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Lab 1: Introduction to Digital Oscilloscopes

Purpose:

Oscilloscopes are devices based on displaying the 2-dimensional graph of the electrical signal with respect to the voltage and time. The objective of this exercise is to use a signal generator to familiar myself with the operation and many features of an oscilloscope. Also building simple circuits and learn how to observe voltage changes at certain points can be aim of this experiment.

Methodology and Results:

The experiment consists of 6 different sub-stages. Methods employed in the sub experiment and the results are provided separately for each section.

Part 1:

a) Methodology: Passive probes are the most popular type of probe used for all-purpose measurements. Attenuation probes use an inbuilt resistor in conjunction with the oscilloscope's input resistance to form a voltage divider, which increases the voltage measuring range of the oscilloscope. Oscilloscope probe's attenuation factor is 10X at this experiment (Figure 1). Other important point about probe is compensation. Compensation setting balance the electrical properties of particular oscilloscope. Measurement done with poorly compensated probe will give less accurate results (Figure 2-3).

Figure 1 – Attenuation of probe 10X

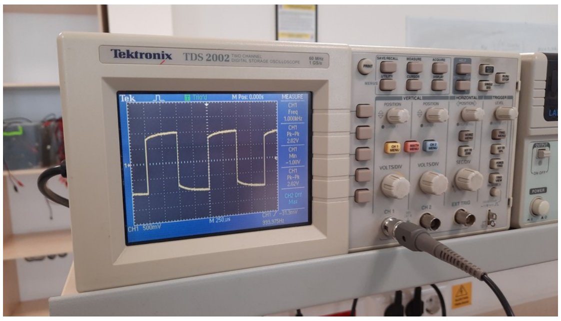

Figure 2 – Undercompensated

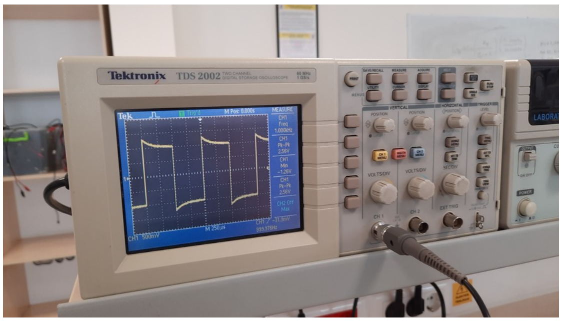

Figure 3 – Overcompensated

To achieve the correct compensation screwdriver is used. To find the correct measurament probe's screw is turned into clockwise or counterclockwise. As the screw turns, the wave edges contract inward or expand outward.

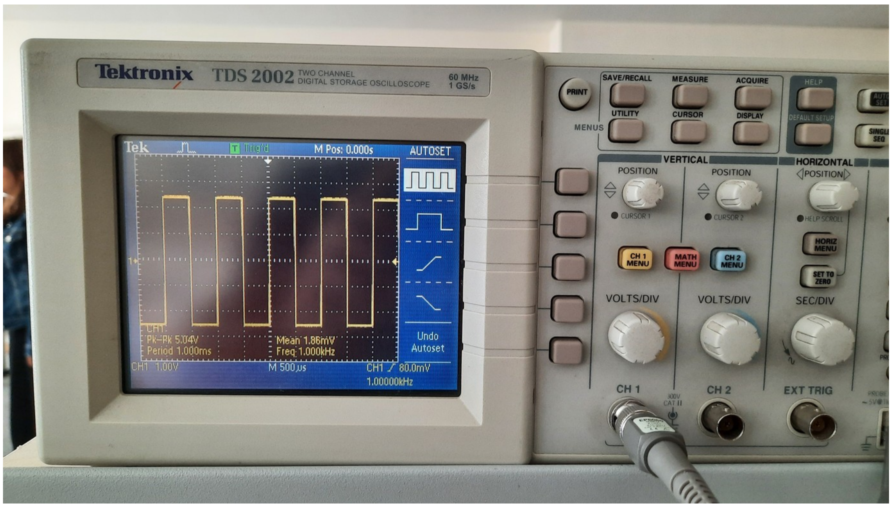

Figure 4 – Compensated correctly

b) Results: If probe attenuation is not 10X, oscilloscope can not measure the signal properly. If the compensation adjustment did not apply, the graphs do not have correct results. If compenation adjustment is applied too much in one direction the graph can be decayed to other direction (as Figure 2-3).

Part 2:

a) Methodology: Signal generator was adjusted to 5 V_{pp}. To obtain 5 V_{pp} value I applied 2.5 V Frequency of generator was adjusted 1 kHz and the signal shape was adjusted to sinusoidal signal. The signal's DC-offset was changed to zero. After adjustments probes positive tip was binded to signal generator's positive tip and ground tip of probes was binded to ground tip of signal generator. To obtain positive edge triggering I changed the slope of oscilloscope to rising.Reversively, to obtain negative edge triggering I changed the slope of oscilloscope to falling (Figure 7-8).

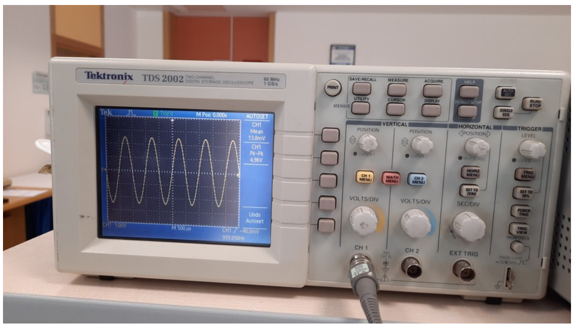

Figure 5 – 5V_{pp} and 1kHz sinusiodal signal

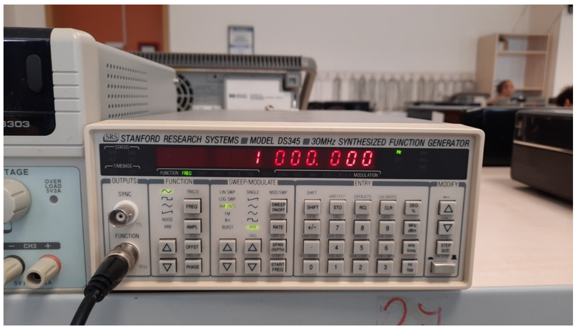

Figure 6 – 1kHz on signal generator

b) Results: Probe is received the frequency generated by signal generator and transmit the signals to the oscilloscope. Oscilloscope generated the 2-dimensional voltage-time graph according to the signals that probe transmitted. V_{pp} and frequency values can be read from the right side of the screen. Frequency of signal is 1 kHz and Voltage of signal is 5 V_{pp} (Figure-5). Also signal's slope can be shown as rising or falling.

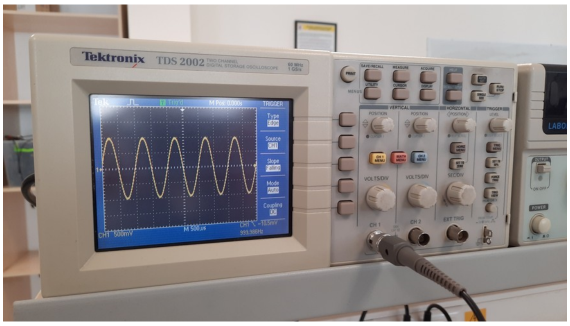

Figure 7 - Positive edge triggering

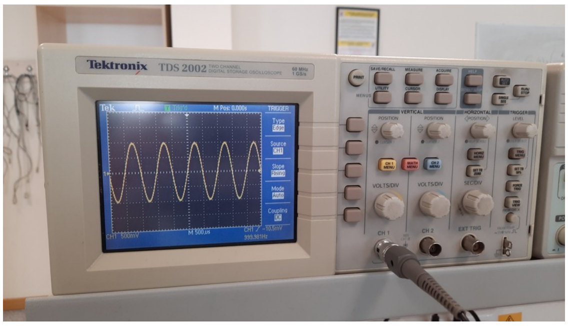

Figure 8 - Negative edge triggering

Part 3:

a) Methodology: Signal generator was adjusted to produce triangular wave with 2 kHz frequency and 1 V_{pp}. To obtain 1 V_{pp}, signal generator was adjusted to 0.5 V. After adjustments probes positive tip was binded to signal generator's positive tip and ground tip of probes was binded to ground tip of signal generator. Probe is connected with the signal generator's port. Then data on the oscilloscope screen is recorded at Figure 7.

Figure 9 – Signal generator at 2 kHz and oscilloscope

b) Results: The trigger knob determine the start and stop points of measurements. If the trigger is moved up or moved down to another voltage level, the signal started to move back or forward horizontal axis. Probe is received the frequency generated by signal generator and transmit thesignals to the oscilloscope. Oscilloscope generated the 2-dimensional voltage-time graph according to the signals that probe transmitted. V_{pp} and frequency values can be read from the right side of the screen.

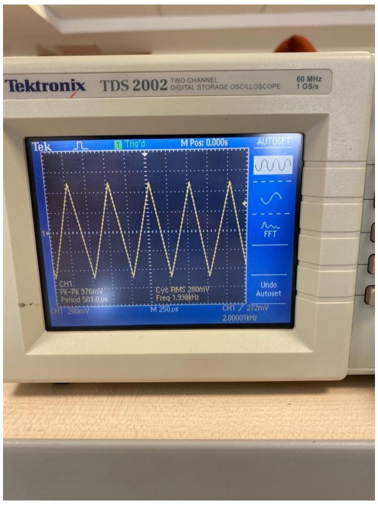

Figure 10 – High Trigger Level

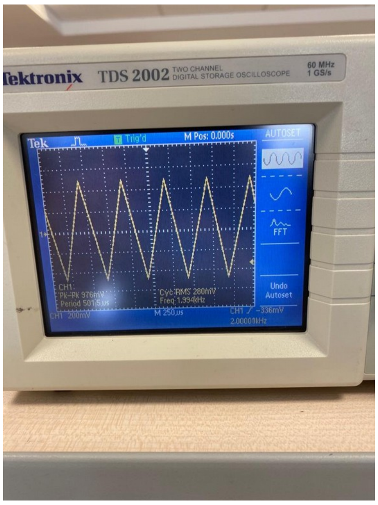

Figure 11 – Low Trigger Level

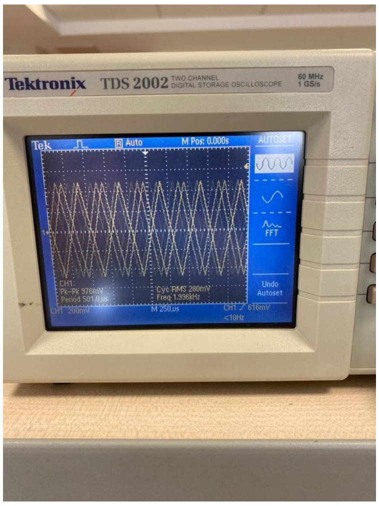

Figure 12 – Trigger level is not inside specified value

Part 4:

a) Questions: A system known as a digital-to-analog converter transforms digital signals into analog signals. The opposite operation which transforms the signal from analog to digital signals is carried out by an analog-to-digital converter. ADC and DAC are used for to transform analog input to digital output and it can make a connection between real world and computer world. In oscilloscope, anolog-to-digital is used because the digital oscilloscope takes the datas from analog source and turn them into digital.

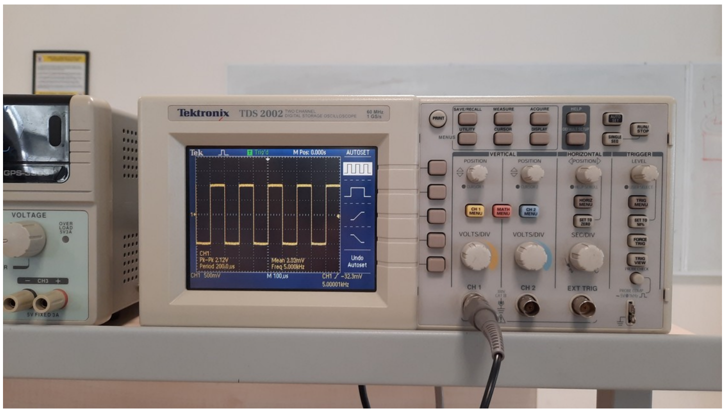

Figure 13 - 1 V_{pp} and 5 kHz square wave signal

b) Methodology: Signal generator was adjusted to produce square waves with 5 kHz frequency and 1 V_{pp} . To obtain 1 V_{pp} , signal generator was adjusted to 0.5 V. Then same process is applied at previous part. Probe is connected with the signal generator's port. Then data on the oscilloscope screen is recorded at Figure 11. Also, we observe different acquisition modes on square waves (sample, peak detect, average) (Figure 11-12-13).

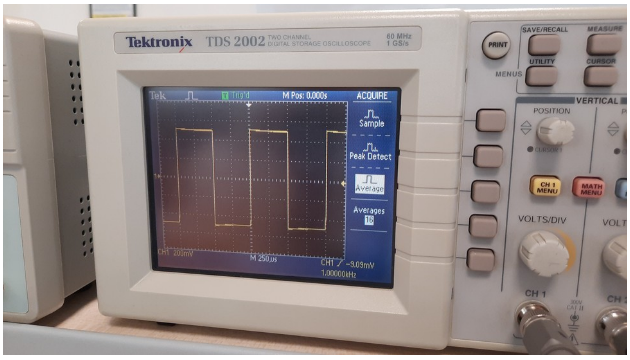

Figure 14 – Average mode is on

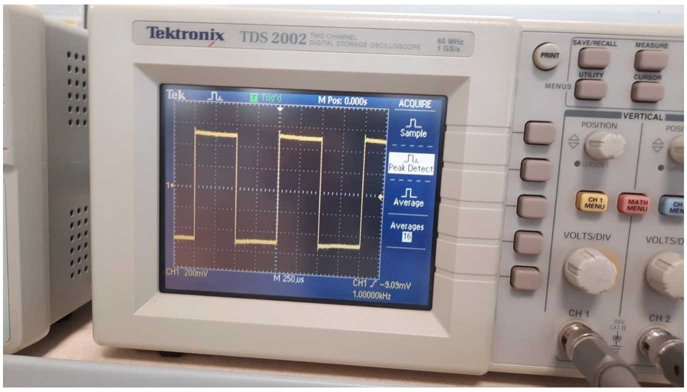

Figure 15 – Peak detect mode is on

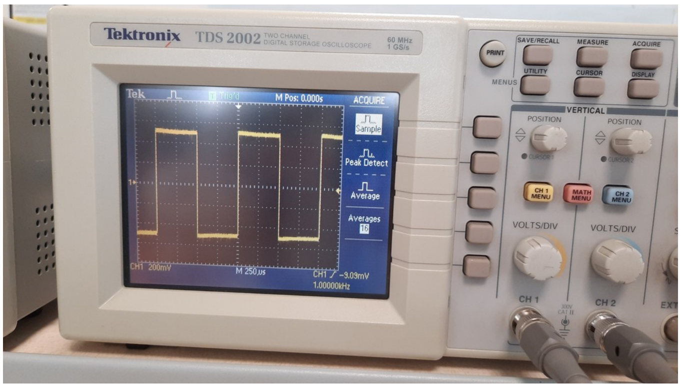

Figure 16 – Sample mode is on

c) Results:

In sample mode, one sample point is saved by the oscilloscope during each waveform interval to produce a waveform point. It is shown in the Figure 13.

In peak detection mode, the oscilloscope uses these samples as the two associated waveform points by saving the minimum and greatest value sample points obtained during two waveform intervals. This mode can be useful to observe instant changes.

In average mode, the oscilloscope saves point at each time interval. In my experiment the number of times was 16. It can be taken different values (4,16,64,128).

Probe is received the frequency generated by signal generator and transmit thesignals to the oscilloscope. Oscilloscope generated the 2-dimensional voltage-time graph according to the signals that probe transmitted. V_{pp} and frequency values can be read from the right side of the screen.

Part 5:

a) Methodology: Signal generator was adjusted to produce square waves with 1 kHz frequency and 2 V_{pp}. To obtain 2 V_{pp} , signal generator was adjusted to 1 V. Also, I applied DC-offset 1 V. Then same process is applied at previous part. Probe is connected with the signal generator's port. Then data on the oscilloscope screen is recorded at Figure 17.

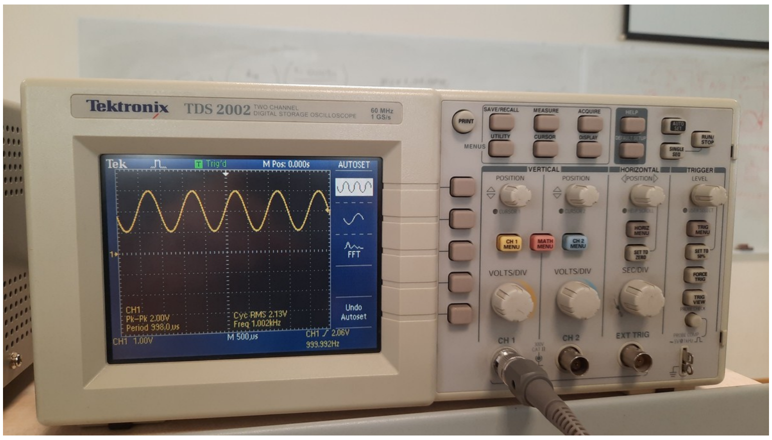

Figure 17 – 2 V_{pp} and 1 kHz frequency signal with DC-offset 1

b) Results: When DC coupling is applied to signal, ground level of the signal is changed with respect to applied DC voltage. In this experiment, we applied to 1 V DC-offset so the graph is moved up to 1 V. Probe is received the frequency generated by signal generator and transmit thesignals to the oscilloscope. Oscilloscope generated the 2-dimensional voltage-time graph according to the signals that probe transmitted. V_{pp} and frequency values can be read from the right side of the screen.

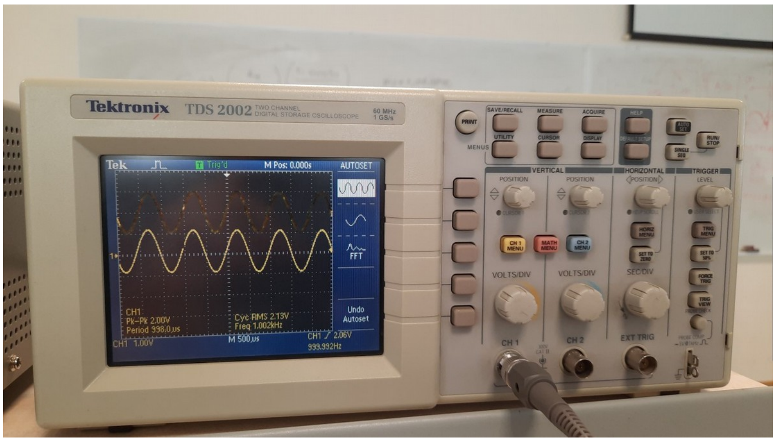

Figure 18 - 2 V_{pp} and 1 kHz frequency signal with DC-offset 0

Part 6:

a) Methodology: Firstly the circuit diagram (Figure 19) is set up on the breadboard (Figure 19-20). Then 2 probes are connected to oscilloscope's channels (Ch1 and Ch2). Probe 1 was connected to Y point and ground tip is connected to ground. Probe 2 was connected to positive voltage side on the breadboard and ground tip was connected to ground. Then I applied 2 V_{pp} and 1 kHz frequency sinusoidal signal.

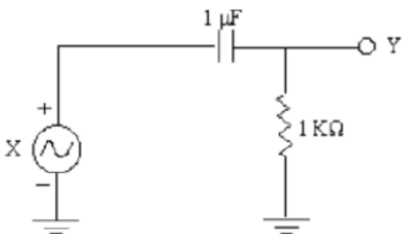

Figure 19 – Circuit diagram

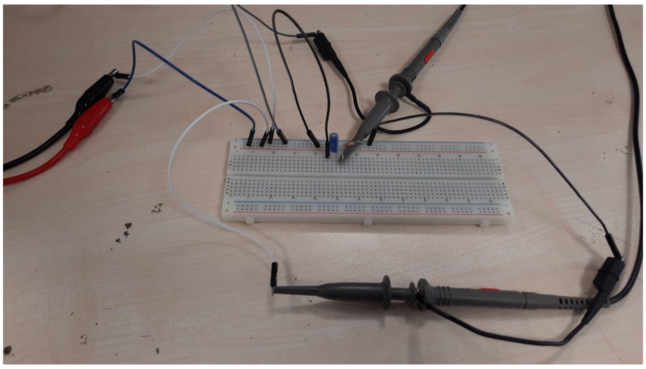

Figure 20 – Circuit on the breadboard

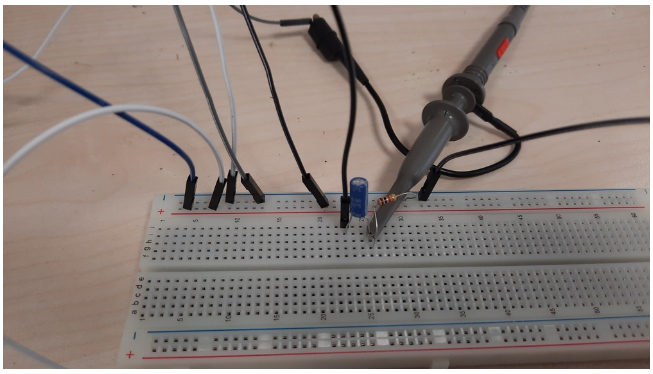

Figure 21 – Circuit on the breadboard (closer view)

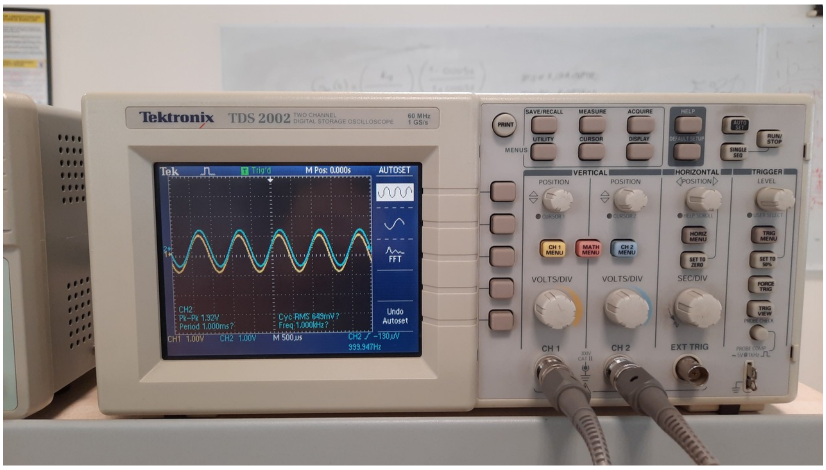

Figure 22 – Oscilloscope connected to circuit and signal generator (1 kHz)

b) Results: When the AC voltage (0 DC offset) applied to the circuit 2 sinusoidal waves are shown on the screen (Figure 21). Because of capacitor on the circuit there is a phase difference between Ch1 and Ch2. When frequency is 1 kHz (Figure 22), delay between voltage signals is 50 microsecond and Ch 2 is ahead. So the phase angle difference is 0.314 rad. When frequency is 100 kHz (Figure 21), delay between voltage signals is 50 nanoseconds and Ch 2 is ahead. So the phase angle difference 0.035 rad. Therefore when the frequency increases, the impedance value decreases and phase difference between 2 signal is decreased. Breadboard is a plate which allows to set up a circuit on it. It is shown in Figure 23. A and D parts are conneced each other horizontally. B and C parts are connected each other vertically.

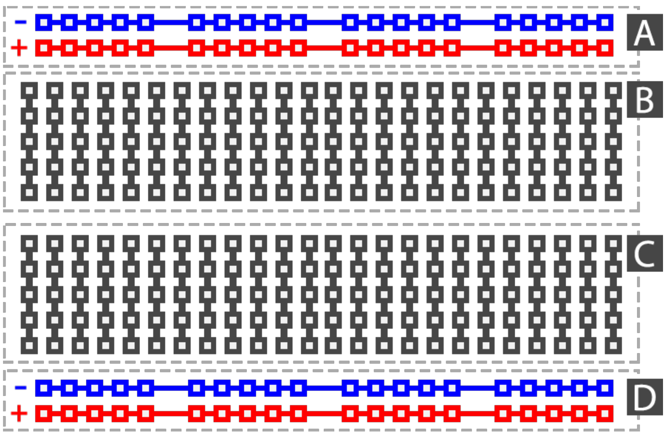

Figure 23 - Breadboard

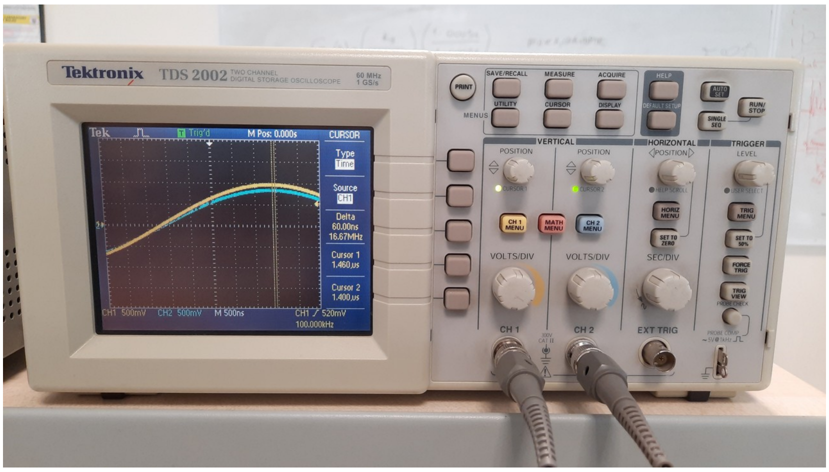

Figure 23 – Oscilloscope connected to circuit and signal generator (100 kHz)

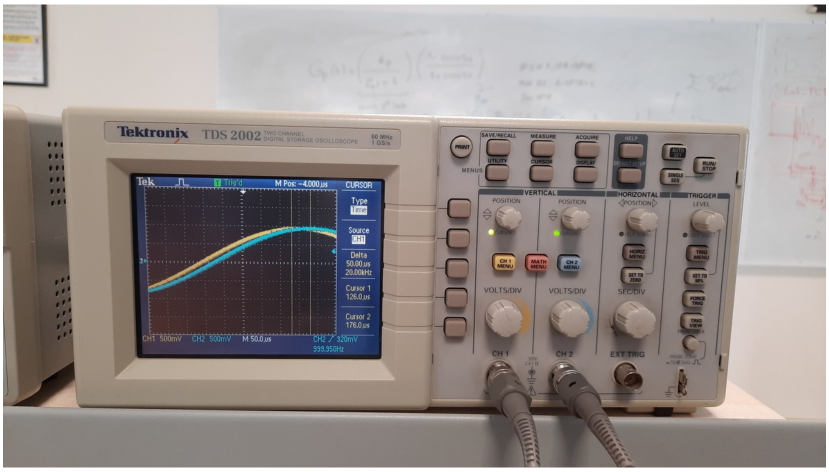

Figure 24 - Oscilloscope connected to circuit and signal generator (1 kHz)

Conclusion:

In this experiment we learned how basic operations can be done by using an oscilloscope and how a signal generator use. We produce square, sinusoidal and triangular waves with signal generator. Also we can change the amplitude and frequency of signals. There was error in my calculation because of signal generator because the signal generator can not produce always exact frequency for long time. So results can have a margin of error.