LAB-1: Introduction To Digital Oscilloscopes

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1.Purpose

The goal of this laboratory exercise was to learn how to use digital oscilloscopes and understand some laboratory equipments such as resistors and capacitors. Another purpose of this experiment was to use breadboard and jumper cable.

2. Methodology

First part of the experiment:

BNC part of the probe is connected to the Channel 1 and hook part is atteched to the oscilloscope. At first, the signal in display may not be a proper square waveform. In order to see it in a proper square waveform, compensation should be done manually. A compensation trimmer on the probe is adjusted by the user until the displayed square wave is square and shows little overshoot or ringing. The user then connects the probe to this signal source. The probe's impedance and frequency response characteristics are suitably matched to the oscilloscope using this procedure.

Second part of the experiment:

In the second part, an oscilloscope and a signal generator are employed. This signal generator is used to produce a sine wave with a 5V peak to peak voltage and a 1 kHz frequency. In order to see a waveform with 5V peak to peak voltage, created voltage should be arrenged as 2.5V on signal generator. Because peak to peak voltage value is twice the valuse displayed on the signal generator. And it's crucial to remember that this sine wave shouldn't have a DC component.

In the second step of the second part, the triggering slope is swapped between rising (positive) and falling (negative). Signals begin to arrive from locations where the slope is positive when the mode is set to Rising. When the mode is set to Falling, signals begin to arrive from locations where the slope is negative.

Third part of the experiment:

This part of the experiment aims to teach the oscilloscope's triggering mechanism. Firstly,a signal generator is used to produce a 2 kHz triangle wave with a 1 V peak to peak voltage. I then adjusted the trigger knob on the oscilloscope.

The primary goal of oscilloscope triggering is to produce a stable representation of a waveform on the screen. The voltage level for signal capture is chosen by the oscilloscope knob. The signal becomes untriggered if the triggering level is higher than the signal's apex, which causes an unstable waveform to appear on the display. Thus, when the signal voltage passes the desired part, the oscilloscope may show the triggered signal wave.

Fourth part of the experiment:

This part of the experiment aims to teach what ADCs and DACs are used for. An analog-to-digital converter (ADC) transforms an analog signal into a digital representation, such as voltage. And DACs stand for digital to analog converters such as. Analog impulses are transformed into digital signals by an oscilloscope and sent to a display for study.

Another aim of this experiment is to teach oscilloscope's acquisition modes which are sample, peak detect, and average. By keeping the first sampled point from each acquisition period, sampling mode performs the sampling function. The most accurate timing interval measurements are made in Sample mode. The maximum and minimum signal levels for each sample are recorded using the Peak Detect mode. It identifies the top and lowest record points over a large number of acquisition. Multiple waveform samples are combined and averaged in the averaging mode.

Fifth part of the experiment:

A sinusoidal signal with 2 Vpp amplitude, 1 kHz frequency and a DC offset of 1V is applied to osciloscope.

The complete function of a signal is altered with the necessary DC voltage when an offset value is added to it using a signal generator as it happens in this part of the experiment. Because DC offset is 1V.

Firstly, DC coupling technique is used in this part of the experiment and then AC coupling method. When AC coupling is used oscillator cuts all off the DC portion of a signal and shows AC signals. But DC coupling method shows all waves between 0 Hz scope's maximum bandwidth.

Sixth part of the experiment:

In this part of the experiment, required materials are a breadboard, jumper cables, a 1 kilo ohm resistor , a 1mikro farad capacitor, 2 probes, an oscilloscope and a breadboard.

A breadboard is a piece of plastic that is rectangular and has several small holes in it. These openings make it simple to incorporate electrical components while building an electronic circuit.

X is connected to Channel 1 and Y is connected to Channel 2. And applied a 2 Vpp 1 kHz sinusoidal signal (with 0 DC offset) as the X signal. Then main differences should be seen between the X and Y waveforms such as Vpp values, phase and delay. At the end, frequency should be arrenged as 100kHz and the same procedure should be repetead.

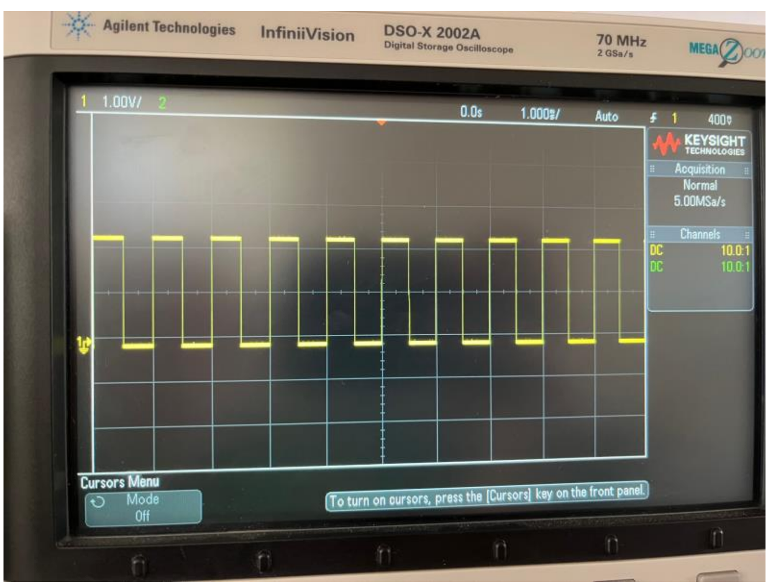
3. Results:

Before I compensated the probe, shape of the waveform was curved and this is something we do not want.

Image 1: Part 1 (Non-compensated signal)

After I compensated the probe, square shaped waveform looked like a straight line.

Image 2: Part 1 (Properly compensated probe)

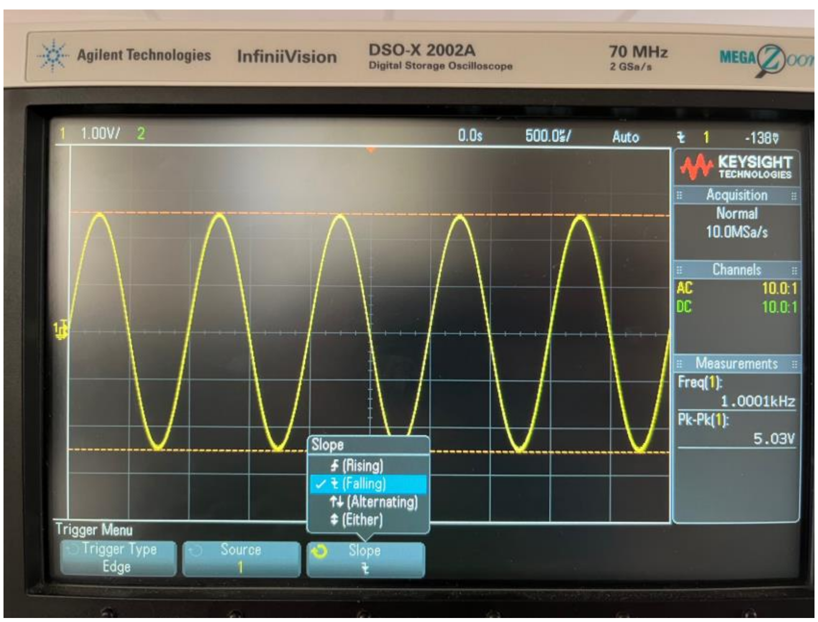


When I arrenged the trigger type as Edge and slope as rising. I saw the sinosoidal waveform below. When the trigger slope is rising, oscillator starts to collect data where the waveform rises.

Image 3: Part 2 (Triggering slope is rising.)

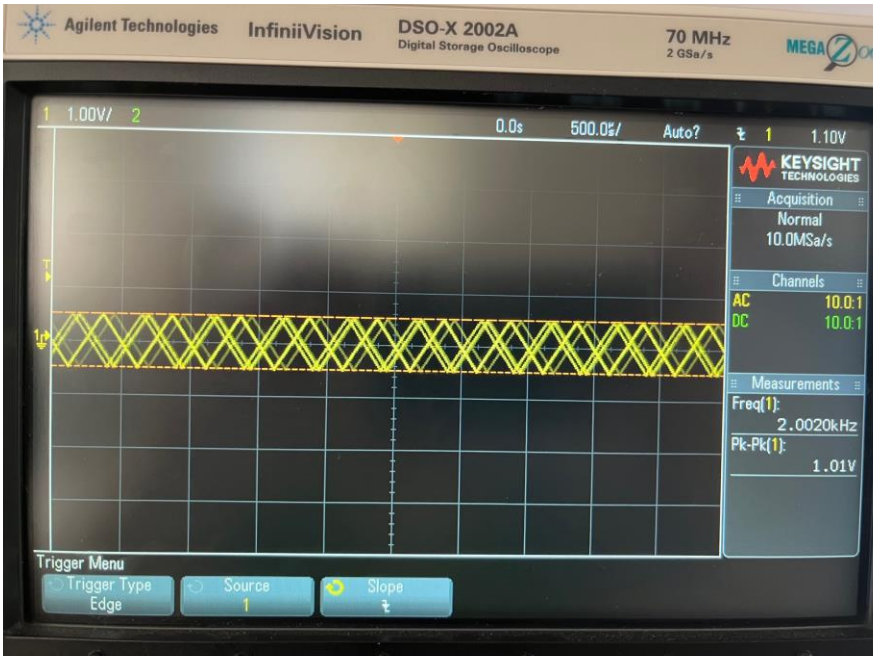
When I arrenged the trigger type as Edge and slope as falling. I saw the sinosoidal waveform below. When the trigger slope is falling, oscillator starts to collect data where the waveform falls.

Image 4: Part 2 (Trigger slope is falling.)



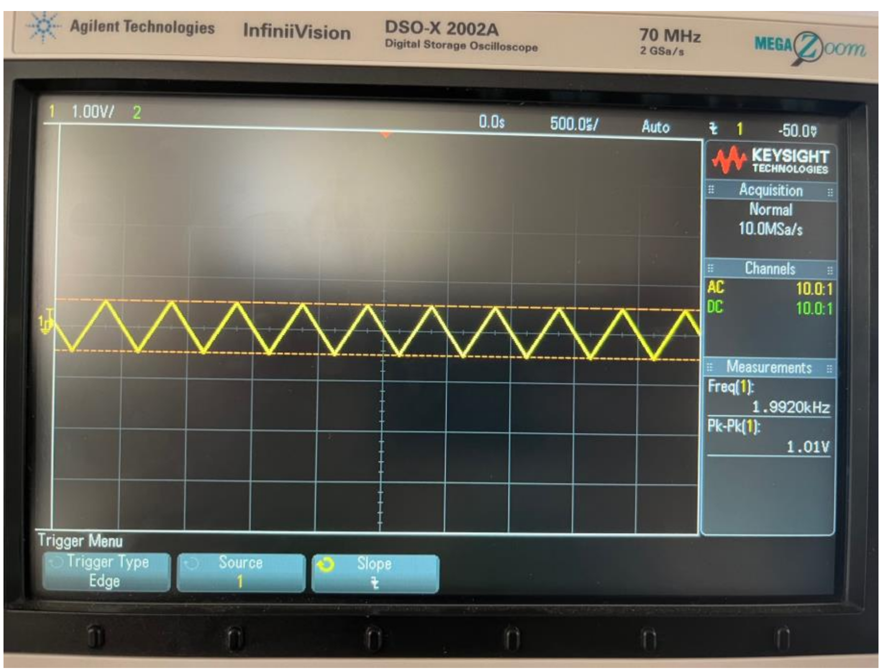
When trigger arrow does not intersect with the waveform, there is no stable graph on display.

Image 5: Part 3 (Unstable waveform)



When trigger arrow intersect with the waveform, there is stable graph on display. And trigger arrow is arrenged with turning trigger knob.

Image 6: Part 3 (Stable Waveform)



In the part 4, I changed the modes of the oscilloscope and the graphs below appered on display.

Image 7: Part 4 (Mode normal)

Image 8: Part 4 (Mode peak detect)

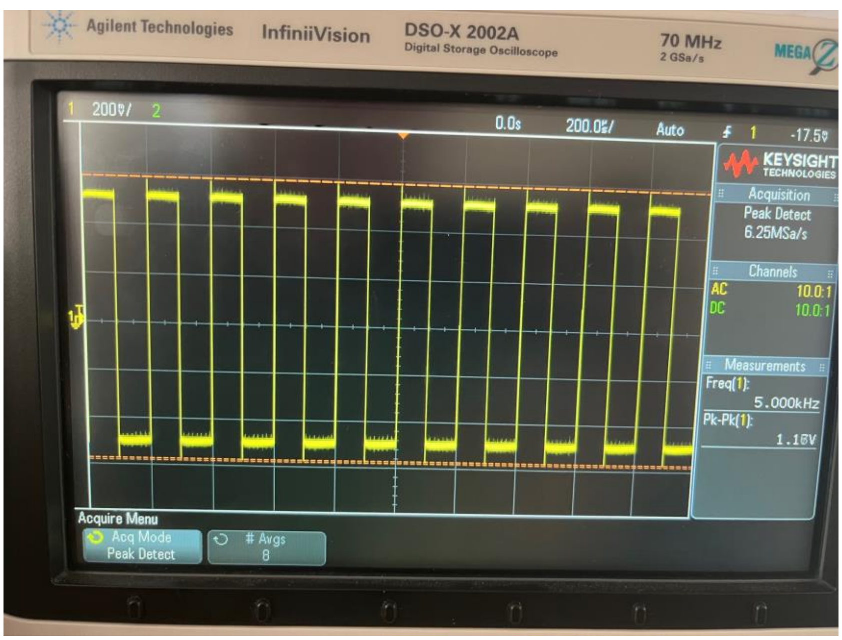
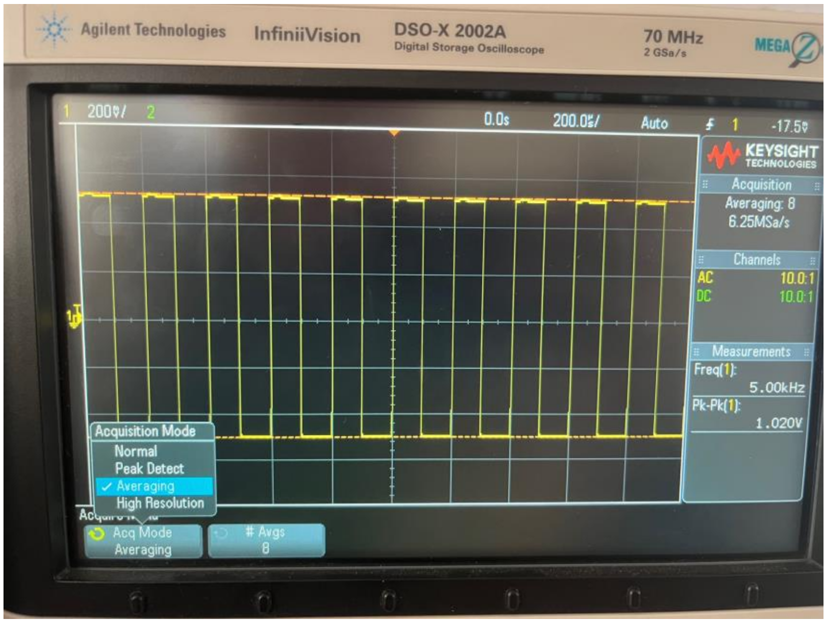


Image 9: Part 4 (Mode Averaging, Avgs 8)



In the part 5, when DC coupling mode is on, oscillator uses both of DC and AC signals together but when AC coupling mode is on it only uses AC signal and does not use DC signal.

Image 10: Part 5 (DC coupling, Pk-Pk 2.05V, Frequency 1.0005kHz, Min -50mV)

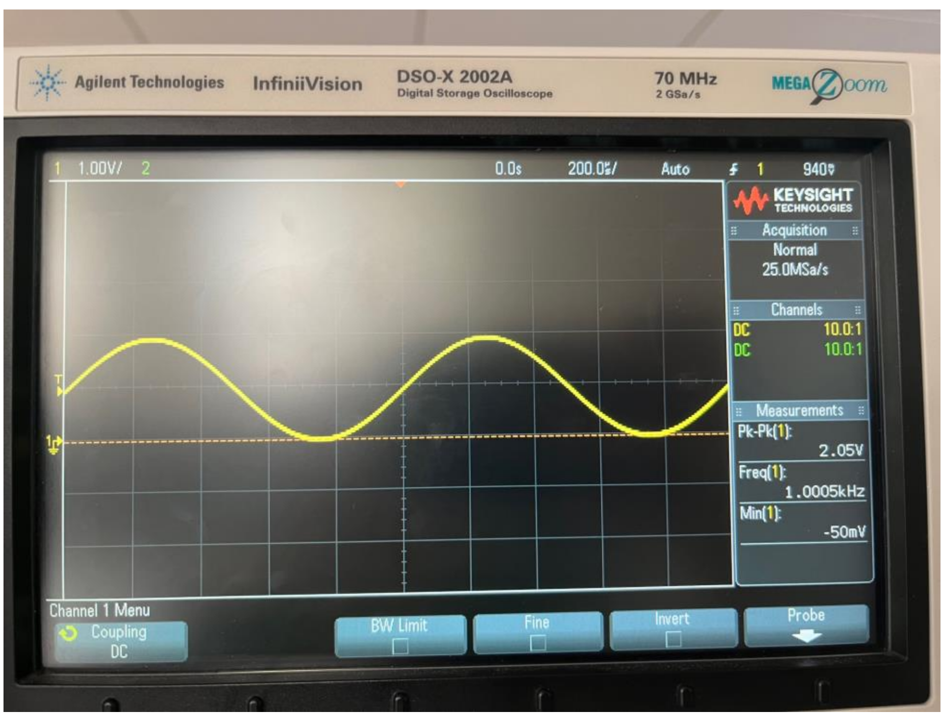
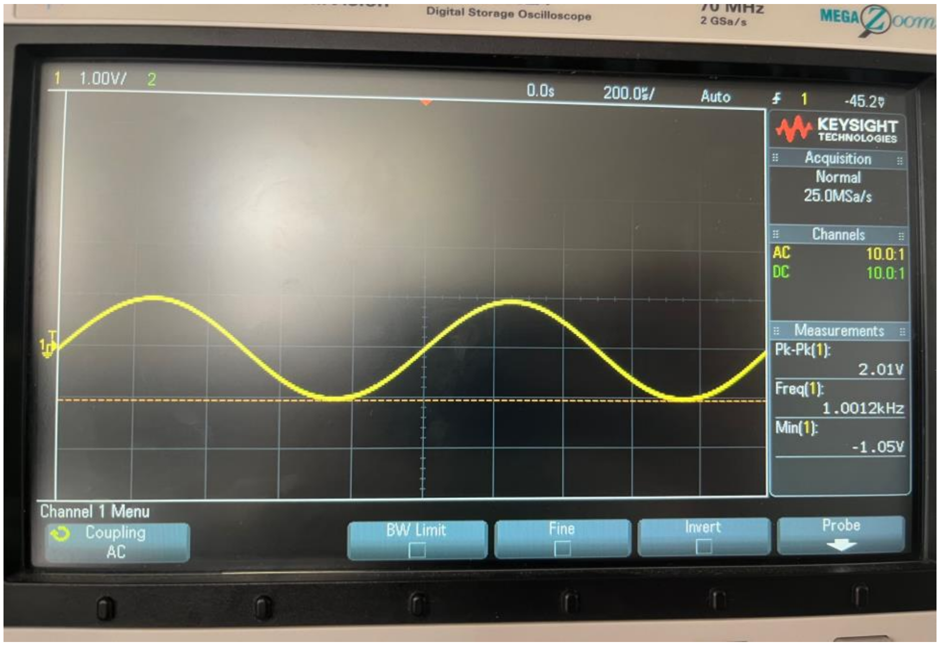
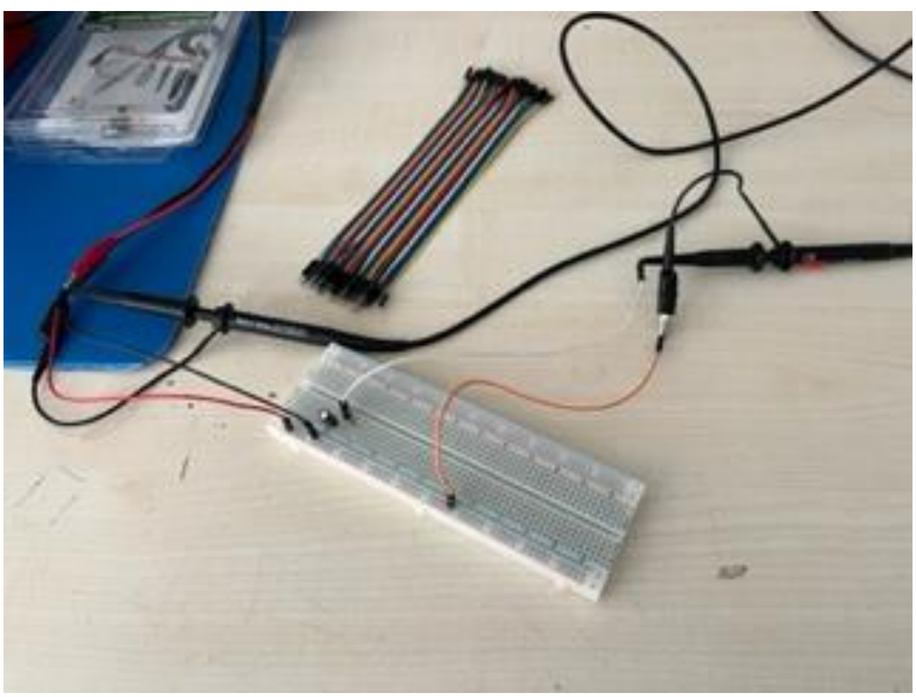


Image 11: Part 5 (AC coupling , Pk-Pk 2.01V, Frequency 1.0012kHz, Min -1.05V)



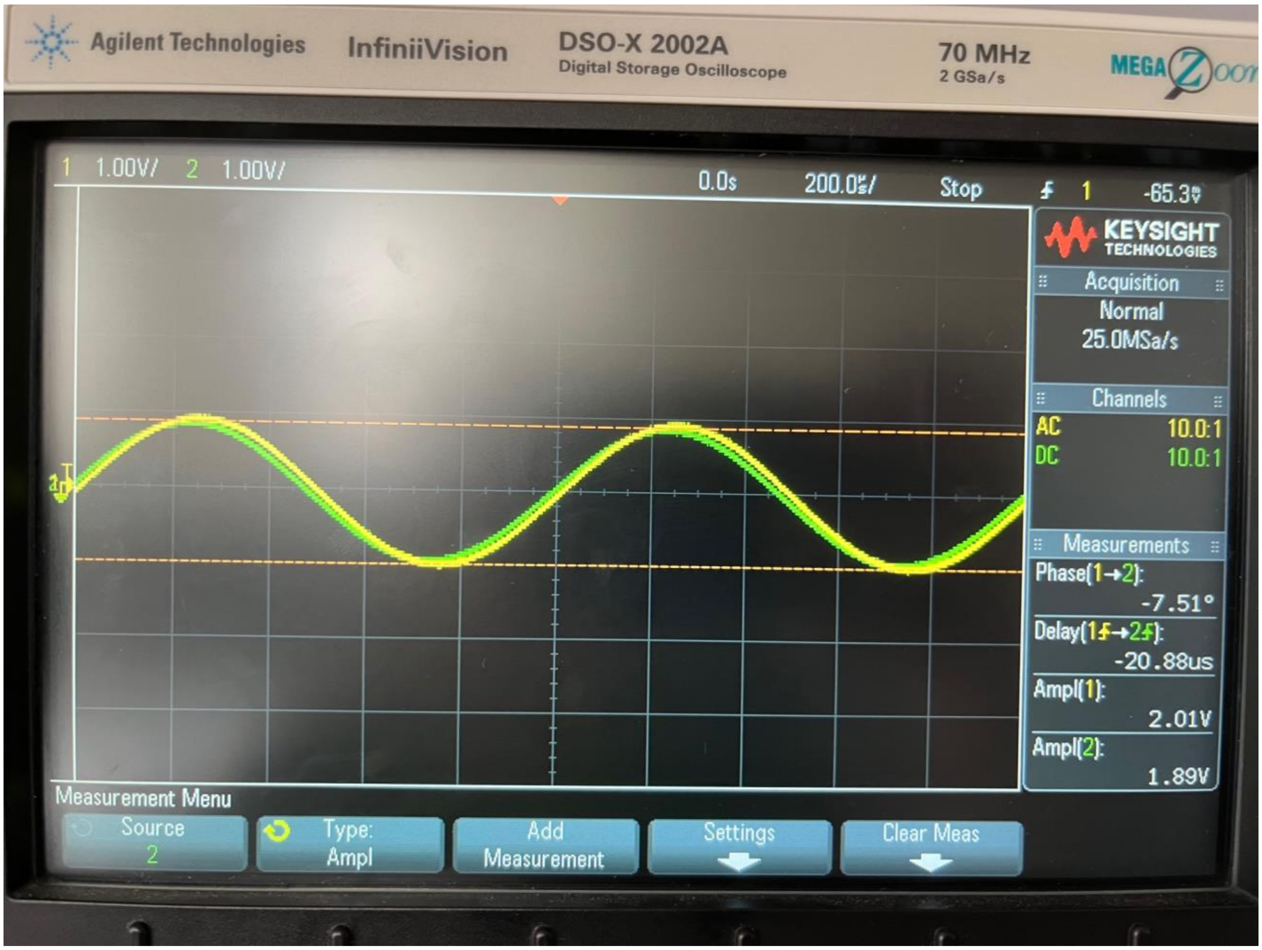
In the sixth part, I built the wanted circuit with the materials below and examined for Vpp values, phase and delay between X and Y. And I saw that when the frequency gets higher the phase gets lower.

Image 12: Part 6 (Circuit)



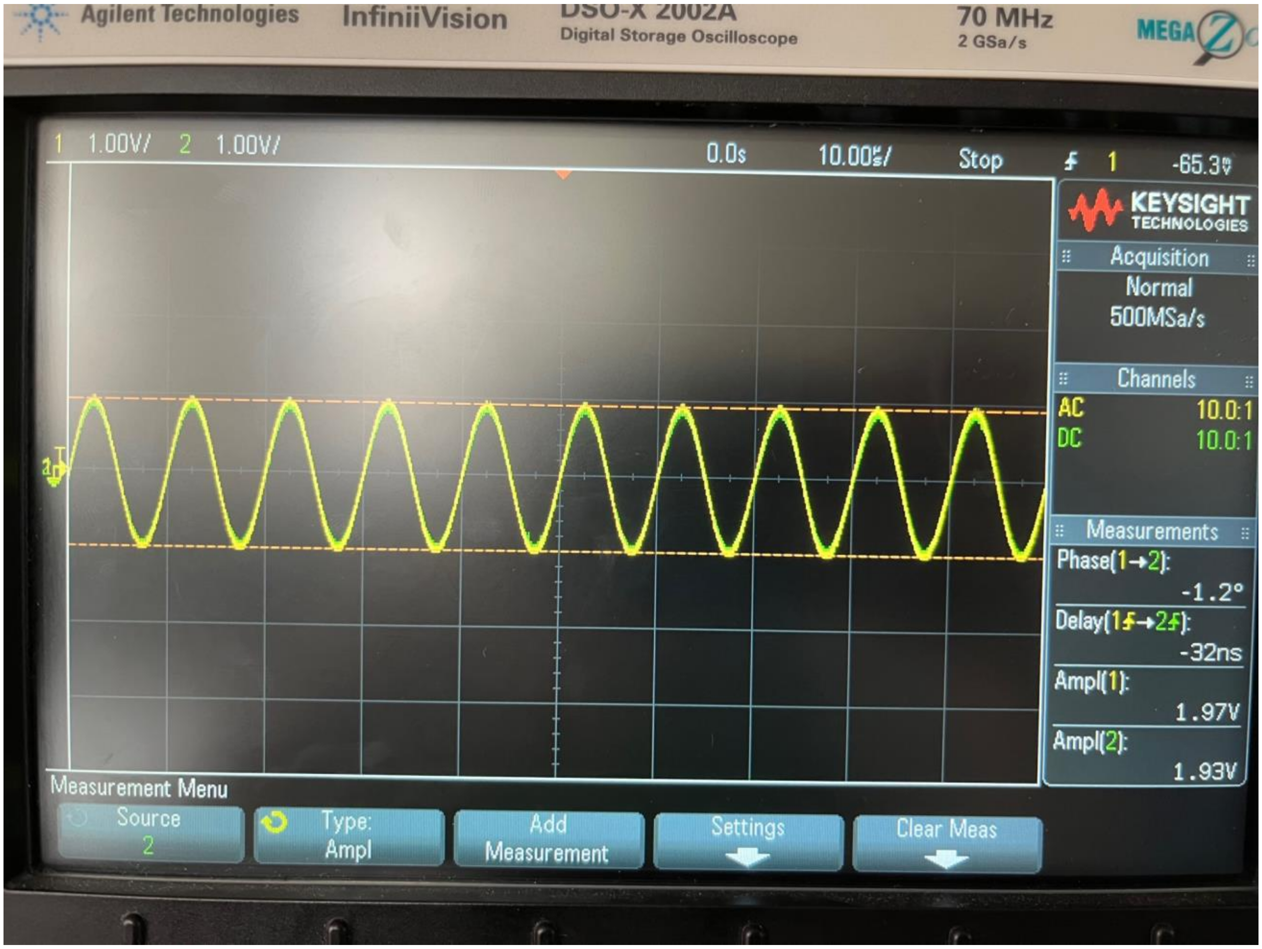
Since the amplitude difference is 0.12 V, peak to peak difference is twice of the amplitude difference and it is 0.24 V. Delay is -20.88 uS. And phase difference is -7.51 degrees. All of them are visible on display.

Image 13: Part 6 (Measurments with 1kHz)



Since the amplitude difference is 0.04V, peak to peak difference is 0.08V. Delay is -32ns. And phase difference is -1.2 degrees. All of the measurments are visible on display.

Image 14: Part 6 (Measurments with 100kHz)



4. Conclusion:

Main purpose of this experiment was to teach us how to use fundemantal and basic laboratory tools and materials for example oscilloscopes, signal generators, breadboard, probes, etc. Additionally, we learned what DACs and ADCs are used for and what does DC offset mean. Finally we built an expected circuit with using breadboard. In my oppinion, this experiment was succesfull because there was no unwanted datas or measurments at the end of the experiment.