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EEE102-2

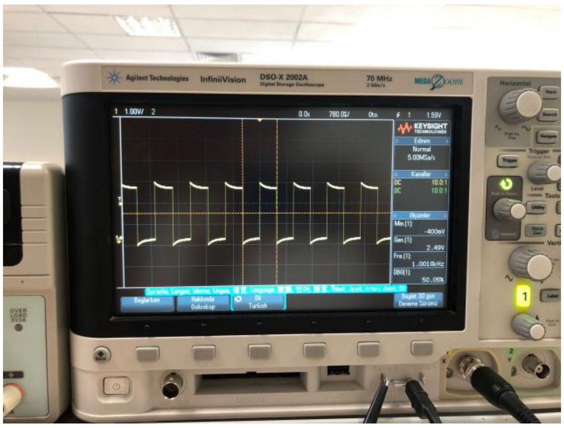
EEE102 Introduction To Digital Circuit Design
LAB 1 Introduction to Digital Oscilloscopes

General Purpose: This Lab is designed to present and teach main features of oscilloscopes such as triggering, acquisition,waveform , their work principles and key points in order to use them correctly. Furthermore it is also expected to understand a breadboard's working principles and how to design a basic circuit on it.

EXPERİMENT 1 ***Compensation***

Compensation of probes is an essential step when starting using an oscilloscope. It equalizes the probes' electrical properties to the oscilloscope's therefore starting measurements without a precise compensation can cause inaccurate results.

The process:

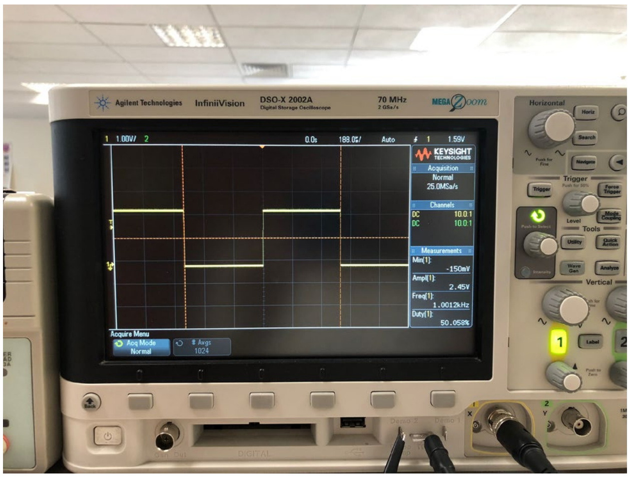


For the compensation process, firstly I generated a compensation signal which have a square waveform as can be seen in figure 1.

Figure 1

I compensated the probe using an adjustment tool as shown in figure 2

Figure 2



Signal obtained from a compensated probe can be seen in figure 3.

Figure 3

EXPERİMENT 2 ***Triggering***

For this experiment I used a 5 peak to peak volt sinusoidal wave with 1kHz frequency. Firstly I generated it using positive edge triggering (figure 4) which starts by showing the part of the signal with a positive slope.

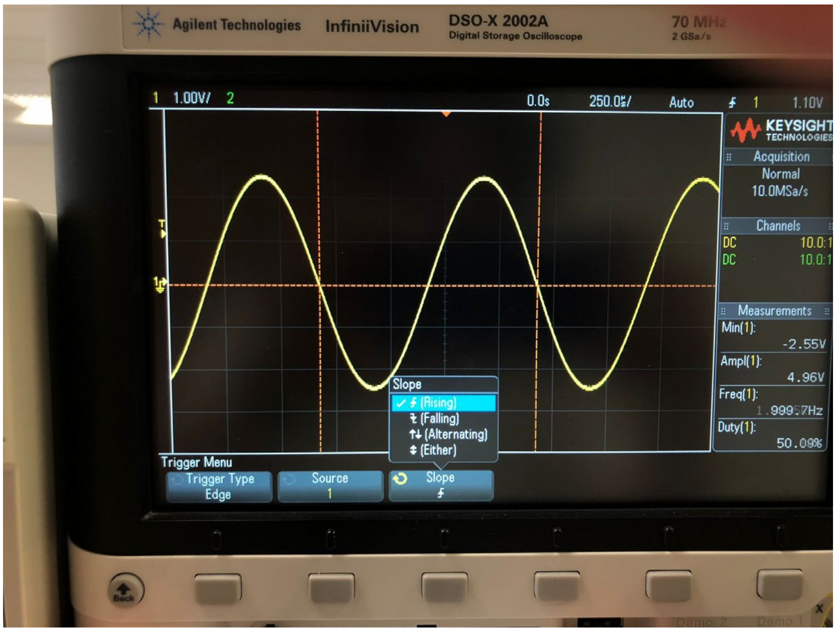


Figure 4

Falling edge triggering

5 V_{pp}

1 kHz

Then I generated the same signal but by applying negative edge triggering mode(figure 5). Contrarily to the positive edge triggering, this mode starts by showing the signal part with a negative slope.

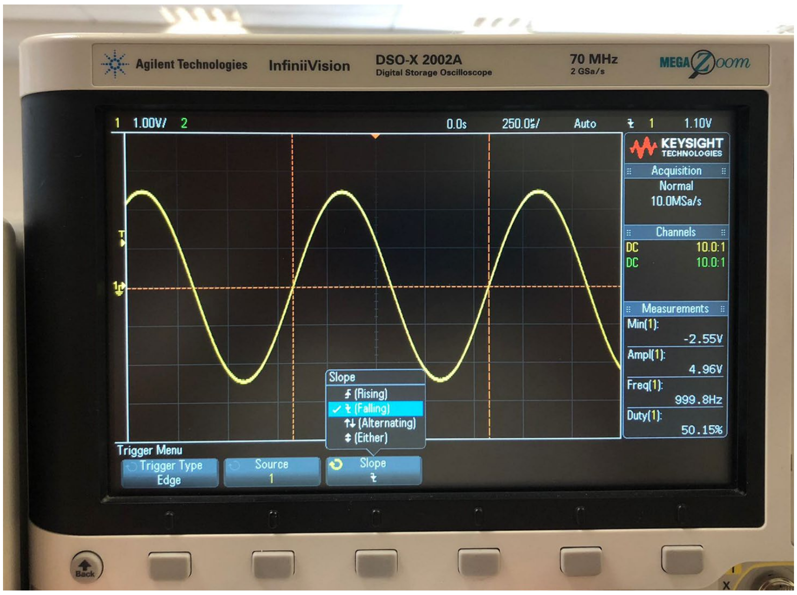


Figure 5

Falling edge triggering
5 V_{pp}
1 kHz

EXPERİMENT 3 ***Trigger Control***

I generated a triangular wave with 1 V_{pp} and 2 kHz frequency. Since the trigger level is not adjusted a proper signal cannot be seen on the screen. (figure 6)

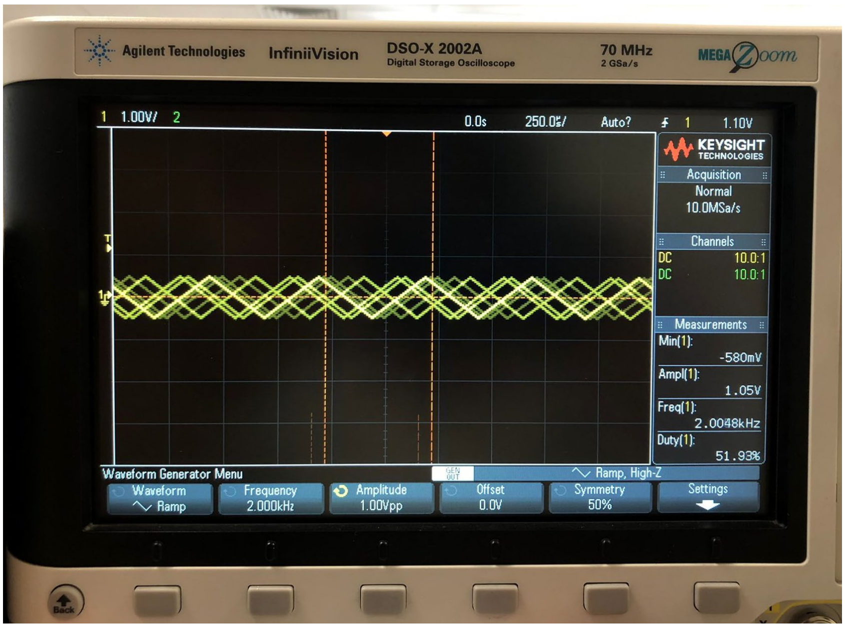


Figure 6

1 V_{pp}
2 kHz

After adjusting the trigger level, a proper and stabile waveform can be detected.(figure 7)

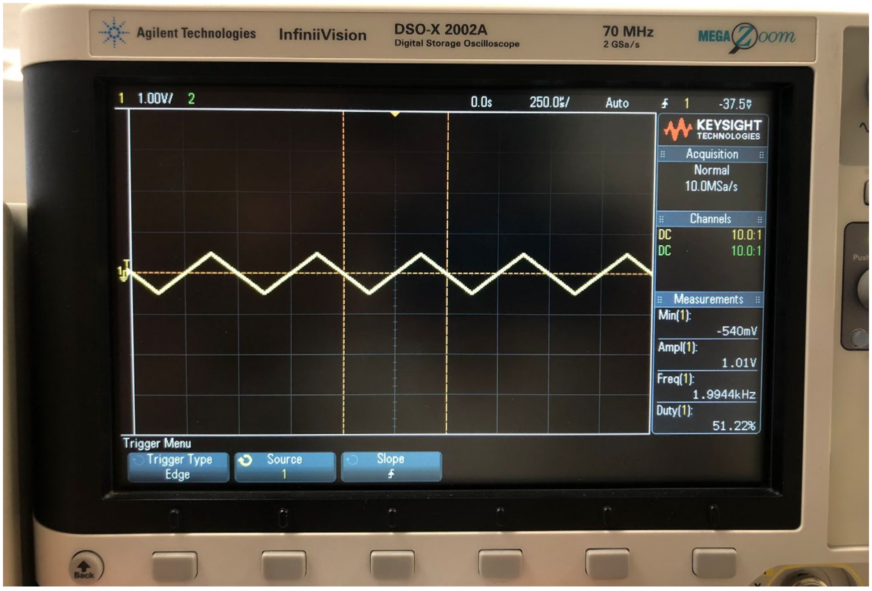


Figure 7

1 V_{pp}
2 kHz

Results of Experiment 3 : Trigger control can be explained as the way of synchronizing signal points in order to obtain a stable waveform. In the beginning of this experiment the trigger level was not within the scope of the waveform therefore signal points weren't organized. However when I changed the level into the scope, a synchronized form of signal points were appeared.

EXPERİMENT 4 ***Acquisition***

Digital to analog converters (ADCs) convert an analog signal into a digital signal form, a sound card can be given as an example. On the other hand, digital to analog converters (DACs) do the opposite, they convert a digital signal into a analog one such as sound therefore speakers can be given as an example.

For this experiment, I applied a square wave of 1 V_{pp} , 5 kHz to the oscilloscope and tried different acquisition modes. As can be seen from figures 8 and 9, I couldn't notice a big difference however in the averaging mode I saw that the noise diminishes and a more clear signal appears since it takes the average value of peaks.

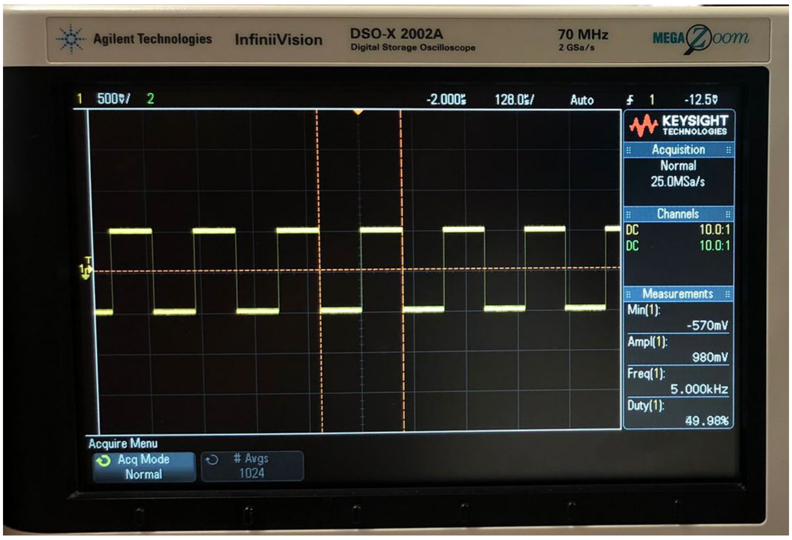


Figure 8

1 V_{pp}
5 kHz
Acq Mode: Normal

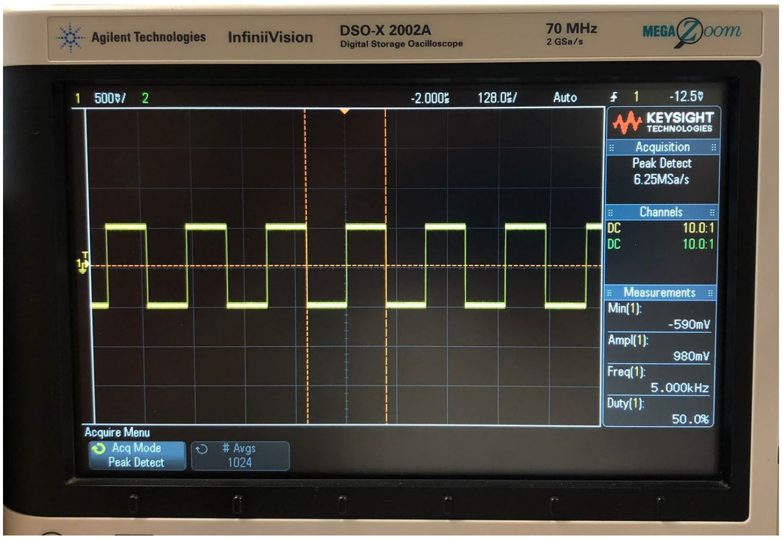


Figure 9

1 V_{pp}
5 kHz
Acq Mode: Peak Detect

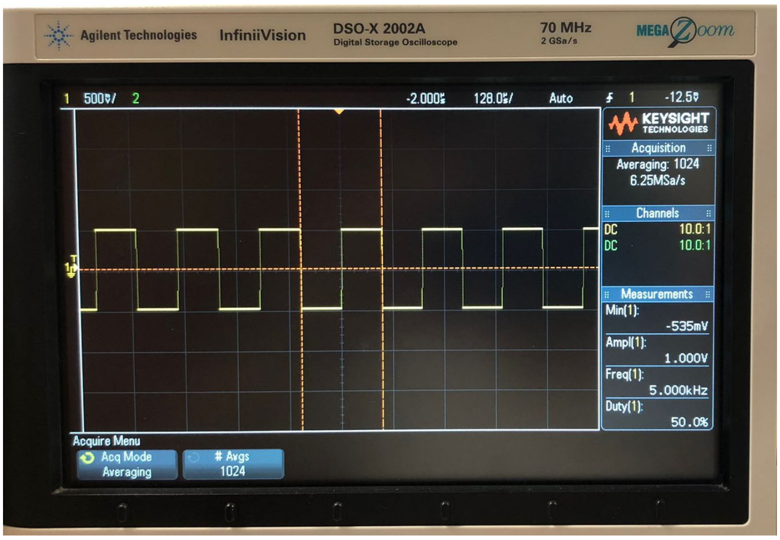


Figure 10

1 V_{pp}
5 kHz
Acq Mode:Averaging

EXPERİMENT 5 ***DC, AC coupling***

I generated a sinusoidal signal with 1kHz frequency and 2 V_{pp} amplitude, I also applied a 1V DC offset . Firstly I generated the signal using DC coupling (figure 11) afterwards I changed it into AC coupling.(figure 12) When comparing these two signals it can be concluded that with an AC coupling the 1 voltage DC offset cancels out. Therefore it creates a 1V difference.

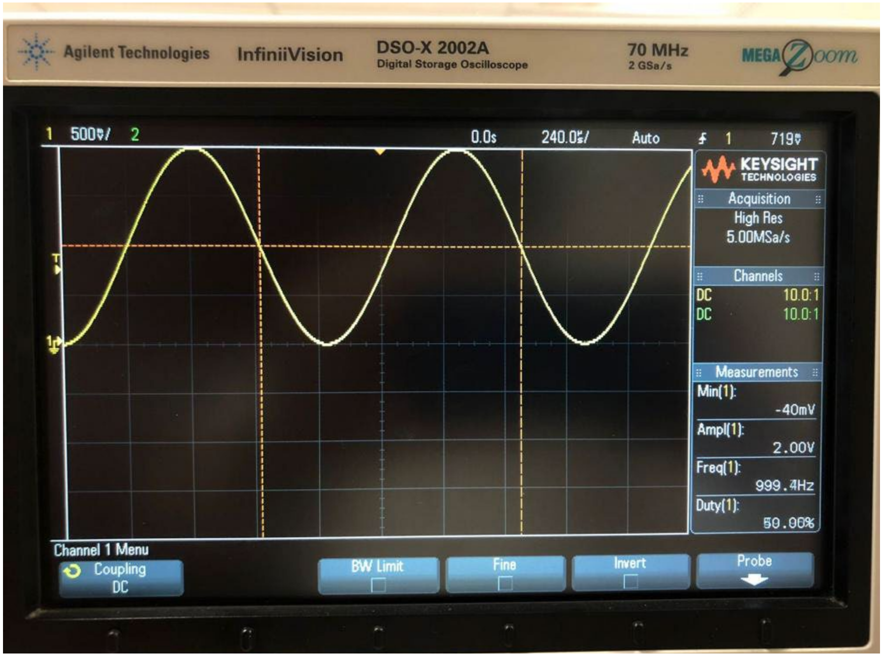


Figure 11

1kHz

2 V_{pp}

1V DC offset

DC coupling

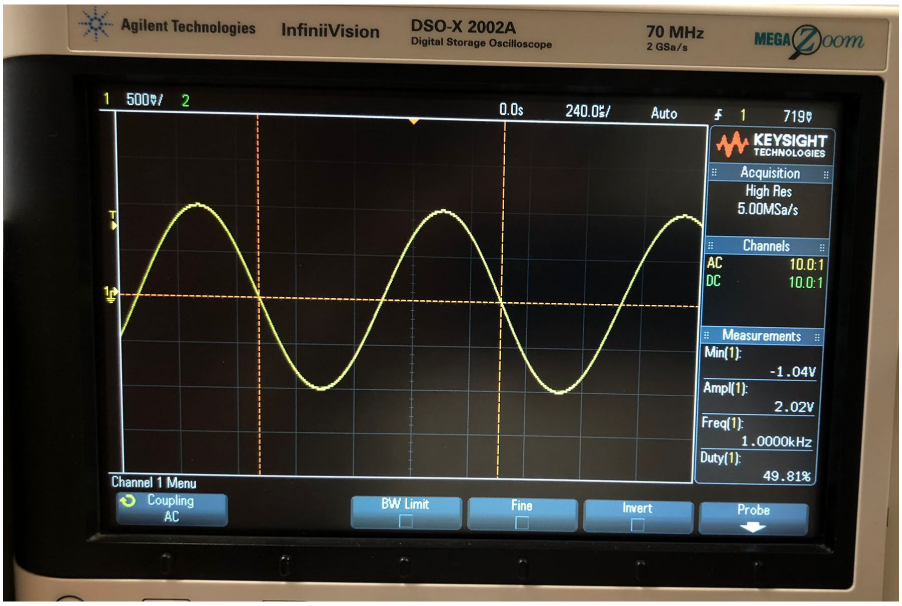


Figure 12

1kHz

2 V_{pp}

1V DC offset

AC coupling

EXPERİMENT 6 ***Signals on a breadboard circuit***

A breadboard is a construction base which doesn't require solder. It consist of holes and the ones on the same column are internally connected as well as + and - lines on it. By placing different circuit elements and wires we can create interchangeable solderless circuits.

While conducting this experiment, I set up a basic circuit on my breadboard as seen in figures 13,14.

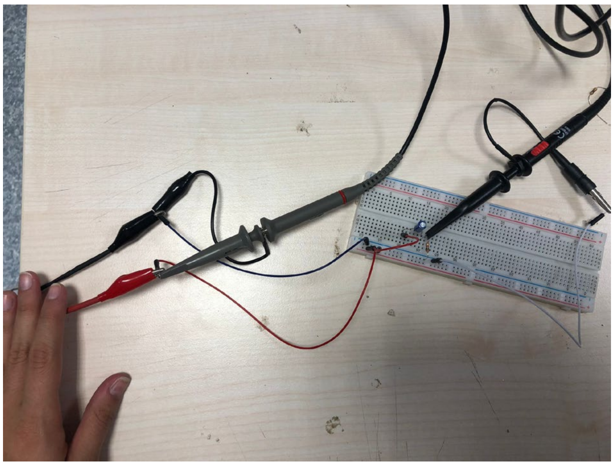


Figure 13

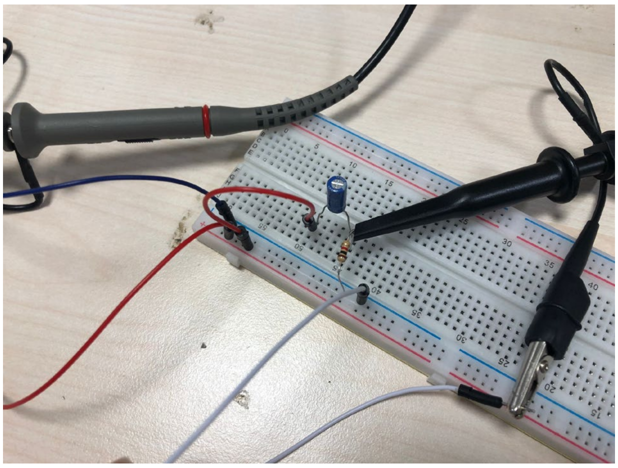


Figure 14

From channel 1, I applied a sinusoidal signal of 2 V_{pp} and 1 kHz with 0 DC offset to the circuit and from another channel, I measured the signal coming between the capacitor and resistor.

Figure 15

By using the cursor I measured the time difference between the peaks . There was a phase difference of 36 µs (figure 15).
I repeated same experiment by changing the frequency of channel 1 into 100 kHz.

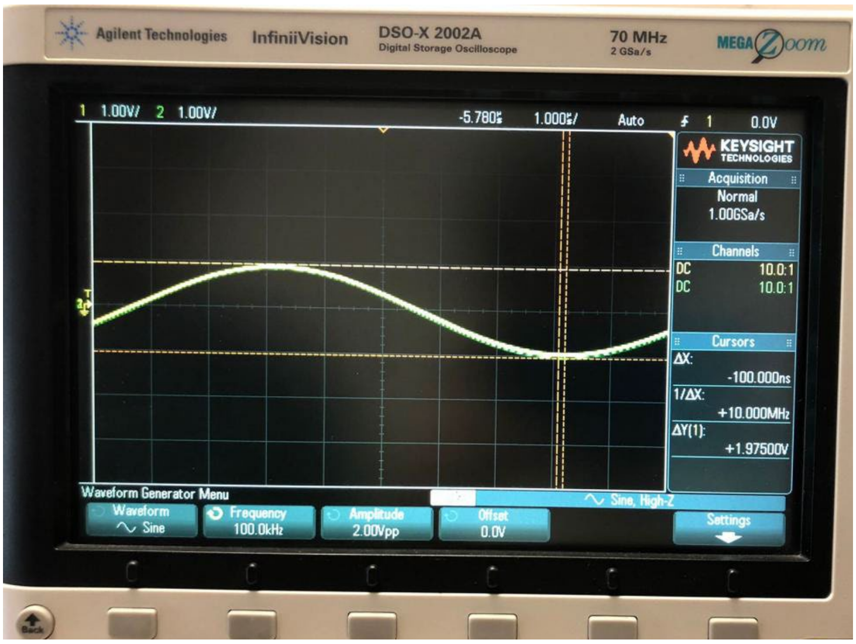


Figure 16

At this frequency level the phase difference was almost impossible to see but it was nearly a 100ns phase difference.(figure 16)

For 1kHz signal (figure 15) there was 0.226 radians of phase angle and for 100kHz the phase angle was 0.063 radians. The reasons behind this difference can be related to the capacitor in the circuit which creates an impedance that changes with the increase in the frequency.

CONCLUSİON

I became familiar with oscilloscope working principles. Although I had some problems while trying to get signal from the circuit in the last experiment I managed to end the lab session successfully.