Elektroniske enheter og kretser
Lab 01

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0. Introduction

This is the first report in this course, detailing the completion of the first lab exercise.

0.0. Table of Contents

0.1. List of Figures

0.2. List of Tables

1. Part 1 - Diode test

This Part is about testing a diode characteristics with a multimeter. This means it is inherently not perfect, but it will function as a reference measurement.

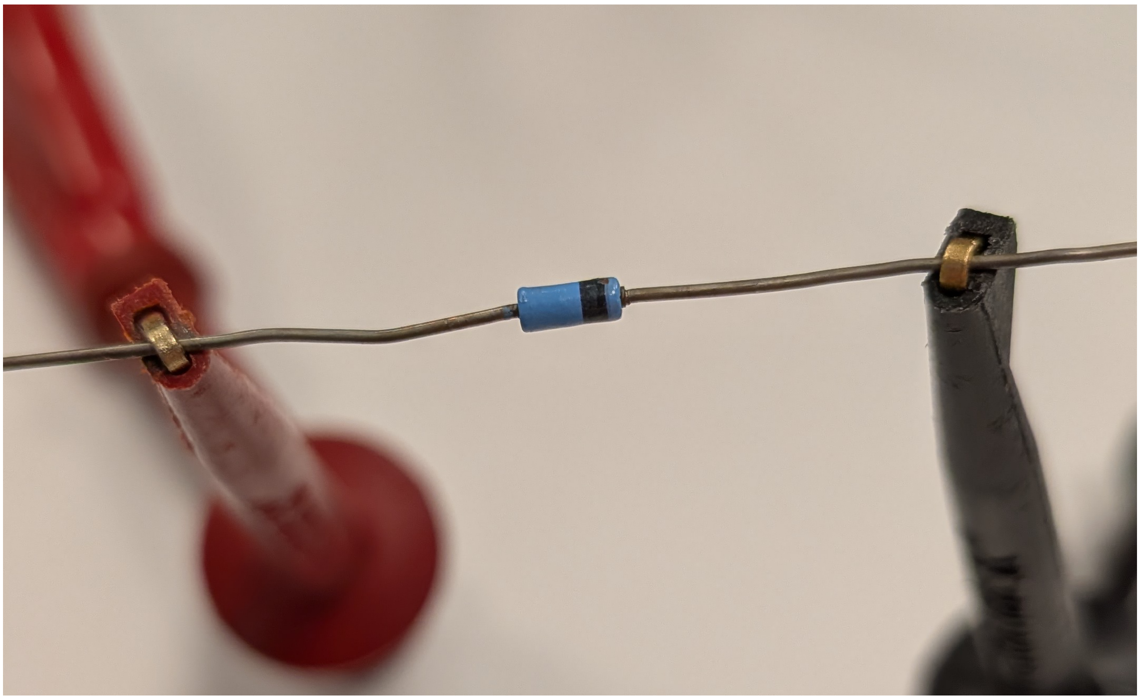


Figure 1.0: Diode being measured

Table 1.0: Diode measurements

Voltage forward	0.593 V	Resistance forward	225400 Ω
Voltage reverse	0L	Resistance reverse	0L

Interesting to note that the measured resistance in forward-bias of the diode fluctuated a lot. It went into high MΩ to low tens of kΩ. It was most stable around $200\,\mathrm{k\Omega}$ and one of these measurements was therefore noted down. This could be because the multimeter is acting as a power supply in resistance measuring mode and depending on the voltage chosen by the auto ranging multimeter the diode behaviour differs.

2. Part 2 - Forward-bias characteristics

This Part is about testing the diode characteristics for forward-bias. The values was stored in a table (RAW data like this is found on the GitHub) and then a plot was made to compare the current through the diode I_D with the voltage drop over the diode V_D.

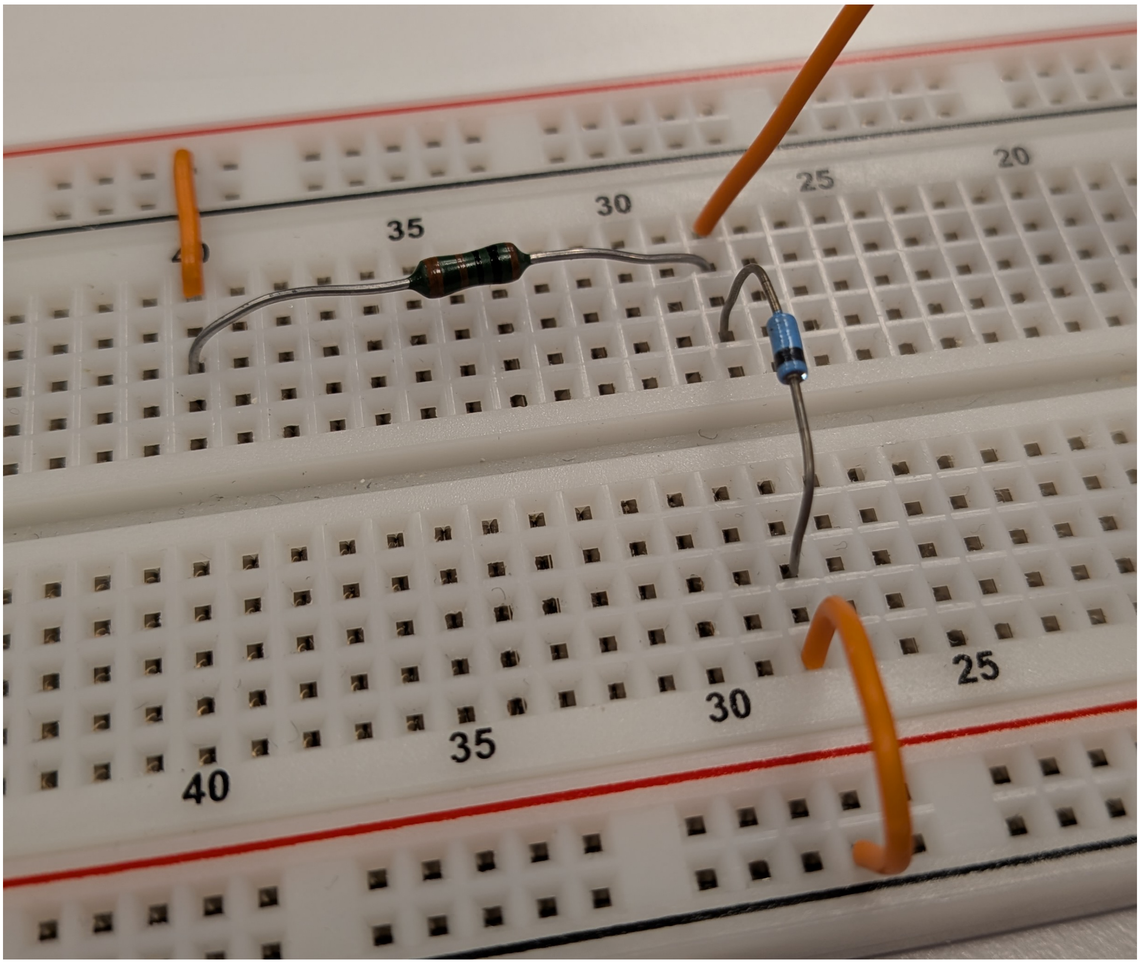


Figure 2.0: Forward-bias circuit

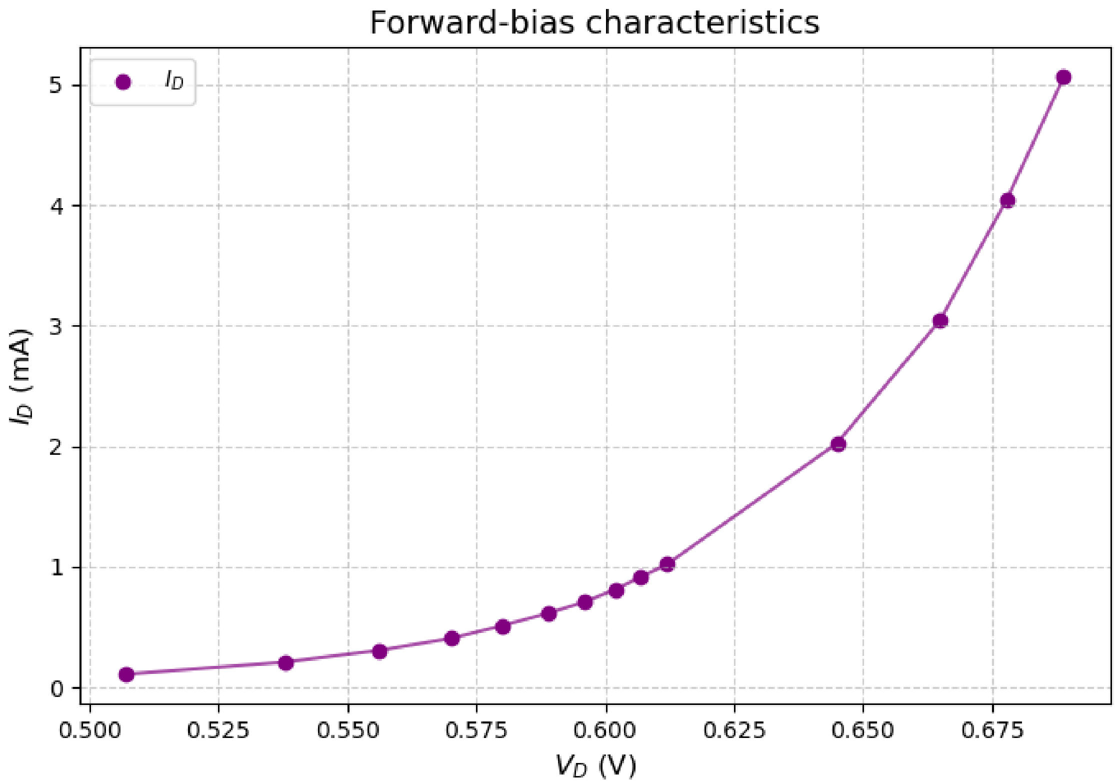


Figure 2.1: Plot of forward-bias characteristics

Now when when extending the plot all the way to the origin it gets a characteristics that looks a lot different. As seen in Figure 2.2 it looks like after the initial curve the value gets linear.

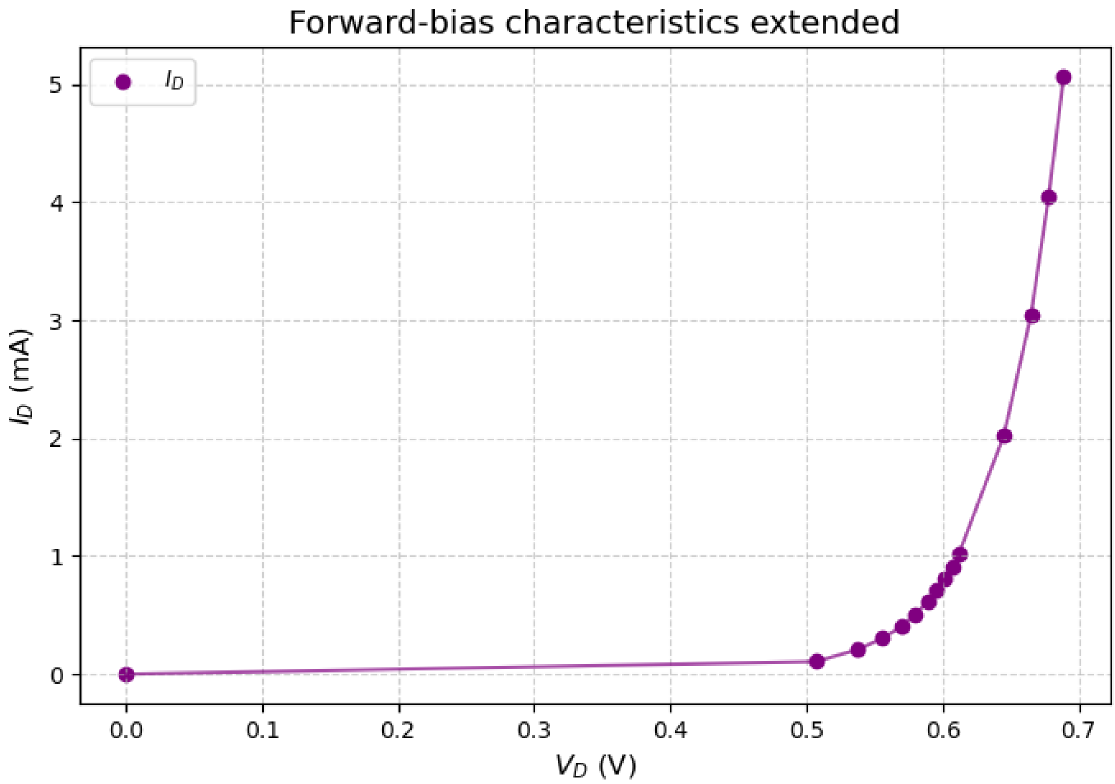


Figure 2.2: Extended plot of forward-bias characteristics

This looks now very much like an exponential relationship, when checked, the end result is very similar to to this function. This shows that the behaviour can be very accurately modelled easily using the exponential function.

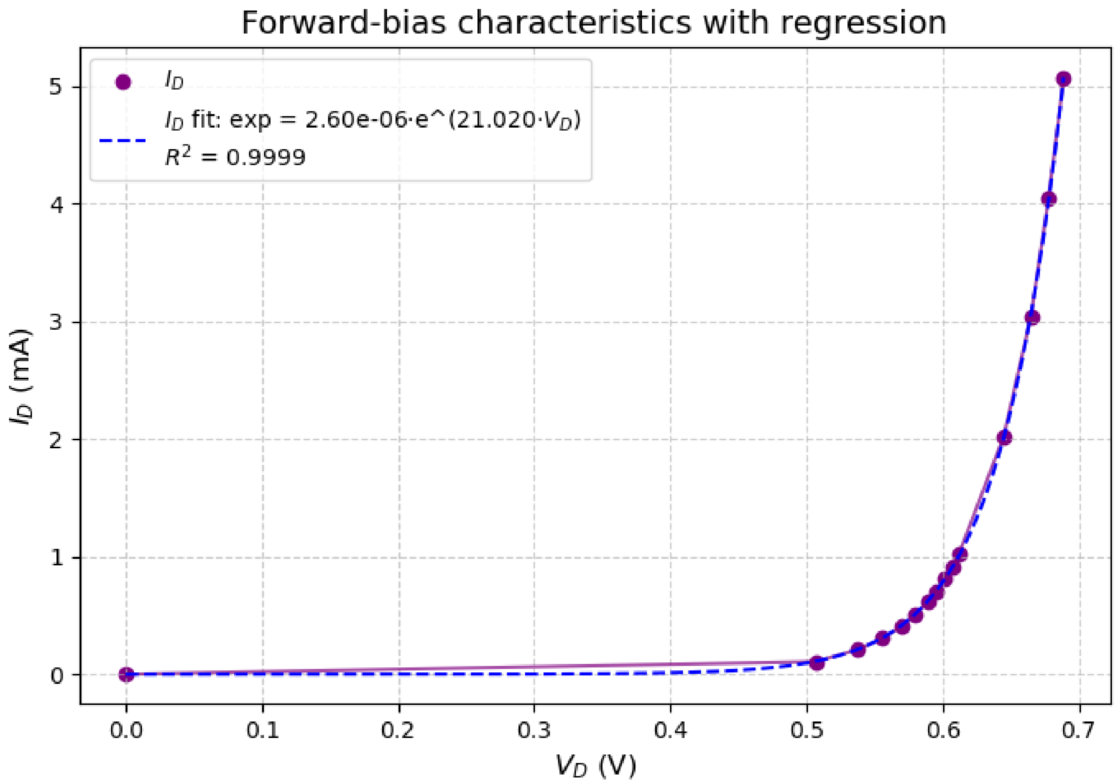


Figure 2.3: Extended plot with exponential regression

3. Part 3 - Reverse-bias

This Part is about testing the reverse-bias current. Measurements was made and noted in the table, note that the assumed resistive value of the voltmeter is specified by the assignment.

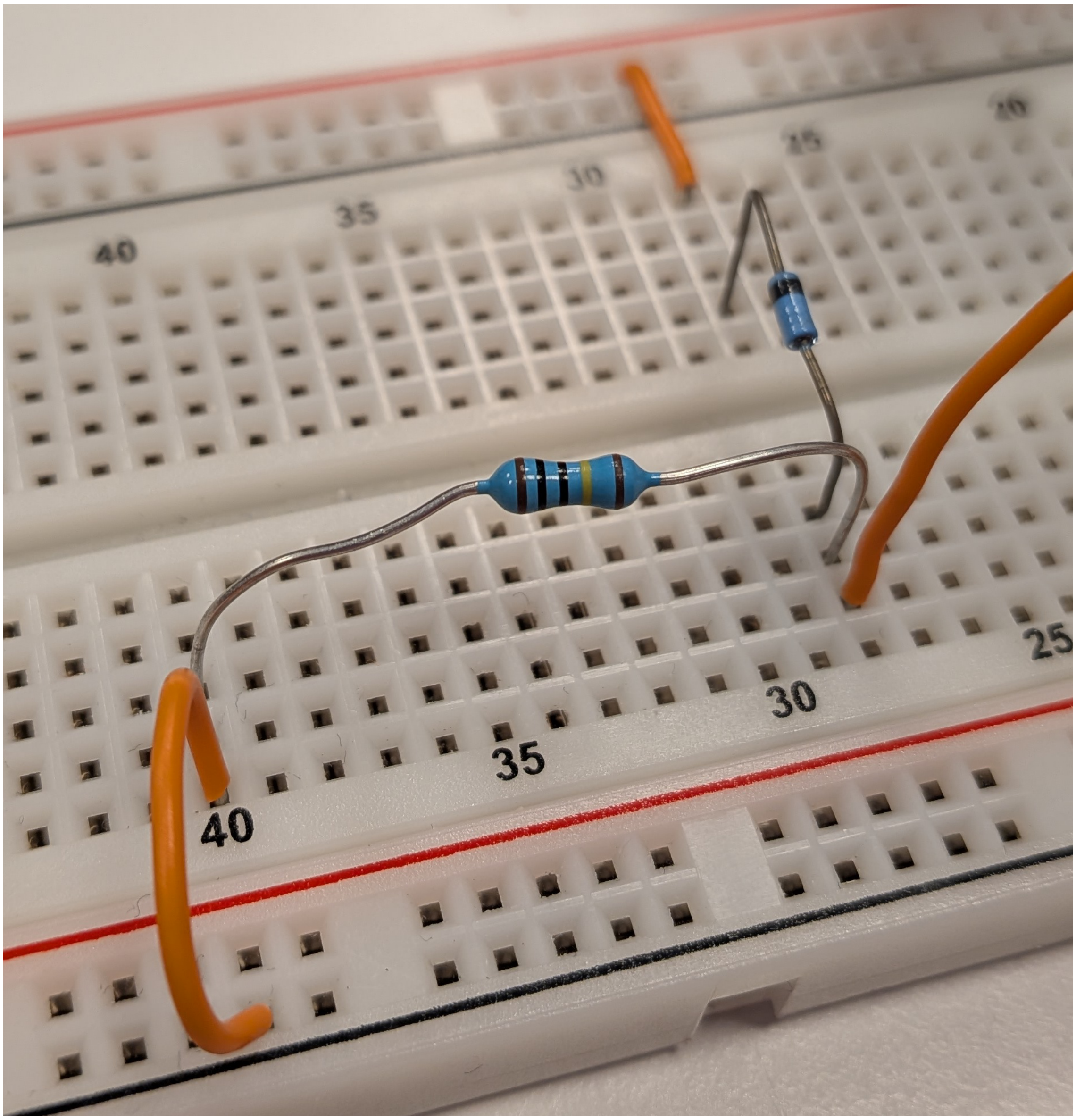


Figure 3.0: Reverse-bias circuit

Table 3.0: Reverse-bias measurements

E (Measured)	20.03	V
R_M (Assumed)	10	MΩ
R (Measured)	1002.5	kΩ
V_R (Measured)	6.2	mV
I_S (Calculated)	6.805	nA
R_{DC} (Calculated)	2942.71	MΩ

It looks as if the values for I_S and R_{DC} miss by an order of magnitude as the calculated reverse-bias resistance often leads to values between hundreds of kΩ and up to a few hundred MΩ. The inherent inaccuracies in the measurements are probably the cause of this error, if this actually is an error.

4. Part 4 - LED characteristics

This part is about testing the characteristics of LED's.

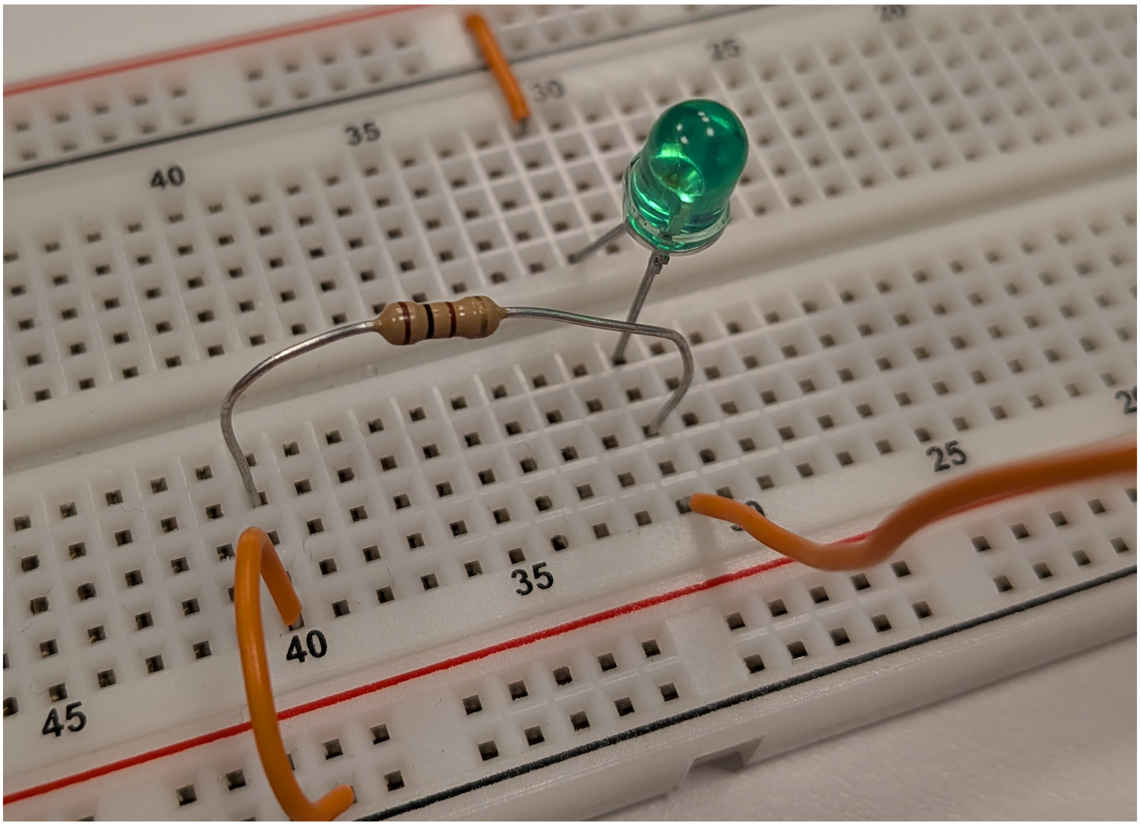
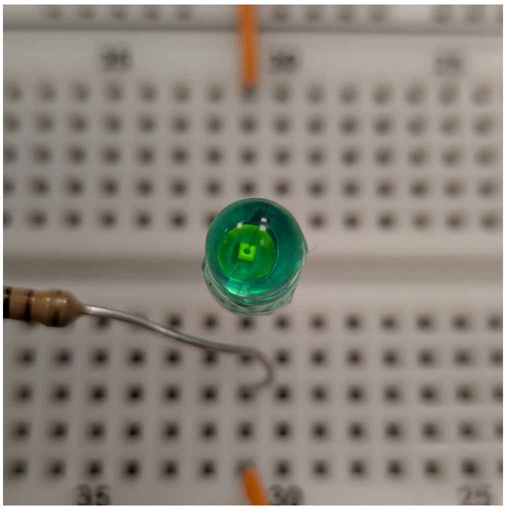


Figure 4.0: LED circuit

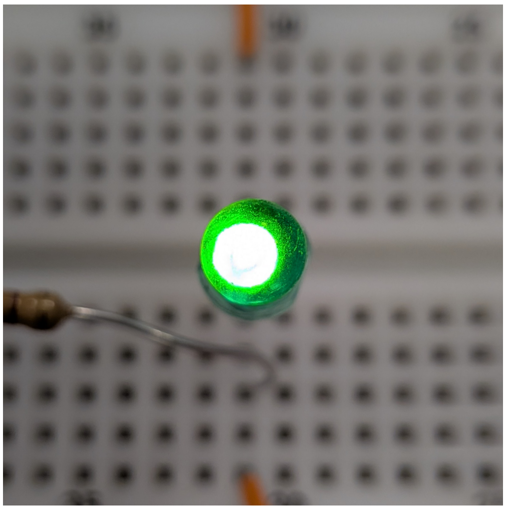
First the circuit was connected and then the voltage supply was slowly ramped up. when first light appeared the value was recorded. Although hard to see, in Figure 4.1a there is a very faint sub-lumen light emitting from the diode. When the supply was ramped up until brightness levelled out at a bright level, the values were recorded again.

Table 4.0: LED measurements

measurements	First light	Bright
V_D (Measured)	1.787 V	2.185 V
V_R (Measured)	17.8 mV	3.632 V
I_D (Calculated)	179.980 μA	36.724 mA



(a) First light



(b) Bright

Figure 4.1: LED light levels

Then multiple data points was collected for different input voltages, and the results are listed below in Table 4.1 and then graphed to display the data in varying ways.

Table 4.1: LED values

E (V)	0.000	1.033	2.008	3.008	4.002	5.010	6.040
V_D (V)	0.000	1.032	1.860	1.987	2.066	2.135	2.201
V_R (V)	0.000	0.000	0.146	1.019	1.934	2.875	3.840
I_D (mA)	0.000	0.000	1.480	10.303	19.555	29.070	38.827

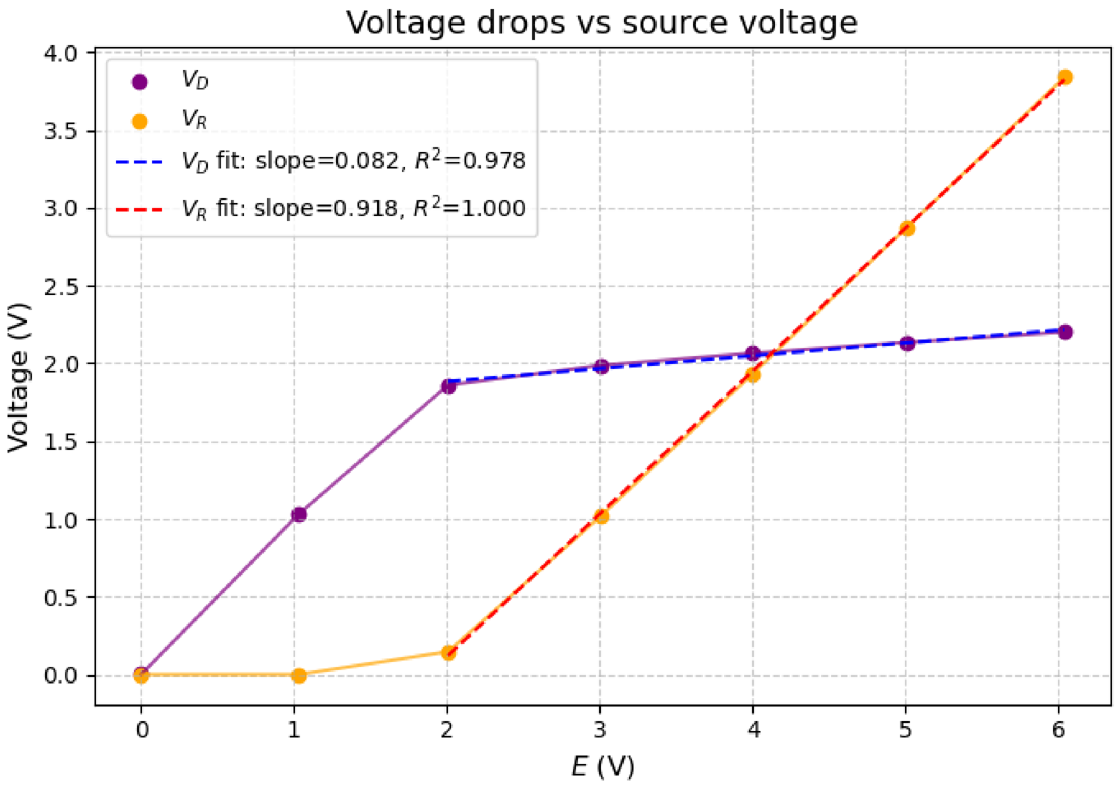


Figure 4.2: Voltage drops

Interesting to note that the voltages behave very linear after the initial two data points where the diode is not yet in its active region. The R^2 value shows how accurately the approximation is and here it is very high.

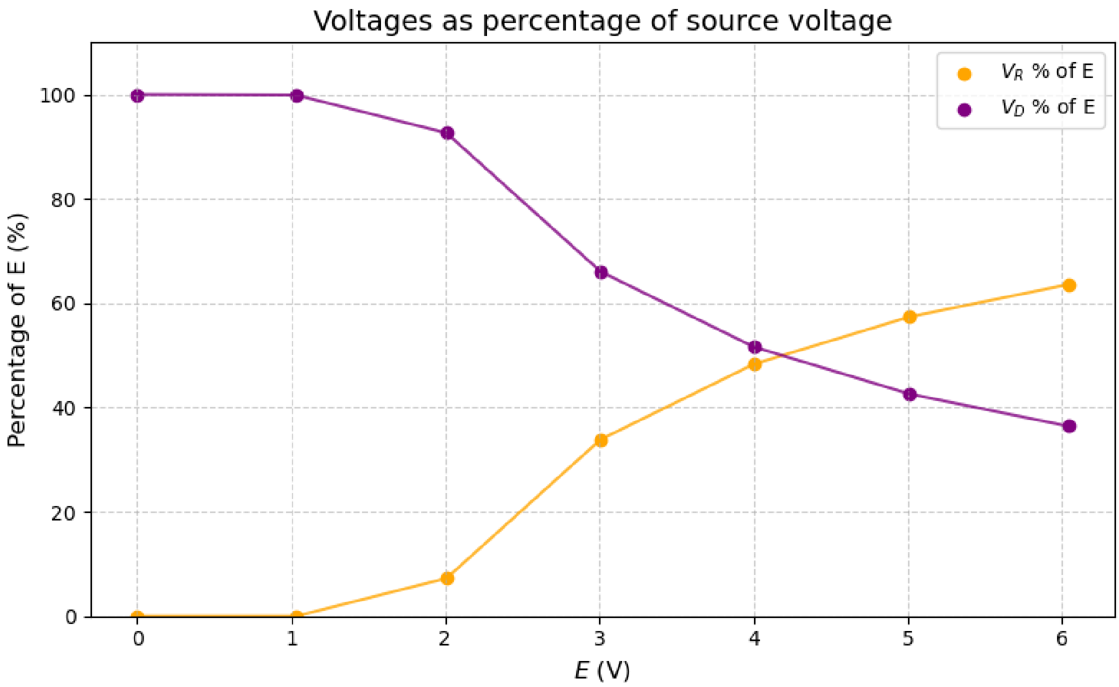


Figure 4.3: Plot of voltage drops as percent of source

Graphing the voltages as precents of the source is a good way of visualizing how voltages will continue to behave when further increasing voltage, assuming no breakdown.

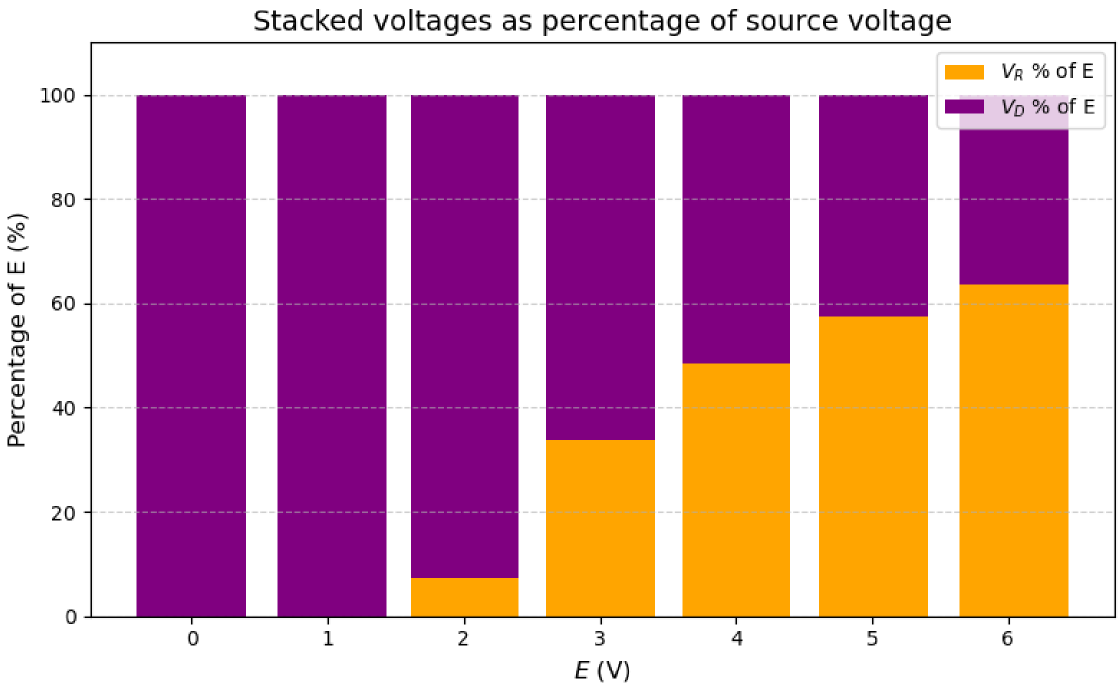


Figure 4.4: Stacked bar chart of voltage drops as percent of source

Using a stacked bar char shows this even more clear, and tells a story about how voltage is divided between the resistor and the diode.

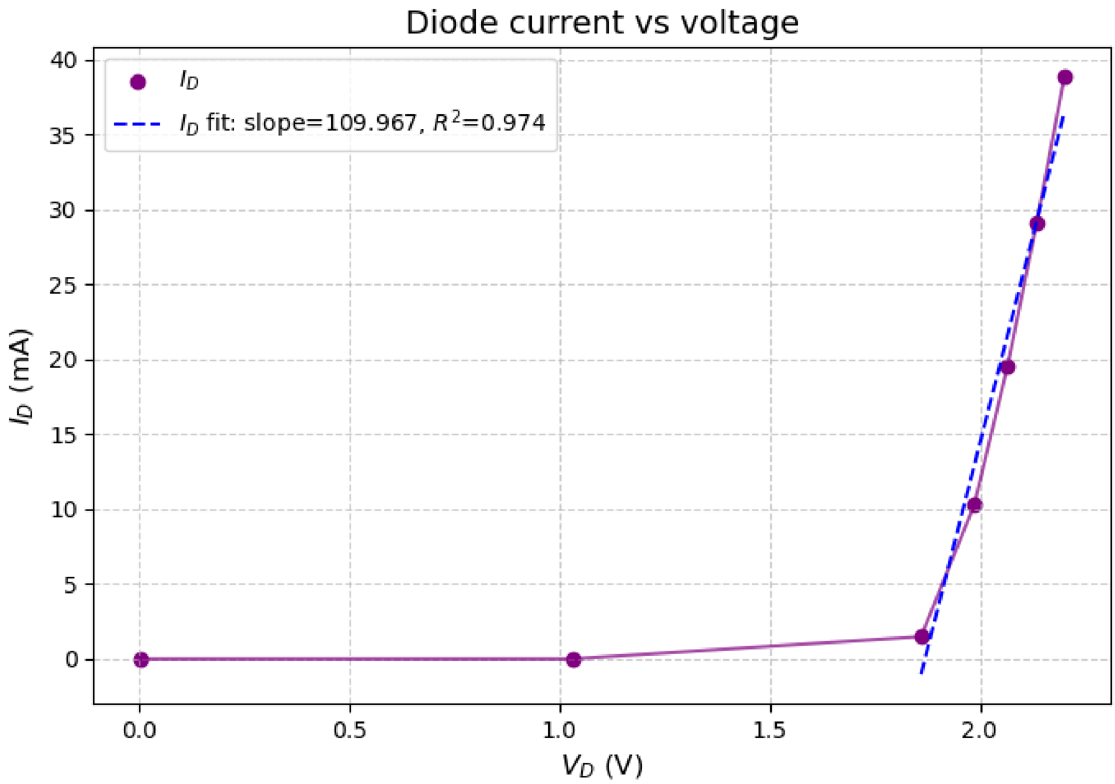


Figure 4.5: Current through the diode vs voltage

As the voltages increase linear the current should do as well, and here again, if the two first datapoint are excluded the the linearity is very good.

5. Part 5 - Zener characteristics

This part is about a zener diode, which is a type of diode designed to work in reverse-bias in the breakdown region and not physically break, but continue to operate here.

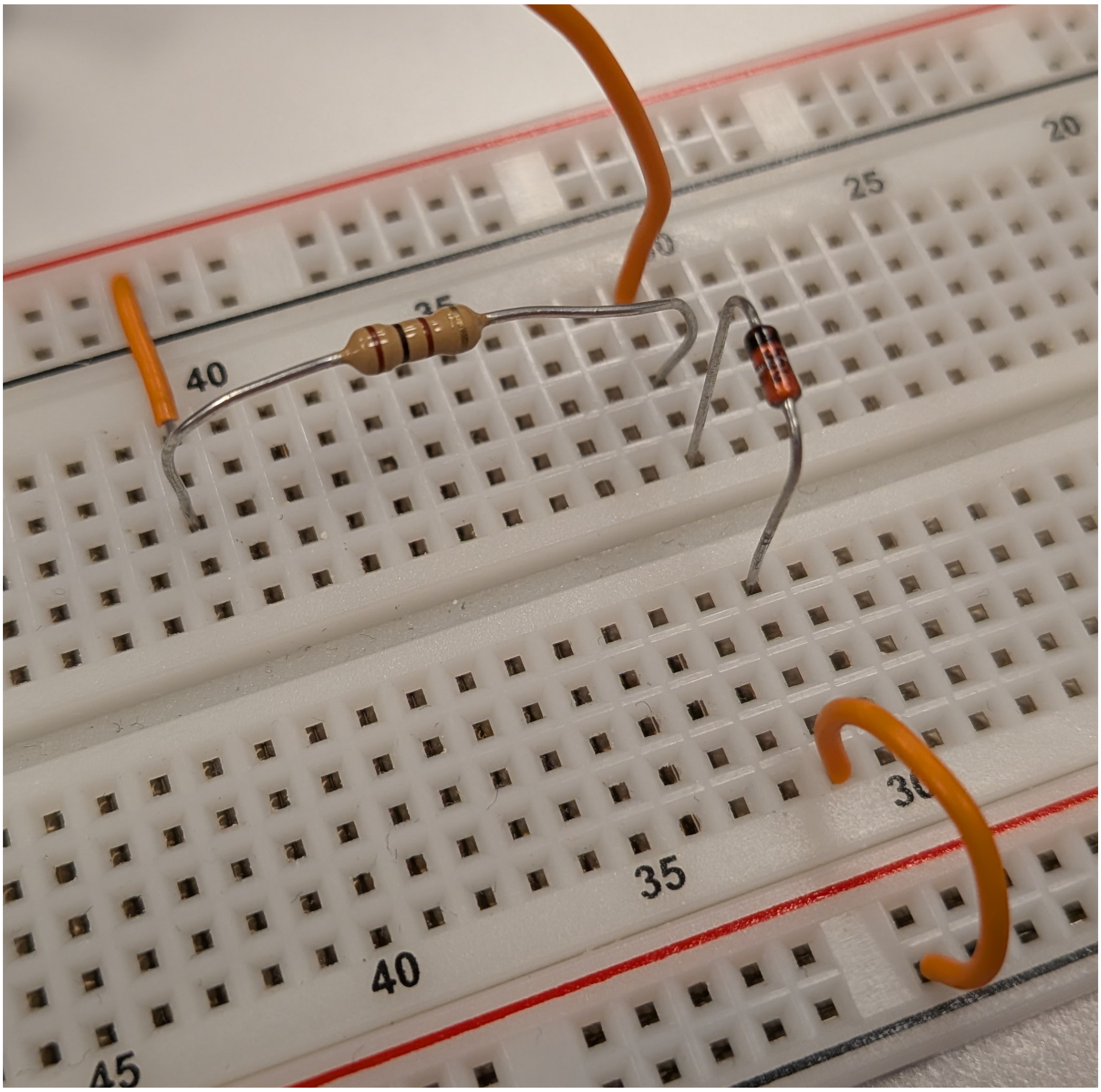


Figure 5.0: Zener diode circuit

The data table for the zener circuit is just all zeros but the last measurements, so instead of a table I want to represent it in graph form.

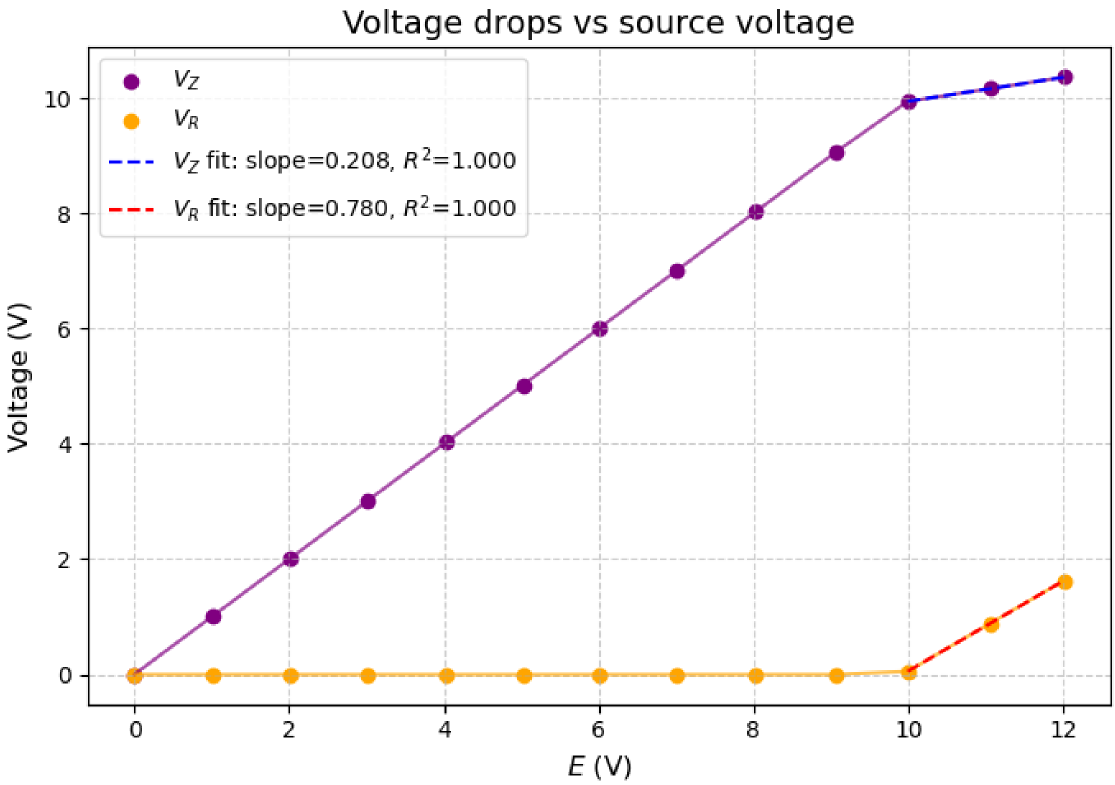


Figure 5.1: Voltage drops

After reaching the zener voltage, the rated voltage of the diode, the voltage drop over the diode is almost flat, you can see this is linear for this small dataset with a very low slope.

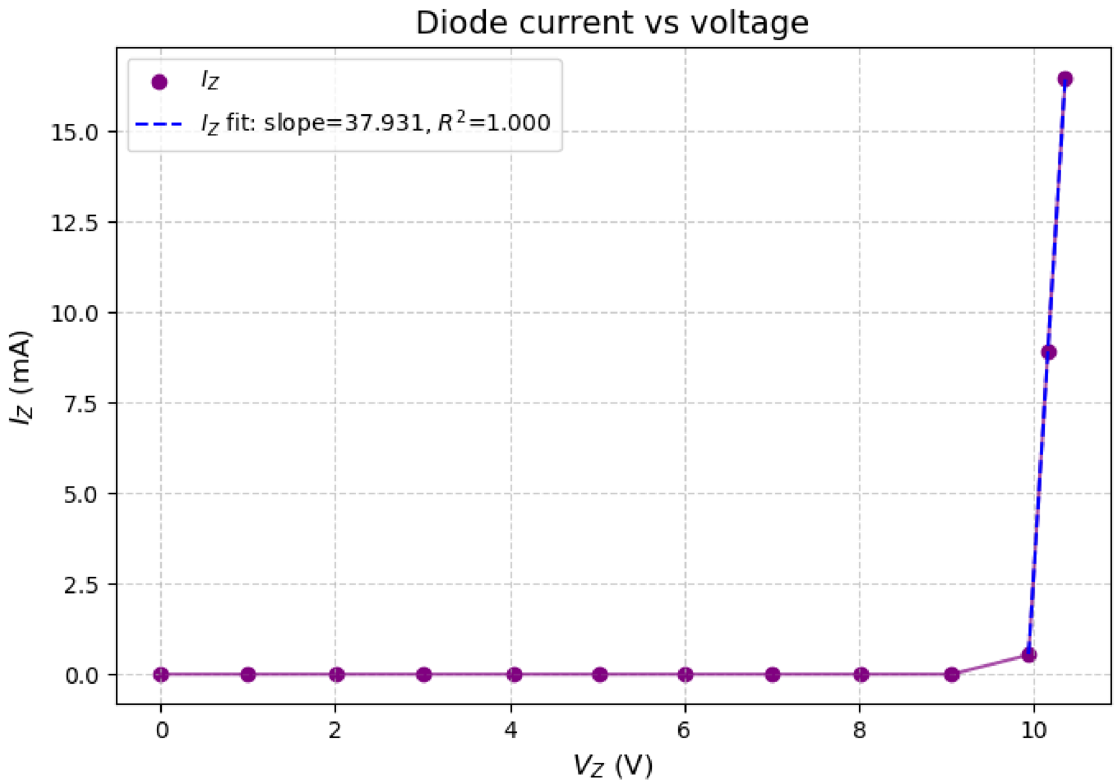


Figure 5.2: Current through the diode vs voltage

As the voltage is almost flat over the diode, this means that the current through the diode will rise almost vertically, an this is shown clearly on the graph, as the slope is very high.

6. Part 6 - Half-wave rectification

This part is about making a half-wave rectifier using a single diode. Then to calculate the DC level of the rectified signal. And to display the signal waveform from the oscilloscope.

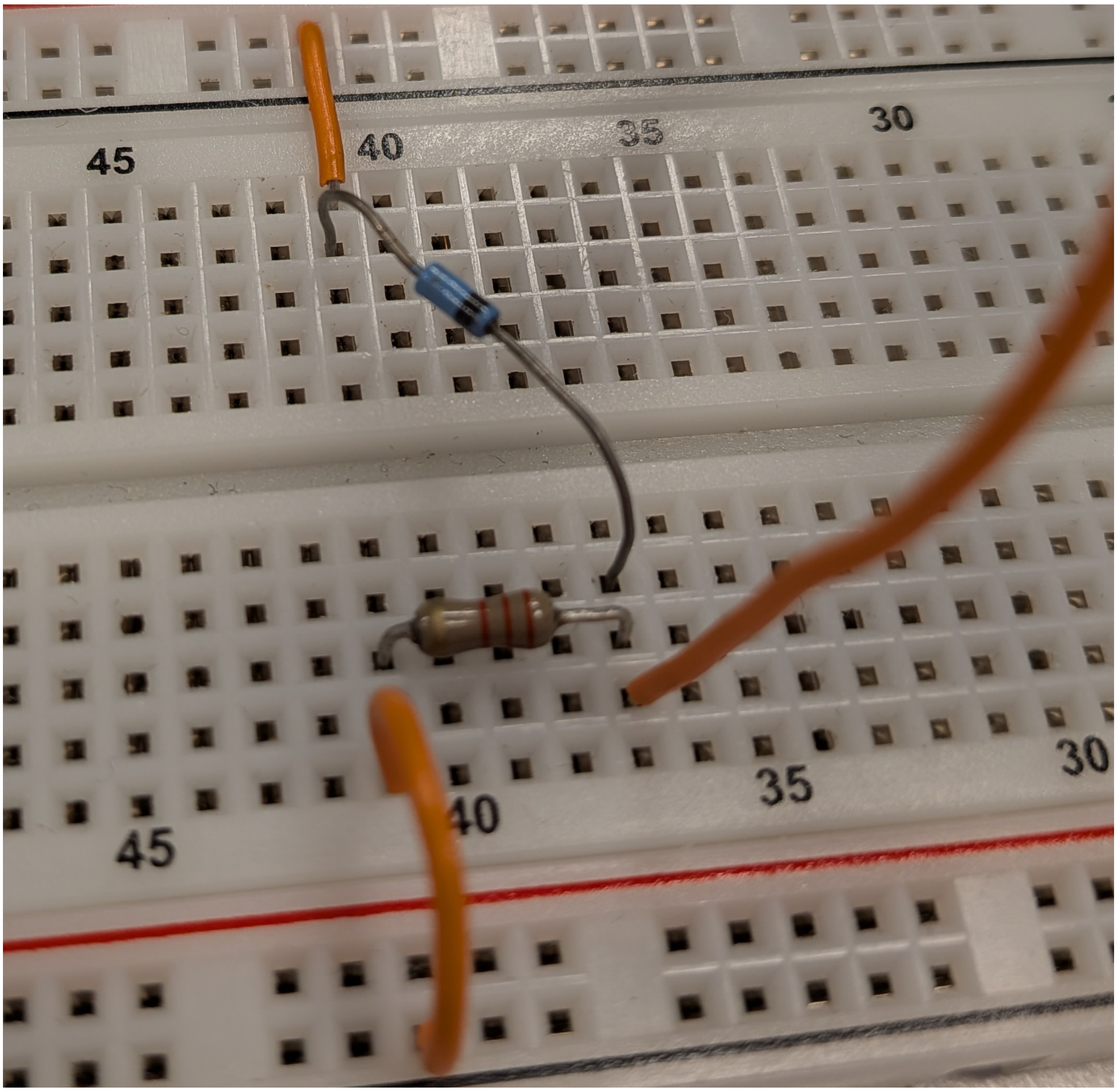


Figure 6.0: Half-wave rectifier circuit

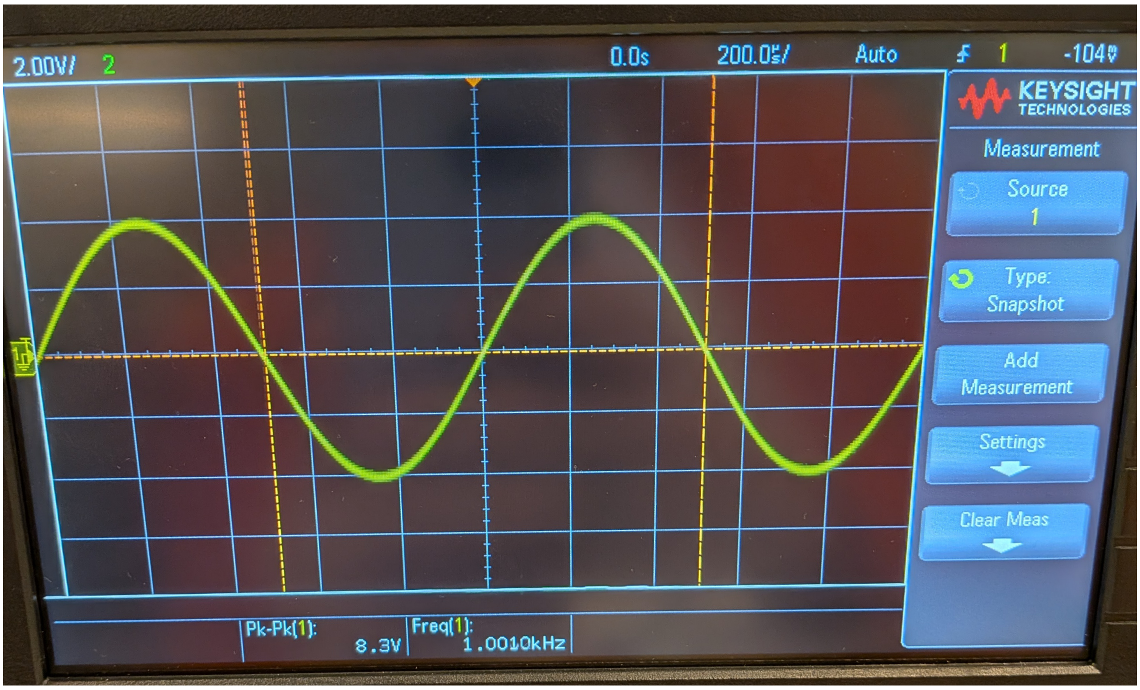


Figure 6.1: Input AC signal

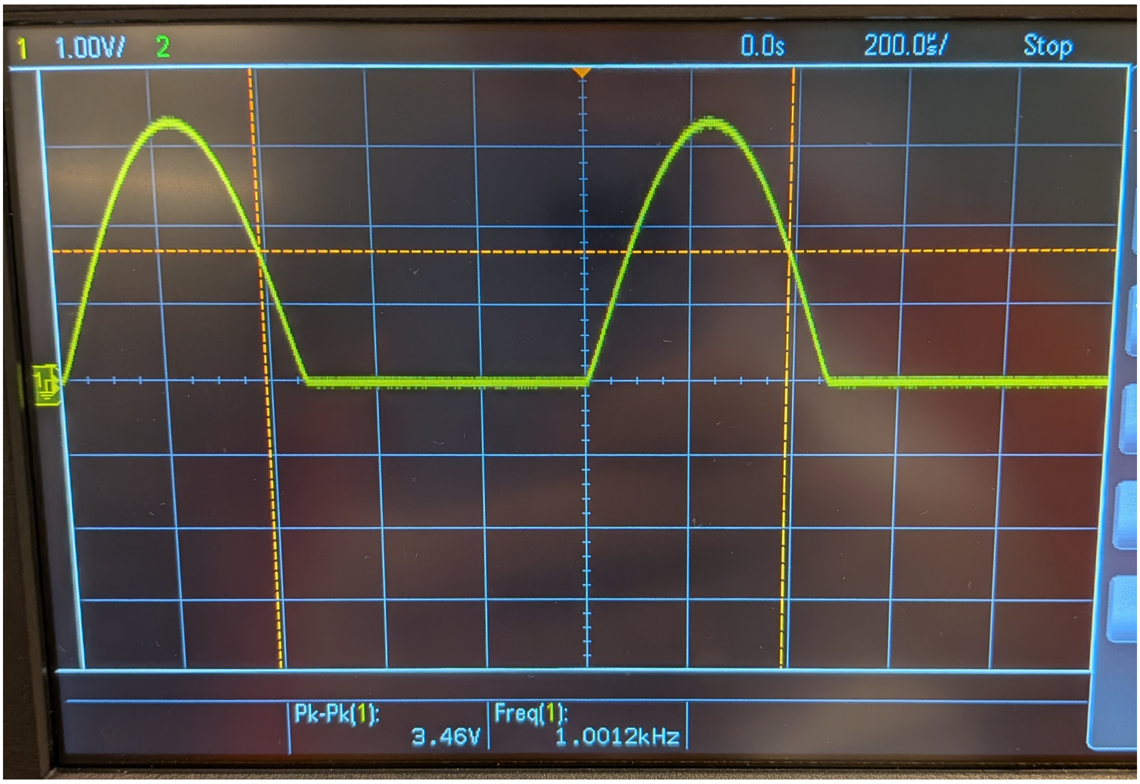


Figure 6.2: Half-wave rectified signal

The output from the rectifier is found in Figure 6.2 to have a $V_{peak} = 3.46\,\text{V}$. This means the calculated $V_{DC} \approx 1.1\,\text{V}$. Filling in this data and the measured DC level using a multimeter we get the following table.

Table 6.0: Rectified voltage calculated vs measured

V_{peak} (Measured)	3.460	V
V_{DC} (Calculated)	1.100	V
V_{DC} (Measured)	0.971	V
Difference	11.750	%

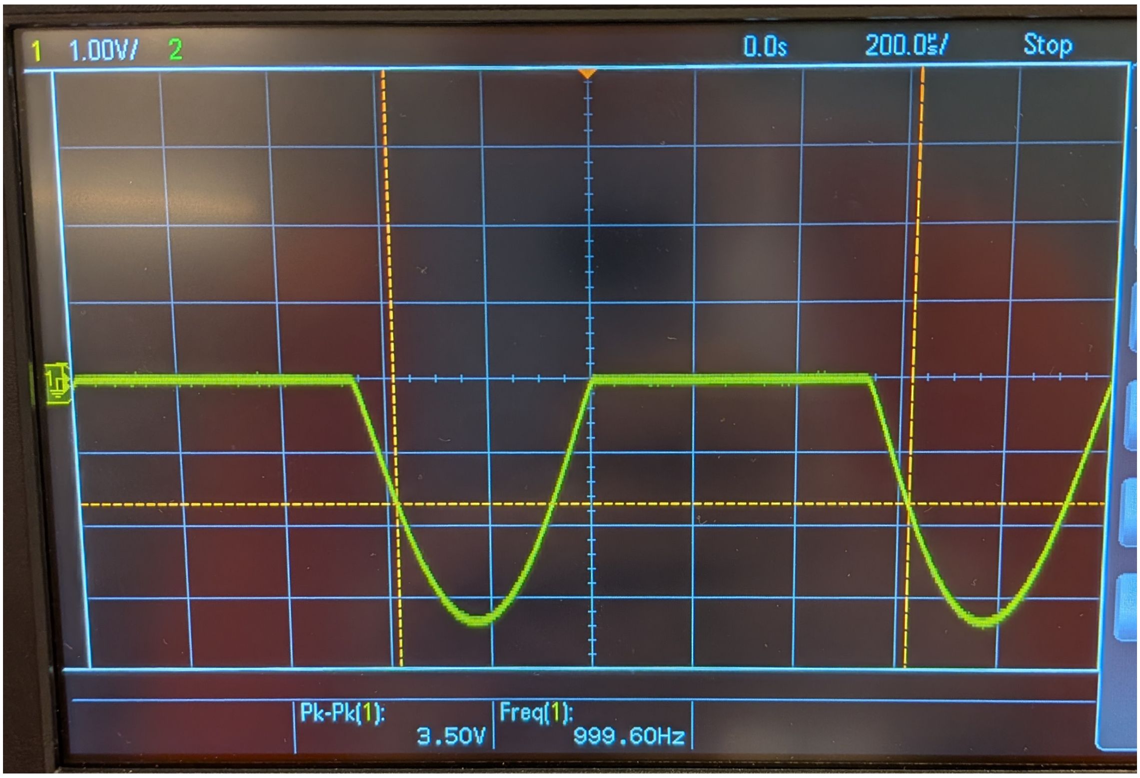


Figure 6.3: Reversed diode

Reversing the diode gives the following signal waveform as expected.