Contents

Experiment **1**

Germanium Point-Contact Diodes

OBJECTIVES

1. To become acquainted with the physical construction of point-contact diodes.
2. To become familiar with point-contact diode characteristics.
3. To become acquainted with circuit applications of point-contact diodes.

EQUIPMENT

1. Low-voltage power supply
2. VTVM
3. 10-ma meter
4. 50-μa meter

MATERIALS

1. Point-contact diode (See your instructor.)
2. 1 k, 1-watt resistor
3. 5 k, 2-watt potentiometer
4. 68 k, $\frac{1}{2}$-watt resistor

REFERENCES

TM-11-690, *Basic Theory and Application of Transistors,* Government Printing Office, Washington, D.C. Chapter 2, 1959.

Riddle, Robert L., and Marlin P. Ristenbatt, *Transistor Physics and Circuits,* Chapter 4. Prentice-Hall, Englewood Cliffs, N.J., 1958.

Kiver, Milton S., *Transistors,* Chapter 2. McGraw-Hill Book Co., N.Y., 1962.

Introduction

An understanding of the physical construction and electrical operation of the diode is important to the eventual understanding of transistors.

The *p-n* junction of a point-contact diode is formed by a stiff phosphor-bronze wire welded to an "n" type crystal. The impurity atoms in the phosphor-bronze whisker form the acceptor or "p" material for the junction.

This experiment will prove that current flows readily *only* in the forward bias direction. When the diode is biased in the reversed direction, the current is not zero as expected. A small leakage current (I_{co}) flows, which is characteristic of point-contact and junction diodes.

Care must be taken when voltages are applied to the diode. The crystal can be damaged very easily by excess voltage, current, or heat.

Procedure

1. Before using a particular diode, check the manufacturer's data sheet. *Do not exceed any rating given.*
2. Construct the circuit in Fig. 1 and proceed to take data for the volt-ampere characteristics of the diode. Take the forward bias measurements first. Be careful; a diode biased in the forward direction has very low resistance and hence a large current will flow. Use R_1 to control the voltage that is applied to the diode. Set the power supply to 50 volts. Make a current reading for each 0.1 volt change. Do not apply a voltage greater than 0.5 to 0.7 volt. Record results in Data Table 1.

Data Table I

E_F	I_f	R_{FORWARD}
0.1 V		
0.2 V		
0.3 V		
0.4 V		
0.5 V		
0.6 V		
0.7 V		

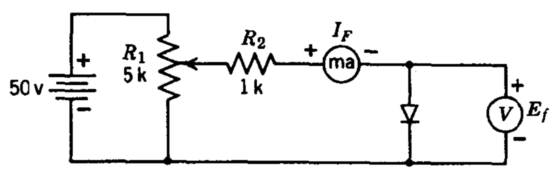

Fig. 1. Forward bias characteristics circuit.

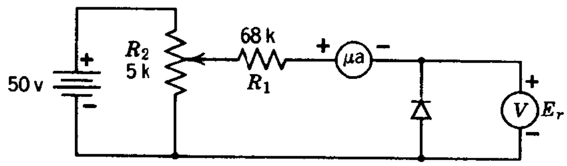

Fig. 2. Reverse bias characteristics circuit.

3. To take the reverse bias characteristics, connect the circuit in Fig. 2. Set the power supply to 50 volts. Use R_2 to control the applied voltage and make a current reading starting with *zero* volts and for every 10-volt change. Record in Data Table II.

Data Table II

E_r	I_r	R_{REVERSE}
0 V		
10 V		
20 V		
30 V		
40 V		
50 V		

4. Plot the forward and reverse volt-ampere curves in Fig. 3.

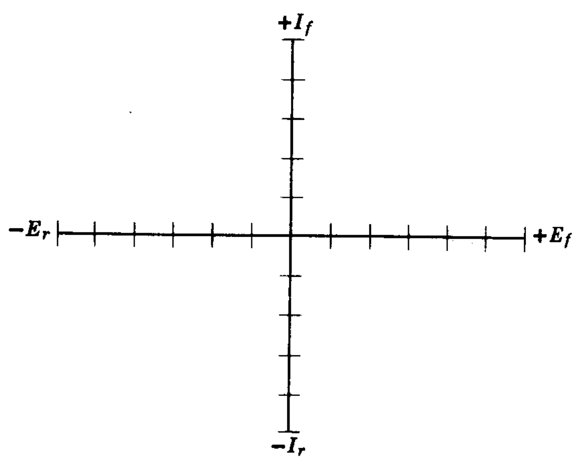

Fig. 3. Forward and reverse volt-ampere characteristics.

QUESTIONS

1. What are the limitations of a point-contact diode?
2. Explain minority current in a reversed biased diode.
3. Explain majority current in a forward biased diode.
4. What happens to the physical construction of the diode when the reverse bias rating is greatly exceeded?
5. List three applications of point-contact diodes.
6. Draw the symbol of a diode and show the direction of electron current flow.
7. If a diode uses the color code markings for identification, which side is the plate?
8. Explain forward-to-back resistance ratio.

CONCLUSIONS

Experiment 2

Silicon Junction Diodes (Zener Diodes)

OBJECTIVES

1. To plot the forward and reverse bias characteristics of a silicon *p-n* junction-type diode.
2. To determine the zener voltage breakdown of a diode.
3. To become acquainted with circuit applications of zener diodes.

EQUIPMENT

1. (2) VTVM
2. 10-ma meter
3. d-c power supply (0 to 300 volts)

MATERIALS

1. Zener diode
2. 1 k, 1-watt resistor
3. 5 k, 2-watt potentiometer
4. 47 k, ½-watt resistor
5. 100 k-ohm, 1-watt resistor

REFERENCES

TM-11-690, *Basic Theory and Application of Transistors*, Government Printing Office, Chapter 2.

Riddle, Robert L., and Marlin P. Ristenbatt, *Transistor Physics and Circuits*, Chapters 4 and 5.

Kiver, Milton S., *Transistors*, Chapters 2 and 8.

Introduction

p-n junction diodes introduce us to the semiconductor theory necessary to understand junction-type transistors. Here we become familiar with the *p-n* junction and how it acts under forward bias and reverse bias voltages.

The zener diode is the result of recent technological advances in the field of solid state physics. In most circuit applications it is reversed biased until the breakdown voltage or zener voltage is reached. In this condition the zener diode is a good voltage regulator.

Procedure

1. Check the manufacturer's data of your particular zener diode. *Do not exceed the zener diode ratings at any time.*
2. Construct the circuit in Fig. 1. *Caution:* a forward biased diode is a low resistance device; hence a large current (majority or forward) will flow. To collect volt-ampere data for a forward biased diode:
   (*a*) With R_1 adjusted to ground, set the power supply to 50 volts.
   (*b*) Adjust R_1 for 0.1-volt steps of E_f. Record I_f for E_f values from 0 volt to 0.8 volt in Data Table I.

Data Table I

E_f	I_f	R_{FORWARD}
0 V		
0.1 V		
0.2 V		
0.3 V		
0.4 V		
0.5 V		
0.6 V		
0.7 V		
0.8 V		

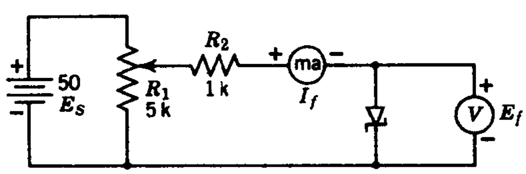

Fig. 1. Forward bias characteristics circuit.

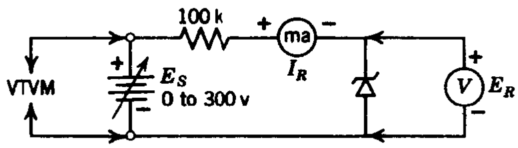

Fig. 2. Zener breakdown circuit.

Data Table II

E_R	I_R	$R_{REVERSE}$

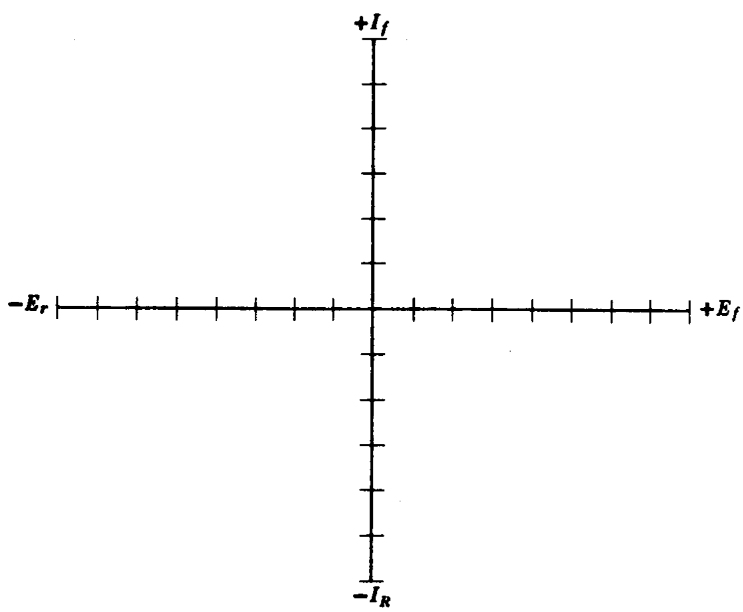

Fig. 3. Forward and reverse volt-ampere characteristics.

3. Construct the circuit in Fig. 2. This circuit will give the reverse bias characteristics.
   (*a*) Set the power supply to 0 volt.
   (*b*) Increase the power supply voltage starting at zero volts until the diode zeners at some E_r value. Record the I_r (minority or leakage) measurement in Data Table II. (Increase the power supply voltage another 100 volts, observing E_S and E_R on a VTVM.)
4. Plot the forward and reverse bias curves for your zener diode. Use Fig. 3 with appropriate values.
5. Construct a circuit with the diode biased in the reverse direction. Prove that this circuit can act as a regulator. Stay within the ratings of your zener diode.

QUESTIONS

1. Explain the action of the *p-n* junction when biased in the forward direction.
2. Explain the action of the *p-n* junction when biased in the reverse direction.
3. How does the *p-n* junction diode compare with the point-contact diode?
4. What is the difference between avalanche breakdown and zener breakdown?
5. Name three zener diode circuit applications.
6. Compare the zener regulator to a tube regulator.

CONCLUSIONS

Experiment 3

Common-Base Characteristics

OBJECTIVES

1. To plot the output characteristic curves for a common-base configuration.
2. To become familiar with common-base circuit biasing.

EQUIPMENT

1. VTVM
2. (2) 10-ma meters
3. (2) 12-volt batteries or low-voltage power supplies

MATERIALS

1. 2N107 transistor or equivalent
2. 2.2k, ½-watt resistor
3. (2) 5k, 2-watt potentiometers

REFERENCES

Kiver, Milton S., *Transistors*, Chapter 3.
Riddle, Robert L., and Marlin P. Ristenbatt, *Transistor Physics and Circuits*, Chapter 7.
Hunter, Lloyd P., *Handbook of Semiconductor Electronics*, Chapter 11, McGraw-Hill Book Co., N.Y., 1956.

Introduction

In this experiment you will use the knowledge gained in biasing diodes in previous experiments. The common-base circuit is connected with the base common to both

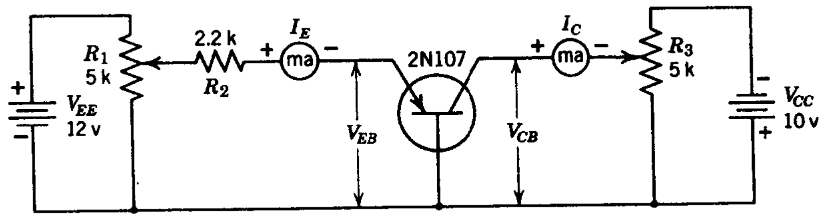

Fig. 1. Common-base characteristics circuit.

the input and output circuits. The input circuit is the emitter-base side. The output circuit is the collector-base side. In all transistor circuits, regardless of type or circuit connection, the input side is always forward biased and the output side is always reversed biased.

In plotting common-base characteristic curves it is common practice to have I_C in the vertical direction and V_{CB} in the horizontal direction. Different constant values of I_E are plotted.

Procedure

1. Check the manufacturer's data for your particular transistor.
2. *Do not exceed the transistor's ratings.* For example, a 2N107 has a maximum collector dissipation of 50 mw, maximum collector current is 10 ma, and maximum collector to emitter voltage is -12 volts.
3. Connect the circuit in Fig. 1. Be sure to observe transistor biasing polarity.
   (*a*) Adjust R_1 to ground and set V_{EE} to 12 volts.

Data Table I

Constant Values I_E	I_C	V_{CB}	V_{EB}