To: Professor Darish	**Date: 10/202015**
From: *Trever Wagenhals*	**Course &Section: 16.311-802**
Subject: Diodes	**Partner(s):**
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SUMMARY

This experiment involved becoming familiar with various junction diodes by measuring and plotting the forward and reverse bias voltages and currents of them, as well as their ac resistance. A signal diode, rectifier diode, and zenner diode were tested, and the input voltages were just adjusted until a certain output voltage was achieved and then noted. This experiment showed overall that no type of diode is ideal and each will have different benefits depending on the situation.

EXPERIMENTAL APPROACH

Equipment and Materials

- One Signal Diode (1N914)
- One Rectifier Diode (1N4002)
- One Zenner Diode (1N751)
- Resistors: 100 ohm, 330 ohm, 1k ohms, 1 M. ohms.
- Power Supply
- Multimeter

Procedure

Before the lab was performed, PSpice was used to calculate the input voltage needed to achieve a certain voltage drop across each type resistor. Creating the circuit shown in **Figure 1** in PSpice and varying the diodes, the input voltage could be adjusted and the voltage drop across the diode could be read to return theoretical data. This data was recorded below in **Table 1, Table 2,** and **Table 3.**

The first steps after the prelab involved testing the forward and reverse resistances measured with the multimeter. These results would be recorded in a notebook, and available in **Table 4** below.

Once the forward and reverse resistance was calculated, the same circuit could then be designed on a breadboard and tested in real life scenarios to see how a forward biased circuit truly acts. Creating the circuit in Figure 1 with each diode and altering the input voltage until voltage drops of 0.45V-0.75V by integrals of 0.05V were measured by the diodes would allow for the current through the circuit to be calculated. Once the voltage was accurate, the voltage drop across the resistor could be checked, and the calculated current would be the needed input voltage for each diode voltage drop over the resistance voltage drop. The Signal Diode data is recorded in **Table 5,** Rectifier Diode in **Table 6,** and Zenner Diode in **Table 7**.

The last portion of the lab involved testing the diodes set in a reverse biased manner. In this test, a much larger 1 M. ohm resistor was used and the input voltage went from 5V-20V by increments of 5V, as shown in **Figure 2.** The data for each resistor is noted in **Table 8, Table 9,** and **Table 10.**

Figure 1: Forward Biased Circuit Setup

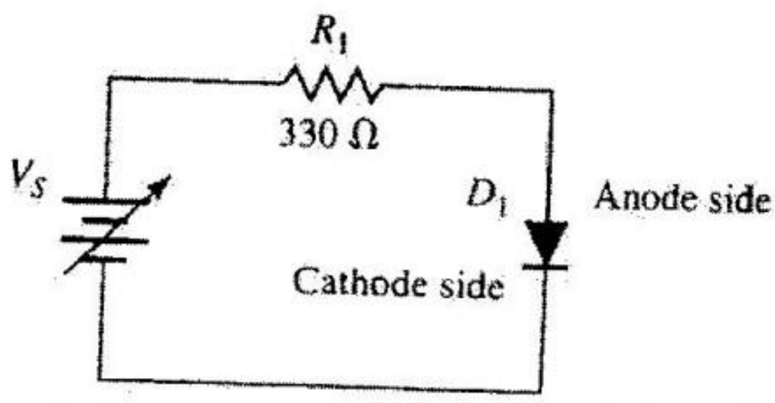
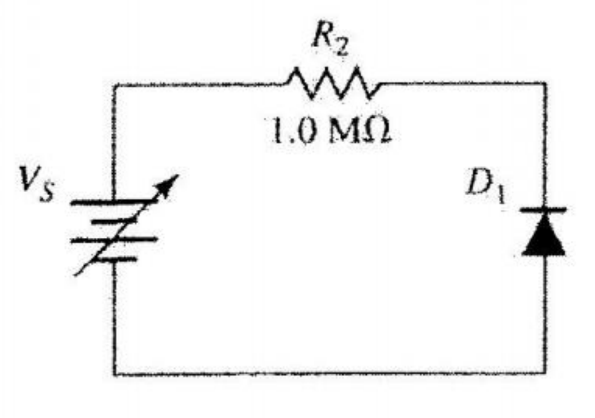


Figure 2: Reverse Biased Circuit Setup



DISCUSSION OF RESULTS

When attempting to produce the prelab data, it was discovered the LTSpice does not offer the exact model diodes that were chosen for the lab. Aside from the signal diode, the rectifier diode and zenner diode were chosen as two diodes that were similar in values, but not identical. Because of this, the data gave an estimate of what should be expected during the lab, but was not as accurate as it could have been.

Table 1: Signal Diode LTSpice calculations

Voltage Drop across Diode	Voltage Input	Current
0.5	0.50082	2.48 x 10^-6 A
0.55	0.55567	1.717 x 10^-5 A
0.60	0.63918	.119 mA
0.65	0.92	.816 mA
0.70	2.5	5.45 mA
0.75	13.6	38.6 mA

Table 2: Rectifier Diode LTSpice calculations

Voltage Drop across Diode	Voltage Input	Current
0.5	0.5051	1.63 x 10^-5 A
0.55	0.563	3.946 x 10^-5 A
0.60	0.6319	9.674 x 10^-5 A
0.65	0.736	.262 mA
0.70	0.991	.884 mA
0.75	2.121	4.15 mA

Table 3: Zenner Diode LTSpice calculations

Voltage Drop across Diode	Voltage Input	Current
0.5	0.5518	.156 mA
0.55	0.707	.476 mA
0.60	1.055	1.36 mA
0.65	1.976	4 mA
0.70	4.4	11.2 mA
0.75	9.8	27.4 mA

The resistances of the diodes all seemed to make sense when measured. The forward resistance was high, but never infinity, and the reverse resistance was typically infinity, not allowing any current flow. The 751 Zenner diode was the only one that had a measurable reverse resistance. Another important detail to note is that when the range of the multimeter was adjusted, the change inside the multimeter also caused the diode's resistances to adjust dramatically. For the figure, only the auto settings data was recorded.

Table 4: Diode Resistances

Type of Diode	Forward Resistance	Reverse Resistance
Signal (1N914)	1.5645 M. ohms	Overload
Rectifier (1N4002)	1.77 M. ohms	Overload
Zenner (1N751)	1.9 M. ohms	14.3 M. ohms

When the voltage drops across the diodes were actually measured and compared to the measurements of the theoretical values, the numbers were actually within reason. Similar voltage drops and currents were measured, although still varying. The variance could be attributed to three factors: the resistance in the resistor and the equipment could be varying and not accounted for, the diodes were not all the exact same models thus have different internal resistances, and the method of inputting the voltage was not accurate enough. Instead of using the power supply that only allowed for voltage increments of 0.1V, instead the oscilloscope should have been used to allow for adjustments as small as 0.01V to get the measurements even closer.

Table 5: Signal diode test results

Voltage Drop across Diode	Voltage Input	Voltage Drop across Resistor	Current
0.50	0.5 V	21.53 mV	0.065 mA
0.55	0.55 V	42.24 mV	.128 mA
0.60	0.6 V	63 mV	.191 mA
0.65	0.9 V	260 mV	.787mA
0.70	2.5 V	1.62 V	4.9 mA
0.75	13.0 V	12.1V	36.7 mA

Table 6: Rectifier diode test results

Voltage Drop across Diode	Voltage Input	Voltage Drop across Resistor	Current
0.50	0.6 V	88.7 mV	2.68 x 10^-6 A
0.55	0.8 V	227.17 mV	6.87 x 10^-5 A
0.60	1.2 V	0.5427 V	1.6 mA
0.65	2.2 V	1.45 V	4.39 mA
0.70	5.3 V	4.47 V	13.5 mA
0.75	15.4 V	14.2 V	42.9 mA

Table 7: Zenner diode test results

Voltage Drop across Diode	Voltage Input	Voltage Drop across Resistor	Current
0.50	0.5 V	0.36 mV	1.09 x 10^-5 A
0.55	0.55 V	4.64 mV	1.725 x 10^-5 A
0.60	0.6 V	7.81 mV	2.36 x 10^-5 A
0.65	0.7 V	52.8 mV	.16 mA
0.70	1.0 V	299 mV	0.906 mA
0.75	2.3 V	1.48 V	4.48 mA

When testing the reverse diode setup, the signal and rectifier diode acted as expected. Because the reverse resistance measured as overload, it was expected that there should be no current flowing through the circuit, thus having no voltage drop across the resistor. When measured, the values were incredibly small (<5mV) and was approaching 0 as measured over time, so it was easy to just assume it as 0mV. The zenner diode actually had measurements because the reverse resistance did not measure as overload, which means that there is a current flow, causing a voltage drop.

Vr	Vr2 (measured)	Ir (computed)
5V	0mV	0A
10V	0mV	0A
15V	0mV	0A
20V	0mV	0A

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5V	0mV	0A
10V	0mV	0A
15V	0mV	0A
20V	0mV	0A

Vr	Vr2 (measured)	Ir (computed)
5V	2.63V	2.63 x 10^-6 A
10V	7.36V	7.36 x 10^-6 A
15V	12.24V	12.24 x 10^-6 A
20V	17.13V	17.13 x 10^-6 A