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Original Work

ABSTRACT

This Original Work is a lab investigation of the different elements an oscilloscope can measure. Since oscilloscopes are instruments used to measure electrical signals in response to physical stimuli, I will be testing signals and measuring the period, frequency, amplitude, and wave shape of different signals. The result of my original work will represent a comprehensive investigation of how I measured these variables, what their graphs mean, and how this information can be useful in the real world.

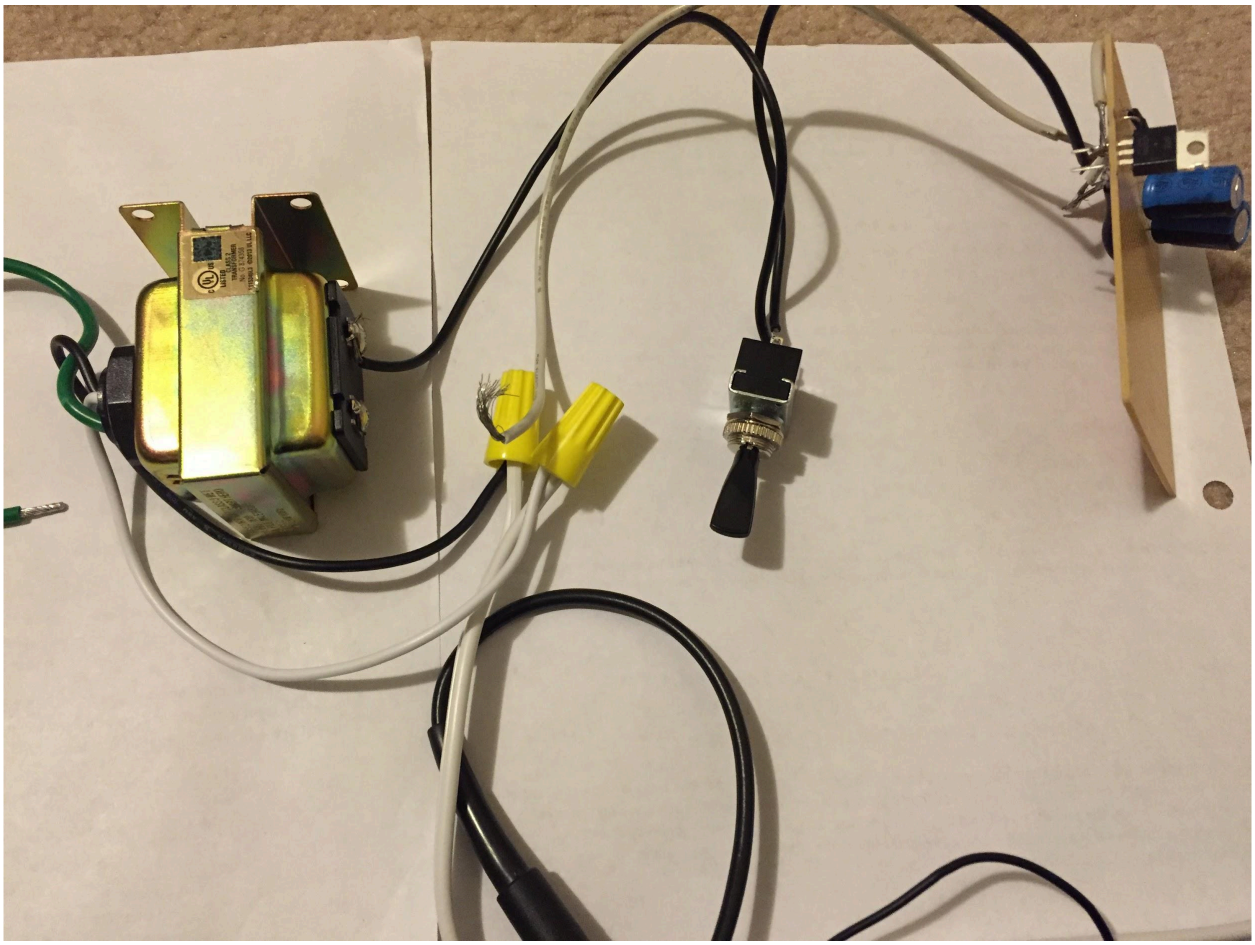
The purpose of this lab investigation involves two parts. One half is to increase my knowledge of this fundamental aspect of electrical engineering; the other is experiencing the process of a hands-on approach. Looks can be deceiving, as I am dealing with one instrument and gathering data over simple variables. However, what I hope to gain is the experience of converting a theory into a result. Not only will I learn how to overcome technical problems that aren't always visible, but also, I will better understand the fundamental process an electrical engineer encounters. This aligns with the goals of original work because I will need to infer reasons behind the data and experiment with an unfamiliar problems.

After understanding what it can measure, I plan to explore how an oscilloscope can be applied to the real world. I will gain insight into the creativity of using, versus having, knowledge. This could potentially lead to an idea for final product, as I will try to propose additional methods of using oscilloscopes in the real-world.

MATERIALS

Oscilloscope, probe, wall outlet, camera, transformer, 2 capacitors, switch, set of diodes, rectifier, extension cord

PROCEDURES



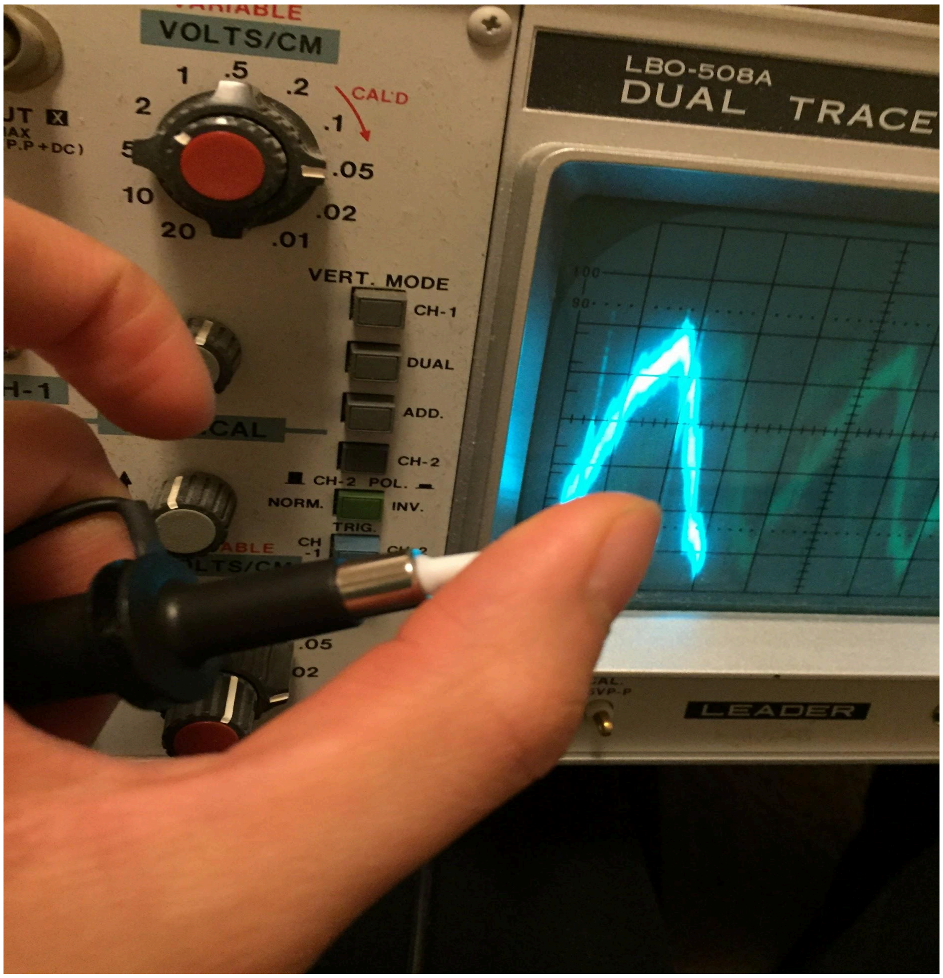
(Schematic diagram of circuit)

1. Turn on oscilloscope and attach to power source.
2. Attach the probe into the input junction and connect probe with source signal.
3. Adjust intensity and focus until beam is visible and clear.

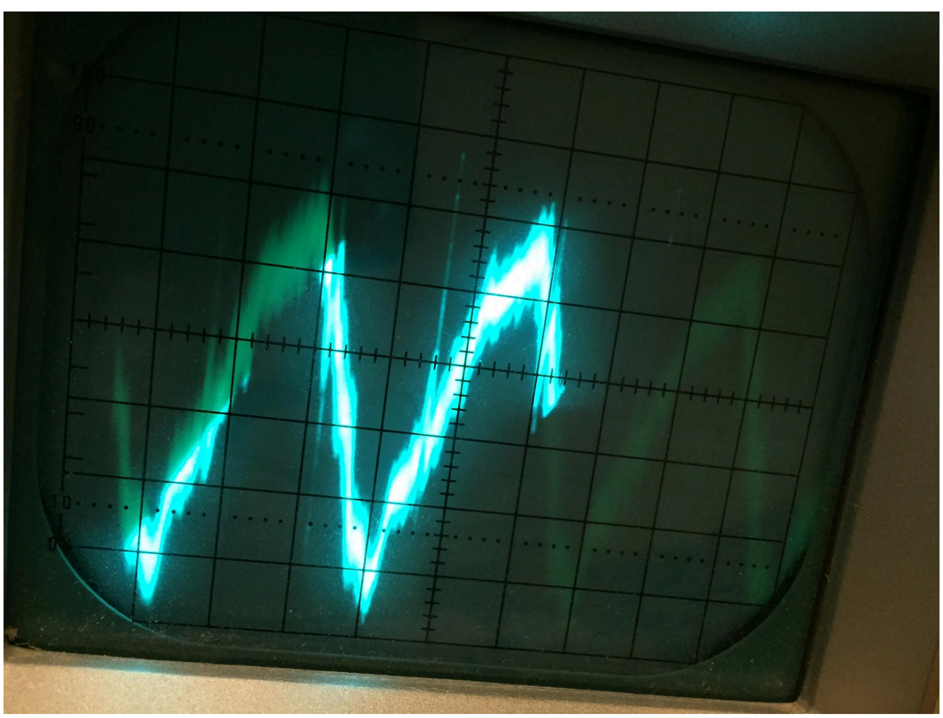
4. Adjust the y-axis of the graph (vertical controls>Channel 1>VOLTS/CM) until amplitude is measurable.
5. Under vertical controls, select DC or AC (depending on source) from the input-coupling switch.
6. Adjust the x-axis of the graph (horizontal controls>Channel 1>TIME/CM) until period is measurable.
7. Capture image of the signal’s graph.

DATA

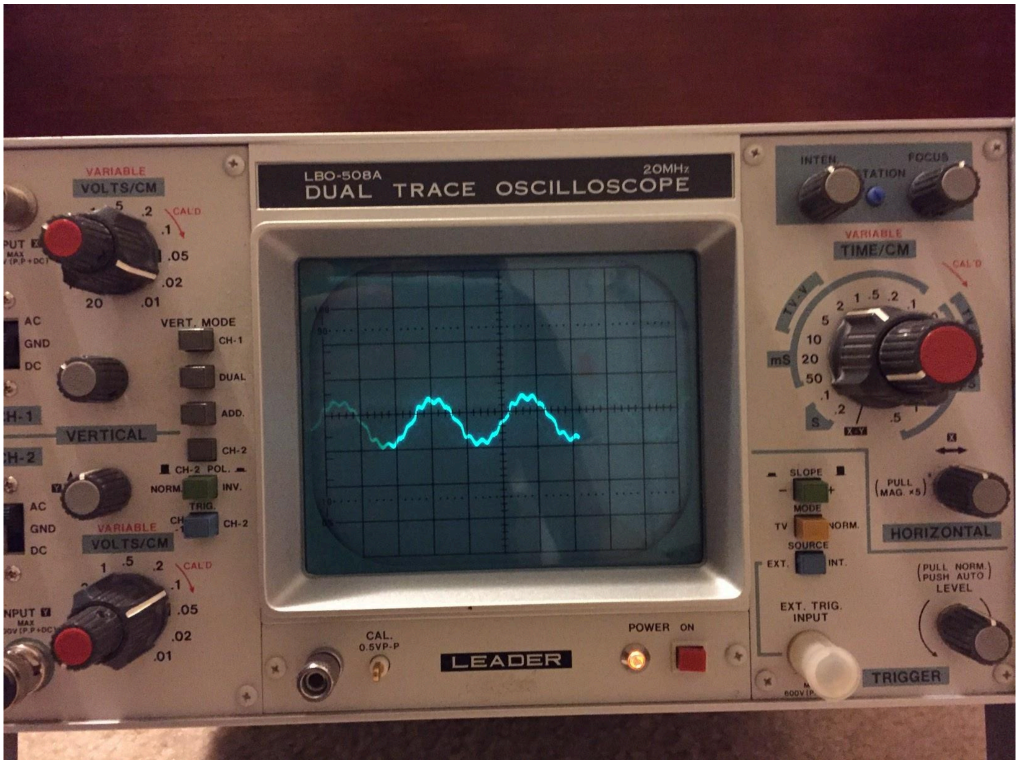
Source 1: Contact with skin

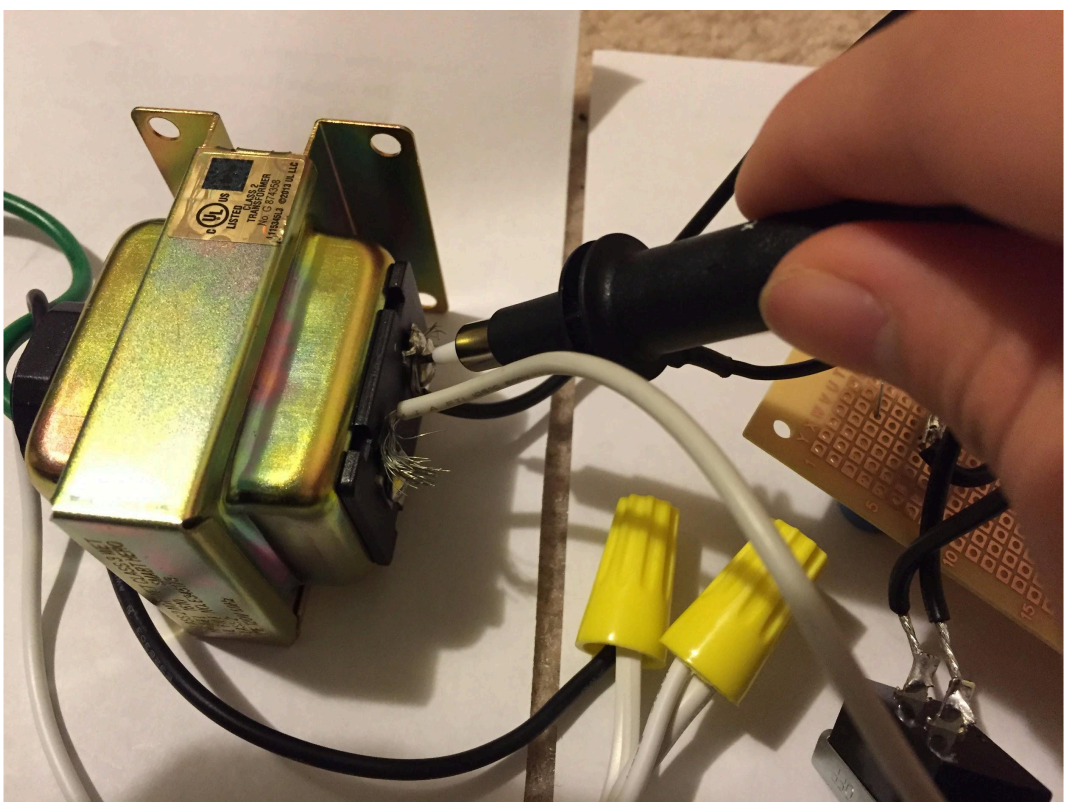



20MHz
OPE
INTEN.
ROTATION
FOCUS
VARIABLE
TIME/CM
CAL'D
TV-V
TV-H
mS
S
X-Y
SLOPE
MODE
TV
NORM.
SOURCE
EXT.
INT.
EXT. TRIG.
INPUT
(PULL MAG. ×5)
HORIZON
(PULL NORM.)
(PUSH AUTO)
LEVEL
TRIGGER

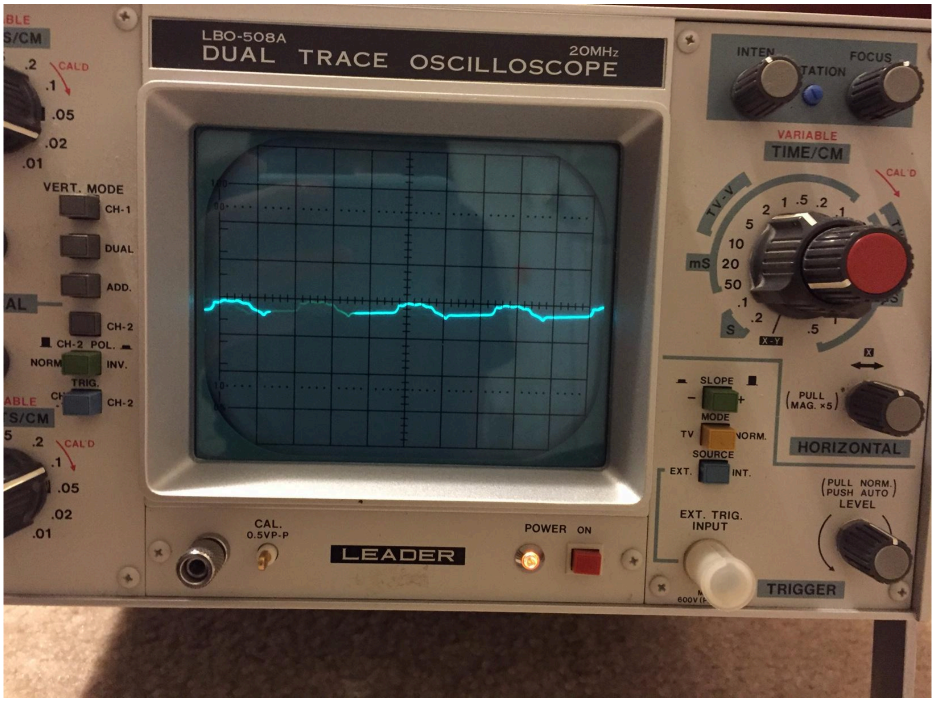


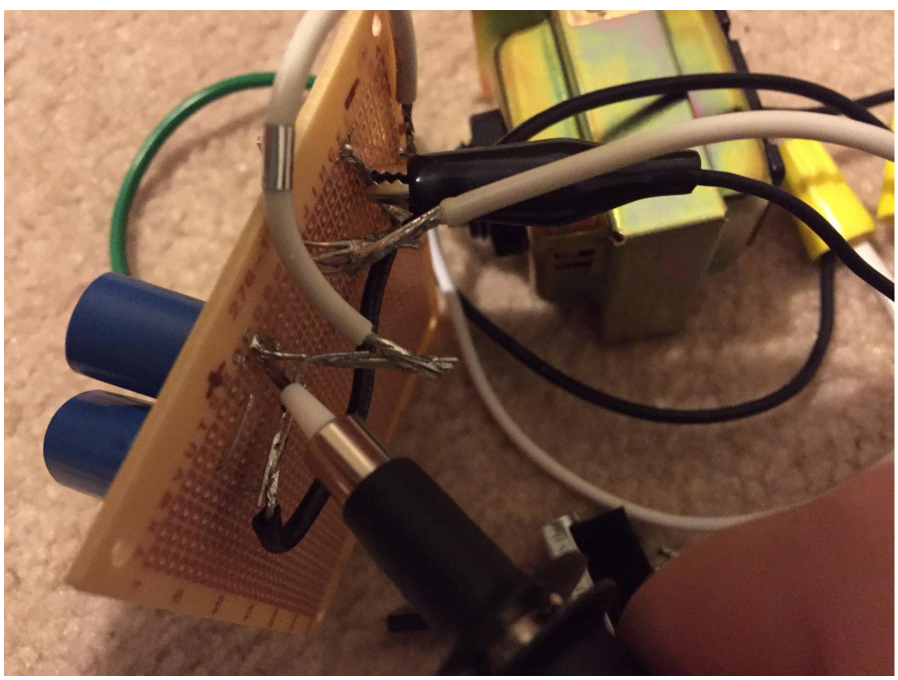
Source 2: Transformer

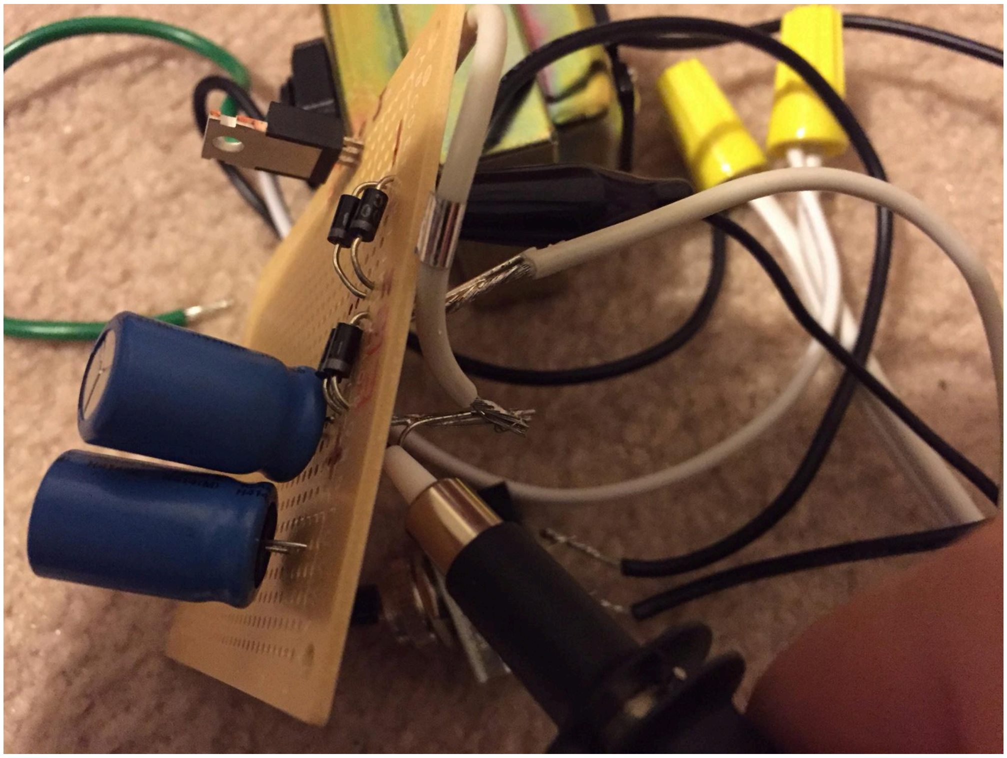




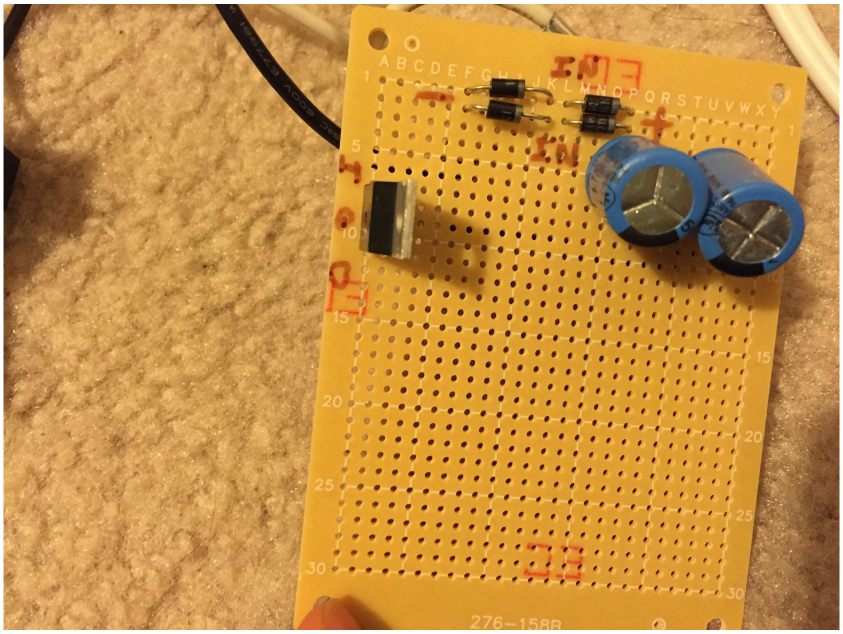
Source 3: Diodes



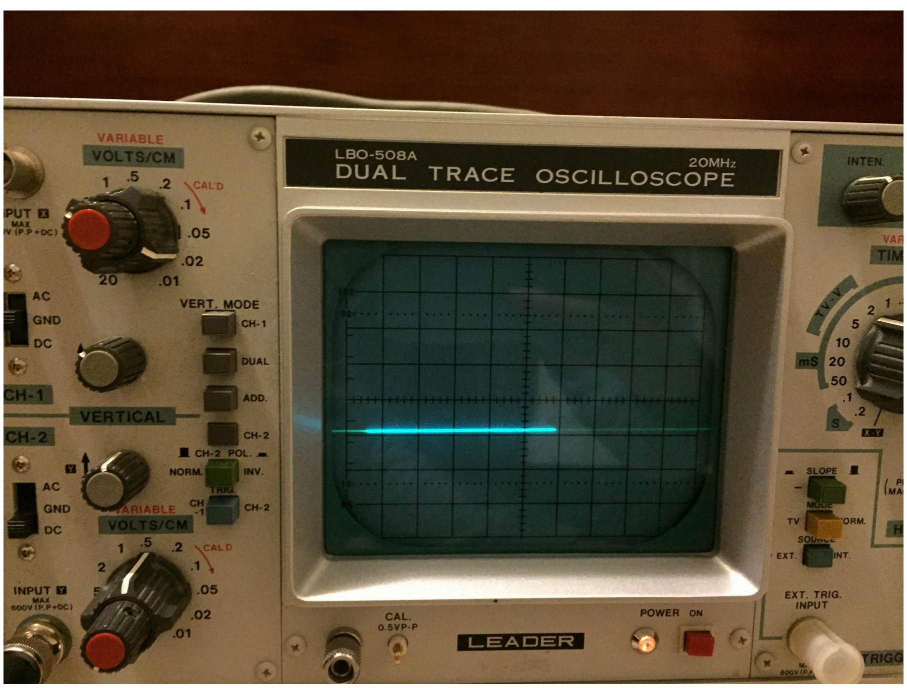




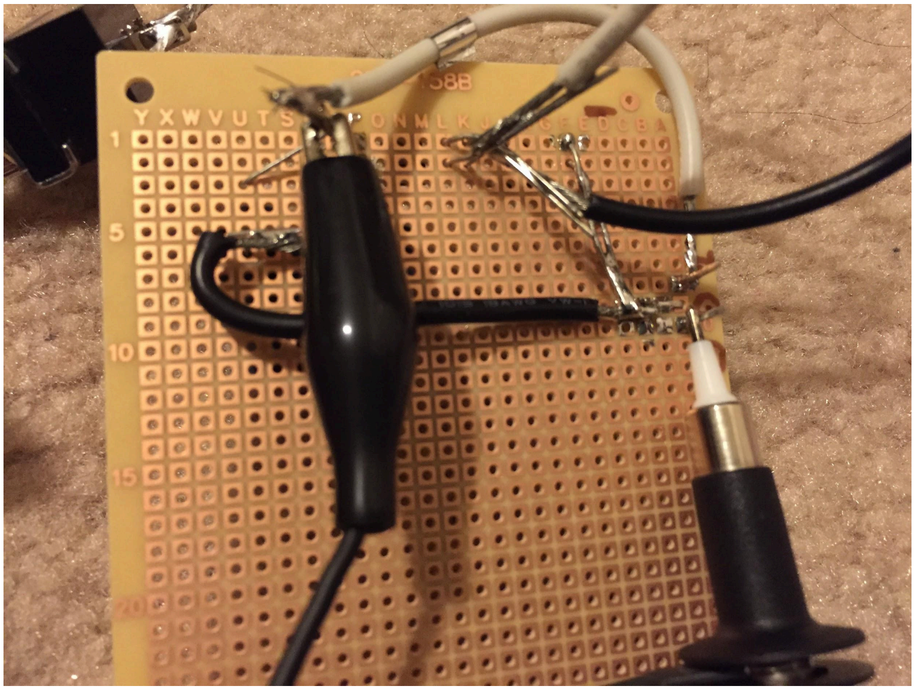
Source 4: Capacitor

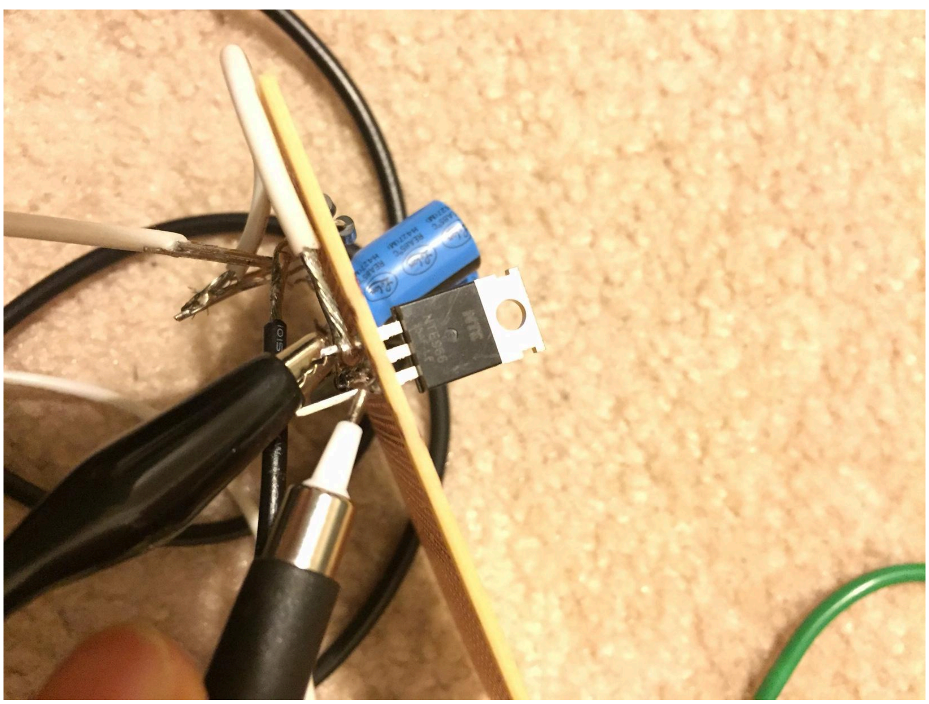


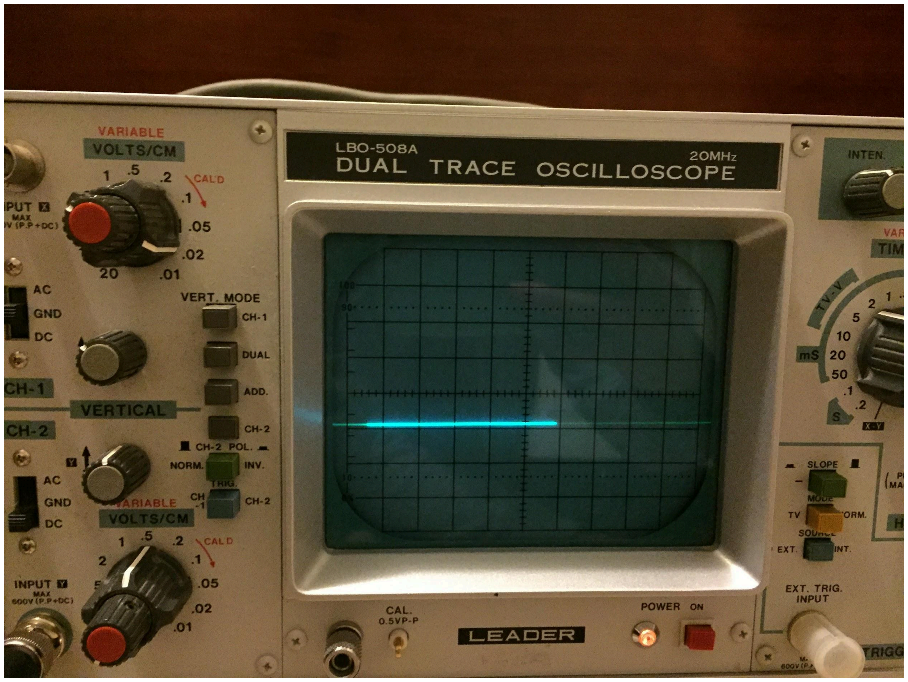
The blue cylinders are the capacitors. The four, black, small cylinders are the diodes (labeled with input location and negative and positive sides). The box to the left is the rectifier. The rectifier has three segments, labeled as I (input), G (ground), and O (output).



Source 5: Rectifier







LBO-508A
20MHz
DUAL TRACE OSCILLOSCOPE
VARIABLE
VOLTS/CM
CAL'D
AC
GND
DC
VERT. MODE
CH-1
DUAL
ADD.
CH-2
VERTICAL
CH-2 POL.
NORM.
INV.
INPUT
INTEN.
mS
X-Y
SLOPE
TV
EXT.
INT.
EXT. TRIG.
INPUT
CAL.
0.5VP-P
LEADER
POWER
ON

ANALYSIS:

Source 1: Contact with skin

This source produced the a surprising result from the graph displayed from contact with skin (in this case, a finger). I had not expected any noticeable signal from my finger, but I ended up recording a frequency of 60 Hz and an amplitude of .06 V. The most likely reason for this graph is that the conductive properties of skin and the leads of the oscilloscope created a loop antenna, receiving the electric field surrounding me, or power line noise, as most wall outlets display a frequency of 60 Hz.

To find the period and frequency, after adjusting the x-axis to 5 ms and the y-axis to .02 V, I located the peak and trough of the signal and recorded the distance between the two x-points (as the horizontal axis has increments of five within each tick mark, resulting in a small increment of 1 ms per subdivision). To find the amplitude, I checked the vertical points of the peak and trough and halved that distance.

The shape of the wave was close to a sine wave, although slightly sawtoothed. The reason for the general shape is because of the power supply's alternating current (a sine wave), but as for the imperfections, skin is not the strongest conductor.

Source 2: Transformer

This source significantly dropped the voltage from 120 V (from an outlet) to about 20 V. The role of a transformer is to step down the voltage for households to use, and once more for devices to use. Transformers use two wrapped coils of wire, with the first one tightly wrapped to induce a magnetic field that in turn induces voltage that drives the secondary, less tightly-wrapped coil. The signal displayed a sine wave, indicative of the alternating current coming from the wall outlet. Here, I switched to “AC” and touched the positive side with the probe.

Source 3: Diodes

The diodes produced an interesting graph. To obtain this signal, I actually did this step last, as I had to clip the wires connected to the capacitor. To measure the signal, I touched the probe on the input side of the diodes and attached the “ground” clip to the negative output side. By doing this, I was able to see the function of diodes, which permits the signal to pass through only one direction. Thus, the negative portion or bottom half of the sine wave would not be able to pass through its side of the loop, resulting in only positive arches shown. When connected to the capacitor, however, this signal will become DC and be a completely flat line.

Source 4: Capacitor

This source caused a conversion of the signal from alternating to direct current. Capacitors consist of two metallic plates with a dielectric material in between. When the voltage was applied, an electric field was created, with positive charge collecting on one plate and negative charge on the other. The graph displayed a straight line because the capacitor’s stored charge was used to “fill up” gaps in the waves from the diodes, as there became a difference in potential. The signal was no longer AC, but still was not a perfectly straight line.

Source 5: Rectifier

The final step to converting the AC signal to DC signal was through a rectifier. As the name suggests, a rectifier essentially “corrects” and stabilizes the incoming signal- in this case, the roughly DC signal from the capacitor. This drops the voltage by a few volts, but stabilizes and straightens out the signal to about 12 V, which can be safely used by devices for charging.

CONCLUSION:

Based on this lab, I was able to investigate the different elements an oscilloscope can measure. Before I began assembling the circuit, I learned about the basic variables that would need adjustment to display the signals (as demonstrated in the procedure). After solidifying my grasp with basic controls, I began to measure the different variables within the circuit. With help from my mentor Mickey Arellano, I gained firsthand experience with the assembly of a circuit and the different requirements for measuring each component. The paper diagram of the circuit was far clearer and simpler than the actual, 3D assembly, revealing the importance of firsthand experience and visualization. With each component, I gained a better understanding of the functions and individual characteristics. The location and patterns behind the shapes of the graphs enabled me to better understand the components of the circuit and how an oscilloscope can be useful in different situations. The transformer retained the AC signal and merely stepped down the voltage. The diodes limited the signal by directing it towards the capacitors, which then filled in the gaps and converted the signal to DC. The rectifier stabilized the signal, slightly reducing the voltage and producing a DC voltage that can be used by consumer devices or small batteries (which use DC signals).

APPLICATION:

The oscilloscope has many real-world applications, modified for the medical world and even basic industrial purposes. For example, in industry, electrical engineers must align multiple components with different signals. However, there is often a delay in retrieving this signal, resulting in mismatched functions and crashes. With an oscilloscope, one can graph the voltage vs. time and find the time interval that contains a delay (shown as the horizontal distance of the diagonal line, where due to resistance of wires, is not perfectly vertical). With this time interval, electrical engineers can arrange different functions to operate at a designated time before/after one another. Another application of the oscilloscope is in the computer industry. The oscilloscope can measure frequency of a signal or a "clock," which led to how I managed to obtain an oscilloscope. For his work, my purchased an oscilloscope to measure these frequencies, because if multiple components of hardware are not set to each other's frequency, the signaling system becomes disjunct and fails to properly operate.

Oscilloscopes also have multiple applications in areas such as medicine and consumer use. The fundamental idea behind a heartbeat monitor is similar to that of an oscilloscope- measuring voltage versus time. The only difference is the need for an amplifier, as the heart or brain's voltage is limited to the millivolts (an EKG sensor also measures the electric potential generated by activity in cardiac tissue). Similarly, an oscilloscope can be used for detecting sound signals that are transferred from a microphone through an amplifier. This idea applies to weather radar and certain areas of defense/radar communication. Essentially, any sensor that produces an electrical signal such as sound, mechanical stress, pressure, light, or heat can be measured by an oscilloscope. An oscilloscope may appear simple and convenient for lab purposes, but it provides the foundation for many real-world applications beyond electrical engineering and computer industry.

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