Report: Introduction to Digital Oscilloscopes

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EE102-01 Lab 1

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Purpose: The purpose of this lab is to get ourselves used to lab equipment including Digital Oscilloscope, function generator and breadboard.

Methodology: In this lab work features of oscilloscope and function generator has been observed in 6 tasks. In Task 1 oscilloscope probes have been compensated using compensation signal of oscilloscope. In Task 2 sinusoidal signal has been generated which has 5V peak-to-peak and 1kHz and observed using positive and negative edge triggering. In Task 3 2kHz 1V peak-to-peak triangular wave has been created with trigger knob. In Task 4, 5kHz 1V peak-to-peak square wave has been generated and observed under different acquisition modes. In Task 5, 1kHz 2V peak-to-peak sinusoidal signal has been generated with 1V DC offset and it has been observed with DC and AC coupling modes. In Task 6, 1kHz 2V peak-to peak sinusoidal signal has applied on a breadboard circuit which has a 1 μF capacitor and 1KΩ resistor. And it observed from 2 different points in circuit Point X and Point Y.

Result & Lab Work:

Task 1:

Probe compensation is the process of adjusting the probe's capacitance to counterbalance the effects of the oscilloscope's inherent input capacitance. It is done by adjusting the screw on the probe. Proper compensation can be seen in the Figure 1.1.

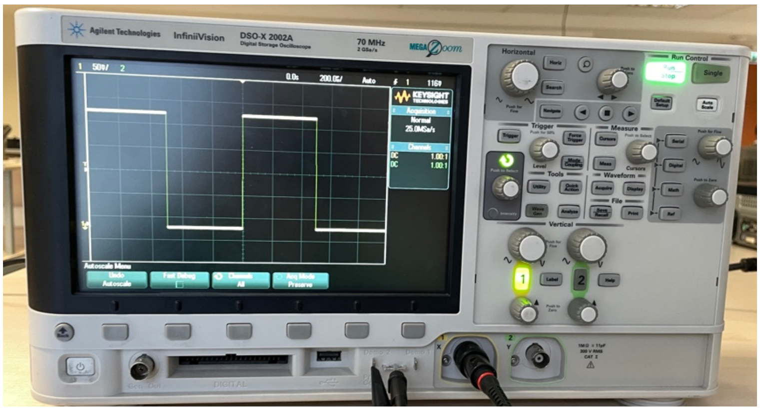


Figure 1.1: Compensated Probe.

If the probe is not calibrated there will not be perfectly straight lines. In that case there is 2 possibilities: under-compensation (Figure 1.2) or over-compensation (Figure 1.3).

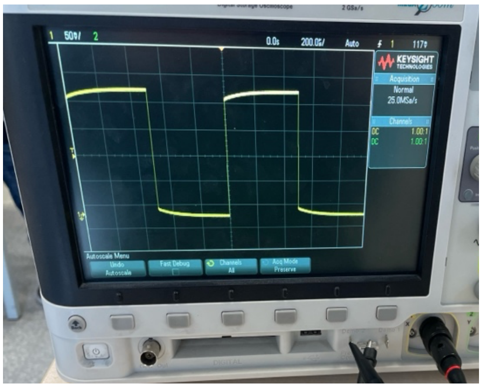


Figure 1.2: Under-Compensated Probe.

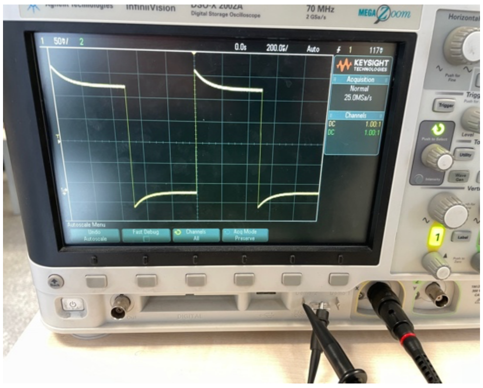


Figure 1.3: Over-Compensated Probe.

Task 2: In Task 2, 5 Vpp sinusoidal signal with frequency 1kHz has been generated without a DC component as seen in the Figure 2.1.

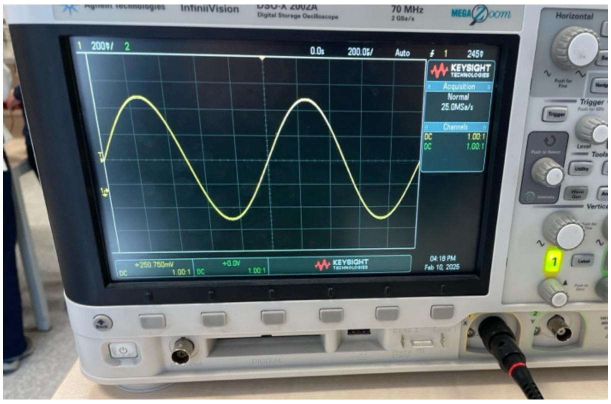


Figure 2.1: 5Vpp sinusoidal signal with frequency 1Khz.

Then sinusoidal signal has been observed under different triggering options. First it observed under “Rising” (positive) and “Falling” (negative) trigger options. When it observed under “Rising” (Figure 2.2) trigger the wave has a positive slope in the origin. When it observed under “Falling” (Figure 2.3) trigger the wave has a negative slope on the origin.

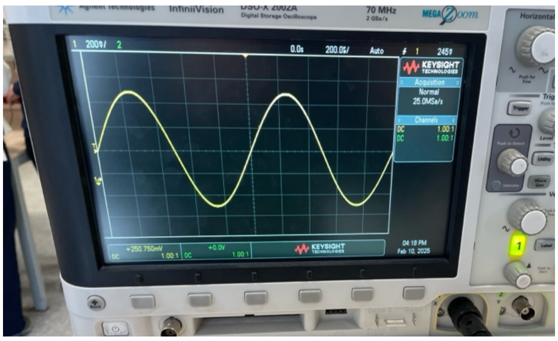


Figure 2.2: “Rising” Positive edge.

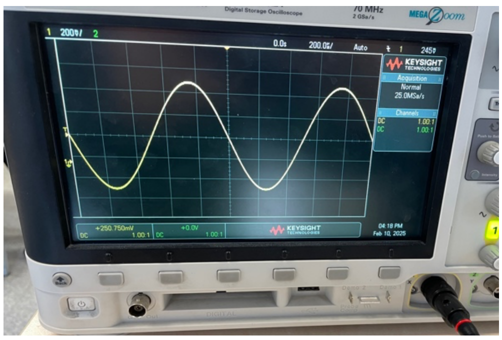


Figure 2.3 “Falling” Negative edge.

Task 3:

In task3, 1V peak-to-peak triangular wave at 2kHz is applied to a digital oscilloscope. When the trigger knob is turned, the position of the signal shifts depending on the direction of the turn, aligning a specific point of the waveform with the origin. If the trigger level is set within the signal's amplitude range, a stable waveform appears on the screen (Figure 3.1). However, if the trigger level is outside this range, the waveform becomes unstable and moves unpredictably (Figure 3.2). In simple terms, triggering helps the oscilloscope capture and display a steady waveform by following specific conditions.

Figure 3.1: Stable Trigger Point.

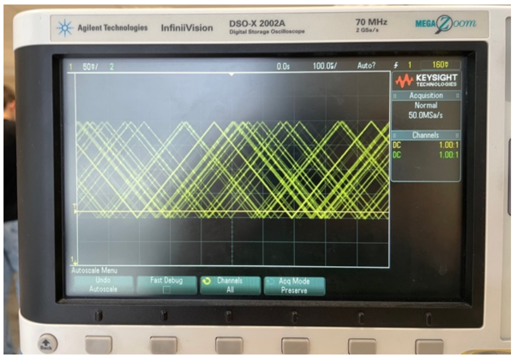


Figure 3.2: Unstable Trigger Point.

Task 4:

In Task 4, 5kHz 1V peak-to-peak square wave has been generated. And it observed under different acquisition modes, for example peak detect, sample and average.

The "Sample" mode (Figure 4.1) is the most popular used mode between options.

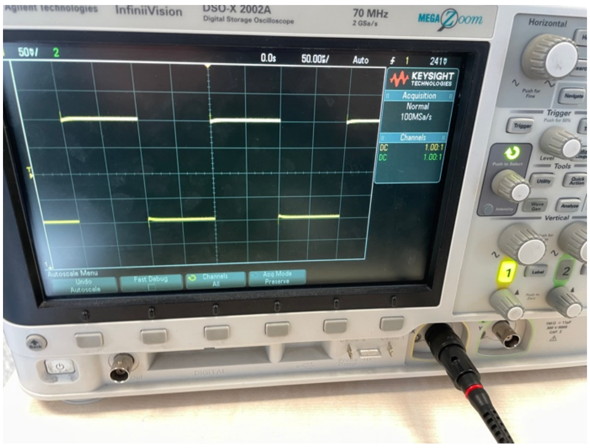


Figure 4.1: "Sample" Mode.

The “Peak-Detect” mode (Figure 4.2) captures the highest and lowest values of each sample to display the waveform. It does this by recording all the values between two points.

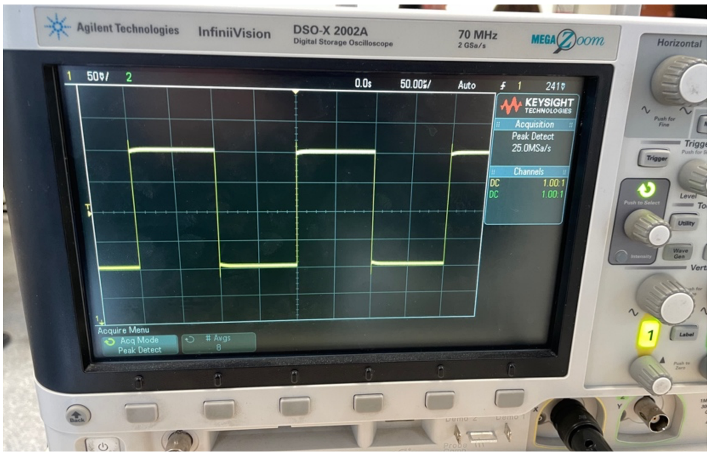


Figure 4.2: “Peak Detect” Mode.

In “Average” mode (Figure 4.3), the oscilloscope captures one sample point per waveform interval, like sample mode. Then averages the waveform points from multiple consecutive acquisitions to create the final displayed waveform.

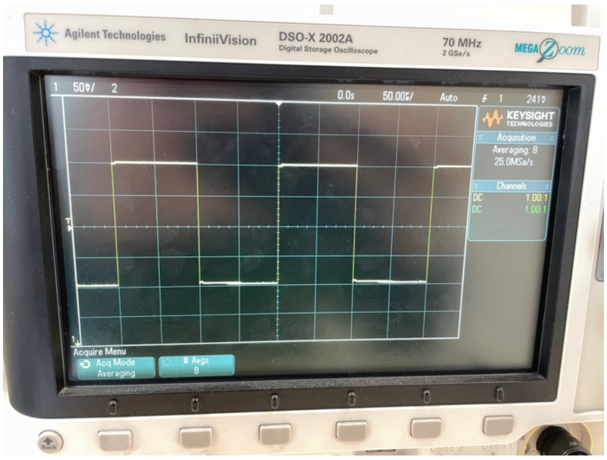


Figure 4.3: “Average” Mode.

Analog-to-Digital Converter: An Analog-to-Digital Converter (ADC) samples an analog signal at specific intervals and converts it into a digital representation that can be processed or stored. Used to convert real-world analog signals into digital signal for processing or storage.

Digital-to-Analog Converter: A Digital-to-Analog Converter (DAC) takes digital signal and converts it into a continuous analog signal for playback or transmission. Used for to convert digital signal into analog signal.

Task 5:

In Task5, 1kHz 2V peak-to-peak has been generated with 1V Dc offset. When the signal is observed under DC coupling mode, signal has shifted 1V above from its original position (Figure 5.1). When it observed under AC coupling mode, signal was not shifted, and it was on its original position (Figure 5.2).

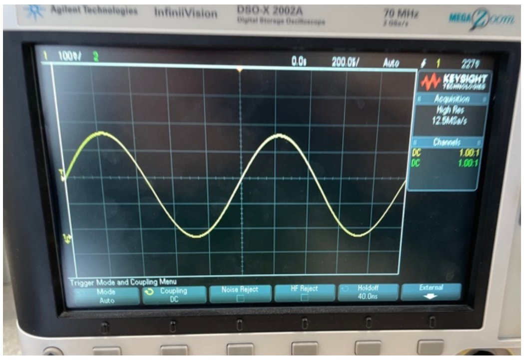


Figure 5.1: DC Coupling Mode.

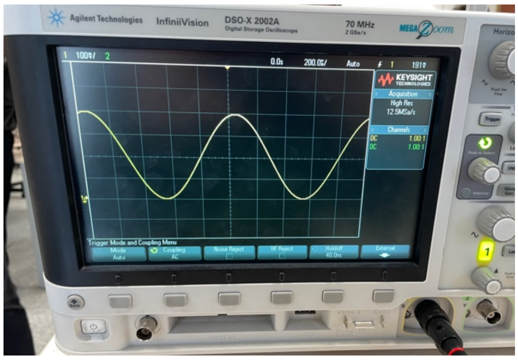
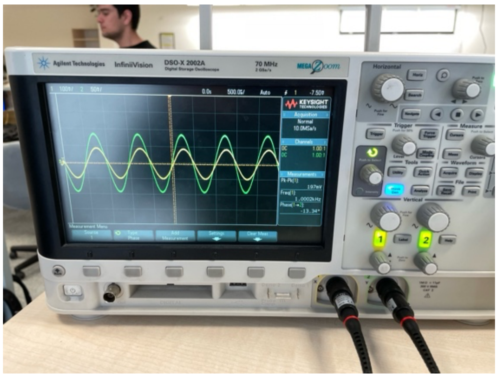


Figure 5.2: AC Coupling Mode.

Task 6:

A breadbord is a tool to build electronic circuits without doing any solder work. It has small holes to connect wires and electronics. It has a lot of rows that are connected to each other which make it easy to work on it.

In Task 6, 2V peak-to-peak, 1kHz sinusoidal signal with a 0 DC offset has been generated and applied to the circuit. The signal has been observed from 2 different points X and Y. There was a 40 μs time difference between two of them (Figure 6.1). Since one period is 2π, the phase difference can be calculated as 80π x 10^{-9}.After changing the frequency to 100kHz (Figure 6.2), the phase difference between two signals are cannot recognizable by bare eyes.



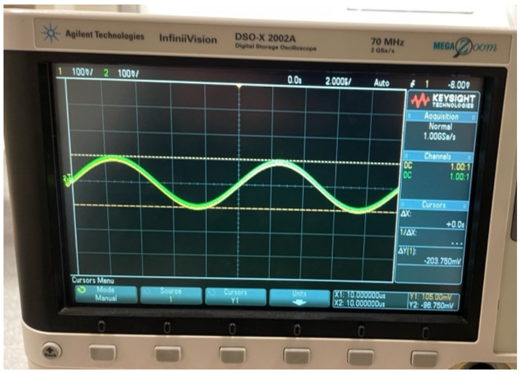


Figure 6.1: 1kHz 2Vpp sinusoidal signal. Figure 6.2: 100kHz 2Vpp sinusoidal signal.

Conclusion:

The purpose of experiments was to get used to with lab equipment including oscillator, function generator and breadboard. It also showed the different wave types such as triangle wave, sinusoidal wave, square wave and, rectangular wave. There was a small error that could be happened from the function generator and oscilloscope. Also, small equipment like oscilloscope probe resistor or capacitor can cause error.

References:

https://www.rohde-schwarz.com/fi/products/test-and-measurement/essentials-test-equipment/digital-oscilloscopes/understanding-probe-compensation_254520.html

https://github.com/SemihAkkoc/EEE102