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EE102-02

EE-102 LAB 1 REPORT: INTRODUCTION TO THE OSCILLOSCOPES

12/02/2024

Purpose

The aim of this lab was to understand how a digital oscilloscope work, the general purpose of use, some of the fundamental concepts about signals, interpretation of the different signals generated by an AC Power Supply, get used to some of the lab equipment and finally observe the time and delay differences between two different points in a capacitor and resistor used circuit.

Methodology and Result

1) In this lab, the first task was to compensate properly the probes so that the observed waveforms could be seen decently. First, the tip point of the probe has attached to the demo 2 and ground clip to the ground. Before the compensation (Figure 1), the top and bottom side of the square waveform were not straight, by using compensation tool, the signal has been adjusted properly. The probe has been adjusted as 10X attenuation factor and after the compensation the result was as Figure 2.

2) After that in the second task, the signal generator has adjusted to 5 Volt (peak to peak) sinusoidal waveform with 1kHz frequency, and the result is monitored on the oscilloscope's screen. After monitoring the sinusoidal graph, the trigger type has been adjusted to edge mode. The positive edge and negative edge triggering slope modes were applied. Triggering on the positive (Figure 3) and negative slope (Figure 4), the observed graphs were symmetrical with respect to the y-axis. Positive(rising) and negative(falling) slope triggers indicate exactly where the oscilloscope should start to obtain signal data from the generator. When it is adjusted as positive (rising edge trigger) slope, the oscilloscope starts to measure when signal intersects with the trigger line as having positive slope, same applies for the negative slope (falling edge trigger), in which the case where the signal having negative slope.

3) In the third task, 1 Volt (peak to peak) triangular wave with 2kHz frequency have been applied. As the triggering knob turned on, a horizontal line on the screen has moved upward and downward according to turning rotation. When the trigger line has exceeded the upper

limit of the signal, the waveform started to distort (Figure 6), it was same for the lower limit. In addition to that, as the triggering altered, the position of the triangular waves shifted slightly. The triggering function in the oscilloscope synchronize the repetitive waveforms as a stable waveform (Figure 5) so that the signal can be displayed properly.

4) Digital to analog converter(DAC) is a electronic system that converts digital signals(binary data) to analog signals such as voltage, current or sound . These converters used in various fields such as music players, mobile phones, televisions, computers. In computers for instance, sound cards have audio DACs to convert digital signals into audio outputs. On the other hand, analog to digital converter(ADC) is a system that converts continuous analog signals such as analog audios, temperature changes or radio signals to digital signals(binary data). Analog to digital converters are used in many real life applications. Microphones uses ADCs to convert analog sound waves into digital signals for the recording process. The oscilloscopes use analog to digital converters(ADCs) to display signals. The probe connected to the oscilloscope captures an analog signal from a circuit or from the function generator and oscilloscope's ADC process the analog signal at high rates and converts it into digital values. Then, it is being displayed on the screen with many measurement tools. In task 4, 1 Volt (peak to peak) square wave with 5kHz frequency has been applied. Firstly, the "Sample" acquisition mode (Figure 7) refers to most common standard way of capturing and displaying waveforms. It captures points at the sample defined rate. Secondly, the "Peak Detect" Mode (Figure 8) captures the highest and lowest value for each captured sample and displays the waveform by setting the upper and lower limit based on these extreme values. The "Average" Mode (Figure 9) calculates the average of defined number of waveforms and displays a noise reduced and resolution increased version of waveforms, which provides a cleaner view.

5) In task 5, 2 Volt (peak to peak), sinusoidal signal with a 1kHz of frequency and 1 Volt of DC offset has been applied. When DC coupling mode was active (Figure 10), from the displayed graph, the maximum voltage value was around 3 Volt and minimum was around 1 Volt. When the coupling mode switched to AC (Figure 11), the graph has shifted approximately 1 Volt downwards. The difference caused by the effect of AC coupling mode, which eliminated the DC component of the signal coming from 1 Volt DC offset.

6) A breadboard is a tool that widely used for creating basic circuits. It has metal strips underneath the surface with holes and electrical connections can be done by connecting electrical components vertically. It has power rails on the sides, which has two parts: Red line indicates (+) and blue lines(-). These lines used to distribute power coming from the signal generator. In task 6, we created the circuit (Figure 12) by using a breadboard. In the circuit, the resistors with 820 ohm and 180 ohm connected in series to complete 1000 ohm resistance. After applying a 2 Volt (peak to peak), sinusoidal signal with 1kHz frequency, we observed (Figure 13). Channel 1(yellow graph on the screen), has been labelled as X and measured the signal coming from the signal generator. Channel 2,(green graph on the screen), has been labelled as Y and measured the signal coming from capacitor. The calculated voltage difference was 0 Volts, and the delay was around 26 microseconds.

To calculate phase difference for the (figure), I used the following formula:

$$\phi = \arctan\left(-\frac{1}{\omega CR}\right)$$

I calculated the phase difference as $\omega = -9.04306$ degrees.

In the second part (Figure 14), I adjusted the frequency from 1kHz to 100kHz. This time the delay was around 43 nanoseconds. Because the frequency has increased, the time difference between two signals were less, as expected. Also again due to increment in frequency, the phase difference decreased. The phase difference for the 100kHz frequency is $\omega = -0.09119$, which is considerably low.

Appendices

Task 1:

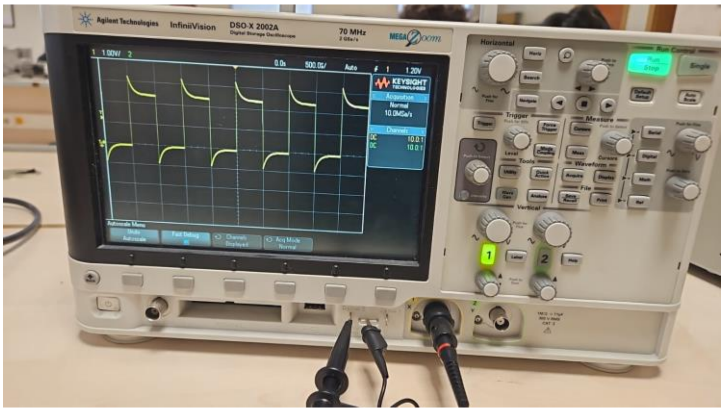

Figure 1: Before Compensation

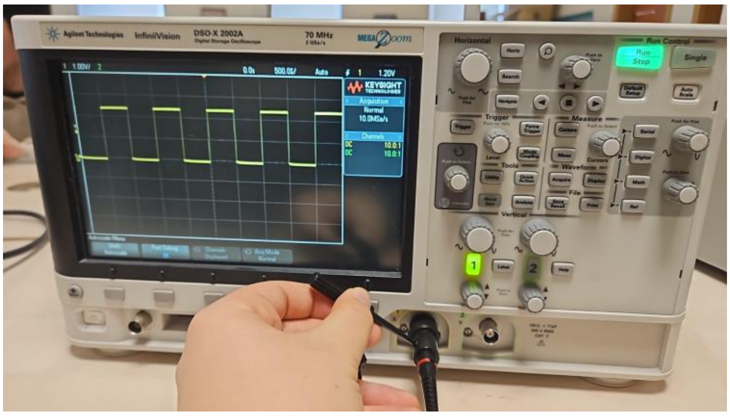

Figure 2: After Compensation

Task 2:

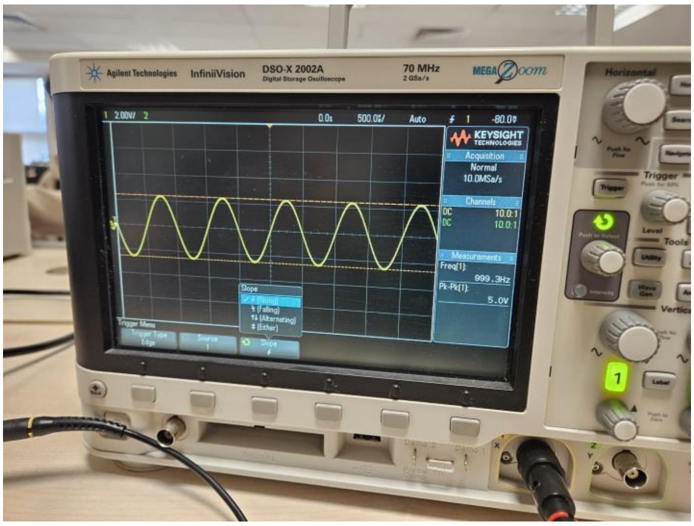

Figure 3: Positive Edge Triggering

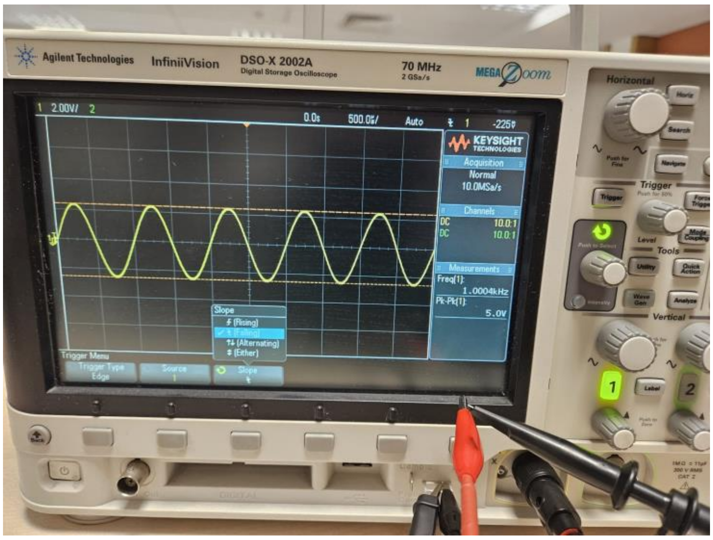

Figure 4: Negative Edge Triggering

Task 3:

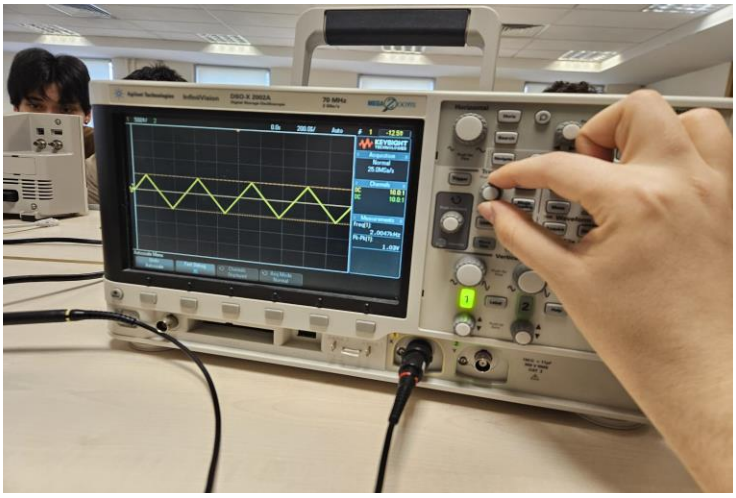

Figure 5: Triggering Point in range of the signal

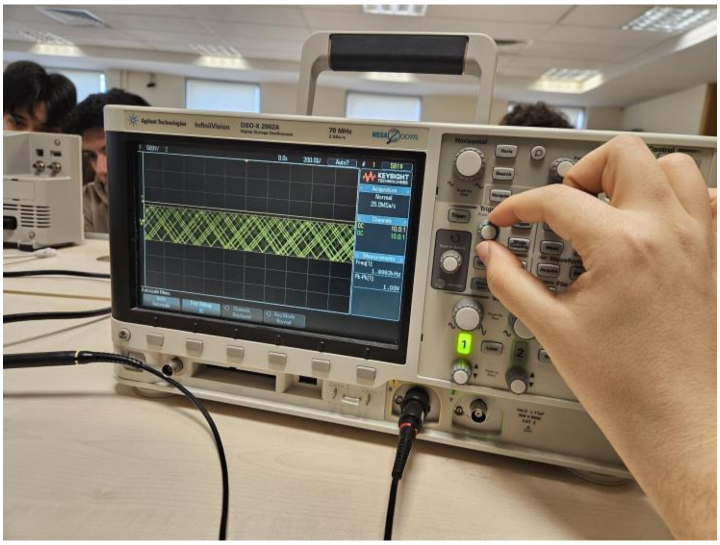

Figure 6: Distortion due to Triggering Point Misalignment

Task 4:

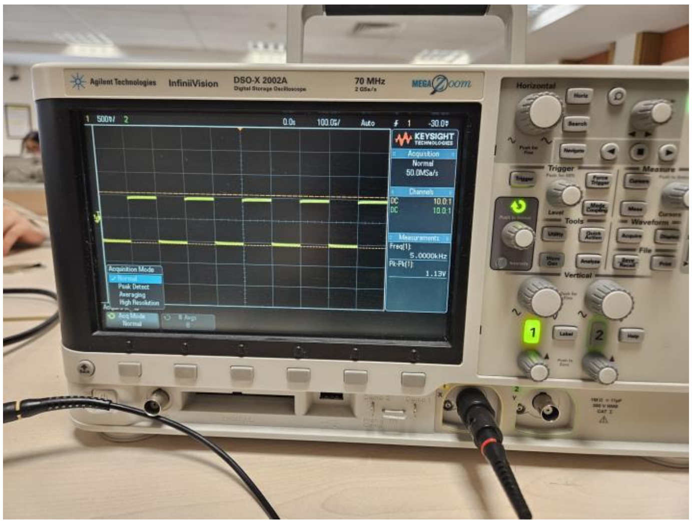

Figure 7: “Sample” Acquisition Mode

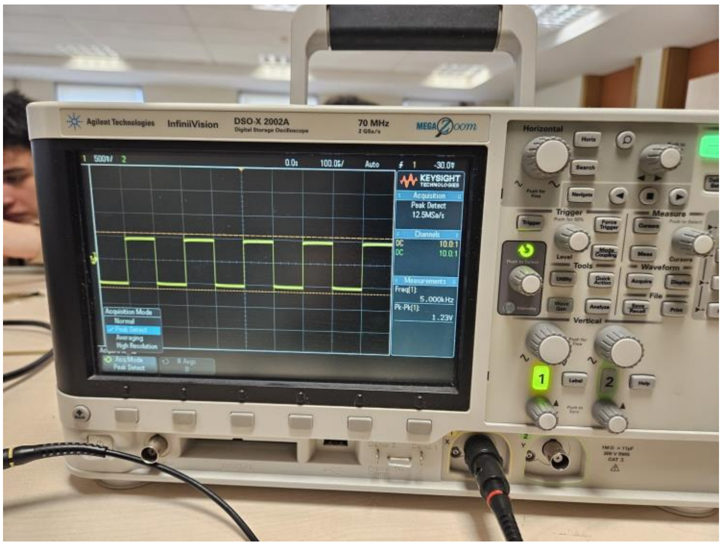

Figure 8: “Peak-Detect” Acquisition Mode

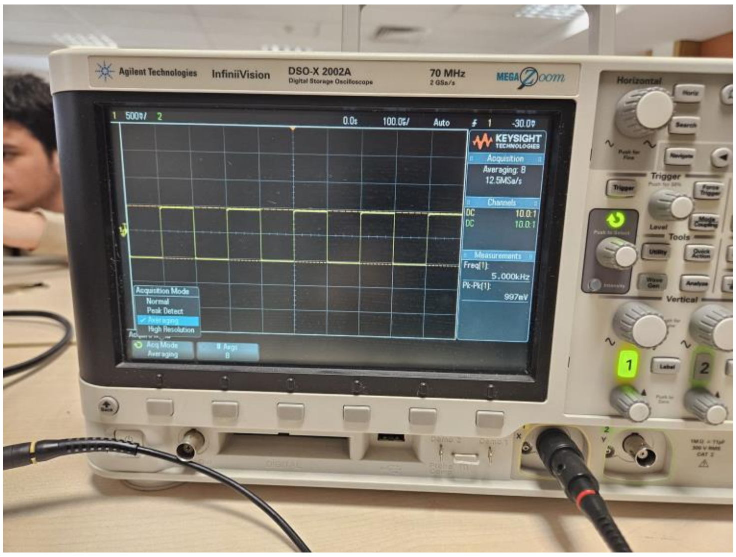

Figure 9: “Averaging” Acquisition Mode

Task 5:

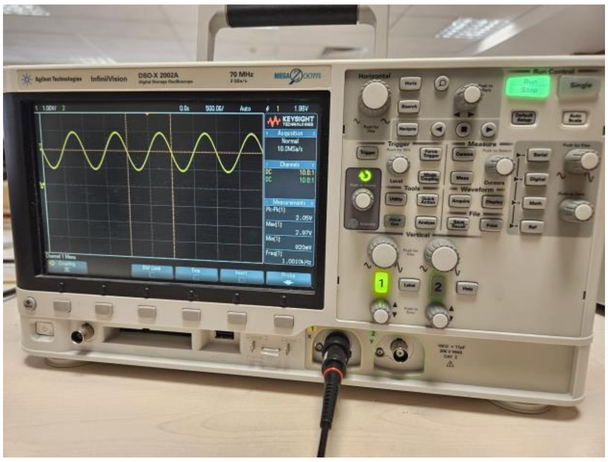

Figure 10: DC Coupling Mode

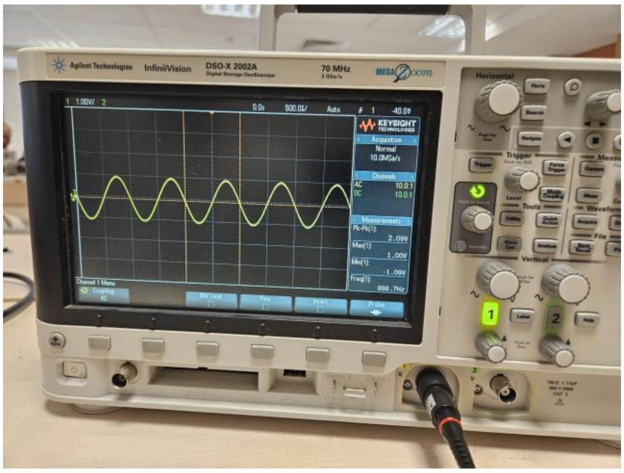

Figure 11: AC Coupling Mode

Task 6:

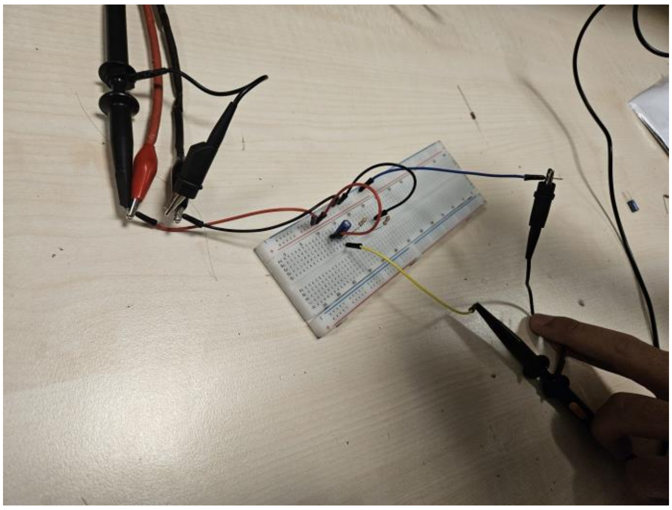

Figure 12: The Circuit

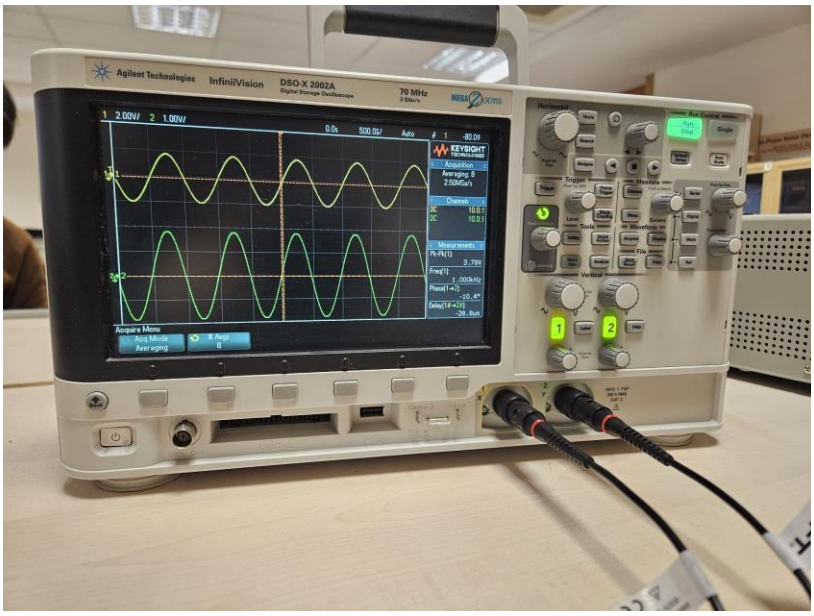

Figure 13: 1kHz Frequency Graphs

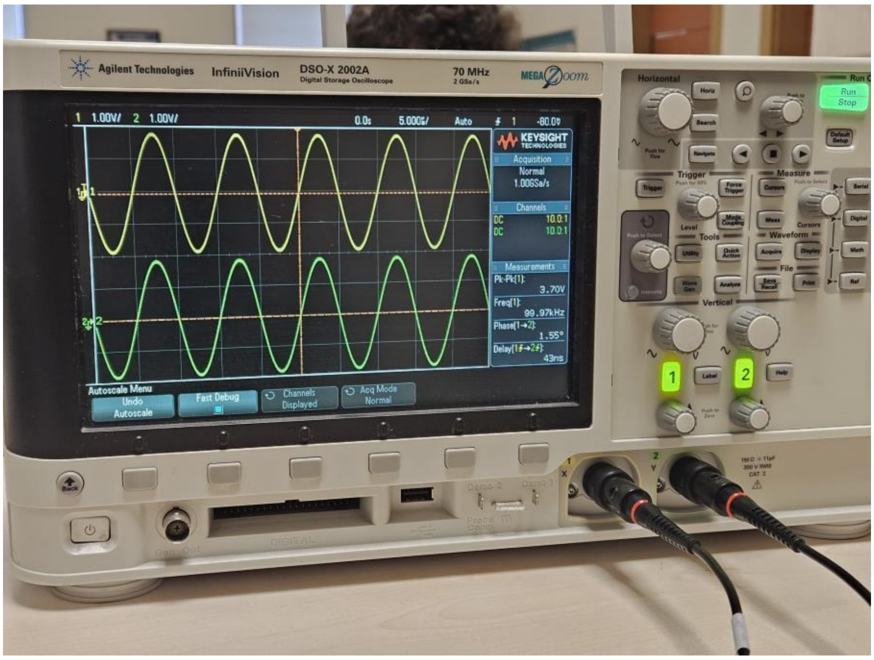

Figure 14: 100 kHz Frequency Graphs

Conclusion

The aim of this lab was to learn how to use oscilloscopes by introducing some of the lab equipment. The experiment investigated successfully. Some of the concepts about oscilloscopes such as triggering, coupling, various signal types, using of signal generator, probe compensation, voltage and delay measurement, phase calculation, acquisition modes has been used and done thoroughly. The most important lesson I've learned from this lab is connecting the ground clip to a ground. To prevent possible accidents, it is crucial. In general, the fundamentals of this lab will be essential for the entire course and my electronics career.

Reference:

https://www.keysight.com/used/us/en/knowledge/glossary/oscilloscopes/what-is-an-oscilloscope-trigger#:~:text=An%20oscilloscope%20trigger%20is%20a,or%20investigating%20a%20transient%20event.

https://www.tek.com/en/documents/primer/oscilloscope-systems-and-controls