Lab Report 1: Lab 1 - 3

Enrique Rivera Jr
Marcus

September 17, 2024

Lab 1: Basic Measurements and Oscilloscope Use

1 Introduction

This lab introduces basic electronic measurement techniques using a multimeter and oscilloscope. The objective is to measure DC and AC voltages, understand the concept of output impedance, and analyze waveforms using a function generator. By constructing simple circuits, we will learn how to measure voltage, current, and impedance, and observe the behavior of waveforms under different conditions.

2 Methods / Notes

2.1 Breadboard Layout and Measurement

Using a multimeter in buzzer mode, we first determined the internal connections of a breadboard. The multimeter's buzzing feature was used to identify connected holes.

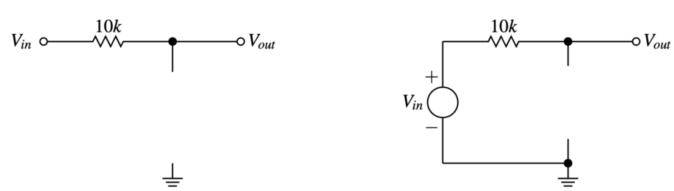

Figure 1: Open Circuit

Figure 2: Closed Circuit

2.1.1 Open and Closed Circuit Measurements

The open circuit was constructed as shown in Figure **??**. The DC power supply was set to 5V, and the voltage was measured across the open circuit using the multimeter. Next, a c losed circuit was constructed, and the current was measured using the ammeter function.

The output impedance Z_{out} was calculated using the formula:

$$Z_{out} = \frac{V_{\text{open}}}{I_{\text{closed}}}$$

2.1.2 Voltage Divider

A voltage divider was constructed using two resistors of equal value (10kΩ each), and the output voltage was measured across the second resistor. The theoretical voltage was calculated using the voltage divider formula:

$$V_{out} = V_{in} \times \frac{R_2}{R_1 + R_2}$$

Both the measured and calculated voltages were recorded.

2.1.3 Function Generator and Oscilloscope

The output of a function generator was connected to an oscilloscope. A 1kHz sine wave with 2V peak-to-peak was generated. The waveform was observed and recorded on the oscilloscope screen. The effect of adding a 50Ω terminator was noted, and both the terminated and unterminated waveforms were sketched and compared.

2.2 Results

2.2.1 (1) Breadboard Layout

The following diagram shows the internal connections of the breadboard. The multimeter was used to map out which holes were connected.

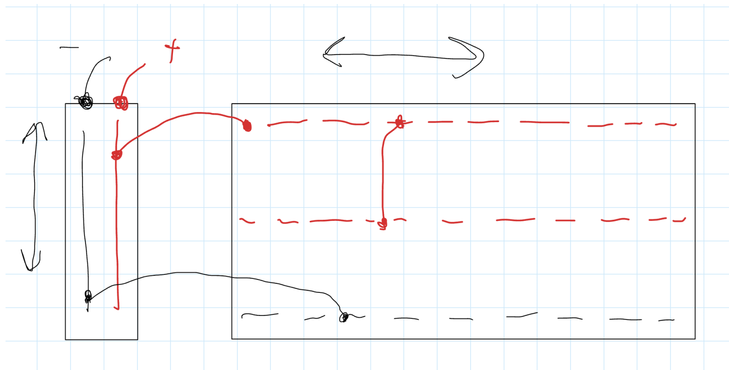

Figure 3: How a breadboard‘s internal connections are laid out.

2.2.2 (2c) Open and Closed Circuit Measurements

The measured open circuit voltage was 5 V and the closed circuit current was 0.5 A. Using these values, the output impedance was calculated to be:

$$Z_{out} = \frac{5\text{V}}{0.5\text{A}} = 10\,\Omega$$

2.2.3 (3) Voltage Divider Results

The measured output voltage for the voltage divider was 2.5 V, matching the theoretical calculation.

Table 1: Voltage Divider Results

V_{in} (V)	V_{out} (Measured) (V)	V_{out} (Calculated) (V)
5	2.5	2.5

2.2.4 (4) Voltage Divider Cases

The following cases were considered for the voltage divider. When R2 $\gg$ R1, the output voltage is approximately equal to the input voltage. When R2 $\ll$ R1, the output voltage is approximately zero.

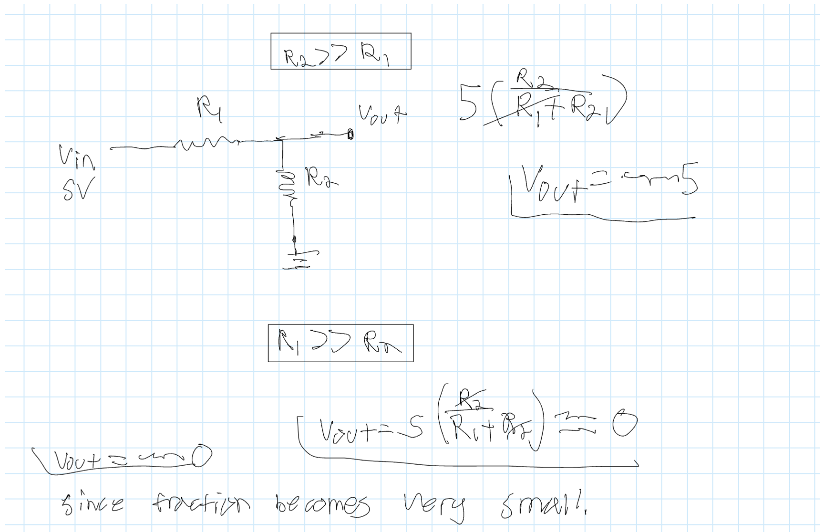

Figure 4: Voltage Divider Cases

2.2.5 (5) Function Generator and Oscilloscope

The following waveforms were observed using the oscilloscope for the function generator output.

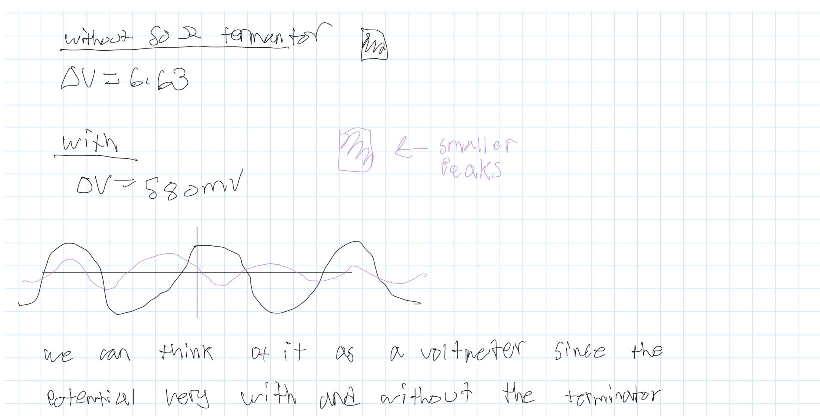

Figure 5: Waveform with terminator connected and disconnected.

2.2.6 (6) Trigger Effect

The trigger effect was observed by adjusting the trigger level and observing the waveform on the oscilloscope.

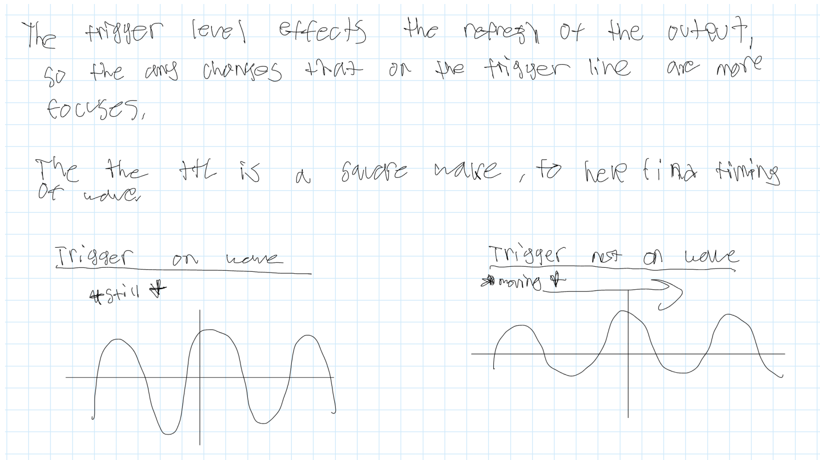

Figure 6: Waveform with Trigger Level adjusted.

2.2.7 (7) DC Offset Effect

The DC offset effect was observed by adjusting the DC offset and observing the waveform on the oscilloscope.

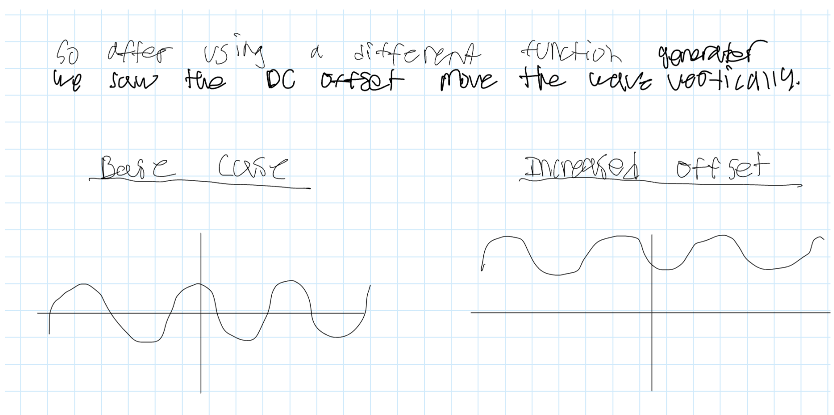

Figure 7: Waveform with terminator connected and disconnected.

2.2.8 (8) Voltage Divider Formula

The DC offset effect was observed by adjusting the DC offset and observing the waveform on the oscilloscope.

$$V_{out} = V \frac{R_{load}}{R_{out} + R_{load}} \qquad V_{out} \approx 38.4\ V \qquad R_1 = 10\ K$$

$$\frac{1}{V_0} \propto \frac{1}{R_{load}}$$

$$\frac{1}{V_0} = \frac{1}{V} \frac{R_{out} + R_{load}}{R_{load}}$$

$$\frac{1}{V_0} = \frac{R_{out}}{V R_{load}} + \frac{1}{V}$$

Figure 8: Derived Voltage Formula.

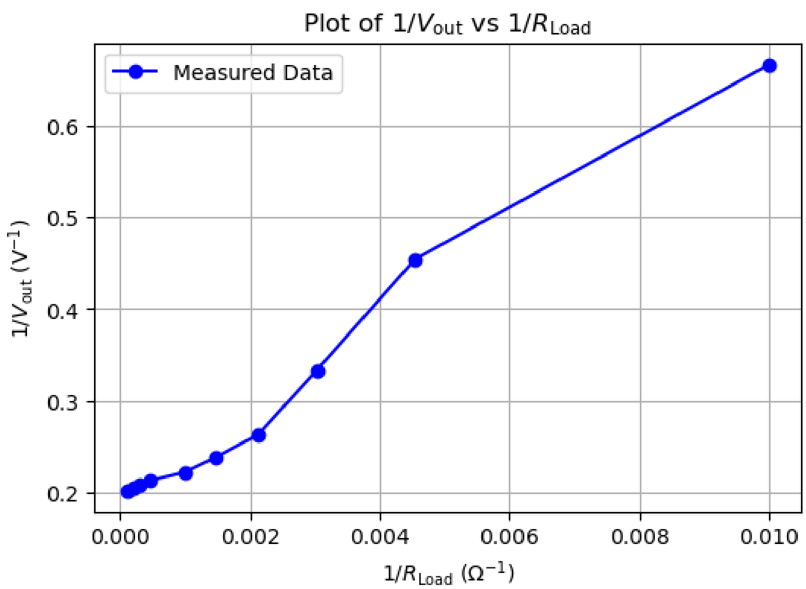

Figure 9: Graph of V_{out} vs. R_{load}

2.2.9 (9) RMS amplitude

	10 HZ	1 KHZ	100 KHZ
sin()	1.04 V	.985 V	0.025 V
square	1.68 V	1.511 V	0.005 V
Triangle	.794 V	.767 V	.254 V

Figure 10: Graph of V_{out} vs. R_{load}

2.2.10 (10) Measured rise (or fall) Time

The rise time was measured to be 0.35 ns.

Lab 2

Lab 3