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SANTA CLARA UNIVERSITY	ELEN 115 Spring 2024	Shoba Krishnan
Project 2: Power Supply Design		

Objective

The objective of this lab is to study different rectifier configurations and the addition of circuit components, such as capacitors and zener diodes dictate the output load voltage.

Lab Procedure

To meet our lab objectives, circuit analysis on different rectifier designs will be built using components on a breadboard, supplied by a 12:1 step down transformer and measurements done using the digital oscilloscope. Key measurements will be comparing the measured output voltage across the load and the input voltage after stepping down from the wall outlet.

III. PROCEDURE

1. Transformer

a) The input voltage is obtained from a transformer that gives a 120Vrms 60 Hz sinusoid at the primary and a 31.8V peak to peak across the secondary. Keep the center tap floating but tie the wire to unused section of your protoboard so as to keep it safely out of the way.

b) Remember to disconnect the transformer form the wall when you are making modifications to your circuit so as to be safe.

Note: Make the Probe Impedance of both the channels of the Oscilloscope equal to 1MOhm.

2. Half Wave Rectifier

a) Build the half wave rectifier circuit on the breadboard with only the Resistive load. Use a 1N4001 diode. Observe the output on the bench oscilloscope.

b) Add the capacitor across the load and observe the filtering action.

c) Make sufficient measurements with an oscilloscope to verify the expected results for rectified voltage and peak-to-peak ripple voltage.

Part 1: Transformer

Using the procedure outlined above, we built the half-wave rectifier seen in the following schematic.

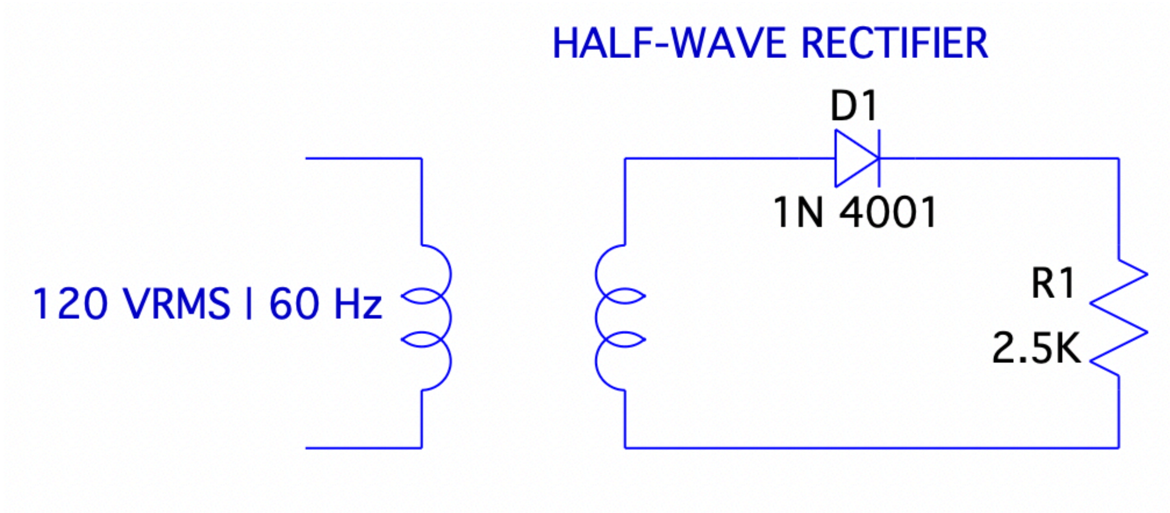

Figure 1: Half-wave rectifier design with fixed load.

With the design setup seen in the schematic in Figure 1, we measured the following voltages.

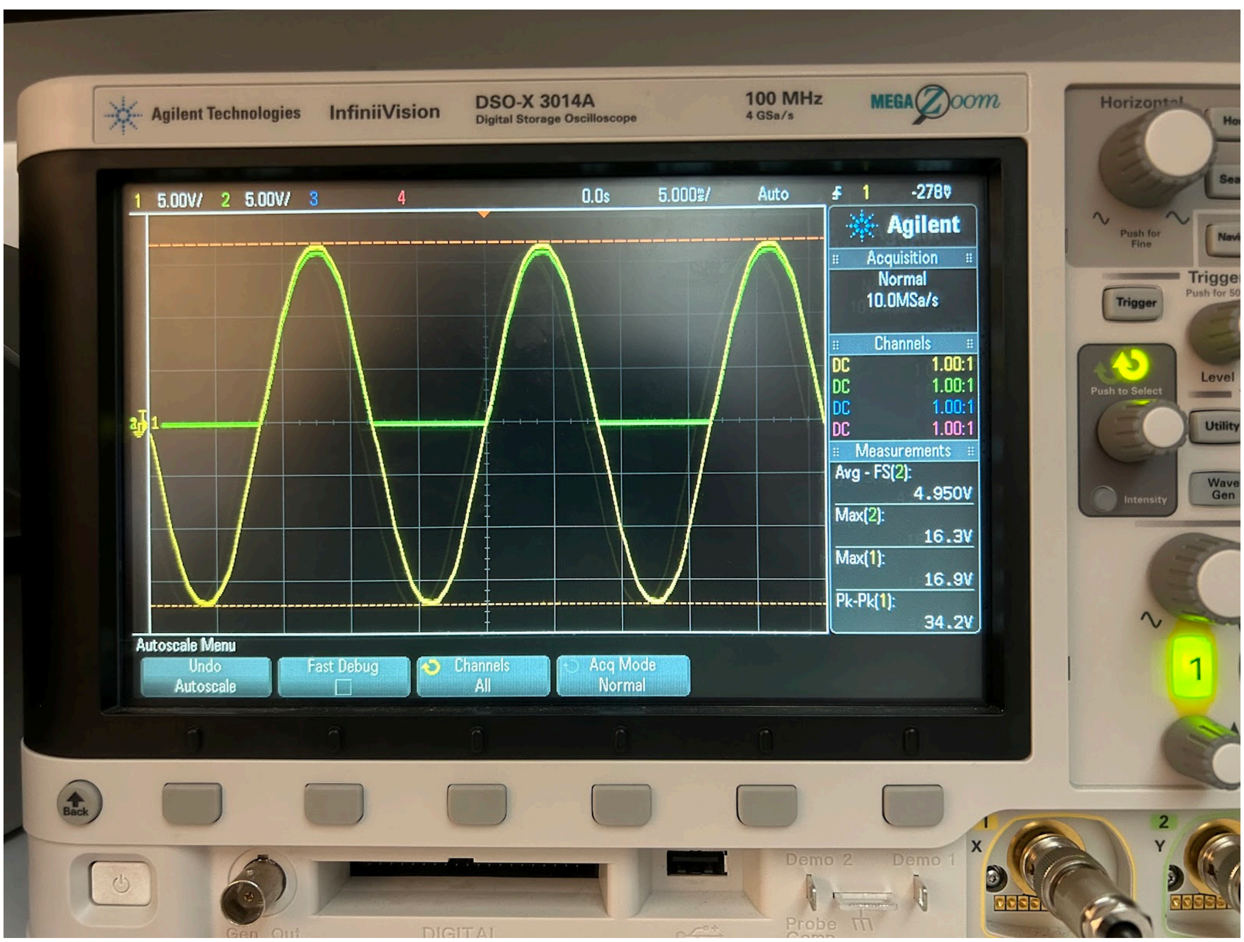

Figure 2: Measured Half-Wave Rectifier response

The half-wave rectifier responds as designed, with a measurable output voltage across the load only occurring during the positive portions of the input oscillations. The max voltage of the input is 16.9 V and the max output voltage is 16.3, which accounts for the ~0.6 V drop across the 4001 diode.

Adding a parallel capacitor in the half-wave rectifier design, we hoped to create a near constant voltage drop across the load, we created the design in the following figure.

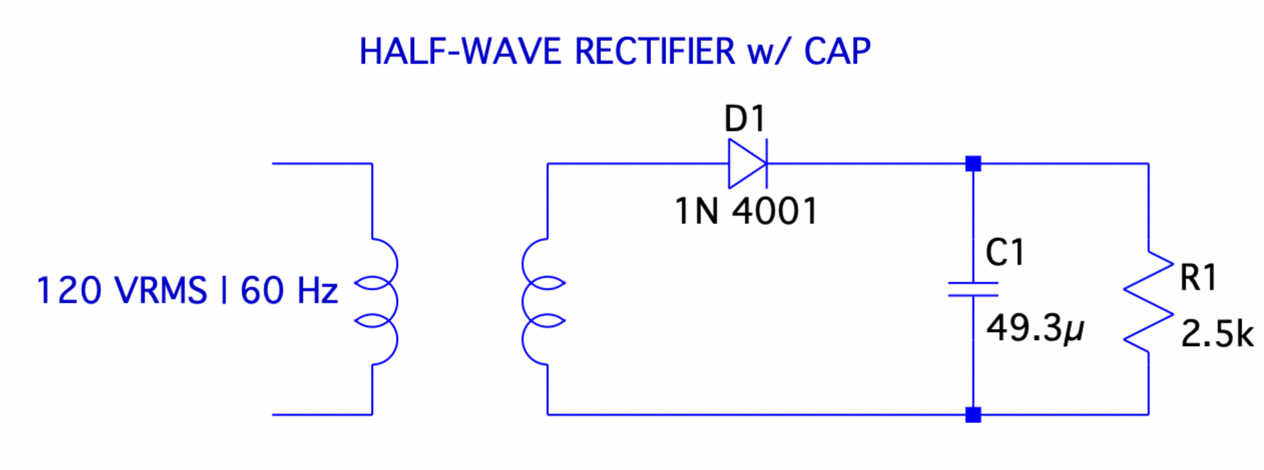

Figure 3: Half-wave rectifier with parallel capacitor

With Capacitor:

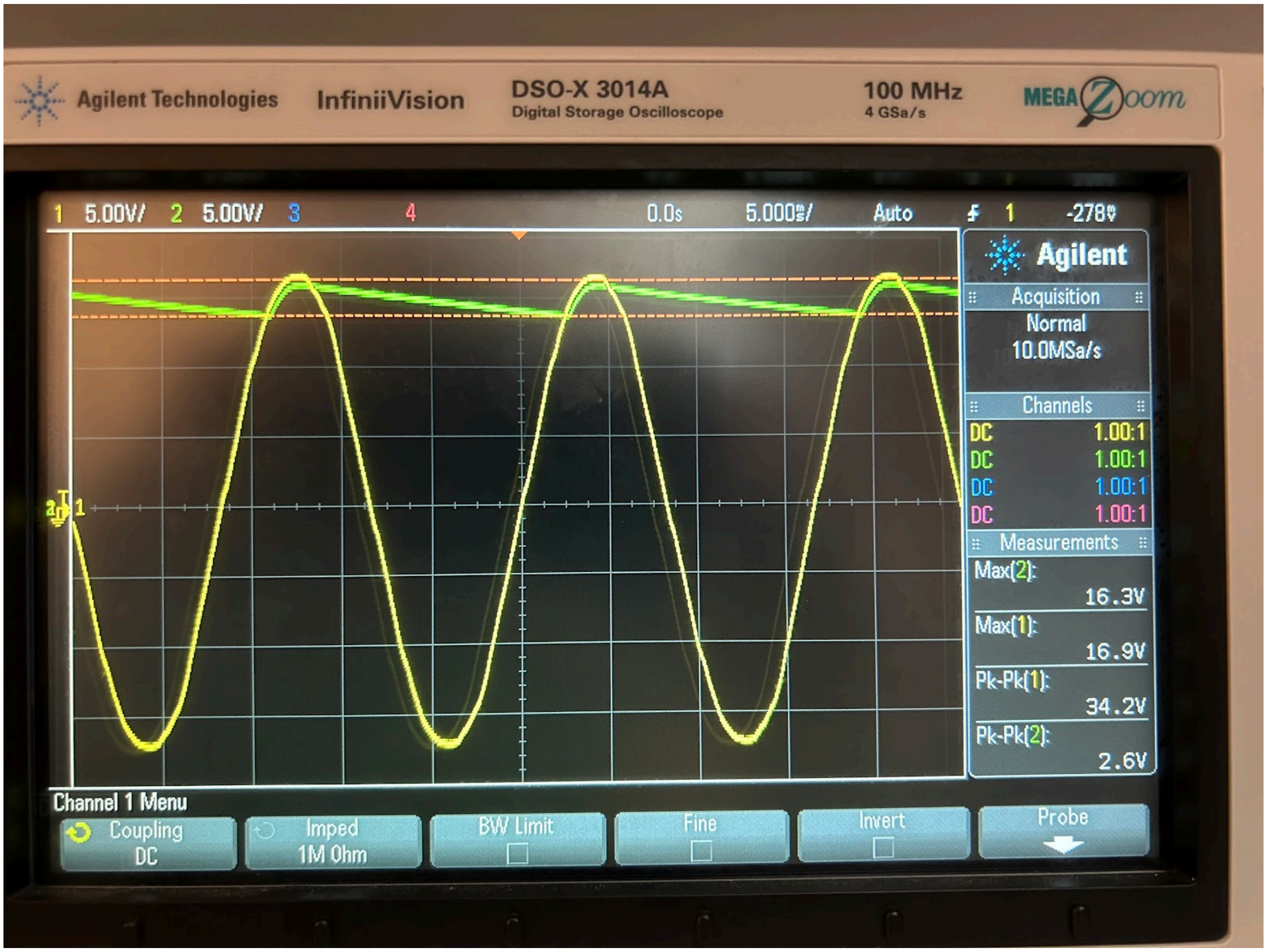

Figure 4: Measured circuit response with capacitor

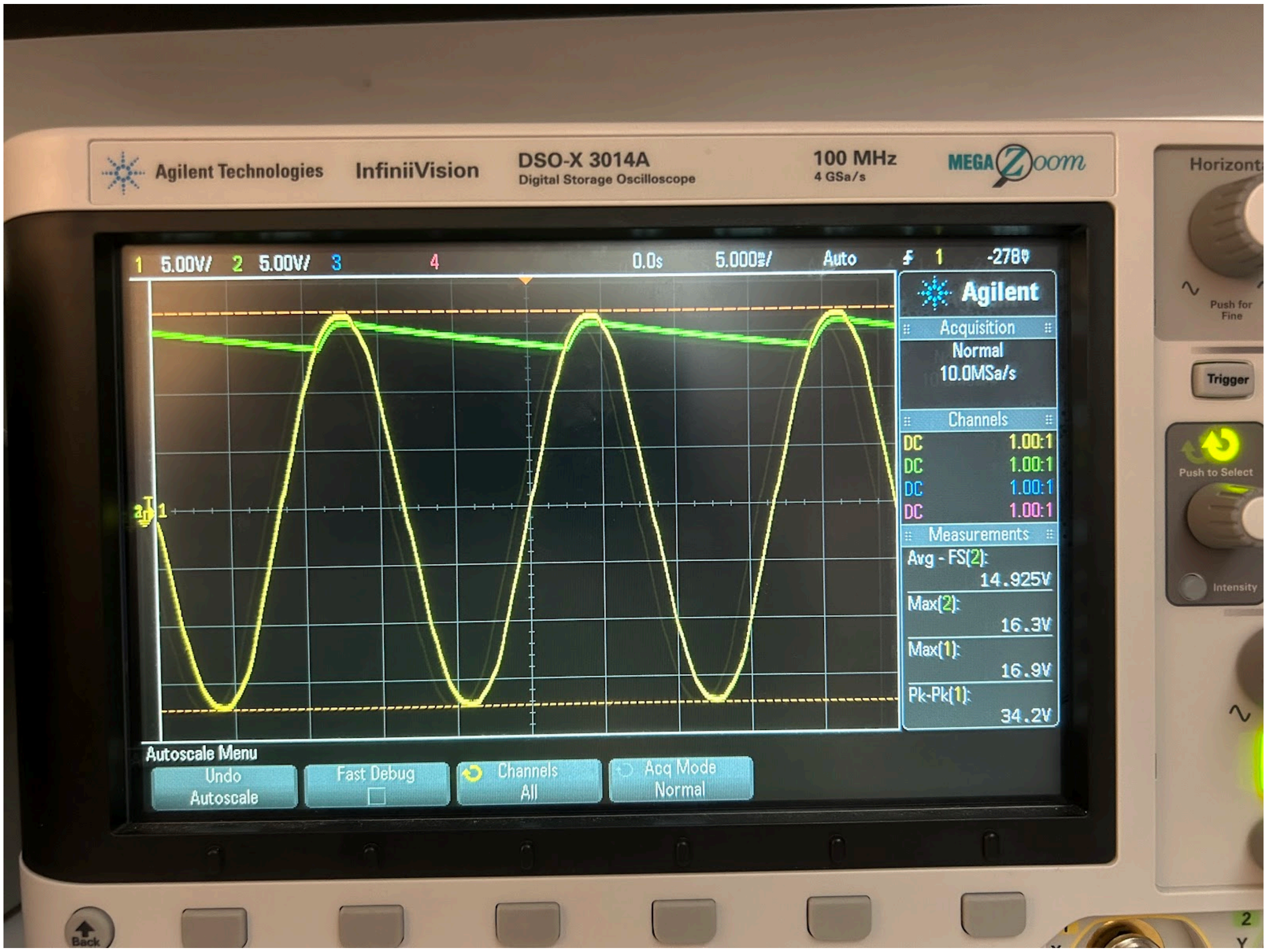

Figure 5: Measured circuit response different resistance.

Part 2: Zener Regulator

Using the procedure outlined above, we built the half-wave rectifier seen in the following schematic: 5.1 volt Zener diode (1N751A) with the original design

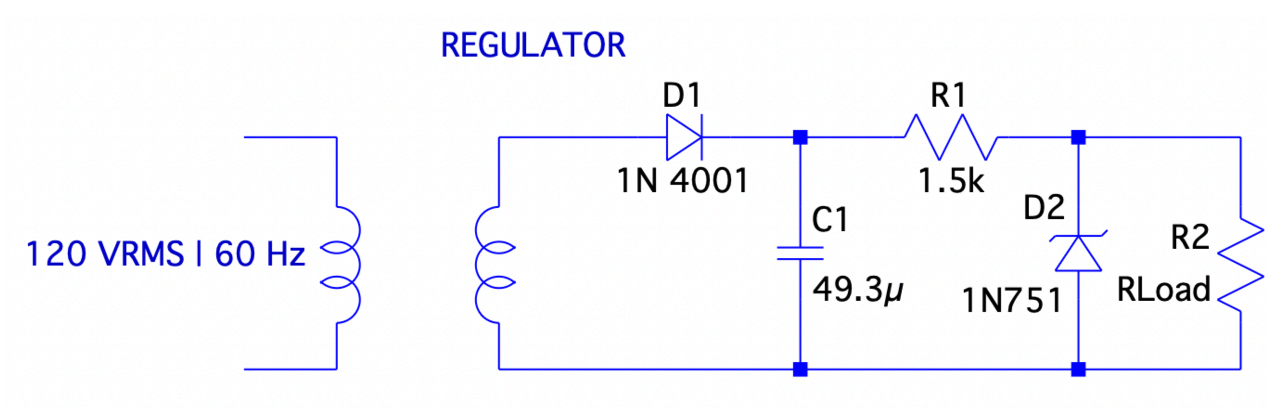

Fig 6: Zener Regulator

a) Connect the Zener diode 1N751A and the designed current-limiting resistor R to your previous circuit to obtain a regulated output.

b) Make sufficient measurements to verify the expected results for regulated voltage and peak-to-peak ripple voltage.
c) Measure the DC voltage level with the digital voltmeter for the minimum value of RL along with several values above and below the minimum value. Be careful not to overload the Zener diode.

The behavior shown is expected. As the resistance of the load goes up, the voltage goes up but not by much. The zener is doing it's job of regulating the voltage.

Table 1: Circuit Voltages at varying resistances

Resistance (Kohm)	Avg Output Voltage (V)	Max Output Voltage (V)	Ripple Voltage (V)
1	4.435	4.6	.4
1.3	4.548	4.8	.6
2	4.611	4.8	.4
2.4	4.623	4.8	.4
3	4.623	4.8	.4

1K Resistor Pictures:

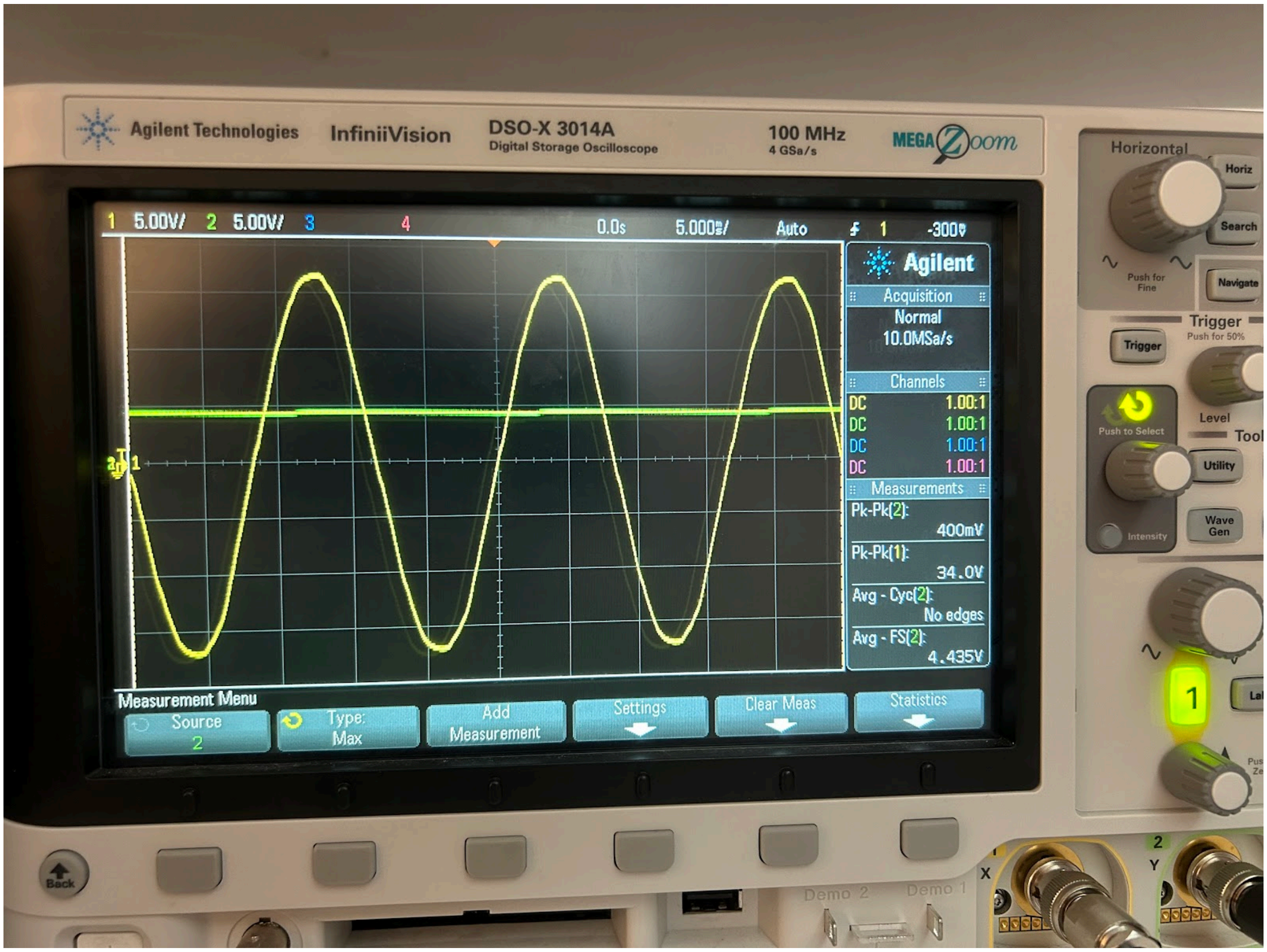

Figure 7: Circuit Response with 1K resistor

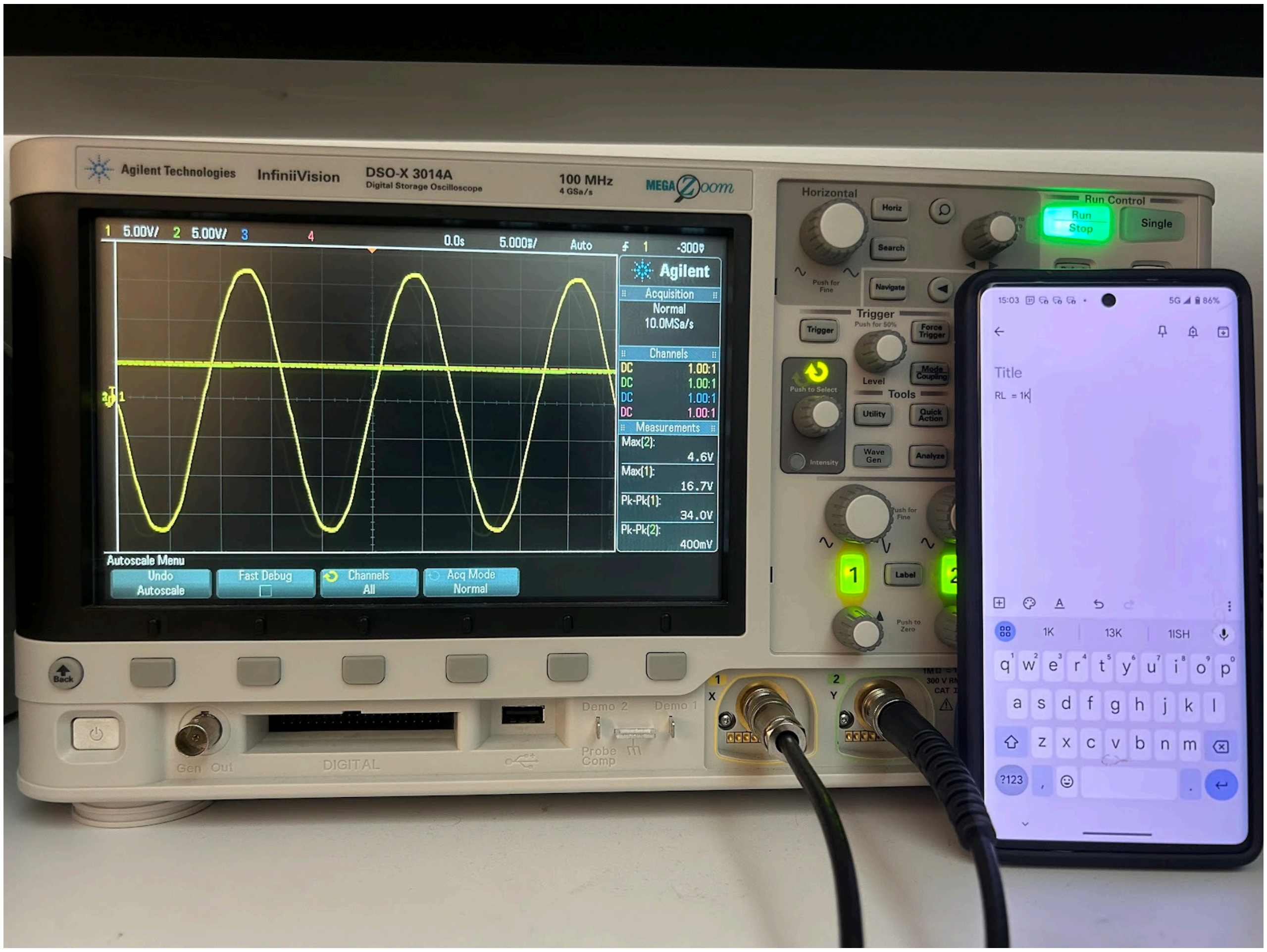

Figure 8: Circuit Response with 1K resistor

1.3K Resistor Pictures:

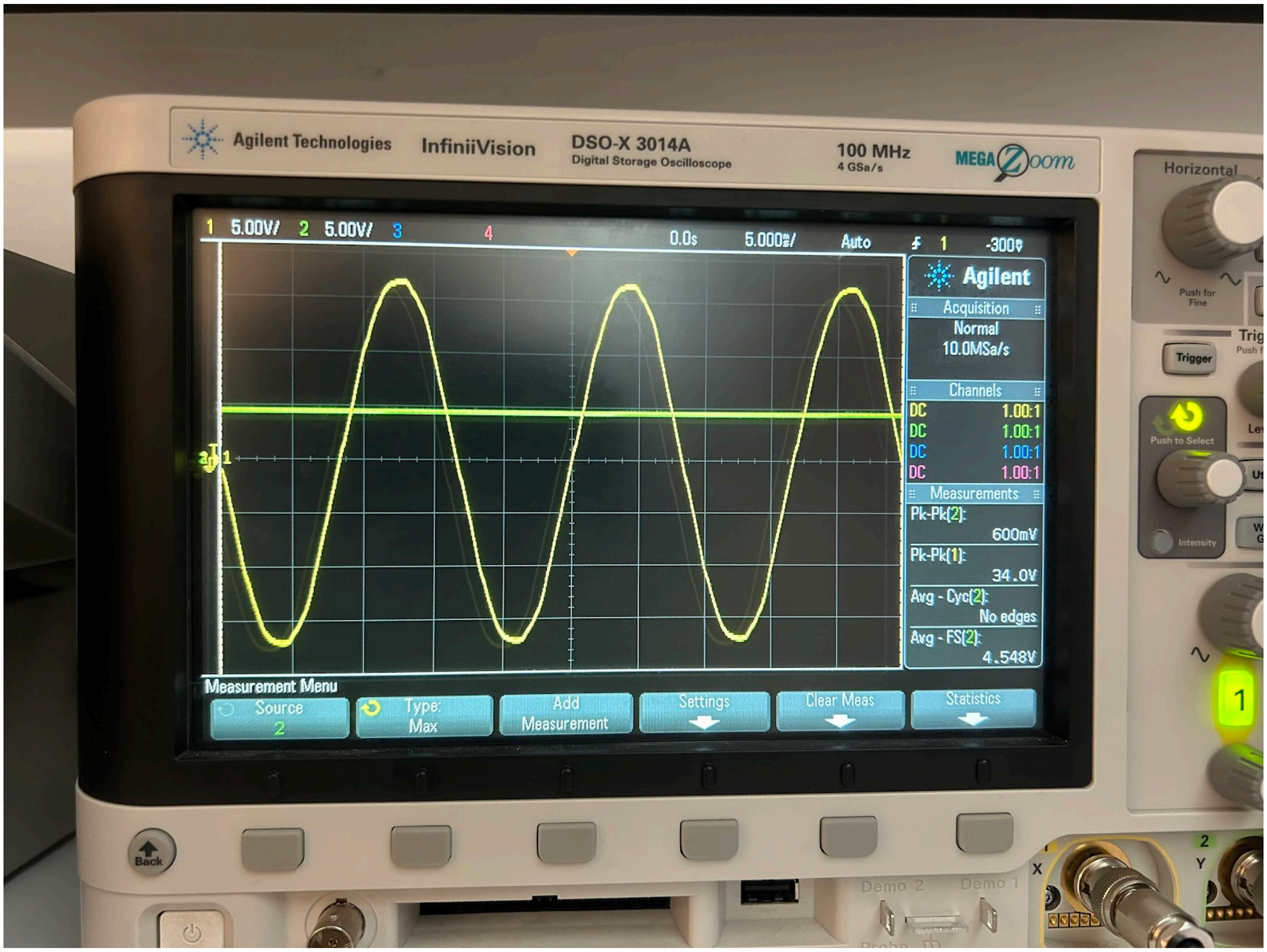

Figure 9: Circuit Response with 1.3K resistor

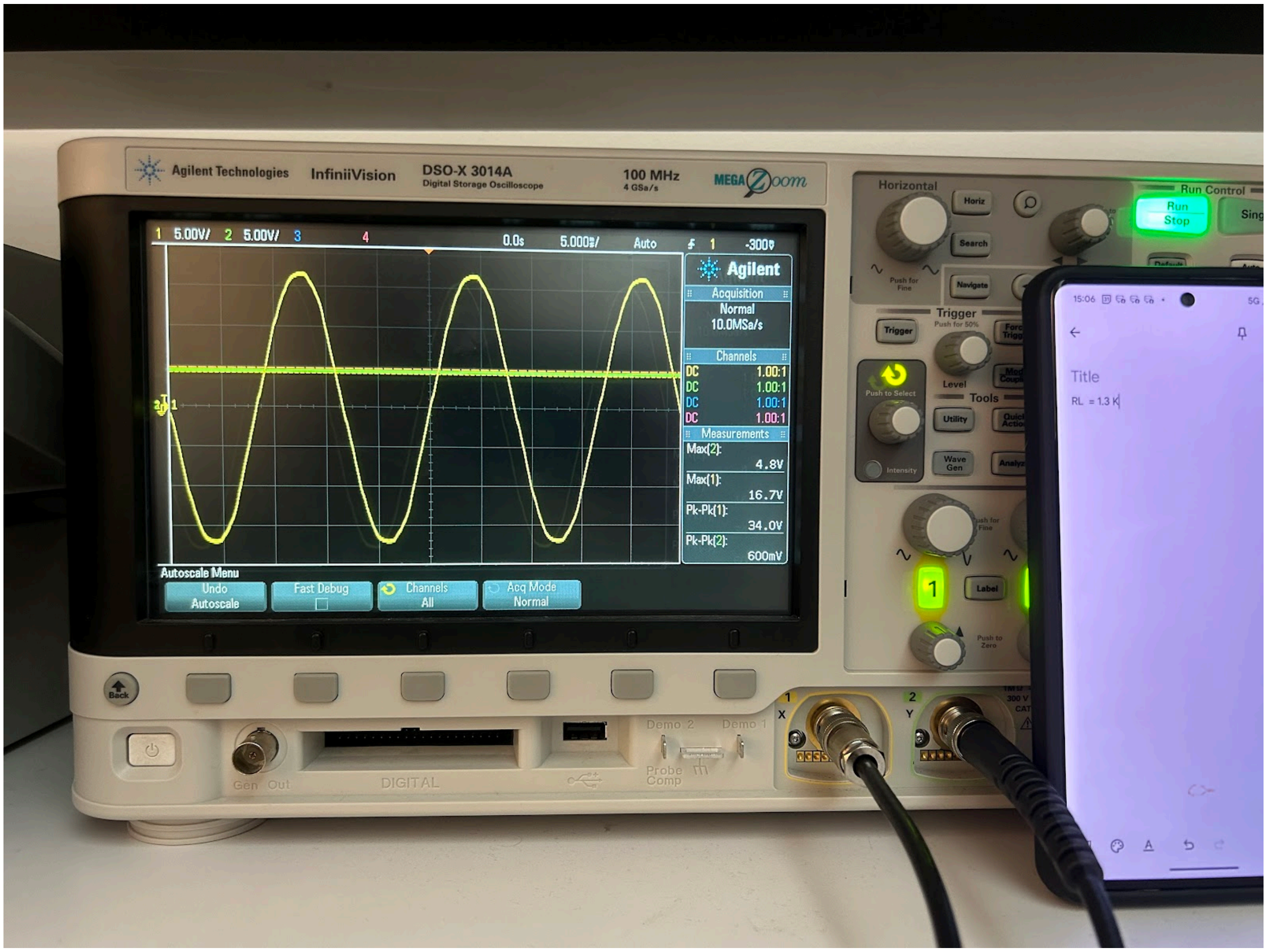

Figure 10: Circuit Response with 1.3K resistor

2K Resistor Pictures:

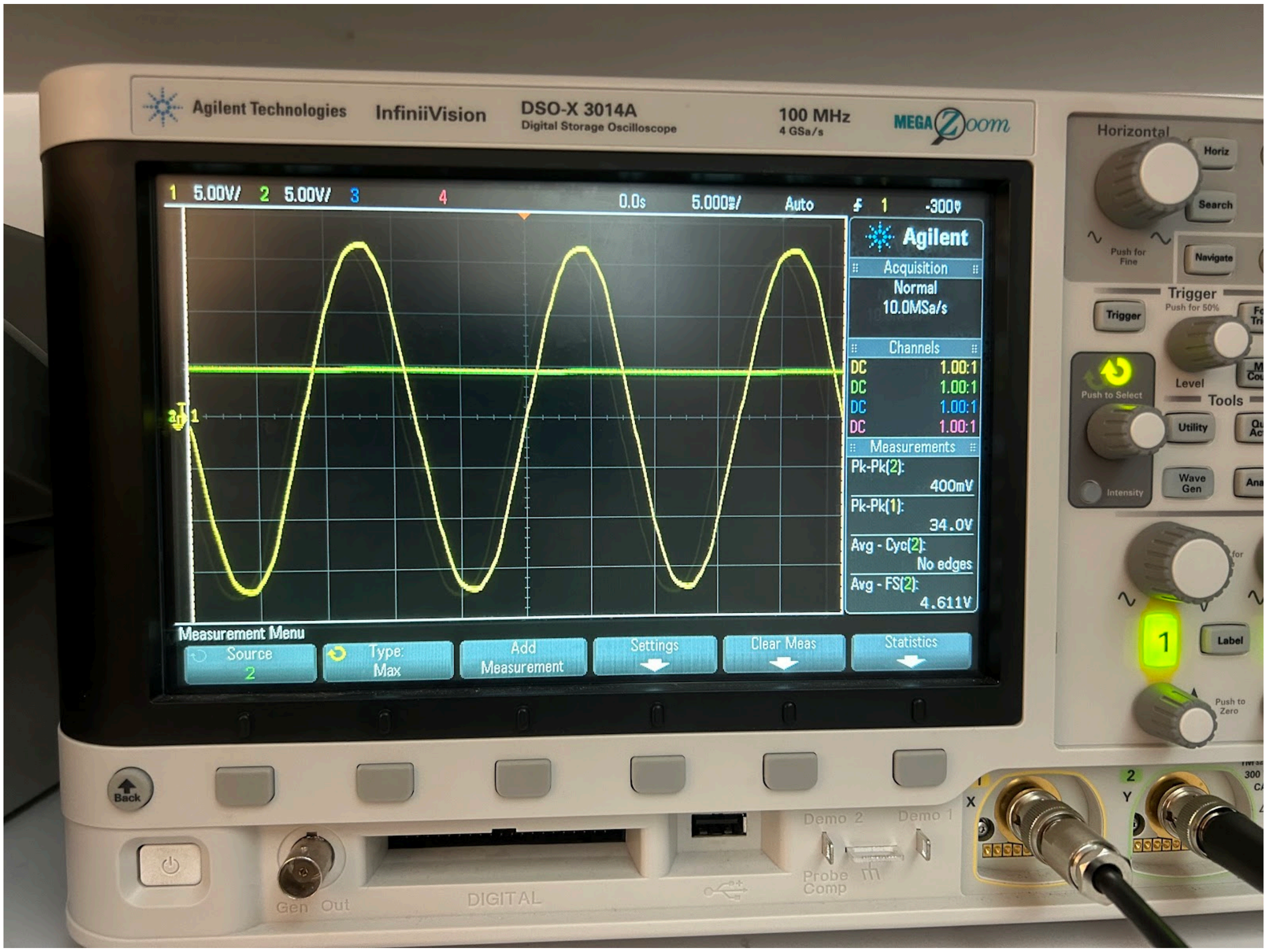

Figure 11: Circuit Response with 2K resistor

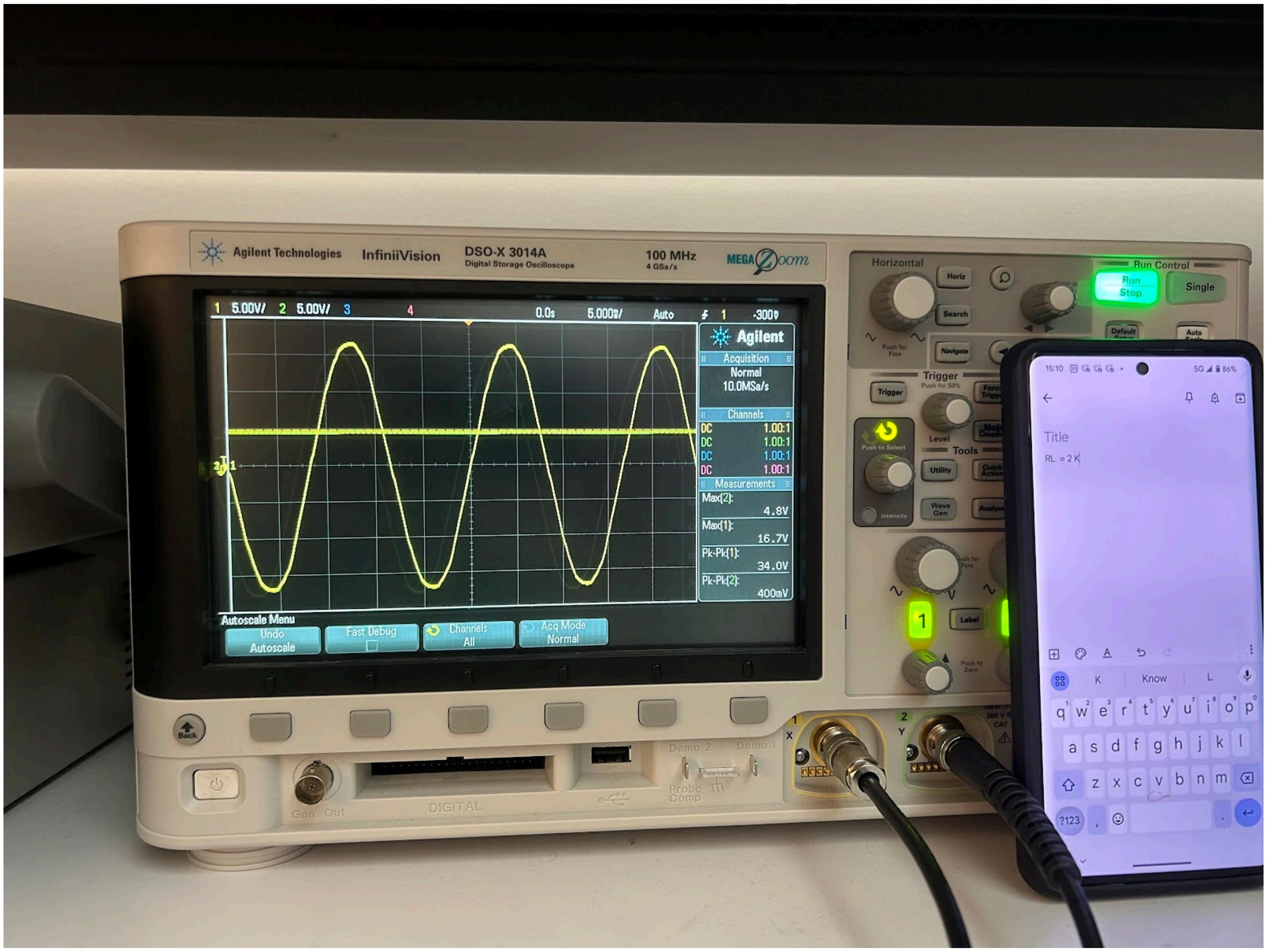

Figure 12: Circuit Response with 2K resistor

2.4K Resistor Pictures:

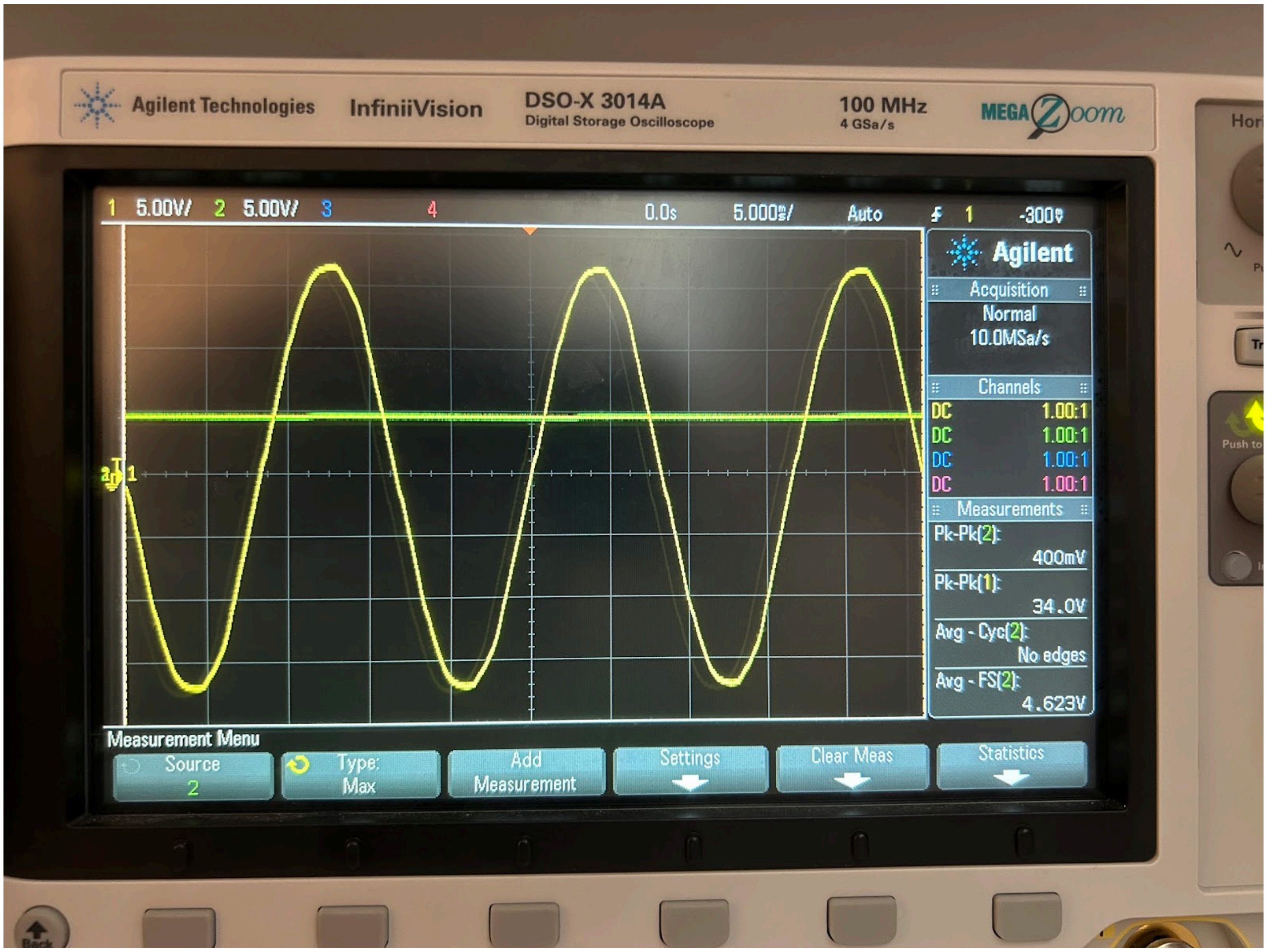

Figure 13: Circuit Response with 2.4K resistor

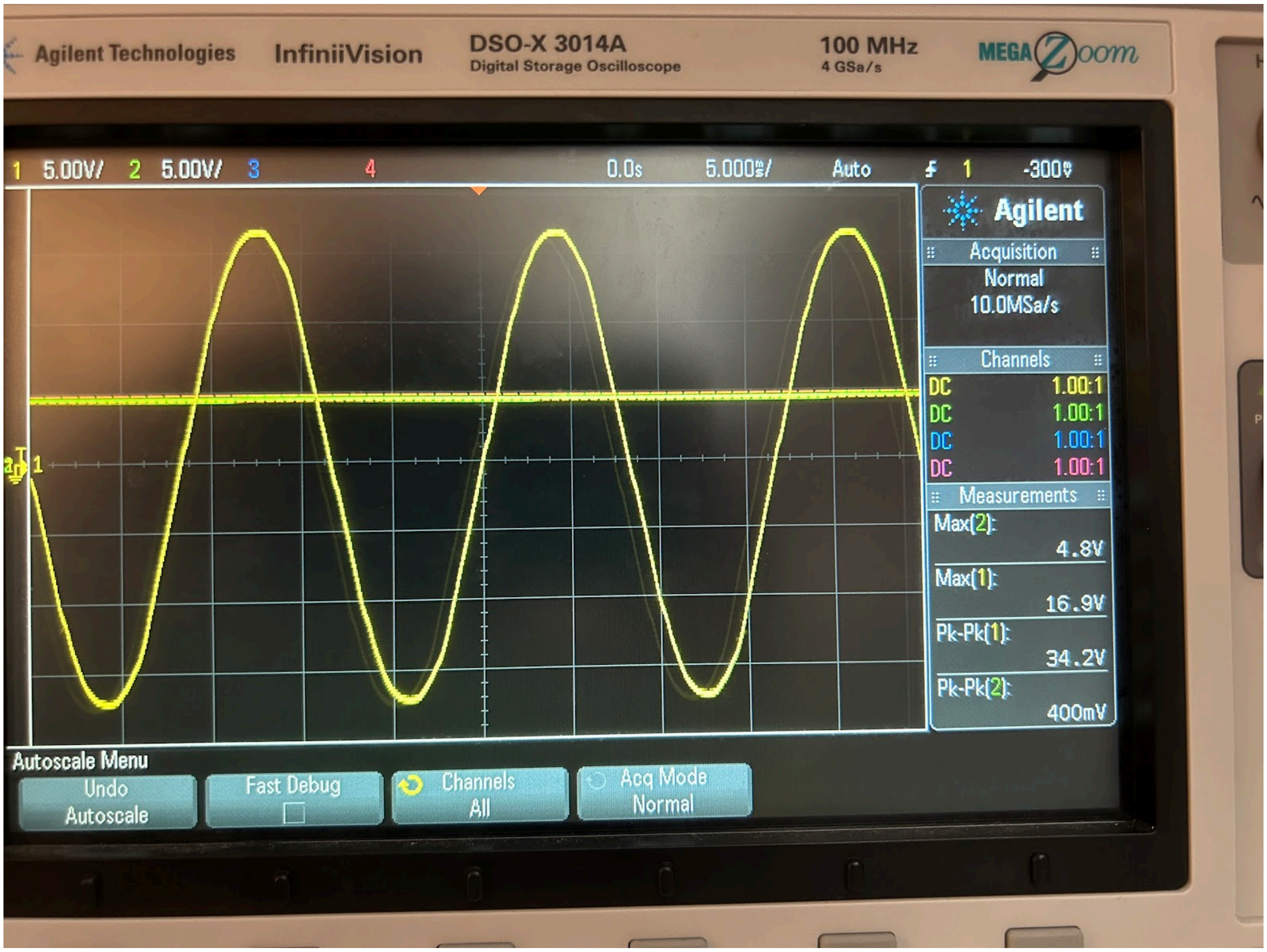

Figure 14: Circuit Response with 2.4K resistor

3K Resistor Pictures:

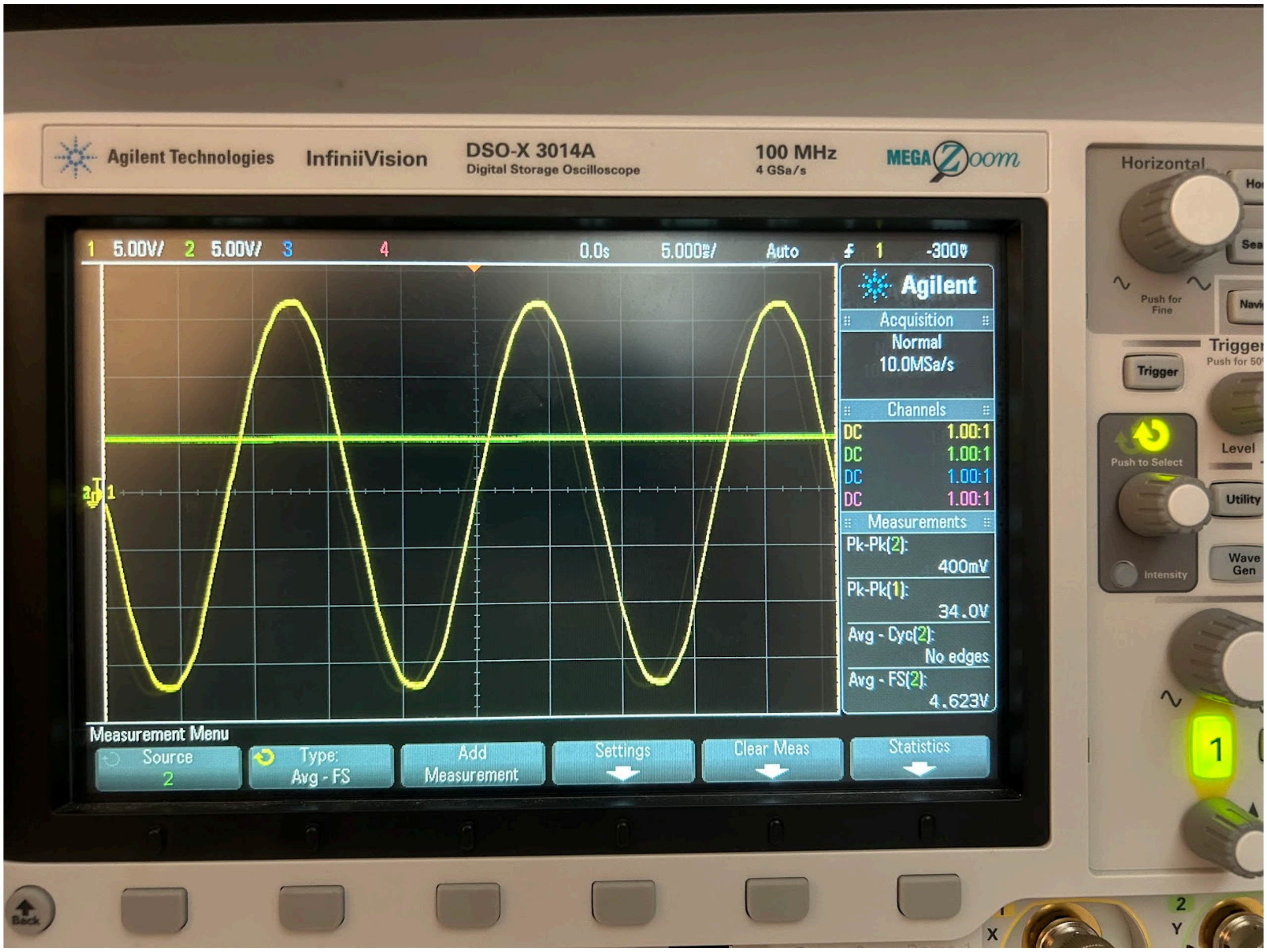

Figure 15: Circuit Response with 3K resistor

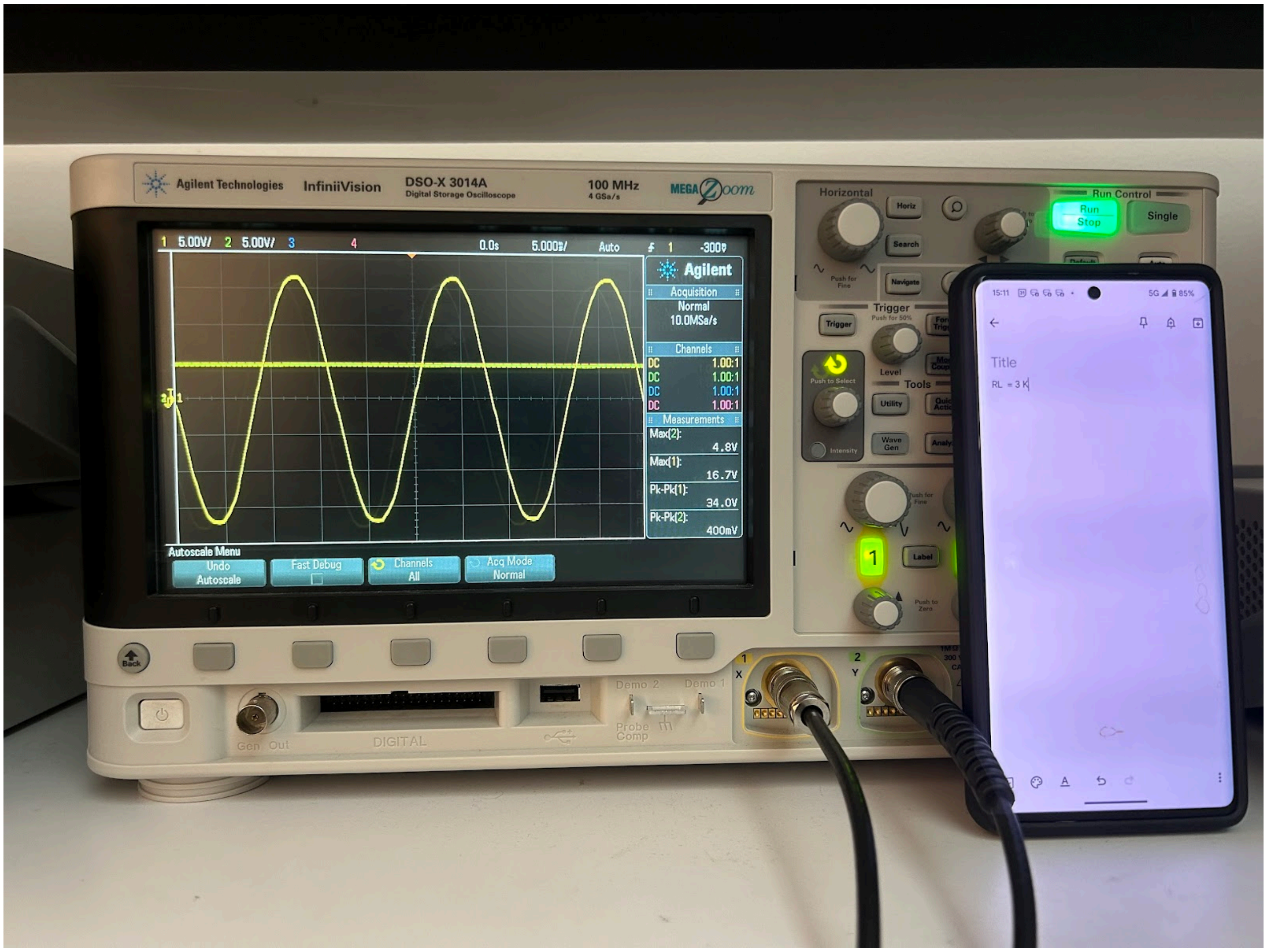

Figure 16: Circuit Response with 3K resistor

Conclusion

In this lab we familiarize ourselves with different rectifiers using two different types of diodes. All measurements were done using lab benchtop equipment and components. We characterized a simple half-wave rectifier with and without a parallel capacitor and measured the ripple of the output voltage in relation to the time constant of the parallel RC element. We then added a zener diode to the circuit and measured the circuit response with different resistance values and found that with the zener diode, the circuit becomes a regulator with with a near constant output voltage even with large swings of current.