Phys219_2017 - Ryan Kaufmann/Exp. 0 (Intro to Lab Elect)/Exp 0 Introduction to Lab

SIGNED by Ryan Kaufmann Sep 17, 2017 @06:50 PM PDT

Ryan Kaufmann Sep 17, 2017 @03:20 PM PDT

Experiment #1: Introduction to Laboratory Electronics

Partner: Eric Brock

Rob Kiefl Sep 07, 2016 @10:28 AM PDT

1. Objective

Ryan Kaufmann Sep 11, 2017 @02:08 PM PDT

Understand how to use equipment in the laboratory, including items such as breadboards, oscilloscopes, power supplies, function generators, and digital multimeters. Also understand the types of cables and connectors and where they will connect to.

Rob Kiefl Sep 07, 2016 @10:29 AM PDT

2. Introduction/ Background

Rob Kiefl Sep 05, 2016 @05:56 PM PDT

There isn't much introduction/background/theory for this lab and there isn't really a common theme. So delete this section if you want. But in all future labs you need to include it

Rob Kiefl Sep 10, 2016 @06:05 PM PDT

2.Connectors and Cables

Ryan Kaufmann Sep 11, 2017 @02:43 PM PDT

In order to find which side was the ground and which was the signal, we started by attaching a banana/BNC converter to one end of a BNC cable, leaving the other end untouched and open. After turning on the multimeter and setting it to an Ohmmeter, we then attached a one cable to one of the converter's prongs (the one without the extended plastic) and the input for the multimeter. The other cable was attached to the output of the multimeter and the outside and inside cables of the BNC cord. The process was repeated for the other prong. This helped us determine which prong was the ground and which was the signal. We knew that the signal ran through the inside cable of the BNC cord and that the ground was on the outside. So then when we received a value on the Ohmmeter, we knew that the prong was connected to a certain cable on the BNC cord. That is, if a prong and the inner cable were attached to the Ohmmeter and the Ohmmeter showed a reading, we knew that the prong was the signal. We believe this worked because the cable has a small amount of resistance that the Ohmmeter detects when the circuit is completed. When the Ohmmeter read a resistance, the circuit must have been completed and the cable and prong that were attached to each other were both linked to the multimeter.

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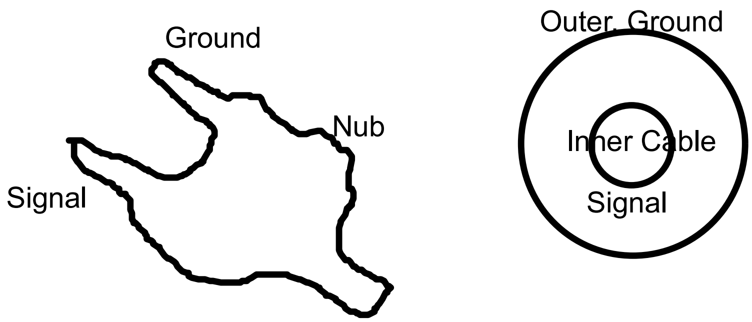
Ryan Kaufmann Sep 11, 2017 @02:47 PM PDT



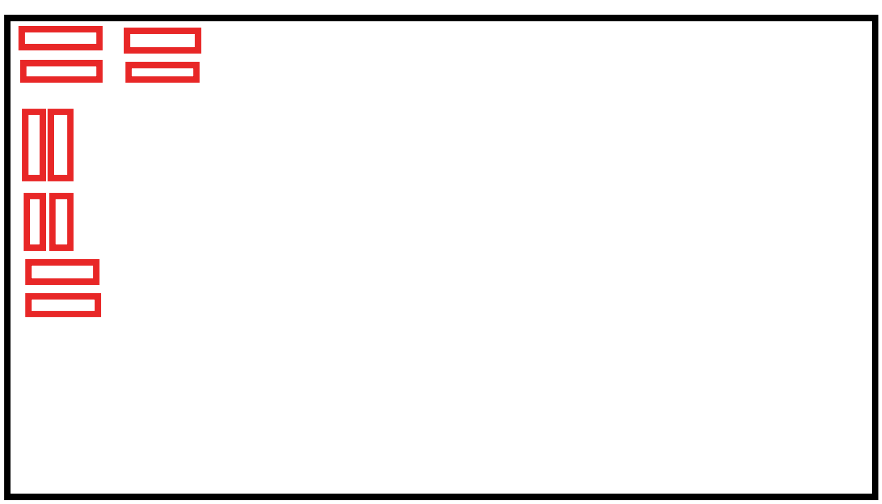
Rob Kiefl Sep 10, 2016 @06:04 PM PDT

3. Prototype Board

Ryan Kaufmann Sep 11, 2017 @03:04 PM PDT

We started this section by turning our multimeter to continuous. This would tell us if the the two connections complete a circuit. We then attached on side of the multimeter in a stationary wire that we placed onto one of the long columns on the breadboard. We grouped the breadboard into distinct categories based on how it was broken up on the board (e.g. the isolated groups of five, the two long sets in the middle, etc.). The other side of the multimeter was attached to another wire which we used to test connections. We then tested six different holes on the breadboard for one stationary wire before moving it. The first three were in the same group as the stationary wire: same row, different column; different row, different column; and different row, same column. It wouldn't make sense to test same row and same column as that would be the same hole which is connected to itself and cannot fit another wire. After these three, we tried different groups, one in the second large column, one on the isolated group, and one on the second breadboard. We then moved the wire to another group of wires and tested the six spots to the best of our abilities. We found the the wires were connected as so:

Ryan Kaufmann Sep 11, 2017 @03:05 PM PDT



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Ryan Kaufmann Sep 11, 2017 @03:07 PM PDT

The breadboard was set up so that in the long columns, the pockets were connected along the short rows of five but not connected outside the column, even to the other long column. Additionally the isolated groups of five were connected only in their isolated groups, so again five each, and not connected outside of those five. Finally, of course, the breadboards were not connected to one another.

Rob Kiefl Sep 10, 2016 @06:05 PM PDT

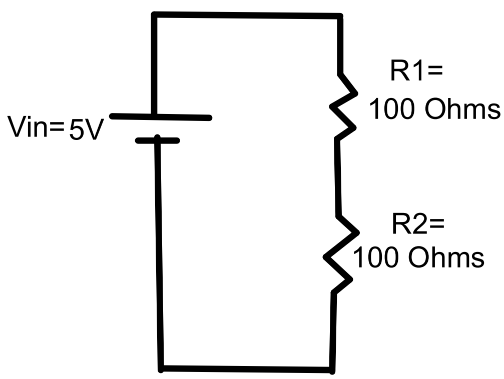
4. DMM and Derived Uncertainties

Ryan Kaufmann Sep 11, 2017 @03:34 PM PDT

4.1 Voltage Divider

Show circuit diagram and give expressions of V_{out} as a function of R_1, R_2, and V_{in}

Ryan Kaufmann Sep 11, 2017 @03:37 PM PDT



Ryan Kaufmann Sep 11, 2017 @03:54 PM PDT

$I = \frac{V_{in}}{(R_1 + R_2)}$ $V_{out} = IR_1 = \frac{V_{in}R_1}{(R_1+R_2)}$

Rob Kiefl Sep 05, 2016 @05:58 PM PDT

4.2 Measurements

Give measurements of all quantities: R_1,R_2, V_{out} and V_{in} with uncertainties

show calculation for how you determined uncertainty in expected value for Vin

Ryan Kaufmann Sep 17, 2017 @01:31 PM PDT

$R_1 = 97.675 \pm 0.001$ $R_2 = 97.745 \pm 0.001$ $V_{in} = 5.0095 \pm 0.0001$ $\sigma_{V_{out}expect} = \sqrt{(\sigma_{V_{in}}\frac{R_1}{R_1+R_2})^2+(\sigma_{R_1}\frac{V_{in}(1-R_1)}{(R_1+R_2)^2})^2+(\sigma_{R_2}\frac{-R_1V_{in}}{(R_1+R_2)^2})^2}$ $\sigma_{V_{out}expect} = \sqrt{(0.0001\frac{97.675}{97.675+97.745})^2+(0.001\frac{5.0095(1-97.675)}{(97.675+97.745)^2})^2+(0.001\frac{-97.675*5.0095}{(97.675+97.745)^2})^2}$ $\sigma_{V_{out}expect} = 0.000053$ $V_{outexpect} = 2.503900 \pm 0.000053$ $V_{out} = 2.5050 \pm 0.0002$

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4.3 Comparison of Expected V_{out} with Measured V_{out}

Our expected V_{out} and measure V_{out} are pretty close to each other. Both are in one standard deviation of each other, meaning that they are within the 68 percentile of each other. That is, the values are fairly close to each other. We can also look at the T-scores between the two values.

Ryan Kaufmann Sep 17, 2017 @01:35 PM PDT

t =\frac{| V_{outexpect} - V_{outmeasure}|}{\sqrt{\sigma_{V_{out}expect}^2 + \sigma_{V_{out}expect}^2}} t = \frac{|2.5039 - 2.5050|}{\sqrt{0.000053^2 + 0.0002^2}} t = \frac{0.0011}{0.00021} t = 5.3165

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We received a T-score of 5.3165. Since our T-score is much more than 1, we can conclude that there is some difference in our expect value and our measured value. This may be because of our negligence of the resistance of wires or other uncertainties.

Rob Kiefl Sep 07, 2016 @10:30 AM PDT

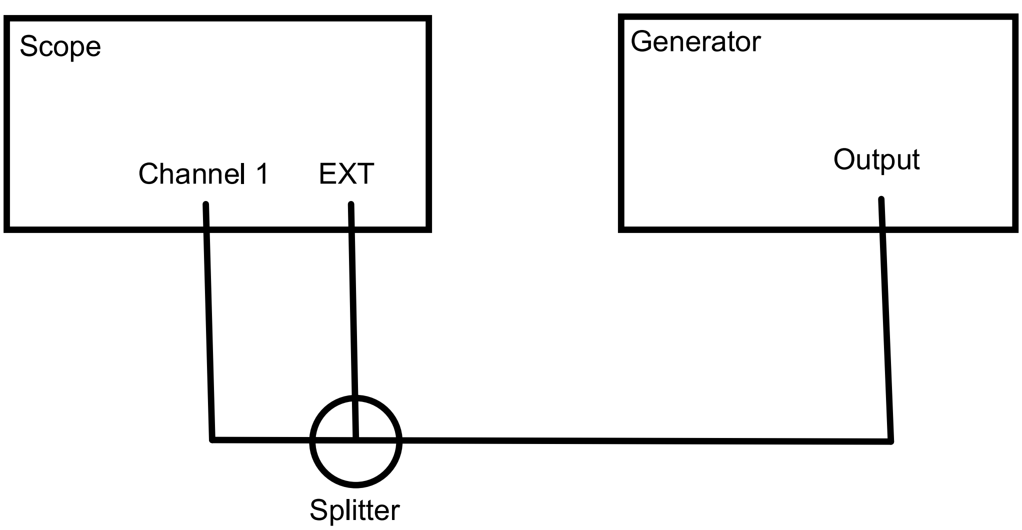
5. Oscilloscope and Function Generator

Ryan Kaufmann Sep 17, 2017 @12:22 PM PDT

5.1 Basics

We set up the oscilloscope and function generator as in the instructions. The output of the generator was plugged into a splitter. One end of the BNC splitter was plugged into the Channel 1 input, and the other was plugged into the EXT input, both on the oscilloscope.

Ryan Kaufmann Sep 17, 2017 @12:26 PM PDT



Ryan Kaufmann Sep 17, 2017 @12:22 PM PDT

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We first started looking at the controls of the oscilloscope. We found the switches to increase and decrease the scale of the vertical and horizontal areas of the graph. Furthermore, we found that by moving the trigger up and down, we could change where the center of our graph was located.

Ryan Kaufmann Sep 17, 2017 @12:41 PM PDT

After we learned how to navigate the graph of the oscilloscope, we dived into figuring out the trigger system. We saw earlier as we explored, that if the trigger was set above the voltage the generator was outputing at, the graph just flew by, as if it was updating in real time. However, when we moved the trigger down into the graph, it seemed to stop updating. Further investigation showed us that it was actually still updating, but the image was staying fairly homogeneous. In fact, it kept updating the image every time the trigger was signaled, that is it hit the voltage identified by the trigger.

Rob Kiefl Sep 05, 2016 @05:58 PM PDT

5.2 Measurements Using Scope

Ryan Kaufmann Sep 17, 2017 @02:55 PM PDT

We then explored how to take measurements on the oscilloscope. We first looked at the differences between measuring using the built in functions and using our own sight. We noticed some uncertainty in the measurements, either by how we were taking them or how the oscilloscope was fluctuating, and gave them a random error (0.4V, 0.04ms, and 0.08V for cursor voltage, automatic period, and automatic voltage, respectively). Then we looked at the machine's uncertainty and combined this with our random uncertainty. The oscilloscope had a manufacturer uncertainty of ±((3% reading + 0.1div + 1mV) + 50mV) in voltage and none in time. After combining we got the following:

	Period	**Vpp**
Cursor	1.000 ± 0.001 ms	3.8 ± 0.665V
Automatic	1.000 ± 0.04 ms	4.12 ± 0.3546V

We also looked at the uncertainty in the function generator. The manufacturer uncertainty of the generator was ±100ppm, or ±0.0001%, in voltage and ±(1% setting + 1mVpp) in time. Thus we receive the following:

	Period	**Vpp**
Function Generator	1.000000 ± 0.000001 kHz	4.000 ± 0.041V

What we find is that the function generator has a much lower uncertainty than the oscilloscope and so we can trust its measurements more than the oscilloscope.

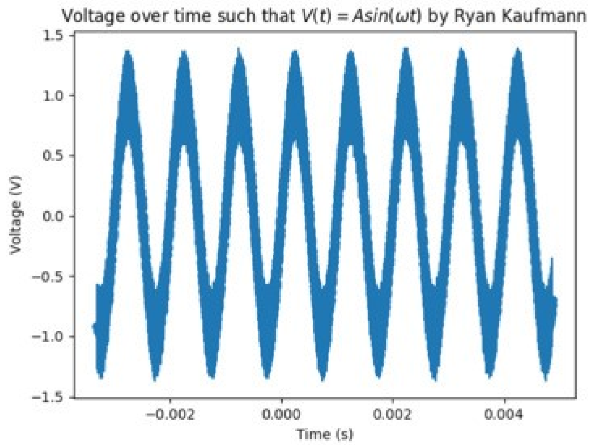
Ryan Kaufmann Sep 17, 2017 @05:21 PM PDT

We then explored exporting and analyzing data. We set our function generator to output at a peak to peak amplitude of 2 Volts at a frequency of 1kHz. We then checked to oscilloscope confirm these settings, which was accurate. This gave us the following data and plot:

Ryan Kaufmann Sep 17, 2017 @03:20 PM PDT

sin_1kHz_2V_1.csv(39.8 KB)

Ryan Kaufmann Sep 17, 2017 @03:59 PM PDT

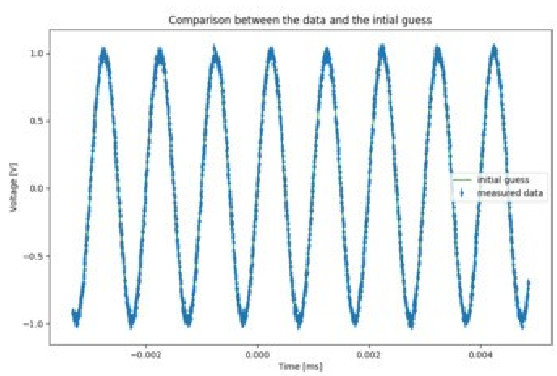


sin1kHzV1.png(41.4 KB)

Ryan Kaufmann Sep 17, 2017 @05:02 PM PDT

We then started to analyze the data. First, we ran the data through a curve fit in python, getting the following plot:

Ryan Kaufmann Sep 17, 2017 @05:02 PM PDT



sin1kHzV1curvefit.png(87.9 KB)

Ryan Kaufmann Sep 17, 2017 @05:29 PM PDT

At the moment, it seems like it is a good fit. It follows the data seemingly precisely. Looking at our residuals plot, 83.3% of the data fits within one standard deviation of the graph. The residuals seemed randomly scattered and centered at 0 as well. We changed the code however to have a sigmay of 0.0205. This gave us the approximate deviation of the points. Using this code, we received an amplitude of 0.98882 ±0.00064V, a frequency of 1000.05 ±0.04Hz, a phase of 0.03635 ±0.00068, and a y-offset of 0.01084 ±0.00045V. These parameters gave us a chi-squared of 1.1074. The sigmay differs a slight bit from the specifications of the slope. This may be because a couple of things, including resistance in the BNC wire, or uncertainty with the function generator.

Ryan Kaufmann Sep 17, 2017 @05:58 PM PDT

We analyzed a second group of imported data. We received the following numbers, along with the older parameters:

	Old Data	**New Data**
Amplitude	0.9888±0.0006V	0.9897±0.0007V
Frequency	1000.05±0.04Hz	999.993±0.047Hz
Phase	0.03635±0.0007	0.0427±0.0007
Y Offset	0.0108±0.0005V	-0.0019±0.0005V
Chi^2	1.1074161	1.0558817

These values are not only close to each other, but they are also accurately match the function generator's settings.There is a bit of error and they don't exactly match. This error may be because of differences in the function generator not putting out an accurate sinusoidal function, or small imperfections in the wire that we use.

Rob Kiefl Sep 10, 2016 @06:06 PM PDT

6. Conclusions

Ryan Kaufmann Sep 17, 2017 @06:50 PM PDT

In this lab, we learned and recalled some of the basics of making and handling circuits and associated equipment. We learned the basics of all the cables that we would be using. We also found how the breadboard connects and how we can create basic circuits. Then we dived into measuring circuits. Along with understanding the basics of multimeters and power suppliers. This was simple as it was just plugging in our wires and cables into the appropriate slots. The harder instruments were the oscilloscope and function generator. We quickly grasped how the oscilloscope worked in conjunction with the function generator. We went through the controls for triggers and scales and learned how to make measurements both using the oscilloscope and our cursor. Finally we explored exporting and analyzing data, including using python to fit curves and the variables associated with it.

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