found that germanium is not as good as silicon.

This reverse current results from what are called minority carriers. These are a very small number of electrons found in a P type region or holes in an N type region. Early semiconductors has relatively high levels of minority carriers, but now that the manufacture of semiconductor materials is very much better the number of minority carriers is much reduced as are the levels of reverse currents.

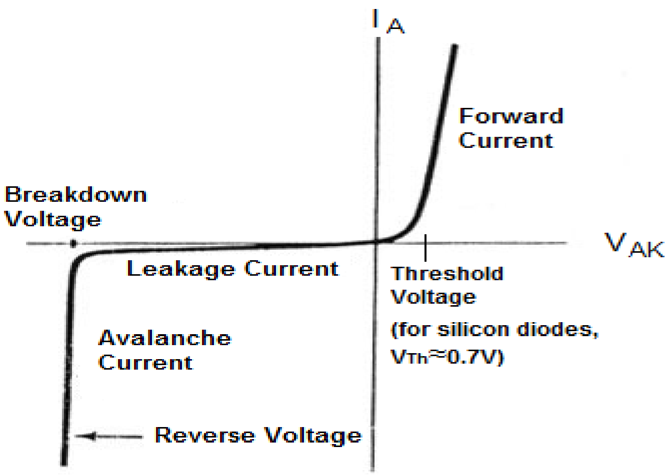


Figure (1)The characteristic of a diode.

Procedure:

1. Connect the circuit as shown in figure (2).
2. Switch ON the power supply on the board.
3. Vary the potentiometer P1 in fully counter clockwise direction and observe that both ammeter and voltmeter read zero.
4. By varying the potentiometer P1, increase the value of V_{AK} carefully and in steps as in table (1) and read the anode current I_A for each step. Record your results in the table.
5. Switch OFF the power supply of the board.
6. Sketch your obtained results in graph paper (V_{AK} on the X-axis, and I_A on the Y-axis). The curve obtained represents the diode characteristics in forward region.
7. Connect the circuit as shown in figure (3).
8. Repeat steps 2 to 6. Record your results in table (2).

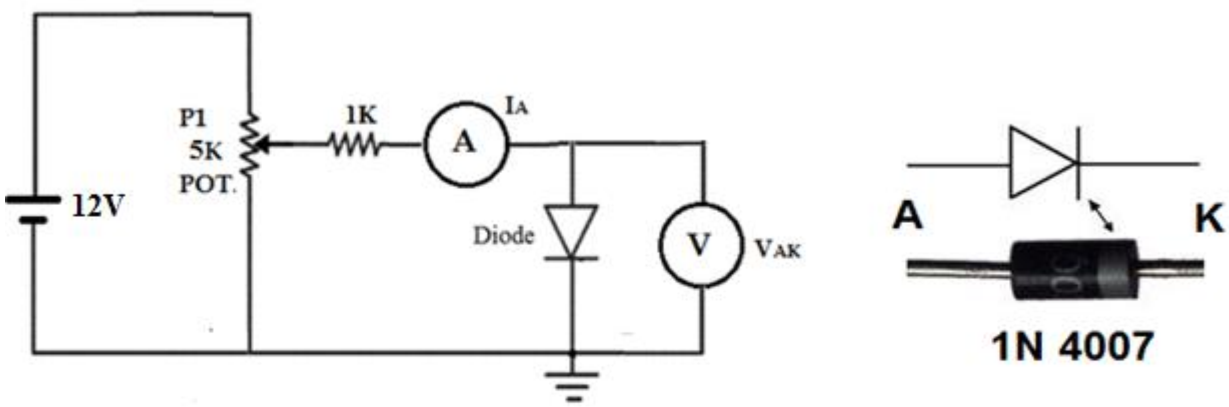


Figure (2) the practical circuit for forward Diode characteristics.

Table (1) Results Obtained for forward characteristics of the Diode.

V_{AK} (V)	0.1	0.2	0.3	0.4	0.5	0.6	0.7
I_A (mA)							

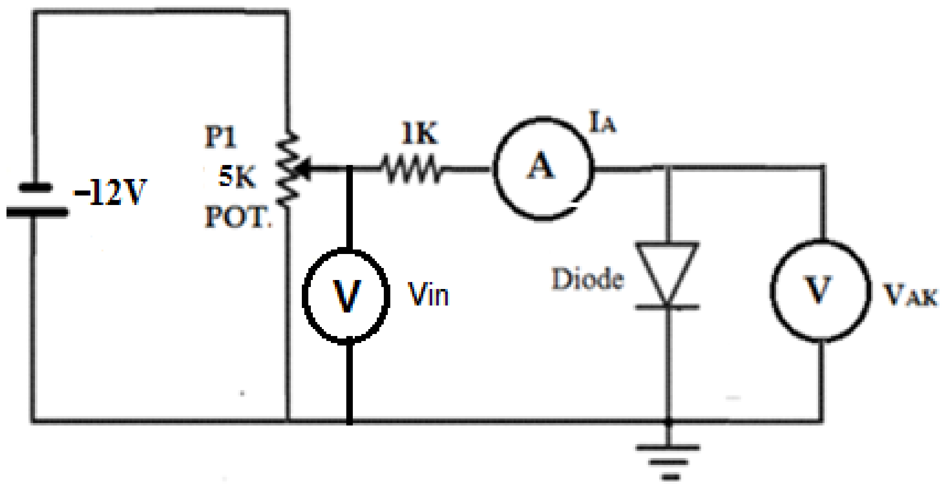


Figure (3) the practical circuit for reverse Diode characteristics.

Table (2) Results Obtained for reverse characteristics of the Diode

Vin (V)	0	-2	-4	-6	-8	-10	-12
V_{AK} (V)							
I_A (mA)							

PART II.

Objective :

To display the V-I characteristics of a Diode on the oscilloscope.

Apparatus used:

1. Diode 1N4007 (on board)   2. Dual channel oscilloscope.
3. Resistance 1K(1/4W).   4. Resistance 1Ω(1/2W).

Procedure:

1. Connect the circuit as shown in figure (4).
2. Set the oscilloscope as follows:
   - X-Y mode.
   - Channel 1 at 1 V/Div. on the Anode.
   - Channel 2 at 10 mV/Div. on the Cathode.
3. Switch ON the power supply of the board and the diode characteristics should displays directly on the oscilloscope. You may necessitate some fine adjustment of the oscilloscope in order to display fine figure.
4. Sketch the displayed figure from the oscilloscope to your graph paper carefully.
5. Find the Knee voltage of the diode [V_D (ON),V_D (max), & I_D (max)].

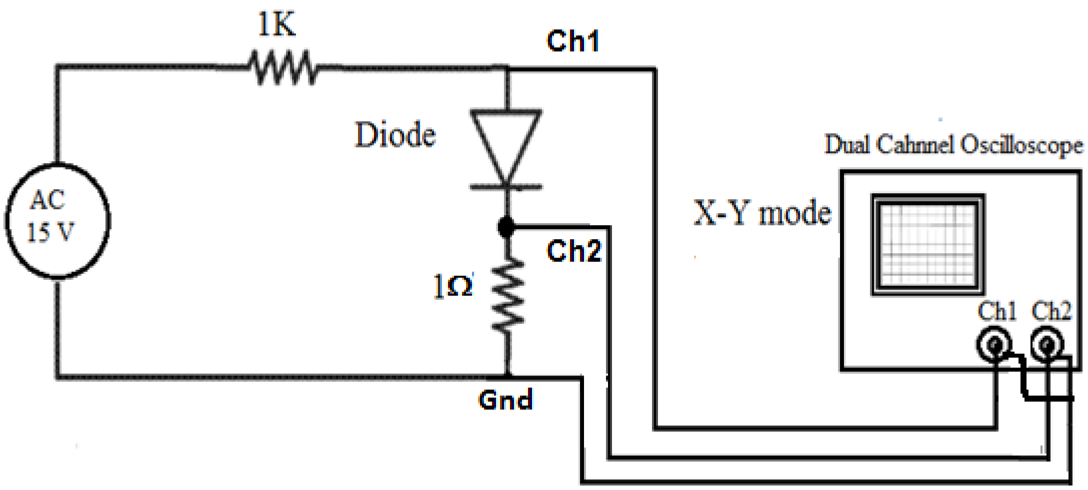
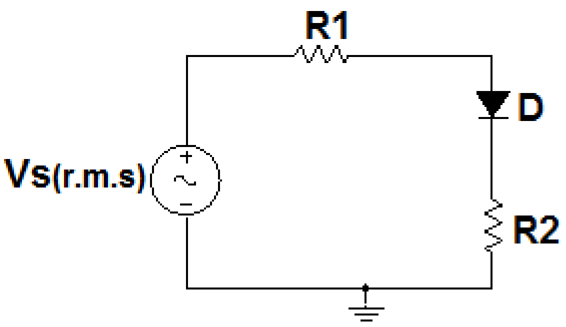


Figure (4) the practical circuit to plot Diode characteristics on the oscilloscope.

Discussion

1. Comment about the obtained results ?
2. What is the benefit of (1 Ω, and 1kΩ) resistances?
3. From AC and DC cct. results, determine Ploss(total) at peak current of the diode?
   Note: Ploss(total) = Ploss(diode) + Ploss (of all the resistances in the circuit) .
4. By only the AVO meter, how can you know the terminals (A & K), drop voltage and the diode is working or not?
5. If the maximum current of the diode c/c cct. is (22 mA) can you determine the r.m.s voltage of the source?
6. If you have number of diodes with maximum current of 70mA each, what do you do if the required load draws 240mA, let you have similar diodes in drop voltage?
7. If you have a type of diodes with (20 V) PIV, and you have AC power supply with (40 V) r.m.s voltage , What do you do ?
8. What the advantages and disadvantages of the parallel & series connected of the diodes ?
9. If you like to buy a diode from a market what are the important parameters that you must taken in mind ?
10. Comment on the state of being one of the devices (of the any cct.) with increasing in temperature, and what the treatment for it ?
11. For the circuit shown below, suppose a value of V_S(r.m.s), then find the value and power of the each resistance, if the maximum current of the power supply and the diode is
    400 mA and 280 mA respectively ?



12. If you replace the (1 Ω) by (470 Ω) how can you determine I_A, V_{ch1} and V_{ch2}?
13. What is the exact measurement of the oscilloscope which have inversion mode in channel(2) for the tow state of measuring, and Why and When is the reading of the second cct. is very similar to the first ?