Experiment 3
Diodes

Introduction

The purpose of this experiment is to explore the properties of silicon and germanium pn diodes, as well as Zener diodes and gallium-arsenide light-emitting diodes (LED).

Equipment Needed

1N4148 silicon diode	1N750 Zener diode	120:16 Vac transformer
1N34A germanium diode	Light-emitting diode (LED)	0 - 20 Vdc power supply

This experiment requires the use of an oscilloscope having dual-trace and X-Y capability. The IEEE-488 interface to the scope will be used to record waveform data and X-Y plots for use in the lab report. When asked to "record" a waveform, the student should use the "Benchlink" software to copy an image of the oscilloscope screen to a floppy disk, or his/her personal account, so that it can later be reproduced in the lab report. The transformer is needed to provide a test signal which is not grounded. The transformer voltage is not critical as long as it is large enough to cause reverse breakdown in the Zener diode, and enough forward current to light the LED.

Procedure

Construct the test circuit shown in Fig. 1. Note that the scope channel 1 and channel 2 connections are shown: because one connection to each scope channel is grounded, these must both be connected to the point indicated as "ground." The device under test (DUT) will be each of the 4 diodes provided in succession. The diode orientation is shown in the figure. Set the scope to its X-Y mode to plot the i_D vs. v_D characteristics of each of the 4 diodes. Channel 1 measures the diode voltage directly (set channel 1 to invert its signal). The vertical axis (in V), generated by channel 2, corresponds to the diode current (in mA).

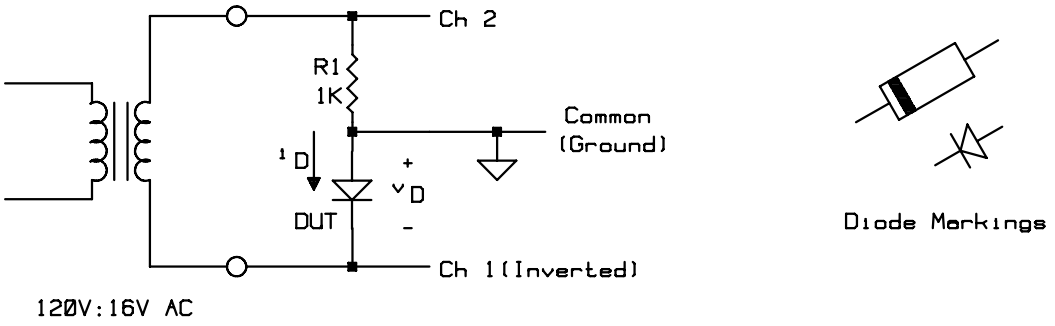

Fig. 1. Circuit for measuring diode i-v characteristics.

1. Start with the silicon diode and verify your circuit by setting the scope for voltage vs. time: channels 1 and 2 should both show half-wave rectified waveforms.

2. Switch the scope to its X-Y mode, using horizontal and vertical sensitivity factors of 1 V/div. The display should now be the diode i-v characteristics. To see the forward characteristics clearly, you may have to expand the horizontal scale to about 200 mV/div. Use the waveform storage capability of the scope to save the waveform. Then replace the silicon DUT with the germanium DUT and overlay the two i-v characteristics. Record this X-Y plot for your report. Be sure to note which curve goes with each diode, and optimize the X and Y scale factors to clearly show the plot origin and diode forward characteristics. Don't forget to invert channel 1 so that positive v_D produces right deflection.

3. Switch to the LED and obtain its forward characteristics. Record an X-Y plot showing the forward characteristics of the LED, silicon and germanium diodes on the same scale.

4. Connect the silicon diode again and optimize the X scale factor to show the reverse characteristics. Switch to the Zener diode and record an X-Y plot showing the reverse characteristics of the Zener and silicon diodes on the same scale.

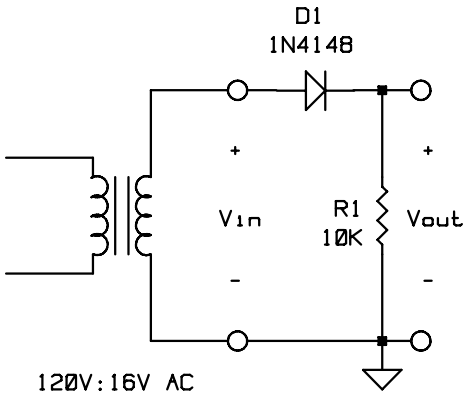

Fig. 2. Half-wave rectifier.

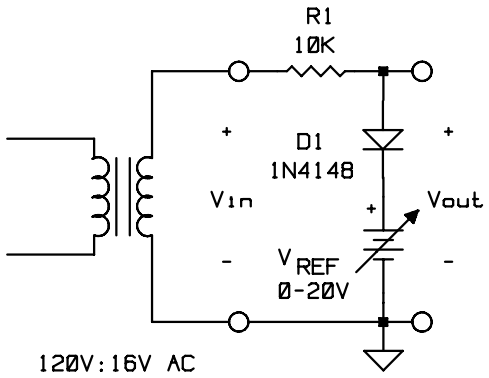

Fig. 3. Clipping circuit.

Build the half-wave rectifier circuit of Fig. 2.

1. Use the dual-trace scope to view the input and output signals V_{in} and V_{out} . Record these waveforms.

2. Use the X-Y function of the scope to record the transfer function (plot of V_{out} vs. V_{in}) of this rectifier circuit.

Build the clipping circuit of Fig. 3. Set the reference voltage V_{REF} to +10 V.

1. Repeat steps 1 and 2 from above.

2. Find out what effect varying V_{REF} has on the behavior of this clipping circuit. Document this effect for your report by recording appropriate data.

Report

Your report should address the following:

1. Include a complete discussion of the similarities and differences among the forward and reverse characteristics of the silicon, germanium, Zener and light-emitting diodes used in this experiment. Illustrate your observations using your recorded scope waveforms.

2. Discuss the behavior of the half-wave rectifier circuit using your recorded waveforms to illustrate your conclusions. Predict the ideal transfer function (based on an ideal diode) of this rectifier and compare it with the recorded transfer function.

3. Discuss the behavior of the clipping circuit using your recorded waveforms to illustrate your conclusions. What happens when you vary the reference voltage?