# Electronics Laboratory

## Winter semester 2025

## Lab 1 – Diodes

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|---|---|---|---|
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Score and comments (only for tutors, please leave blank)

*Please fill out this cover sheet and submit it with your lab report.*

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**Electronics Laboratory**
**WS 25/26**
Prof. Dr. Hans Zappe

# Lab 1 - Diodes

12. November 2025

## 1.2 A Variety of Diodes

### 1.2.1 Simulation

The goal of the Simulation is to measure and plot the characteristics of different Types of Diodes, in this case one Si Diode (Model: 1N4148), one Schottky Diode (Model: BAT41) and one Zener Diode (Model: ZD3V9).

**Circuit Diagrams:**

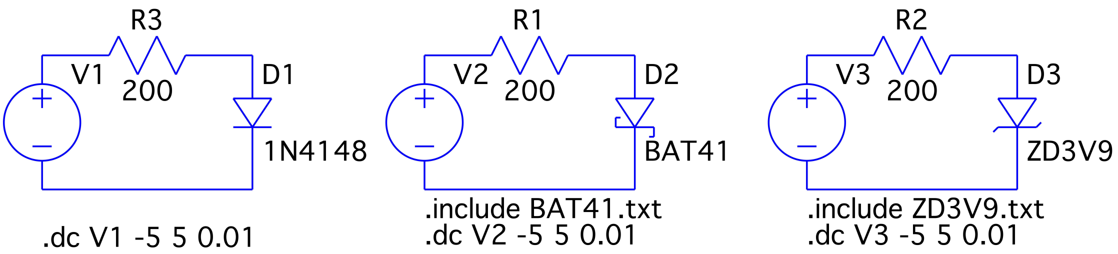


Figure 1: Circuit Diagrams from LTSpice[1]

**Plots:**

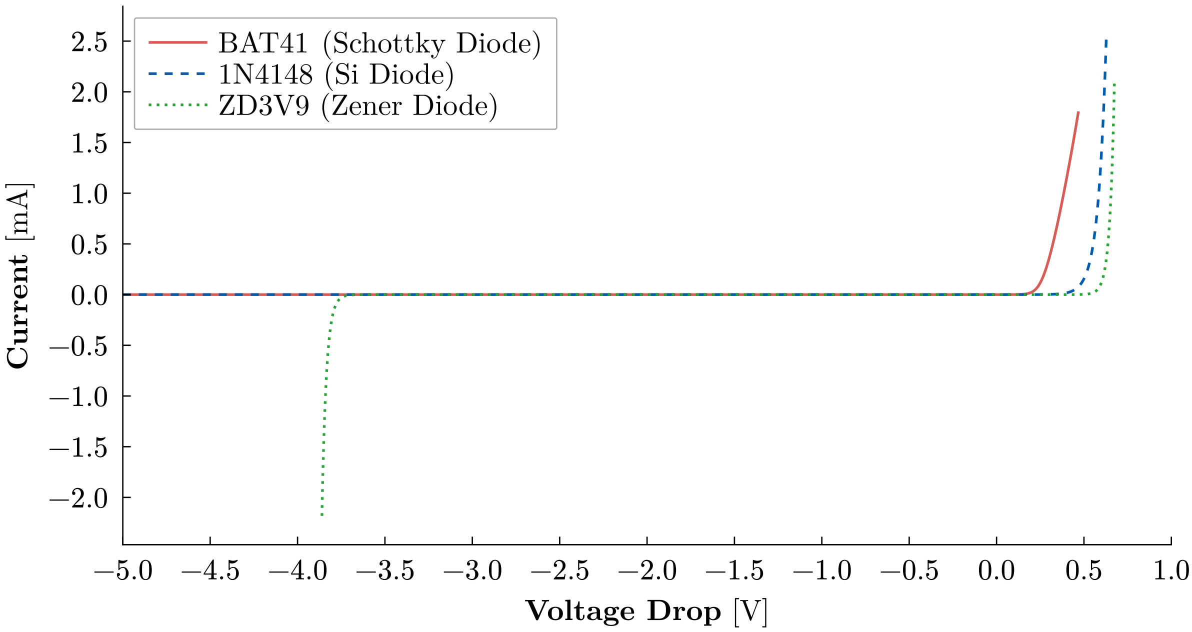


Figure 2: Simulated IV-Curves of all three Diodes

[1] Our actual command for the rightmost plot was: `V3 -4.297 4 0.01`, the one in the diagram (which we were supposed to use) did not work (bec exponential groth we think) we did the min. working values)

**Text Questions:**
(f) Small-Signal Resistance $r_D$ for $|I_D| = 20$ mA for:

- 1N4148 Diode is $r_D \approx 0.223\ \Omega$
- BAT41 Diode is $r_D \approx$ _._ $\Omega$ (could not be estimated)[2]
- ZD3V9 Diode is $r_D \approx 0.213\ \Omega$ (reverse and forward)

(g) One essential difference between the characteristics is the breakdown voltage, which for the Schottky diode is $\approx 0.3$ V, for the Si diode is $\approx 0.6$ V and for the Zener diode is $\approx 0.7$ V.

Also, the Zener Diode has the classical Zener-Curve in the negative voltages, having a reverse breakdown voltage of $\approx 3.8$ V, whereas the other ones stay at 0.0 A.

**Conclusion:**
We explored the IV-Curves and characteristics of the different types of diodes. The plot had the interesting attribute that it only simulated to $\approx 1V$ because of the exponential nature of the curve (as seen in Figure 2).

### 1.2.2. Measurement

The goal of the measurement is to verify the Simulation we created in the previous exercise.

**Circuit Diagrams:**

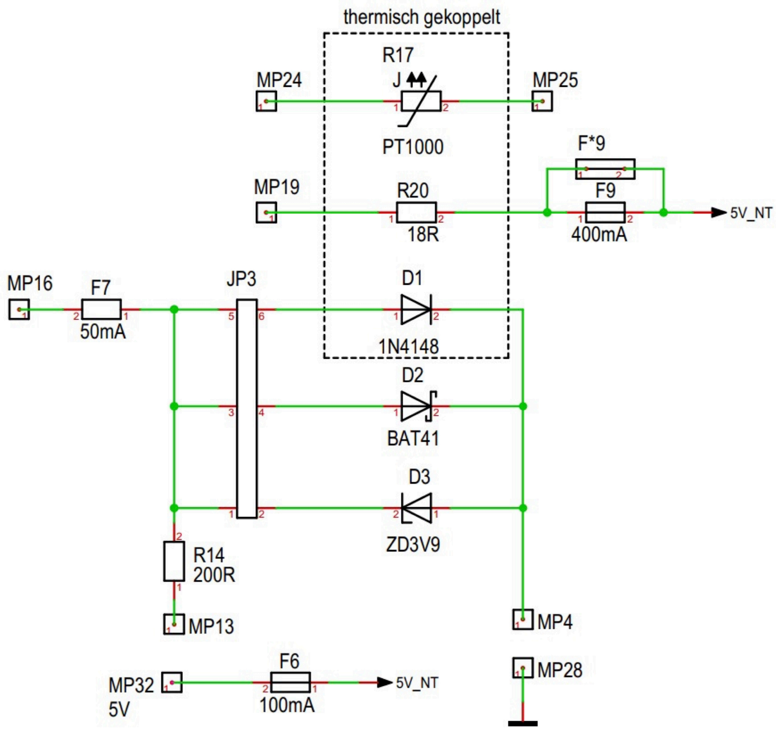


Figure 3: Schematic of the diode characteristics circuit

[2]We could not calculate a value because LTSpice only generated up to (0.469 V, 18.1 mA) as described earlier and seen in Figure 2, so we could not compute derivative for 20mA

**Plots:**

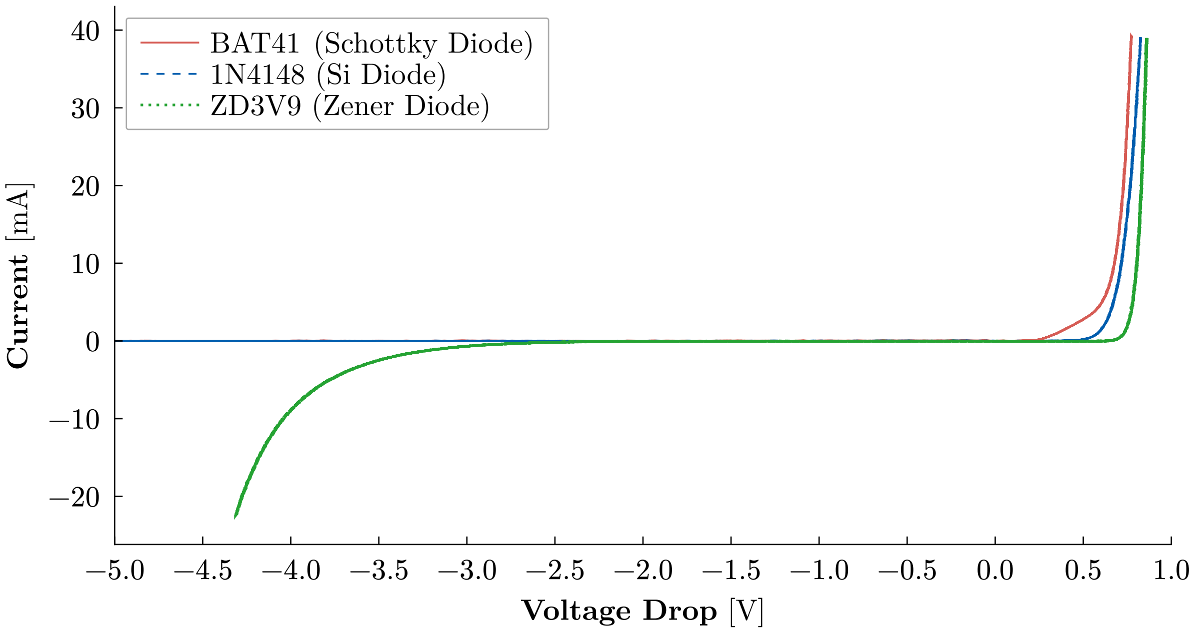


Figure 4: Measured IV-Curves of all three Diodes[3]

**Text Questions:**

(a) The true value of $R_{14} \approx 199.1\Omega$

(b)

| Diode | Forward Bias [V] | Reverse Bias[4][V] |
|---|---|---|
| $D1$ (1N4148) | 0.612 | 0 |
| $D2$ (BAT41) | 0.382 | 0 |
| $D3$ (ZD3V9) | 0.712 | $\geq 2$ |

The results of $D1$ and $D2$ look fairly similar to the simulation, but all the diodes did read slightly higher voltages when measured in reality.

The Zener Diode (D3) was very different in real life, because the multimeter only operates to 1.99V in Diode Test mode, so we could not read the value for reverse bias, which was approximately $3.85V$ in the simulation.

**Conclusion**

We measured and compared the real-word IV-Curves of the three different diodes, compared our results to the simulation and found similar results.

## 1.3 Light-emitting diodes

### 1.3.1 Simulation

The goal of the simulation was to visualize the IV-Curves for a green, a red and a yellow LED.

[3]Zener Diode mirrored at (0, 0) for better visual

[4]$\geq 2$ means we could not measure it with our multimeter as the maximum 'diode test' can do is 2V

**Circuit Diagrams**

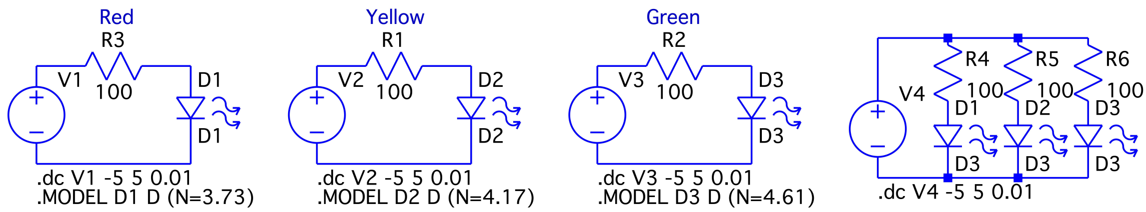


Figure 5: LED Circuit Diagrams from LTSpice

**Plots**

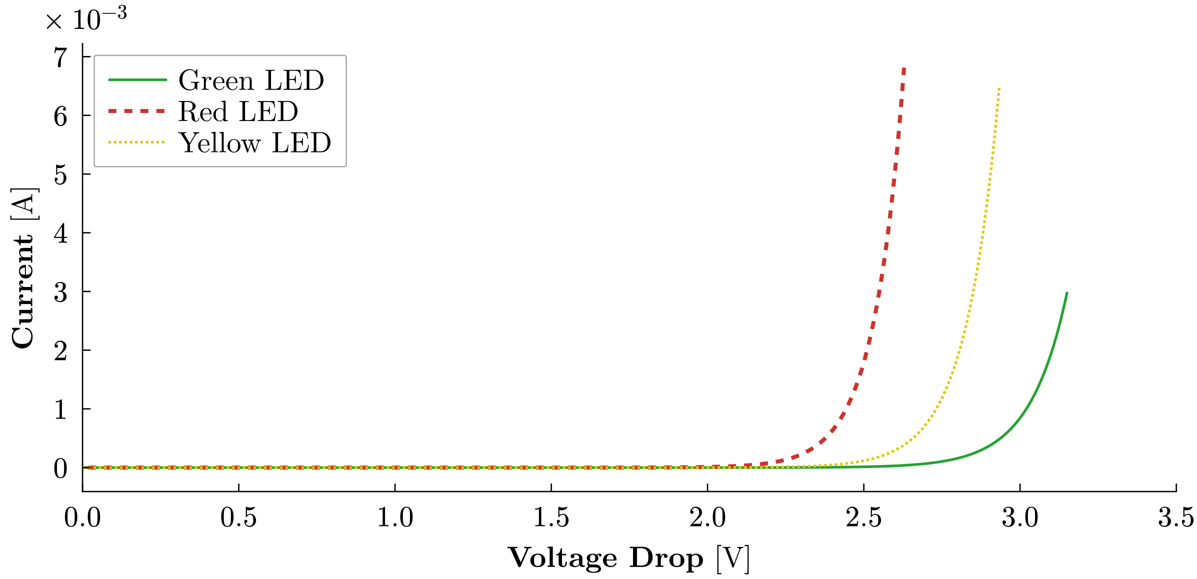


Figure 6: LED IV Curves

**Text Questions:**

(b) $V_f$-Values:

- Red LED ≈ 2.5V
- Yellow LED ≈ 2.8V
- Green LED ≈ 3.1V

(c) Red is the brightest LED, then yellow and then green

**Conclusion**

We successfully measured the IV-Curves of the three different-colored LEDs and looked at their relative brightness.

### 1.3.2. Measurement

The goal of the measurement was to see the LED Brightness and to mesaure the LED characteristics.

**Circuit Diagrams**

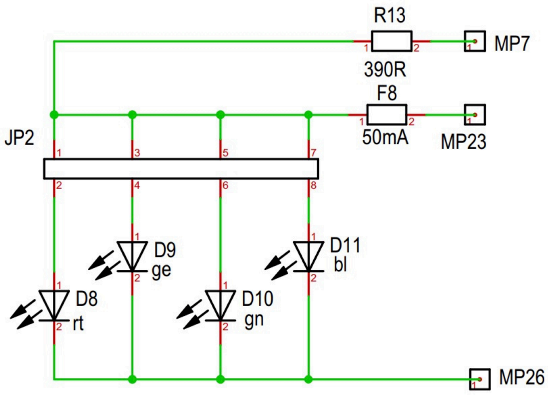


Figure 7: Schematic of the LED characteristics circuit

**Text Questions**

(a) $V_f$ measured with handheld multimeter

| LED | $V_f$ [V] |
|---|---|
| $D11$ (blue) | $\geq 2$ |
| $D10$ (green) | 1.858 |
| $D9$ (yellow) | 1.828 |
| $D8$ (red) | 1.760 |

(f) Relative brightnesses of the different LEDs

| Kombination (L & R) | LED 1 (L) | LED 2 (R) |
|---|---|---|
| $D8$ & $D9$ | Bright | Bright |
| $D8$ & $D10$ | Bright | Not so bright |
| $D8$ & $D11$ | Bright | Off |
| $D9$ & $D11$ | A little less bright | Off |
| $D10$ & $D11$ | Dim | Off |

(g) Red has the smallest breakdown voltage, so it is the brightest LED in all configurations. The voltage of the yellow LED is a little more, and we see that it is a little more dim than red when connected with the blue one. The green LED has an ever higher one, so it is quite dim, blue is even more and never turns on.

**Conclusion**

We could see all simulated effects in real-world brightness and verified $V_f$ with a handheld multimeter.

## 1.4. Temperatur dependence

### 1.4.1. Simulation

The goal of the simulation was to see how the diodes behave under different temperatures.

**Circuit Diagrams**

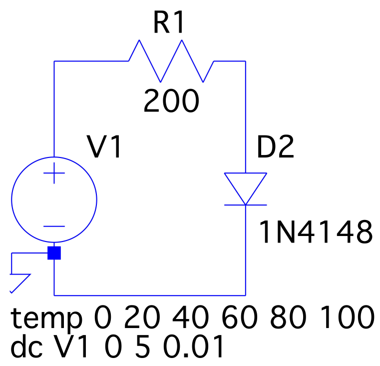


Figure 8: LTSpice circuit diagram of Temperatue Sweep

**Plots**

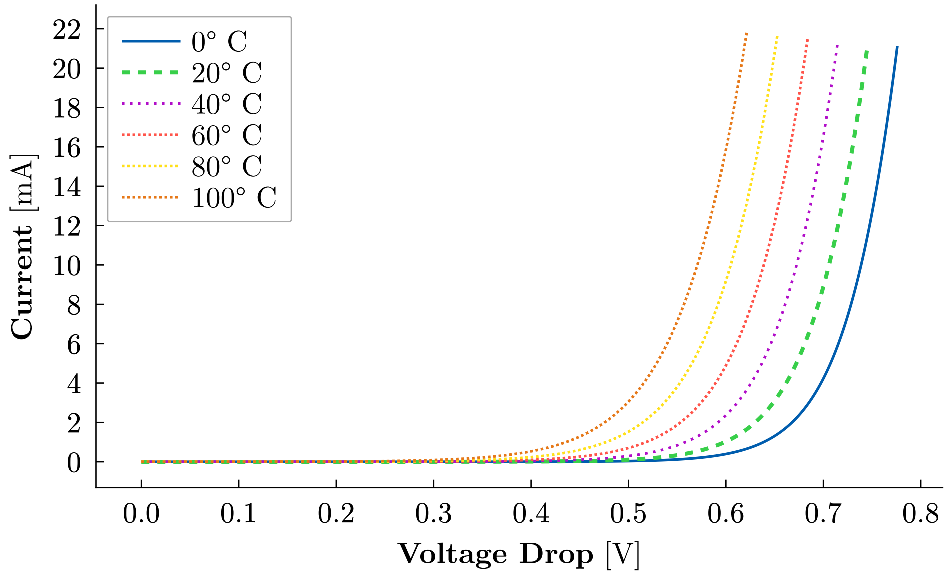


Figure 9: Diodes under different operating Temperatures

**Conclusion**

We could clearly see the differences in operating temperatures.

### 1.4.2. Measurement

The goal of the measurement is to see the influence of the temerature over the diodes in real life.

#### Circuit Diagrams

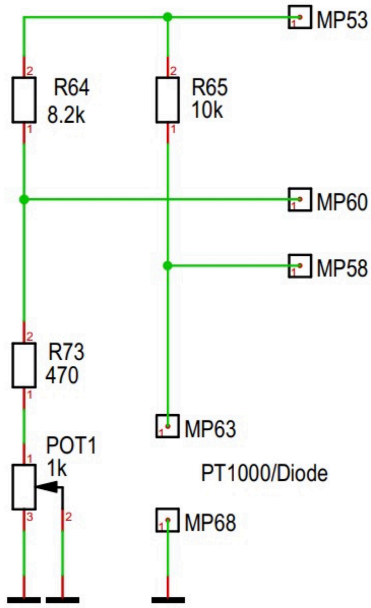


Figure 10: Schematic of the *bridge* circuit

**Text Questions**

(a) We measured 1078 Ω, that corresponds to 19.5 °C

(h) $V_{MP60} - V_{MP58} \approx -48.1$ mV

Original Turn-On Voltage: 0.612 V

New Turn-On Voltage = 0.612V − 0.048V = $\underline{0.564\text{V}}$

(i) 1270 Ω, corresponds to 67.5°C

(j) $\delta T = 67.5°C - 19.5°C = 48°C$, $\quad \frac{\delta V}{\delta T} = \frac{-0.048V}{48°C} = 1\frac{\text{mV}}{°\text{C}}$

Typical literature Value is $\approx -2\frac{\text{mV}}{°\text{C}}$

**Conclusion**

We could definitely see correspondence between temperature and resistance and measure values, although we are not quite sure why we differed from the literature value by factor 2.

## 1.5. Rectifier

### 1.5.1. Simulation

The goal was to simulate a full-wave rectifier with 1N4148 Si diodes.

### Circuit Diagrams

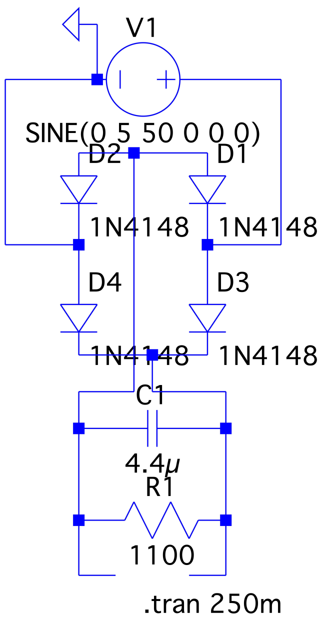


Figure 11: LTSpice circuit of full-wave rectifier

### Plots

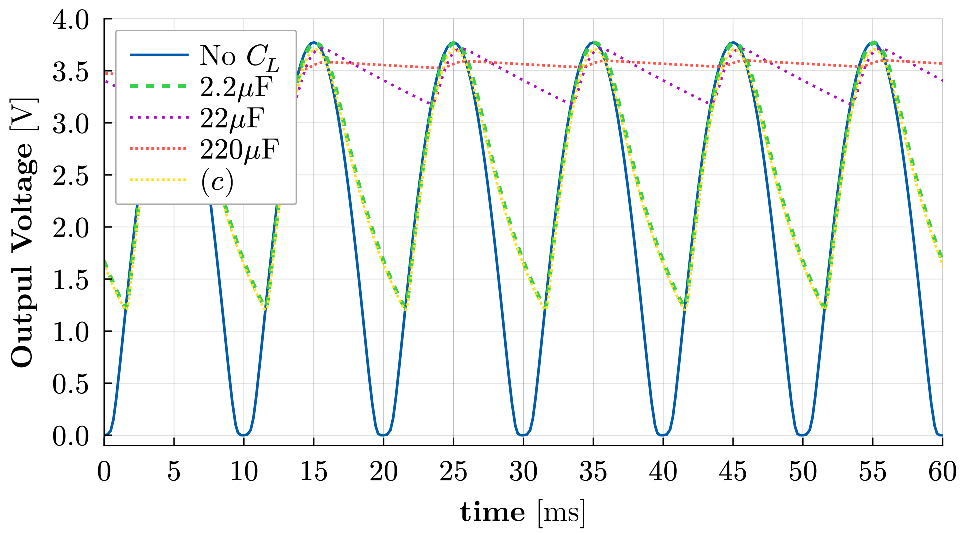


Figure 12: Full-wave rectifier output

### Text Questions

(c) $C_L = 4.4\ \mu$F, $R_L = 1.1$ k$\Omega$ is almost the same output as $C_L = 2.2\ \mu$F, $R_L = 2.2$ k$\Omega$ as seen in Figure 12

(e) Hum Voltages:

- No $C_L \approx 3.7$ V
- 2.2$\mu$F $\approx 2.5$ V
- 22$\mu$F $\approx 0.5$ V
- 220$\mu$F $\approx 0.1$ V

### Conclusion

We clearly saw full waves being full waves being rectified and could see hum-voltages.

### 1.5.2. Measurement

The goal of the measurement was to measure the full-wave rectifier and its behaviour.

**Circuit Diagrams**

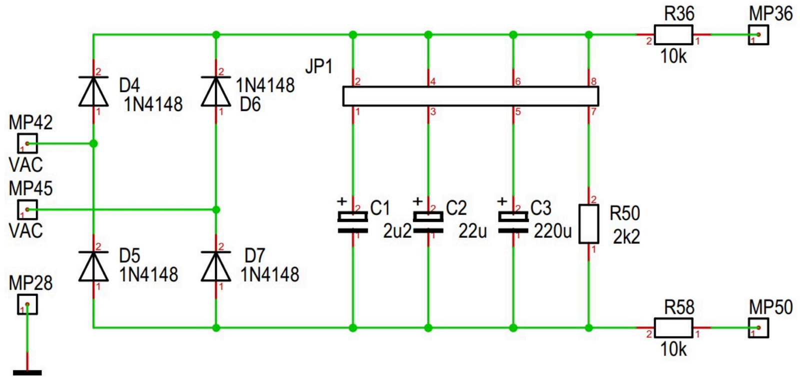


Figure 13: Schematic of the *rectifier* circuit

**Plots**

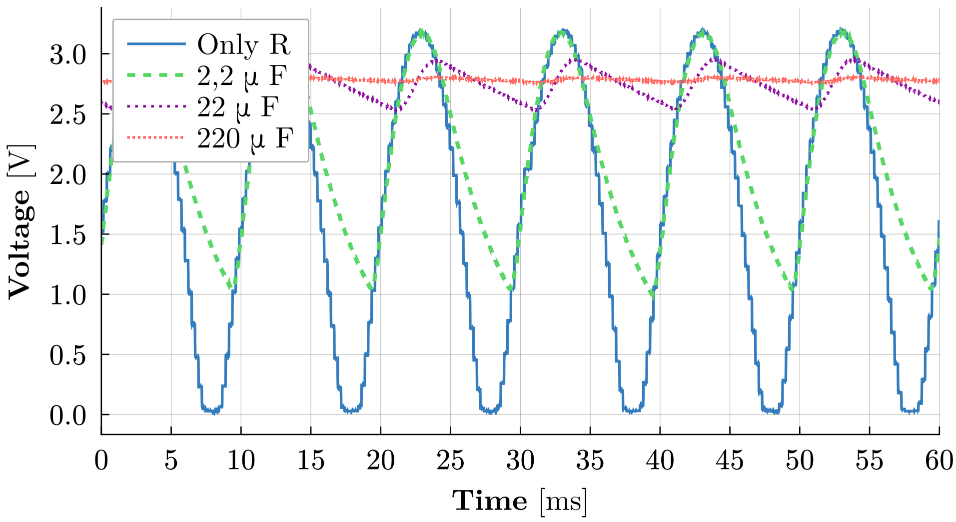


Figure 14: Measured Difference in Voltage

**Text Questions**

(g) Hum Voltages:

- Only R ≈ 3.2 V
- 2.2$\mu$F ≈ 2.2 V
- 22$\mu$F ≈ 0.45 V
- 220$\mu$F ≈ 0.05 V

**Conclusion**

The measured values and hum-voltages look a little chunky but really similar to the simulation. This is fun!