

V-I characteristic of PN Junction

Object: To draw V-I characteristic of PN Junction diode and to determine knee or cut in voltage.

Apparatus used: PN Junction diode, voltmeter (0-2volt), voltmeter (0-30 volt), mili-ammeter, micro-ammeter, variable source (0-2 volt and 0-30 volt).

Theory: PN Junction Diode:

The voltage current equation for diode is given by following formula.

$$I = I_0 \left(e^{V/\eta V_T} - 1 \right) \quad (1)$$

Here, I: current through diode; V=Applied voltage to the diode

V_T : voltage equivalent to temperature (KT/e)

η : constant (=1 for distances Ge and 2 for Si)

In forward bias When $V_F = +V$, then $e^{V/\eta V_T} > 1$ thus eq.(1) becomes as

$$I_F = I_0 e^{V/\eta V_T} \quad (2)$$

Hence the theoretical analysis indicates that **forward current increases exponentially with voltage**. But practically it is not found because PN junction diode has a certain barrier/threshold/knee potential. Initially the applied forward potential to diode is used to neutralize this barrier potential. Therefore the current is approximately zero. The current increases appreciably after the barrier potential.

In reverse bias When $V_R = -V$, then $e^{V/\eta V_T} < 1$ thus eq.(1) becomes as

$$I_R = -I_0 \quad (3)$$

Thus in reverse bias of diode, a constant current flows through the diode whose direction is opposite to forward bias current. This current is known as reverse saturation current and it is independent of voltage. At large reverse bias voltage, the reverse bias current increases gradually to maximum due to avalanche breakdown.

Circuit diagramme:

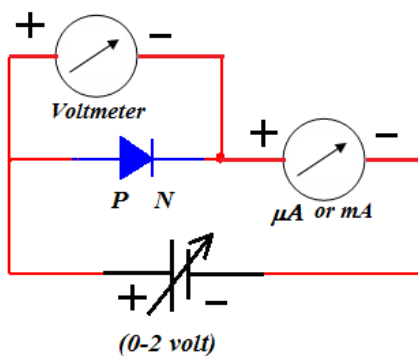


Fig 1: PN junction Diode in FB

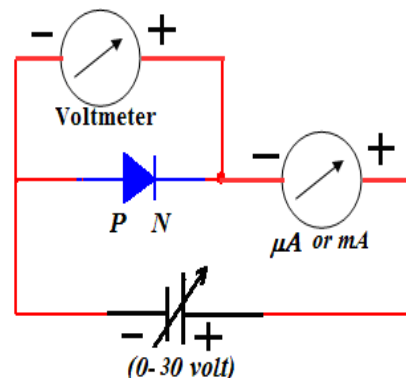


Fig 2: PN junction Diode in RB

Observation:

1. Least count of voltmeter (0-2volt) =0.02 volt
2. Least count of voltmeter (0-30volt) =0.5 volt
3. Least count of miliammeter =0.2 mA
4. Least count of micro-ammeter =5 μ A
5. V_F and I_F for PN junction Diode in FB

Sr. No.	V_F (Volt)	I_F (mA)
1.	0	0
2.	0.1	0
3.	0.2	0
4.	0.3	0
5.	0.4	0
6.	0.5	0
7.	0.6	0.2
8.	0.62	0.2
9.	0.64	0.4
10.	0.66	0.6
10.	0.68	0.8
11.	0.70	1.2
12.	0.72	2.2
13.	0.74	3.2
14.	0.76	5.2
15.	0.78	7.0
16.	0.80	9.4

6. V_R and I_R for PN junction diode in RB

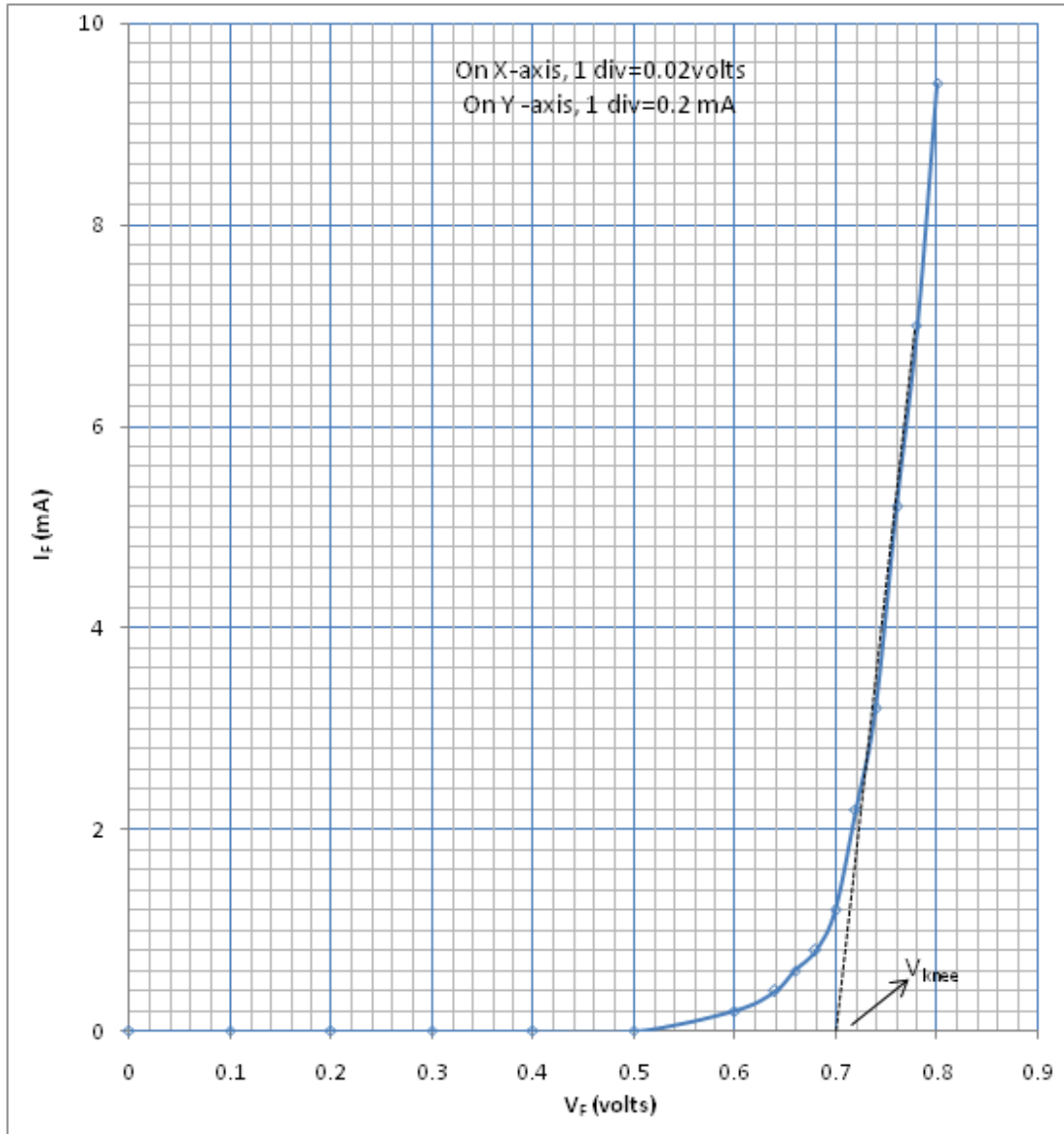
Sr. No.	V_R (Volt)	I_R (mA)
1.	0	0
2.	2	0.04
3.	4	0.1
4.	6	0.2
5.	8	0.2
6.	10	0.2
7.	12	0.2
8.	14	0.2
9.	16	0.2
10.	18	0.2
11.	20	0.2
12.	22	0.2
13.	24	0.2
14.	26	0.4
15.	28	0.8
16.	30	1.2

Result:

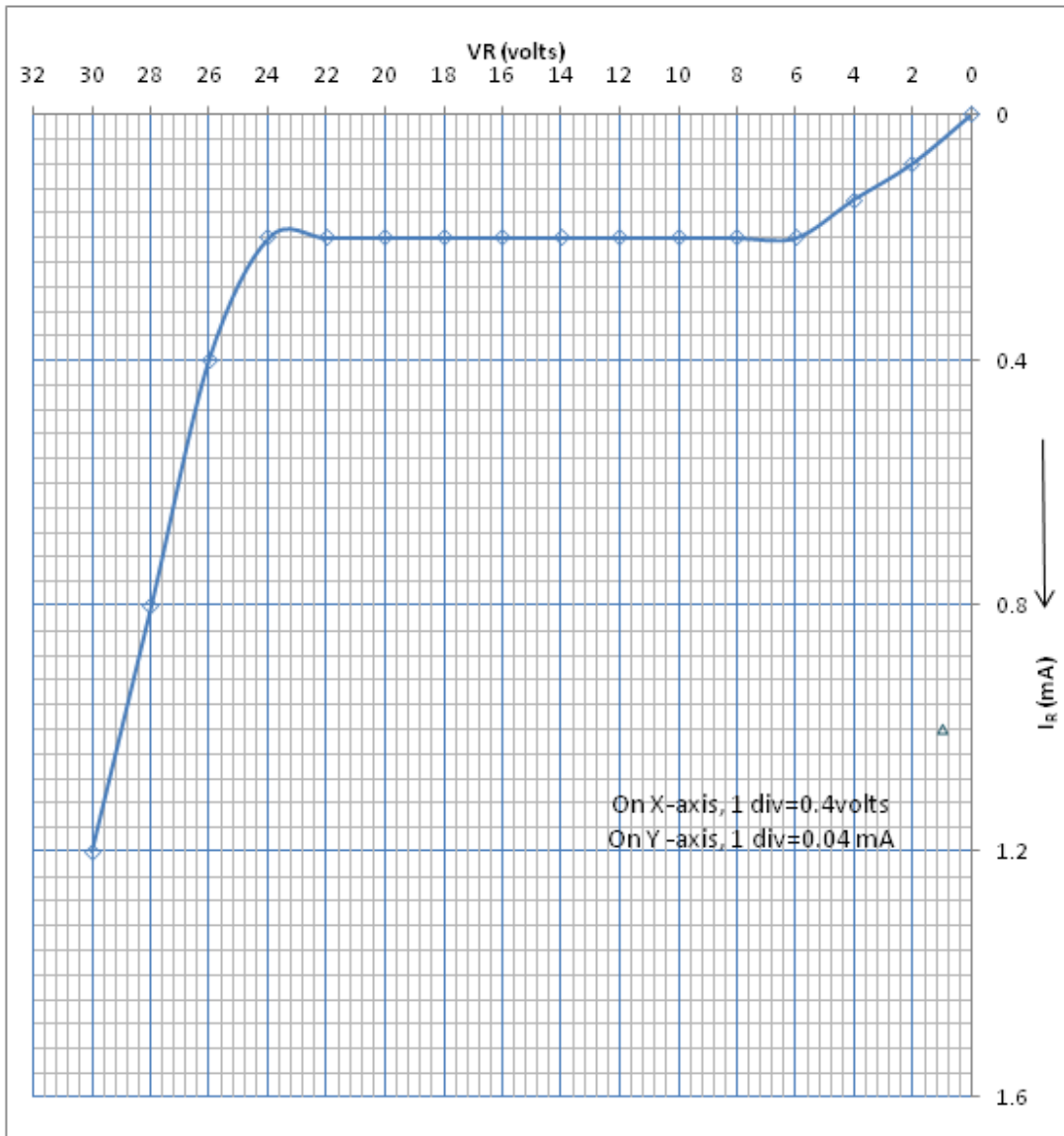
The V-I characteristic of PN junction diode indicates that the forward current is negligible up to the knee voltage. After that it increases appreciably. The knee voltage for diode is 0.7 volt. In reverse bias, the constant current of μ A order flows through the diode and it increases gradually to maximum at large reverse voltage.

Precautions:

1. The connection should be tight otherwise fluctuation in voltage and current will happen.
2. At the turning point of curve, more reading should be taken.
3. For the plot of Graph, current should be taken mA for both forward and reverse biased diode.
4. The reading should be in multiple of least count.



V-I Characteristic Curve for PN Junction Diode in FB



V-I Characteristic Curve for PN Junction Diode in RB