

Lab 1: Introduction to Equipment

1 Introduction

The purpose of this first lab is to become familiar with the standard equipment of an electronics lab. You will use the multimeter, function generator, and oscilloscope.

2 Accuracy of the Multimeter

Set the voltage on the breadboard to an arbitrary voltage between 10V and 14V. Measure this voltage with at least 5 different multimeters. Optionally, measure the voltage using different probes, wire lengths, voltage ranges, etc. For your report, list your voltage measurements, give the average and the range of values, and from this determine the accuracy of a voltage measurement.

3 Multimeter Loading

Construct the circuit shown in figure 1. (Note that the “resistance of multimeter” is not an actual resistor you put in the circuit; it is the multimeter itself.) Calculate the voltage V if the multimeter wasn't in the circuit. What is the measured voltage V ? For your lab report, calculate the resistance of the multimeter using the measured value of V .

This effect is called “loading”. As an additional demonstration of this effect, try measuring V with two multimeters simultaneously and see how the measured value of V changes. Unfortunately, we can never make truly “ideal” measurements which don't perturb the system we are measuring.

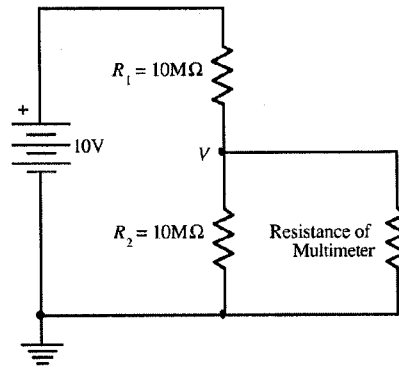


Figure 1: Multimeter equivalent circuit

4 O-scope DC Measurements

Repeat the experiment of section 2 using oscilloscopes instead of multimeters. You only need to use two different 'scopes, but have at least three different people read the voltage for each. For your lab report, list these voltage measurements, their average and their range, and compare the precision of the oscilloscope to that of the multimeter. Repeat the experiment of section 3 using the oscilloscope, with $1M\Omega$ resistors instead of the $10M\Omega$ ones.

5 O-scope AC Measurements

Use a triangle wave of about 1 kHz from the function generator (MAIN output) fed into the oscilloscope (channel 1 input). Try to produce a trace on the oscilloscope that looks as much like the one in figure 2 as you possibly can. For your lab report, record the settings you used on the oscilloscope (horizontal scale,

vertical scale, trigger mode and level, input coupling, and any other setting you think is important). Also record the peak voltages and the frequency of your signal.

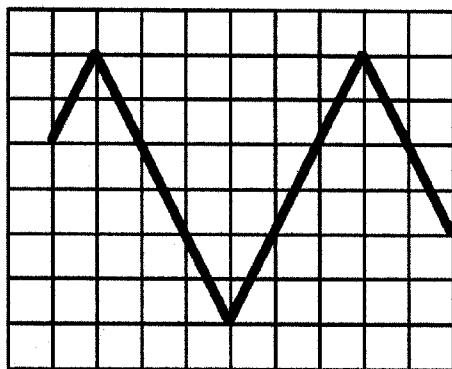


Figure 2: Desired oscilloscope trace

Next, use the function generator's SYNC output as the oscilloscope's channel 2 input. Adjust the oscilloscope's display so that both traces are visible and easy to compare. Trigger on the channel 1 input. For your lab report, draw what you see, labeling each trace appropriately (e.g., peak voltages, voltage and time scales, times of intersects, etc.). Note in particular the phase relationship between the two signals.

Next, replace the channel 2 input with the MAIN output of a different function generator. Try to adjust the function generators so that both traces "hold still". Can you accomplish this? Why or why not?

6 Measuring AC Sine Waves

Recall the general formula for a sine wave:

$$v(t) = V_0 + v_o \cos(2\pi ft) \quad (1)$$

Use the function generator to generate a sine wave with $V_0 = 5V$, $v_o = 3V$, and $f = 7kHz$. For your lab report, give the name of each of these parameters and which function generator knob controls them. Observe this waveform on the scope with the input coupling set to "DC". Pay close attention that you

know where the reference point (i.e. 0V) for the trace is. Measure the three parameters set above. Now change the input coupling to "AC" and repeat the measurements. For your lab report, describe what has changed and describe why having both settings is helpful.

Measure the same sine wave using the multimeter. Try both the DC voltage and AC voltage settings. Does the DC setting give V_0 ? Is the reading steady? Does the AC setting give v_o ? Does it give $v_o/\sqrt{2}$? This is the "RMS" voltage. For a 7kHz signal, the multimeter may not be able to measure the AC signal correctly (You'll learn why in a couple weeks). Try setting $f = 60Hz$. Does the multimeter read $v_o/\sqrt{2}$ now? Can you think of a reason why the multimeter would be optimized for a 60Hz signal?

7 Oscilloscope Test

Call the TA and have them set an secret signal on the function generator. Your task is to use the oscilloscope to determine DC offset (V_0), AC amplitude (v_o), and frequency of the signal. Resist the temptation to use the "AutoSet" button.

8 Oscilloscope Summary

For your lab report, use your own words to describe what the follow oscilloscope settings do:

- horizontal scale
- vertical scale
- trigger mode (i.e. rising or falling)
- trigger source
- trigger level
- input coupling (DC vs. AC)