USER'S MANUAL/TEST RESULTS

TO STUDY THE CHARACTERISTICS OF JUNCTION DIODES
(Silicon diode Type-1N4007 & Ge.diode Type-DR-25)
S.No.22655

A Product of:

RAMAN SCIENCTIFIC INSTRUMETNS

23, AWAS VIKAS, ROORKEE – 247667
Ph. No. +91 1332 260007, FAX No. +91 1332 274950
visit us at www.rsiindia.com, email: rsi_india@yahoo.com

SEMICONDUCTOR DIODES

INTRODUCTION

Semiconductors are solids whose resistivity lies between the conductor and insulator. A conductor has conductivity between 10^4 to 10^6 Ohm^{-1} cm^{-1} and an insulator has conductivity less than 10^{-6} Ohm^{-1} cm^{-1} while a semiconductor has conductivity between 10^{-6} to 10^3 $Ohm^{-1}cm^{-1}$ which increases with the increase of temperatures. These solids are called the semiconductors.

Junction diodes, Zener diodes, transistors, metallic rectifiers, Integrated circuits are the examples of semiconductors. They are widely used in radio, TV receivers, computers and in various electronics test and measuring instruments.

Semiconductor devices perform many control functions. They may be used as rectifiers, amplifiers, detectors, oscillators and switching elements. Some characteristics which make the semiconductor such an attractive member of the electronics family are as follows.

1. They are small and light in weight, which permits miniaturization of electronic equipment.
2. An integrated circuit (IC) "chip" containing circuits comprising transistors, resistors, capacitors, wiring and contacts. This IC can do the work previously performed by a vacuum tube device whose dimensions were about 100 times as large.
3. Semiconductors are solids. There is therefore little chance that elements will vibrate.
4. Semiconductors require little power and radiate less heat than tubes. They do not need warm up time and operate as soon as power is applied.
5. Semiconductors are rugged and may be made impervious to external environmental conditions.
6. Semiconductors do not undergo the chemical deterioration which occurs in tube cathodes. The deterioration of the tube cathodes eventually results in unacceptable tube performance.

Generally two types of semiconductors materials are used:

(a) Germanium (b) Silicon

They must be highly purified before they can be used or processed into effective semiconductor materials. These types of semiconductors are called **Intrinsic Semiconductors.** But in this state they have very low conductivity. Their conductivity may be increased by adding some impurities. The types of impurities called doping. And when a crystal is doped it is called **Extrinsic Semiconductors**.

According to the type of impurities added the Extrinsic Semiconductors can be divided in two types.

(a) P-Types Semiconductors (b) N-Type Semiconductors

(a) P-Type Semiconductors:

If a trivalent impurity atom like Boron or Aluminum is added to Germanium, Indium or Gallium to silicon, then the conductivity of Germanium and Silicon increases by increasing the positive (holes) carrier. So they called the P-Type semiconductors.

(b) N-Type Semiconductors:

If a pentavalent impurities like arsenic or Antimony is added to Germanium and Silicon then the conductivity increased by increasing the number of negative charge carriers (Free electron). So they called the N-Type Semiconductors.

JUNCTION DIODE:

When a P-Type and N-Type Germanium or Silicon are joined together as shown in fig.1 (a), a junction diode is created. The diode thus created has a characteristic to pass current in one direction readily but not in other. Fig.1 (b) shows the circuit symbol of semiconductor diode.

The terminal marked Anode (built with P-type materials) is connected to the P-Type material while the terminal marked Cathode (built with N-type materials) is connected to the N-Type material marked dot or circle on commercial diodes as shown in fig. 1 (c).

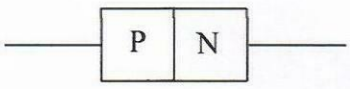


Fig. (a)

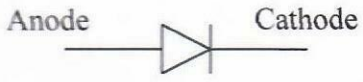


Fig. (b)

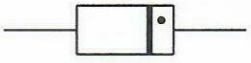


Fig. (c)

Fig. 1

Biasing of a Junction Diode:

(a) Forward Bias:

If a diode is connected in such a manner that the positive battery terminal is connected to the Anode of the diode and negative battery terminal to the cathode of the diode, then current flow in this connection and the diode is to be called in forward bias Fig. 2 (a). In this configuration the diode has low resistance and is called low forward resistance.

(b) Reverse Bias:

If a diode is connected in such a manner that the negative battery terminal is connected to the Anode of the diode and positive battery terminal is connected to the cathode of the diode then very small current flow in this connection due to minority charge carrier. And the diode is called to be in reverse bias conditions Fig 2 (b). In this case the diode has very high reverse resistance.

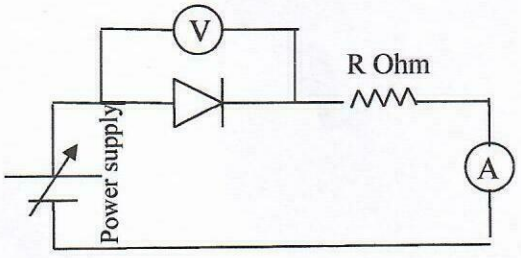


Fig.2 (a) Forward Bias

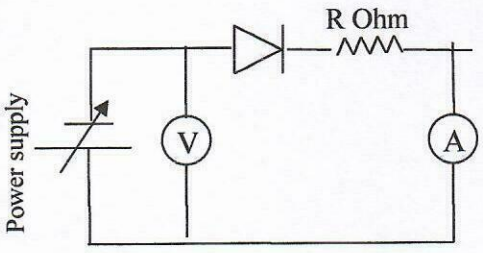


Fig.2 (b) Reverse Bias

Volt-Ampere Characteristics of Junction Diodes:

The volt-ampere characteristics of a diode is a graph which shows how current in that diode varies with the voltage applied across it. This can be determined by measuring the current in diode for successive number of higher applied voltage in both the direction and plotting a graph of current Vs voltage.

The turn-on Forward bias voltage for silicon diode is typically 0.7V & for Germanium diode is 0.3V. A typical Volt-ampere characteristics for silicon and Germanium diode is shown in fig (3)

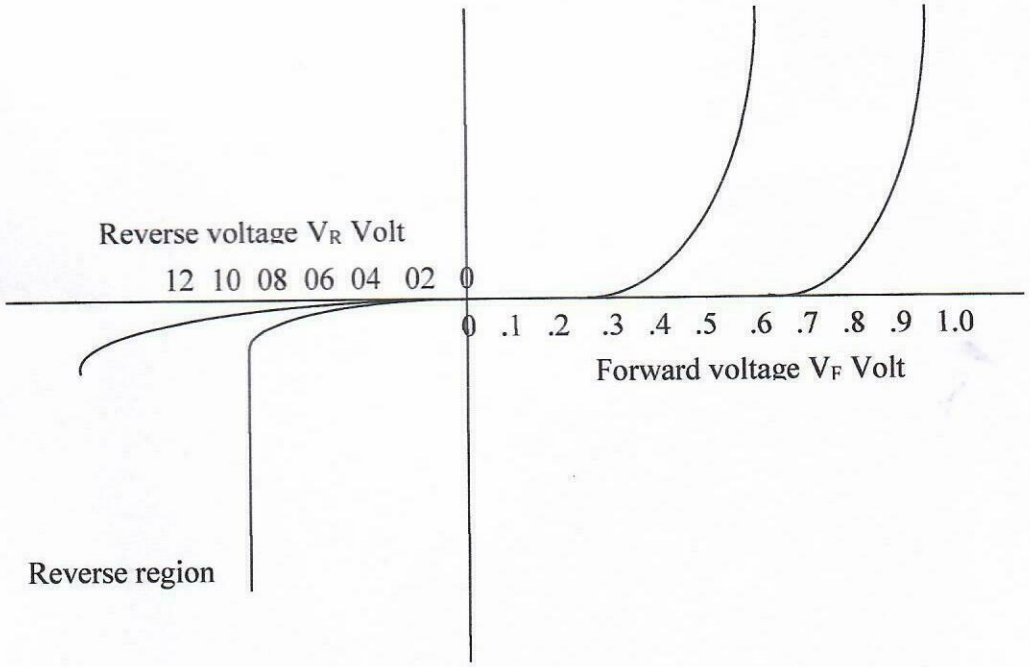


Fig. (3)

OBJECT: To Draw and Study The Volt Ampere (V-I) Characteristics Of A Junction Diodes.
(Silicon Type-1N4007 and Ge. Type DR-25) Digital Version

APPARATUS USED: Set-up 'Make Raman' (To Study Semiconductor diode) and Layout Fig. 4

DESCRIPTION OF THE SET-UP: The experimental set-up has been laid down on a decorated bakelite board with an aim of providing an easy understanding to the students. The set-up consists of the following:

(a)	Variable D.C. Power Supply	:	0 – 12 volt continuously variable.
(b)	Digital Voltmeter (Dual range)	:	0 - 20 volt
(c)	Ammeter (Double range)	:	0 – 20 mA
(d)	Junction diode(Si and Ge)	:	Silicon IN 4007 , Germanium DR-25
(e)	Patch chords		

EXPERIMENT-I

OBJECT: To study the volt ampere (V-I) characteristics of a Silicon diode type 1N4007.

METHOD:

(a) For Forward Bias

1. Make connection as shown in Fig. 2(a) such that the diode is forward biased.
2. Set the power supply knob at extreme left so that the output is approximately zero.
3. Connect the set-up with main and switch it 'ON'.
4. Apply some forward voltage (V_F) say 0.2, 0.4, 0.5, 0.54, 0.58,0,60, 0.62, 64, .68 .... So on and note the corresponding forward current (I_F) in ammeter for each value of voltage V_F.
5. Record these readings in table -1 as given below.
6. Plot graph between voltage V_F and current I_F taking voltage on X-axis and current on Y-axis.
7. Calculate the knee voltage (turn on voltage) from the graph and compare it with the theoretical value

(b) For Reverse Bias

1. Change the diode connections such that the diode reverse biased as shown in Fig.2 (b).
2. Apply some reverse voltage (V_R) say 2, 4, 6 .....so on and measure the corresponding reverse current (I_R) in ammeter for each value of voltage (V_R).
3. Record these readings in table - 1 as given below.
4. Plot graph between voltage V_R and current I_R taking voltage on X-axis and current on Y-axis.

TABLE: 1

S.No.	Forward Bias		Reverse Bias	
	Voltage V_F Volt	Current I_F mA.	Voltage V_R Volt	Current I_R uA.
1.	.....	.....	.....	.....
2.	.....		.....	.....
3.	..	.....	.....	.....
4.	...	.....	.....	.....
	..	...	.....	

RESULTS:

1. Graph shows the V-I characteristics of a Silicon diode.
2. The turn-on voltage for Silicon diode is .....as observed experimentally.

EXPERIMENT-II

OBJECT: To draw & study the volt ampere (V-I) characteristics of a Germanium Diode Type DR-25

METHOD:

(a) For Forward Bias

1. Repeat the experiment -I with Germanium diode keeping the forward voltage (V_F) say 0.1, 0.14,0.16 0.18 ... so on and measure the corresponding forward current (I_F) as given above. Make table as shown above i.e. Table-1.

(b) For Reverse Bias

1. Repeat the experiment-I with Germanium diode keeping the reverse voltage (V_R) say 2 , 4, 6, ... so on and measure the corresponding reverse current (I_R) as given above. Make table as shown above i.e. Table-1.

RESULTS:

1. Graph shows the V-I characteristics of a Germanium diode.
2. The turn-on voltage for Germanium diode is .....as observed experimentally.

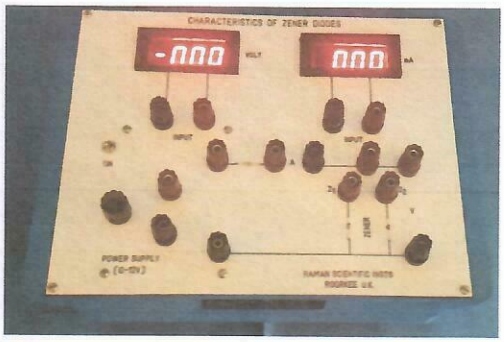


Fig. Complete Layout

TO DRAW AND STUDY THE CHARACTERISTIC OF JUNCTION DIODES

TEST RESULTS **SET-UP S.NO.22655**

OBSERVATIONS AND TABULATIONS

(a) For Silicon diode 1N 4007

S.No.	Forward Bias		Reverse Bias	
	Forward Voltage V_F Volt	Forward current I_R mA.	Reverse voltage V_R Volt	Reverse Current I_R uA.
1.	0.000	0.00	0.0	0.00
2.	0.200	0.00	2.0	0.01
3.	0.400	0.03	4.0	0.03
4.	0.500	0.30	6.0	0.05
5.	0.550	0.80	8.0	0.07
6.	0.600	2.01	10.0	0.09
7.	0.620	3.18		
8.	0.640	4.74		
9.	0.660	6.60		
10.	0.680	10.05		
11.	0.700	15.33		

(b) For Ge diode DR-25

S.No.	Forward Bias		Reverse Bias	
	Forward Voltage V_F Volt	Forward current I_R mA.	Reverse voltage V_R Volt	Reverse Current I_R uA.
1.	0.00	0.00	0.0	0.00
2.	0.05	0.05	2.0	0.02
3.	0.100	0.26	4.0	0.04
4.	0.150	0.90	6.0	0.06
5.	0.20	2.33	8.0	0.08
6.	0.22	3.46	10.0	0.10
7.	0.24	4.91		
8.	0.26	6.25		
9.	0.28	8.94		
10.	0.30	11.67		
11.	0.32	15.36		

RESULTS:-

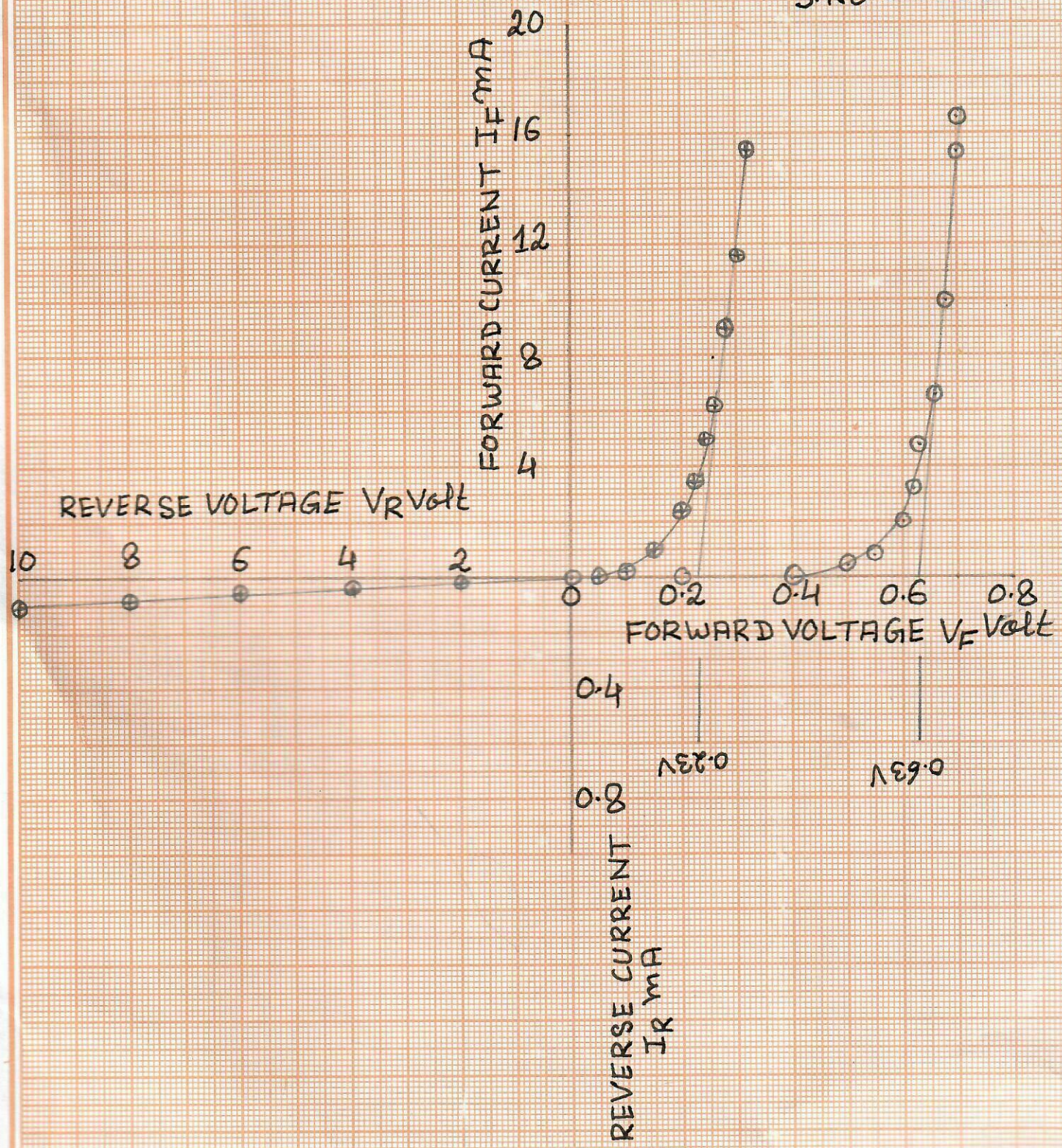
1. Graph no. 1(a) and (b) shows the V-I characteristics of given Silicon (Type 1N 4007) and Germanium (Type DR 25) Junction diodes in Forward and Reverse Bias conditions.
2. The Practically observed knee voltage for Silicon diode is 0.63 V
3. The Practically observed knee voltage for Ge diode is 0.23 V

TEST RESULTS:

CHARACTERISTICS OF JUNCTION DIODES

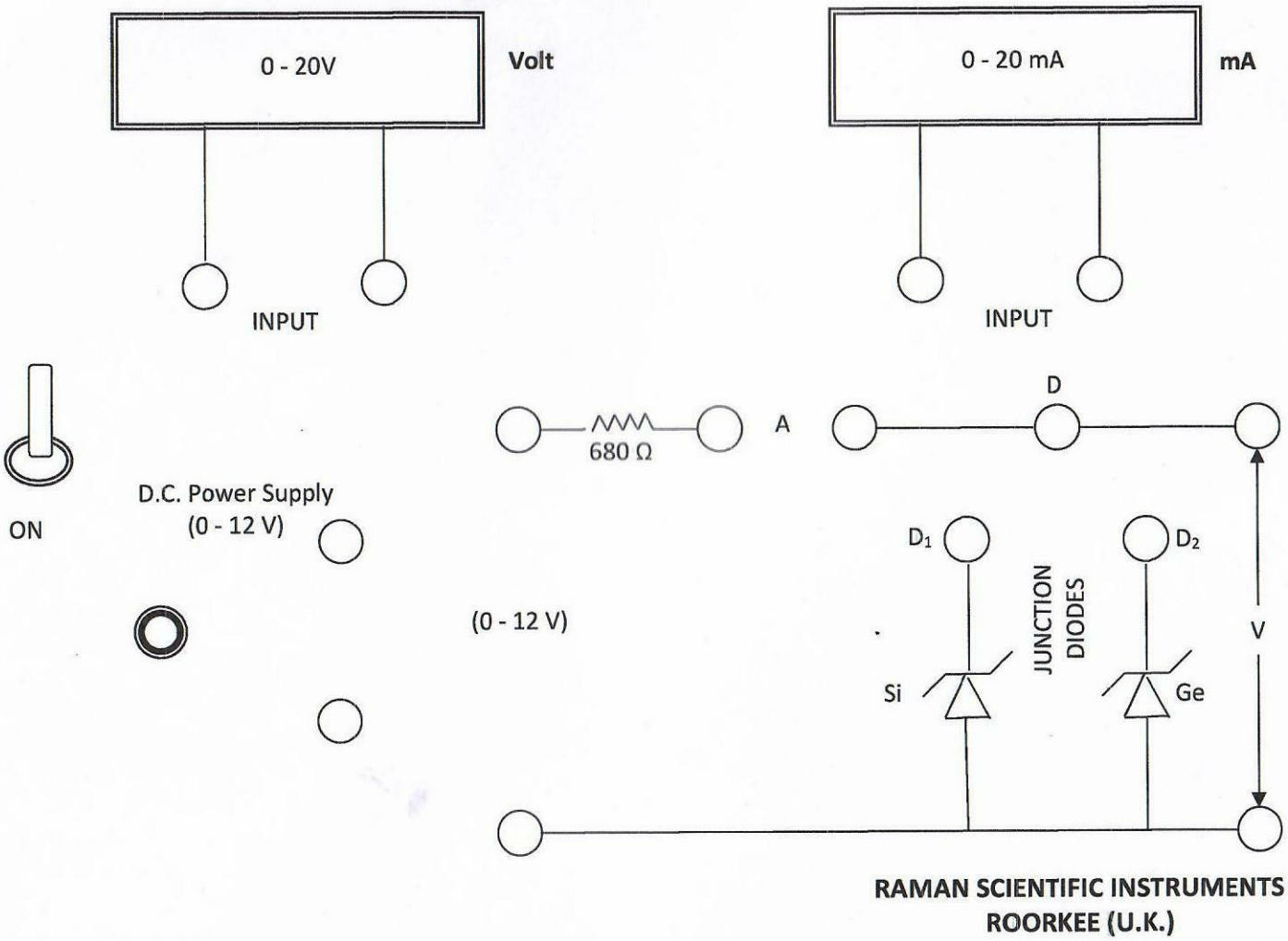
TYPE: 1N4007 Si & DR-25 Ge.

S.NO. 22655



AQA (TRIPLE A) EXECUTIVE QUALITY (SPECIAL)

TO STUDY THE CHARACTERISTICS OF JUNCTION DIODES
(Silicon & Ge.)



RAMAN SCIENTIFIC INSTRUMENTS
ROORKEE (U.K.)