# Introduction to Power Supplies

Kevin "Yama" Keyser[1, a)]
*University of Missouri-Kansas City*

In Laboratory 3, we begin our introduction to transformers, diodes, and their applications to electronic circuits. We continue our expanding our knowledge of using oscilloscopes and plotting two functions on the same graph in order to quantitatively compare our input to our output, to try to understand the visual difference of what our circuit is doing to our input voltage.

## I. BACKGROUND

For Laboratory 3, the main background information we need to understand will be how to use an oscilloscope, to know how to properly ground and not short our circuit, and what direction our diodes should be placed in our circuit.

## II. PROCEDURE

The procedures for Laboratory 3 will be attached as a separate sheet of paper to the back of the laboratory write up.

## III. PRESENTATION OF DATA

### A. 3-1: Transformer Output Voltage Measurements

No tabular data. All information will be presented in the Discussion section.

### B. 3-2: Diodes

| Channel 1 | |
|---|---|
| RMS (V) | Peak-to-Peak (V) |
| 1.549 | 4.40 |
| Channel 2 | |
| RMS (V) | Peak-to-Peak (V) |
| 0.4573 | 1.340 |

a) Electronic mail: kk8r8@mail.umck.edu

### C. 3-3: Half-Wave Rectified Power Supply

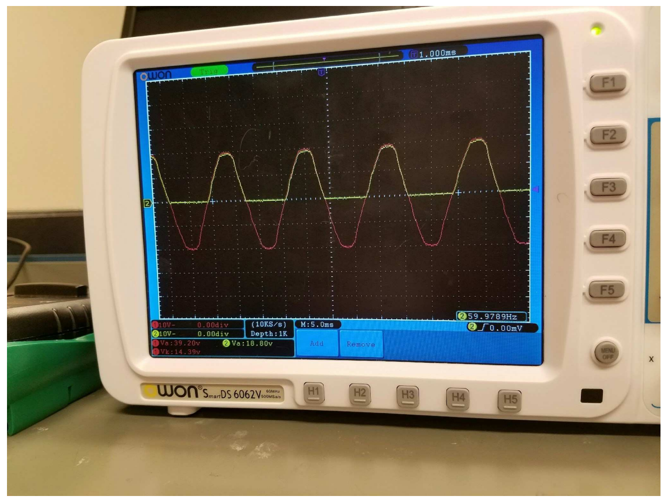


FIG. 1. Input and Output plot of a half-wave rectifier.

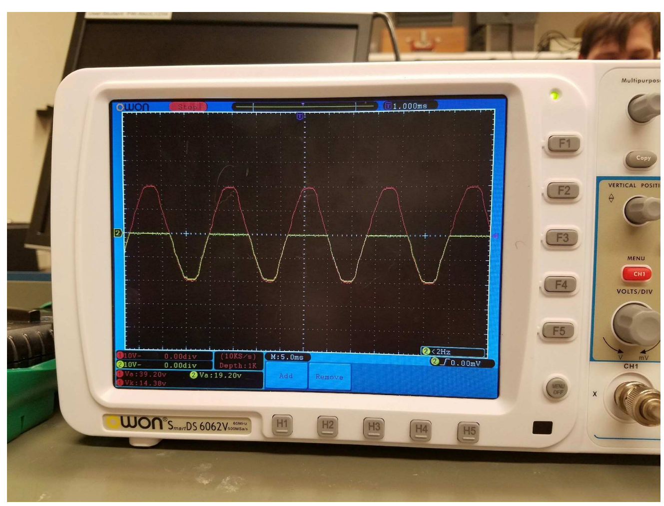


FIG. 2. Input and Output plot of a half-wave rectifier, where we insert the diode in with a reverse bias.

### D. 3-4: Full-Wave Rectified

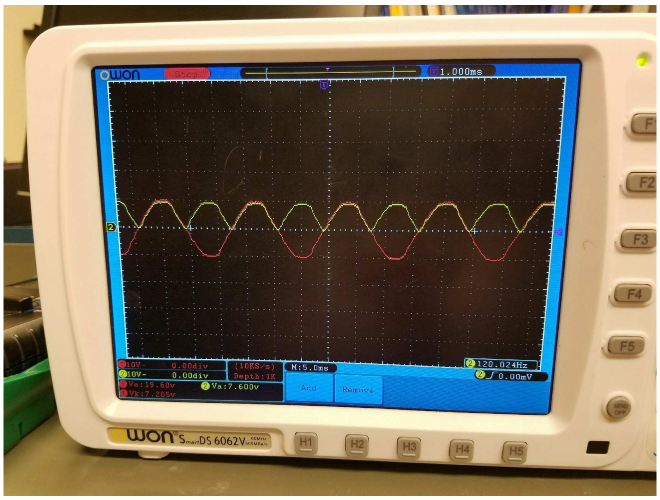

FIG. 3. Input and Output plot of a full-wave rectifier.

### E. 3-5: Bridge Rectifier

| RMS | |
|---|---|
| Input (V) | Output (V) |
| 14.19 | 9.65 |
| Peak-to-Peak | |
| Input (V) | Output (V) |
| 39.20 | 20.00 |
| Amplitude | |
| Input (V) | Output (V) |
| 38.40 | 19.60 |

### F. 3-6: Filter Capacitors

FIG. 4. Input and Output of our filter capacitor circuit with a $200\Omega F$ resistor, and a $10\mu F$ capacitor.

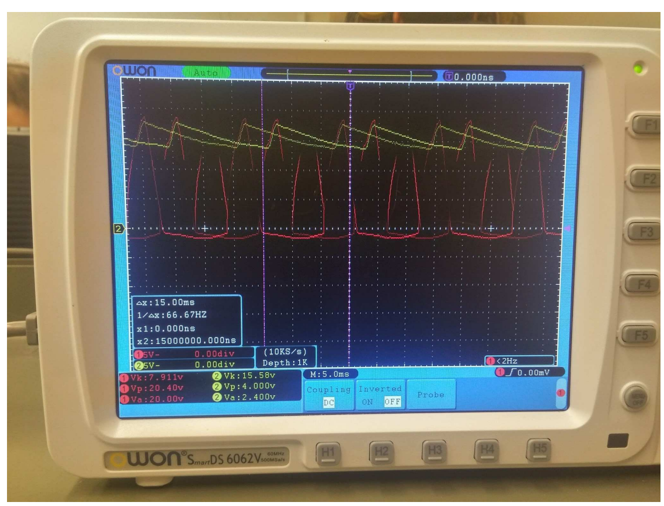

FIG. 5. Input and Output of our filter capacitor circuit with a $200\Omega F$ resistor, and a $100\mu F$ capacitor.

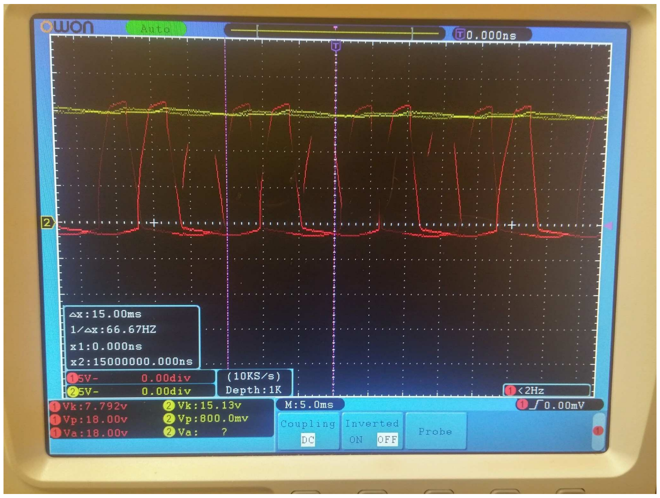


FIG. 6. Input and Output of our filter capacitor circuit with a 200Ω$F$ resistor, and a 1000$\mu F$ capacitor.

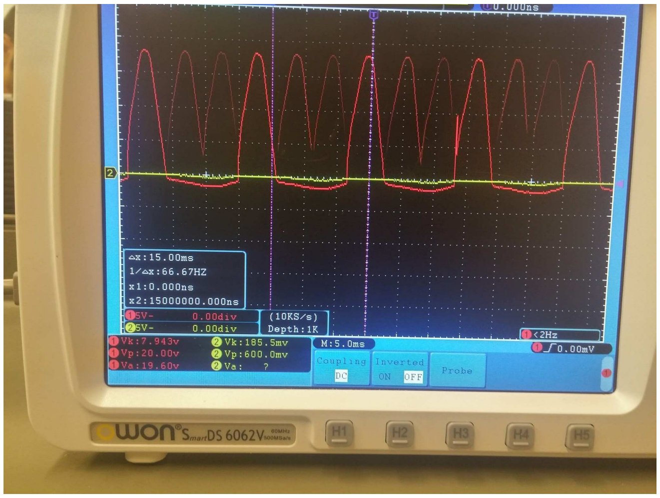


FIG. 7. Input and Output of our filter capacitor circuit with a 1kΩ$F$ resistor, and a 10$\mu F$ capacitor.

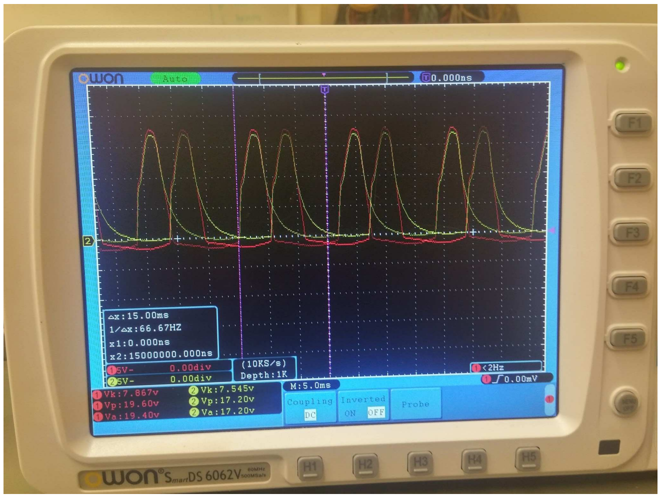


FIG. 8. Input and Output of our filter capacitor circuit with a 1kΩ$F$ resistor, and a 100$\mu F$ capacitor.

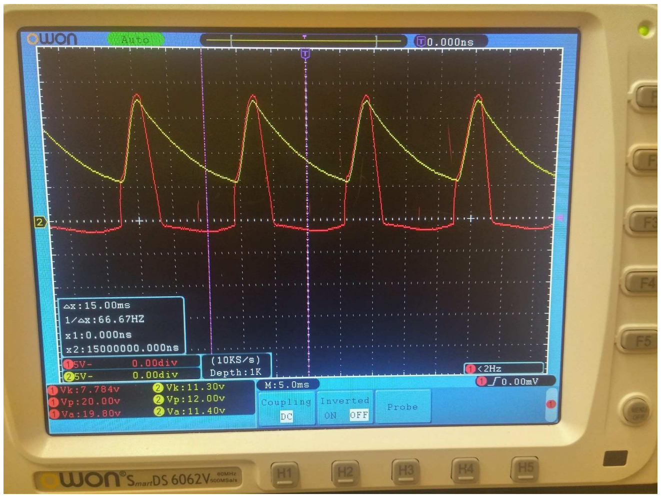


FIG. 9. Input and Output of our filter capacitor circuit with a 1kΩ$F$ resistor, and a 1000$\mu F$ capacitor.

### G. 3-7: Voltage Regulators

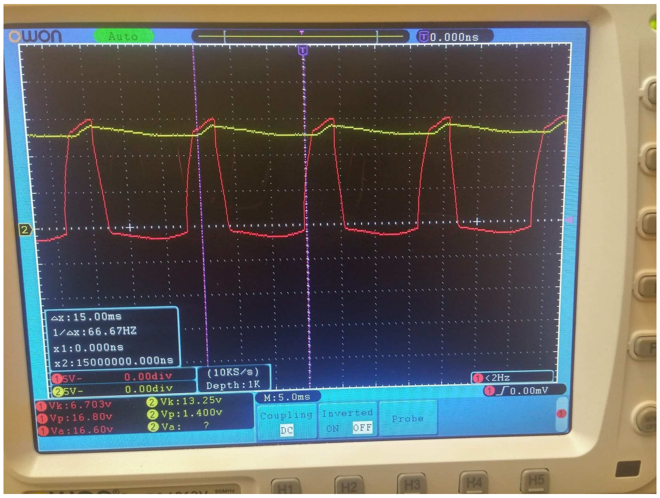


FIG. 10. Input and Output of our voltage regulator circuit with a 1k$\Omega F$ resistor, and a 1000$\mu F$ capacitor.

## IV. DISCUSSION

### A. 3-1: Transformer Output Voltage Measurements

The purpose of this experiment was to show you how much percentage of the full output you get when grounding the full width of the circuit, versus going from center tap to ground. Theoretically, if your center tap is directly in the middle of your secondary winding, then our output voltage should be half of what it would be if you connected your circuit across the whole secondary wiring.

The precision of these transformers is never going to be 100% accurate without a financial burden being introduced, so for our experiment, we see that our center tap is close enough to half the output voltage of the full voltage of the transformer.

### B. 3-2: Diodes

We do see a small ohmic effect when it comes to our diode. There is a small voltage drop across the diode, but it is a (depending on your input voltage) negligible amount.

For which side is the anode, and which side is the cathode, by definition, the Anode is the side that current comes in from an outside source, where as the Cathode is the side that outputs current. The cathode side is generally marked with a thin band on the diode that is a different color from the rest of the diode.

### C. 3-3: Half-Wave Rectified Power Supply

We find out in a later homework assignment how a P-N junction works, but the consequences of such are seen here. We see from our image that all of our negative voltage is blocked by diode. This is a forward bias. Due to the depletion layer that is formed when we send a negative voltage through the diode, our output for the negative part of our input voltage goes to zero.

When we connect the diode in a reverse bias, we end up with an opposite effect. All of our positive voltage now gets blocked by the diode, and our negative voltage is able to go through.

### D. 3-4: Full-Wave Rectified

For experiment 3-4, the full-wave rectifier gives our circuit 2 options. Since we are using the center tap as ground, and forward biasing both of our diodes, what we should see for Channel 1 is a sinusoidal wave that has half the voltage of the full output of our transformer. What we get for Channel 2 though, is that since both sides of the transformer are outputting a voltage, with the center tap as ground, and both of the diodes are forward biased, we are getting only the positive voltages from both "‘sources"’, giving us what looks like the absolute value of a sinusoidal wave.

### E. 3-5: Bridge Rectifier

The bridge rectifier configuration is very similar to our full-wave rectifier, but we have two extra diodes in place to keep the negative voltage from passing through to our other side of our parallel circuit and causing a short.

This allows to have a full-wave rectifier, without the cost of losing half of our voltage due to having to use the center tap. The benefit of this is that our amplitude will be twice as high as the full-wave, and the same as the half-wave, but the RMS for our bridge rectifier will be twice as high as our RMS for our half-wave.

### F. 3-6: Filter Capacitors

With experiment 3-6, we replaced the 10k$\Omega$ resistor with a RC parallel circuit. What we saw with the output was a filtered voltage output. Since we are getting the same bridge rectifier in place, we are only seeing positive voltages, ranging from 0V to our peak of 20V, but this time around, we have a capacitor in series with our resistor for the ground.

We know that the capacitor has a capacitive reactance that is represented as $X_C = \frac{1}{\omega C}$, so the higher our capacitance, the lower our capacitive reactance, and thus, the lower our impedance. Also, the lower our resistance, the lower our impedance as well. This would explain why we have the most stable output with the combination of $200\Omega$ resistor and a $1000\mu F$ capacitor, as this configuration will give us the lowest impedance.

### G. 3-7: Voltage Regulators

We saw a more stable DC voltage for our output voltage in the voltage regulator circuit. Since a voltage regulator is designed to maintain a constant voltage level, we see less of a drop in voltage when our input voltage drops as the voltage is a function of frequency.

## V. CONCLUSION

With using diodes, capacitors, and resistors, we are able to show how we can take an AC volatage source, and modify it to our needs, slowly but surely with each experiment. We first show how to filter out certain polarities of voltages, then how to not lose our "'filtered"' voltages with our full-wave rectifier. Next we learned that by not connecting to the center tap, but adding more diodes in, we can avoid losing half of our amplitude. Then, using filter capacitors and voltage regulators, we can smooth out our AC input into a DC output.

Is this how our Elenco Variable Power supply works? Though we may complain about the lack of granularity and precision at lower voltages, when you add the overhead complexity of a potentiometer and that they are getting an AC input, and how difficult it was for us to smooth out our AC input into a flat DC output, you can really appreciate how hard something that we presumes should be so "'easy"' is.

Every lab is here to teach us that nothing is easy nor comes for free in physics. Granularity costs time, money, and knowledge. As does precision, and as physicists if we feel we can do better, we should, instead of simply saying so.