CLASS: B.E. E &TC **SUBJECT: RMT**

EXPT. NO.: 8 **DATE:**

Roll No.: 42428

TITLE: To measure VI characteristics of Gunn Diode and study of PIN modulator.

OBJECTIVE:

1. To study the Gunn Diode as a source of microwave power.
2. To draw the characteristics on the effect of variation of bias voltage on frequency/power.

EQUIPMENTS: Gunn diode power supply, Gunn diode, Attenuator, Detector, Frequency meter, CRO.

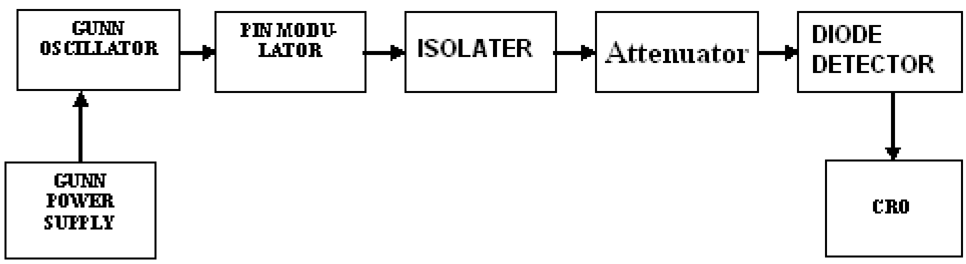
THEORY:

A Gunn diode, also known as a transferred electron device (TED), is a form of diode used in high-frequency electronics. It is somewhat unusual in that it consists only of N-doped semiconductor material, whereas most diodes consist of both P and N-doped regions. In the Gunn diode, three regions exist: two of them are heavily N-doped on each terminal, with a thin layer of lightly doped material in between. When a voltage is applied to the device, the electrical gradient will be largest across the thin middle layer. Conduction will take place as in any conductive material with current being proportional to the applied voltage. Eventually, at higher field values, the conductive properties of the middle layer will be altered, increasing its resistivity and reducing the gradient across it, preventing further conduction and current actually starts to fall down. In practice, this means a Gunn diode has a region of negative differential resistance.

The negative differential resistance, combined with the timing properties of the intermediate layer, allows construction of an RF relaxation oscillator simply by applying a suitable direct current through the device. In effect, the negative differential resistance created by the diode will negate the real and positive resistance of an actual load and thus create a "zero" resistance circuit which will sustain oscillations indefinitely. The oscillation frequency is determined partly by the properties of the thin middle layer, but can be tuned by external factors. Gunn diodes are therefore used to build oscillators in the 10 GHz and higher (THz) frequency range, where a resonator is usually added to control frequency. This resonator can take the form of a waveguide or microwave cavity. Tuning is done mechanically, by adjusting the parameters of the resonator.

Gallium arsenide Gunn diodes are made for frequencies up to 200 GHz, gallium nitride materials can reach up to 3 terahertz.

SETUP_DIAGRAM:



PROCEDURE:

1. Connect microwave bench set-up & components as shown in figure.
2. Keep the control knobs of Gunn power supply as below:
   Meter switch – off
   Gunn bias knob – fully anticlockwise
   PIN bias knob – mid position

PIN mode frequency – mid position

3. Set the micrometer of Gunn oscillator for required frequency of operation (say, 9GHz) using calibration chart.
4. Switch on the Gunn power supply.
5. Measure the Gunn diode current corresponding to the various Gunn bias voltages through the digital panel meter and meter switch. Increase the Gunn bias voltage in steps of 0.5 up to 10 volts and note down the corresponding output current. Do not exceed the bias voltage more than 10 volts.
6. Draw the curve of Gunn bias voltage Vs output current.
7. Also, while increasing the Gunn bias voltage in steps, measure the output power using CRO and its corresponding frequency using a frequency meter. Plot the graphs as function of Gunn bias voltage.
8. Measure threshold voltage which corresponds to maximum current.

Note: **DO NOT KEEP GUNN BIAS KNOB POSITION AT THRESHOLD POSTION FOR MORE THAN 10-15 SECONDS. READING SHOULD BE OBTAINED AS FAST AS POSSIBLE. OTHERWISE DUE TO EXCESSIVE HEATING, GUNN DIODE MAY BURN**

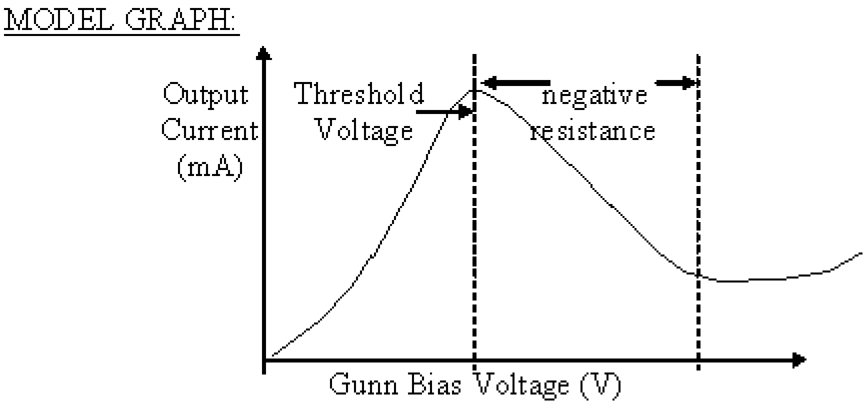


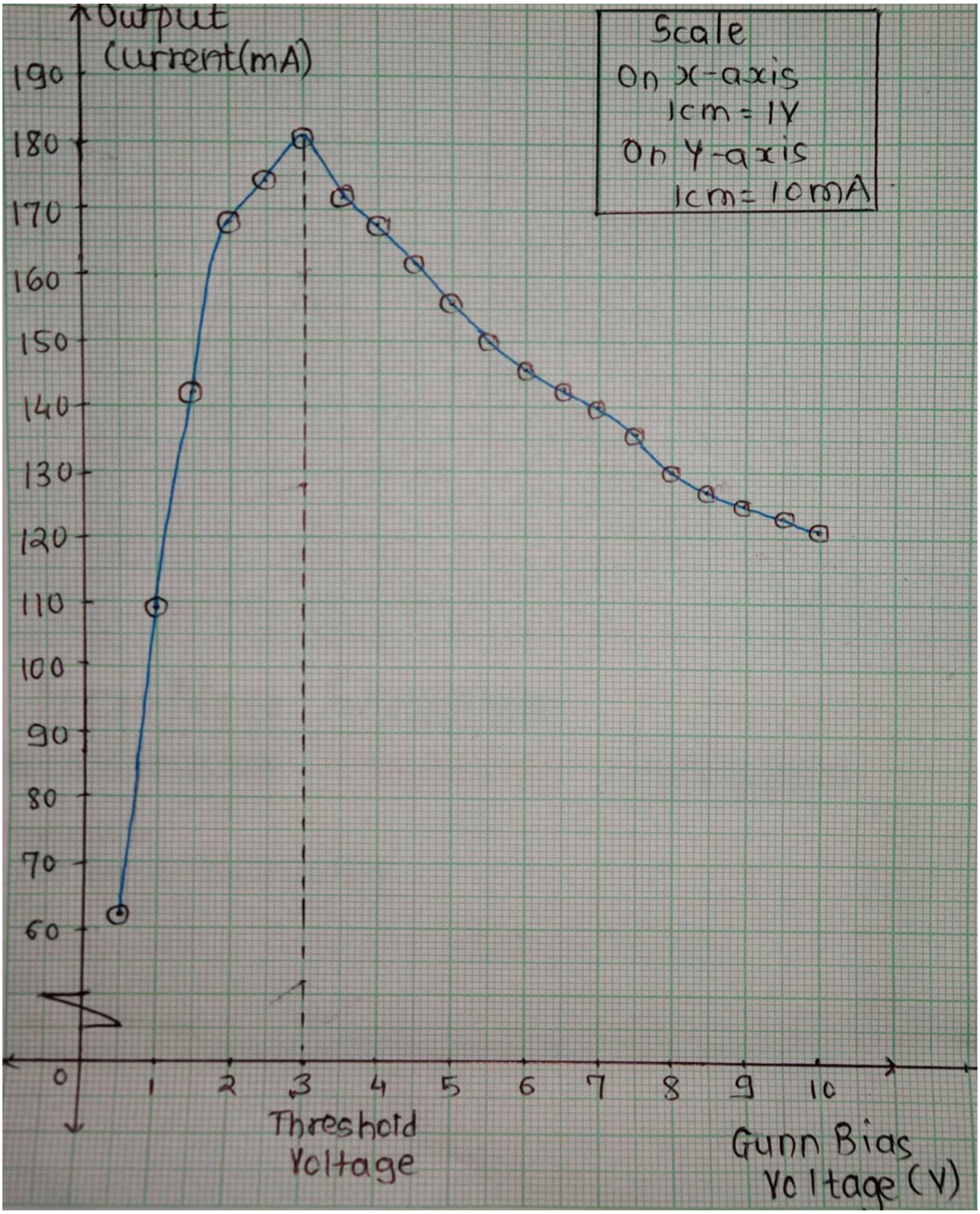
Fig. An approximation of the VI curve for a Gunn diode.

OBSERVATION TABLE:

Micrometer setting = 5.28 mm   Frequency = 11.4 GHz

SR NO	GUNN BIAS VOLTAGE (V)	OUTPUT CURRENT (mA)	OUTPUT POWER (mW)
1	0.5	62	31
2	1.0	109	109
3	1.5	142	213
4	2.0	168	336
5	2.5	174	435
6	3.0	181	543
7	3.5	172	602
8	4.0	168	672
9	4.5	162	729
10	5.0	156	780
11	5.5	150	825
12	6.0	146	876
13	6.5	143	929.5
14	7.0	140	980
15	7.5	136	1020
16	8.0	130	1040
17	8.5	127	1079.5
18	9.0	125	1125
19	9.5	123	1168.5
20	10.0	121	1210

GRAPH:


Output
Current(mA)
Scale
On x-axis
1cm = 1V
On Y-axis
1cm = 10mA
190
180
170
160
150
140
130
120
110
100
90
80
70
60
0
1
2
3
4
5
6
7
8
9
10
Threshold
Voltage
Gunn Bias
Voltage (V)

CONCLUSION:

In this experiment we studied the Gunn Diode as a source of microwave power. We observed the effect of variation of bias voltage on frequency/power and found the threshold voltage to be 3V where we get the peak current. From the observations and drawn characteristics we can say that the observed characteristics resembles the ideal one.

REFERENCES:-

1. Microwave and Radar Engineering—M.Kulkarni
2. Basic Microwave Lab Manual—Sisodia

CALIBRATION CHART OF X-BAND GUNN-OSCILLATOR (10mW)

FREQUENCY (GHz)	MICROMETER READING (mm)
8.2	20.05
8.4	18.15
8.6	16.53
8.8	14.80
9.0	13.65
9.2	12.51
9.4	11.92
9.6	11.35
9.8	10.70
10.0	10.06
10.2	9.02
10.4	7.99
10.6	7.11
10.8	6.25
11.0	5.95
11.2	5.60
11.4	5.28
11.6	4.78
11.8	4.30
12.0	3.53
12.2	3.18