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Lab 1: Introduction to Digital Oscilloscopes

Purpose

The experiment will aim to observe the basics of an oscilloscope, oscilloscope probe, breadboard and signal generator. Also, the investigation focuses on applying different functions of oscilloscope to observe the signal wave generated by a signal generator.

Steps of Experiment

1. The oscilloscope probe needs to be compensated. To begin with, the probe was connected to channel 1 in the oscilloscope. The selection switch on the probe was changed to 1x to 10x. The ground cable of probe was connected to ground socket of oscilloscope, and the tip of the oscilloscope to the probe compensation signal. In this model of oscilloscope, there was a button called probe check. This button function was to create probe adjustment signal. Moreover, an adjustment tool was used for screwing the screw in the connector of probe. By this way, the graph of probe adjustment signal became square wave graph. The figure 1 was a result shown in the oscilloscope when probe was compensated.

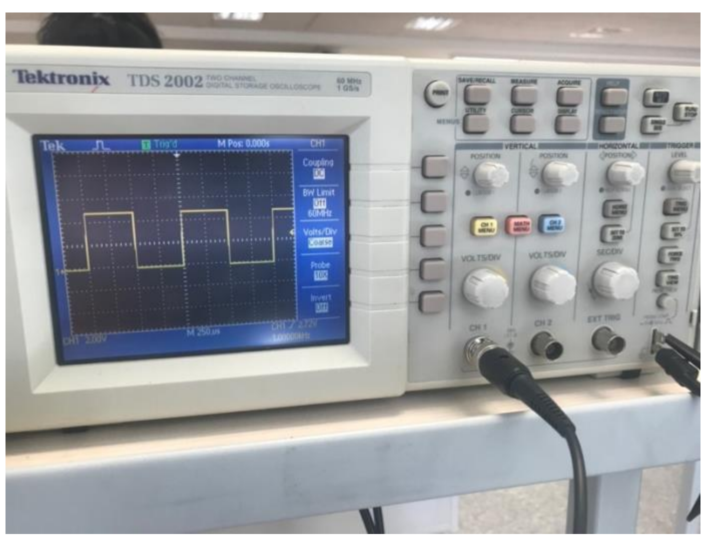


Figure 1: The compensation graph of probe

2. Firstly, probe of oscilloscope was connected to probes of signal generator. The red cable output of the signal generator was connected to the oscilloscope probes’ tip. Also, the black cable output of the signal generator was connected to the oscilloscope probe’s ground. 1khz frequency and 2.5 Volt for amplitude of the wave was entered. This process was done to obtain 5 Vpp(peak to peak). Figure 2 was the result obtained. Moreover, the sinusoidal signal was selected. Coupling was changed DC to AC. Afterward, I selected the rising in the slope section at trigger men, so that positive edge triggering was made.   As a result, the wave is inversed at the graph which is figure 3. When the negative edge triggering was applied which falling in the slope section at trigger menu, the graph went back to normal. The result came from the negative edge triggering is figure 4.

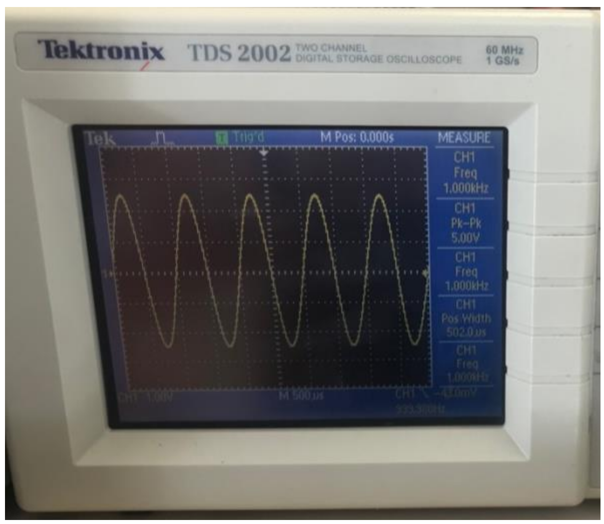
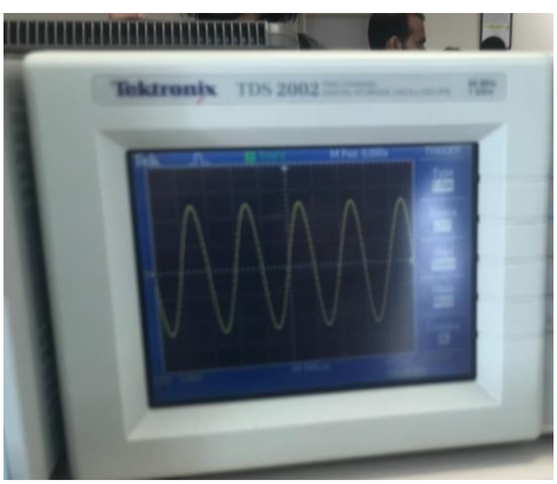


Figure 2: The sinusoidal wave graph



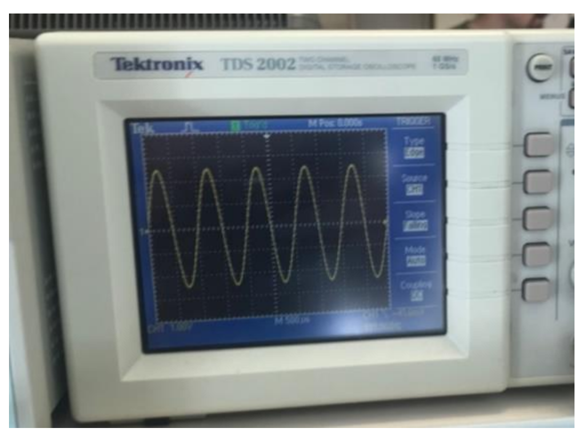


Figure 3: Positive edge triggering (rising) graph

Figure 4: Negative edge triggering (falling) graph

3. 0.5 Volt amplitude, 2khz frequency, and a triangular wave were selected in the signal generator. Figure 5 was obtained in the oscilloscope. Initially, the trigger point was inside the wave graph. When the trigger point was got out form boundaries of the wave by using the trigger knob, the wave was unclear. As a result, triggers change the criteria to capture correct waveform for working.

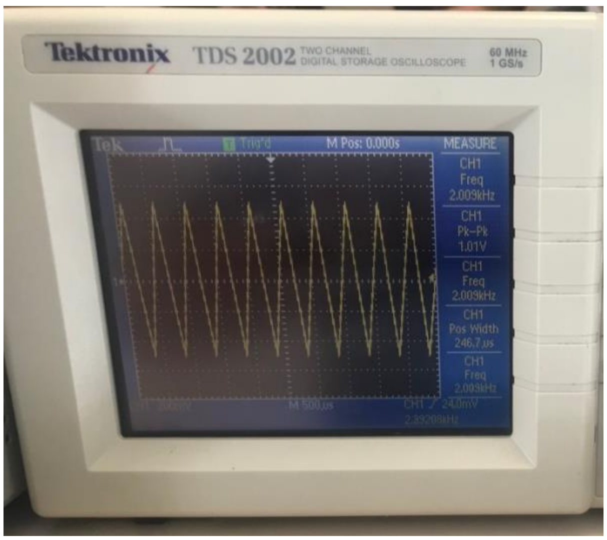


Figure 5: When the trigger point is inside between boundaries

Figure 6: When the trigger point is inside between boundaries

4. Digital to analog converter (DAC) is the digital data converts to the analog data. DAC is generally at electronic device to convert digital sounds files to analog sound that we hear (Technopedia). Analog to digital converter (ADC) is the analog data converts to digital data. ADC is generally used at microcontrollers (İbrahim, 2015). In this oscilloscope, ADC is used. It gets the analog data from the probe. ADC converts it to digital data, so the digital data represents in the screen of the oscilloscope. To begin with, 1 Volt amplitude, 5 kHz frequency and square wave was selected in the signal generator. After, all acquisition modes were tried. The initial acquisition mode was sample, which is default value in the oscilloscope. The figure 7 was the result of it. Moreover, the peak detect mode was tried which was figure 8. It made a

smalslightnge in the graph. Lastly, the average mode was chosen. The graph of this mode was figure 9. The wave became more understandable by using the average mode.

Figure 7: Sample mode selected

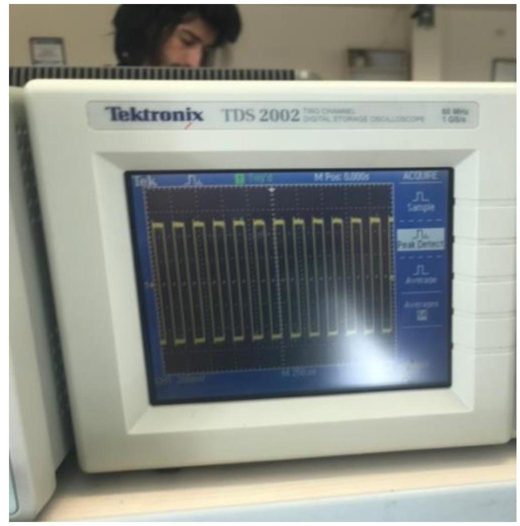


Figure 8: Peak Detected mode selected

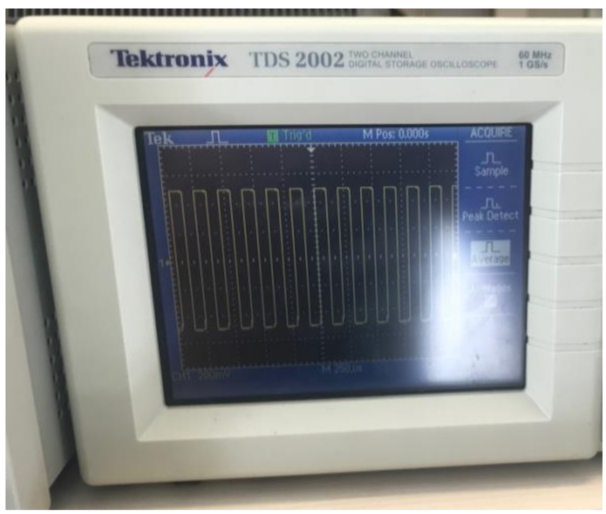


Figure 9: Average mode selected

5. Initially, 2.0 Volt amplitude, 1 kHz frequency and sinusoidal wave was selected in the signal generator. The difference between other set is there is an offset option at the signal generator was used. There was 1 Volt offset selected in the signal generator. Moreover, the coupling was changed to DC from AC. The result obtained from the

oscilloscope was figure 10. The wave was shifted to up. However, the wave graph did not change when the coupling was changed to DC to AC. The figure of the AC coupling with offset was figure 11.

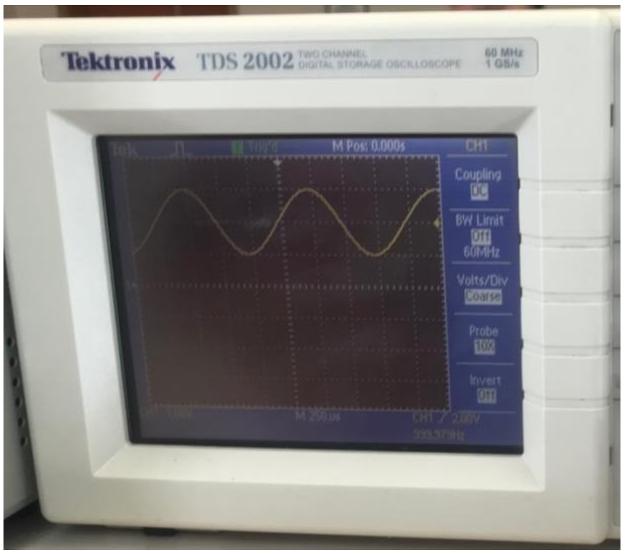


Figure 10: DC coupling

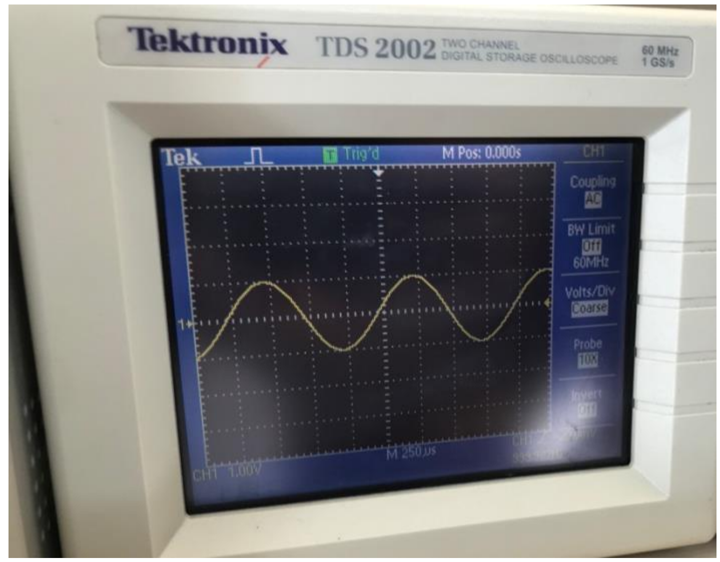


Figure 11: AC coupling

6. The breadboard used for creating temporary circuits. It contains series of metal sheets inside. Also, it has connected holes on the top, so you can put electrical components in the breadboard for making connections. In this step of the experiment, I made the circuit on the breadboard which is shown in figure 12. Two channels were used in this part of the experiment. One of the channels was connected to the signal generator's positive cable. Another one is connected to the resistor line in series. Both probes' ground cables were connected to the ground terminal of the circuit.

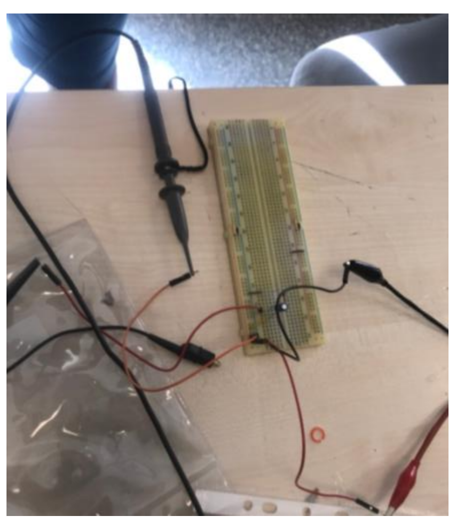


Figure 12: The circuit at the breadboard

1.0 Volt, 1 kHz frequency and the sinusoidal signal was chosen at the signal generator. Furthermore, figure 13 was obtained. There was a delay between channel one and channel 2. The delay between channels was 232.0 μs. Formula one was applied to find the phase difference between channels. The result came from formula one was 1.46 radians.

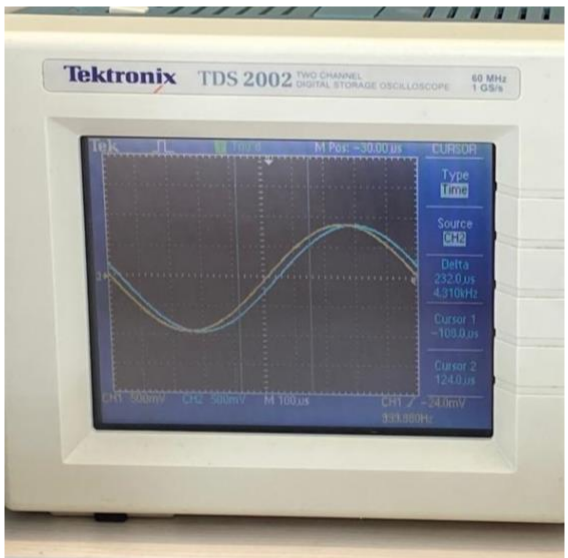


Figure 13 The wave graph of channels in 1 kHz frequency

Phase difference = 2π(Time difference) (Frequency of the wave)

Formula 1: Phase Difference Formula

$2\pi(232.0\ \mu s)\ (1\ kHz) \cong 1.46$ radians (3 Significant figures)

Equation 1: The calculation of phase difference at 1 kHz frequency

Afterward, the frequency was changed from 1 kHz to 100kHz. The graph of the wave was figure 14. The delay between the channels was 2.320 μs. The phase difference between the channels was 1.46 radians. As a result, there was nearly difference between the waves. As a result, the capacitor behaves like wire.

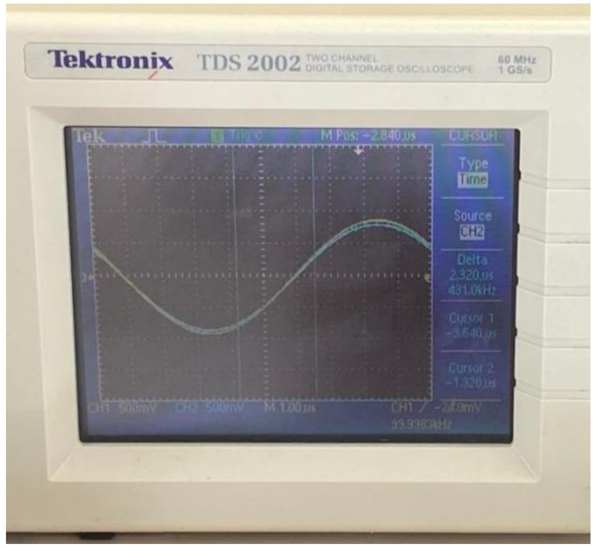


Figure 14: The wave graph of channels in 100 kHz frequency

$$2\pi(2.320\ \mu s)\ (100\ kHz) \cong 1.46 \text{ radians (3 Significant figures)}$$

Equation 2

Conclusion

In the experiment, the general usage of oscilloscope was learned. Different types of signal waves such as triangular or sinusoidal was generated by using the signal generator. The different properties of the oscilloscope were used to create the observable wave. T he compensation of the oscilloscope probe was significant to get correct waves on the oscilloscope.

Bibliography

Ibrahim, D. (2015). Microcomputer Systems. In PIC32 Microcontrollers and the Digilent chipKIT (pp. 1–14). Elsevier. https://doi.org/10.1016/b978-0-08-099934-0.00001-6

What is digital-to-analog converter (DAC)? - definition from Techopedia. Techopedia.com. (2022, September 26). Retrieved September 26, 2022, from https://www.techopedia.com/definition/25285/digital-to-analog-converter-dac