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EEE102 Introduction to Digital Circuit Design Lab Report 1

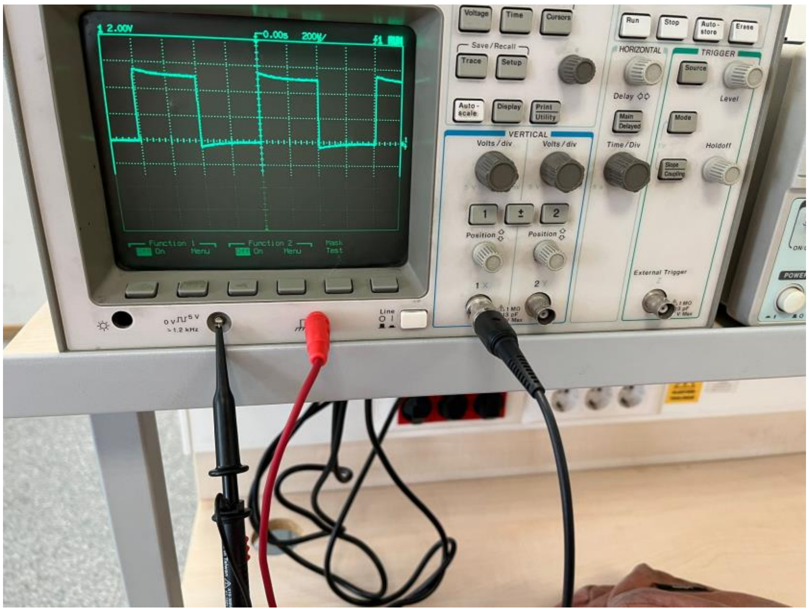
Section: 001

Purpose and Summary of the Lab

The objective of the experiment was to get familiar with uses of a digital oscilloscope, a signal generator, and to learn how a breadboard works and how to build a digital circuit on one. During the experiment, signals of different types (sinusoidal, square, triangular, etc.), frequencies and amplitudes were generated using a signal generator, a basic circuit was built on a breadboard, and properties of all of them were examined using a digital oscilloscope.

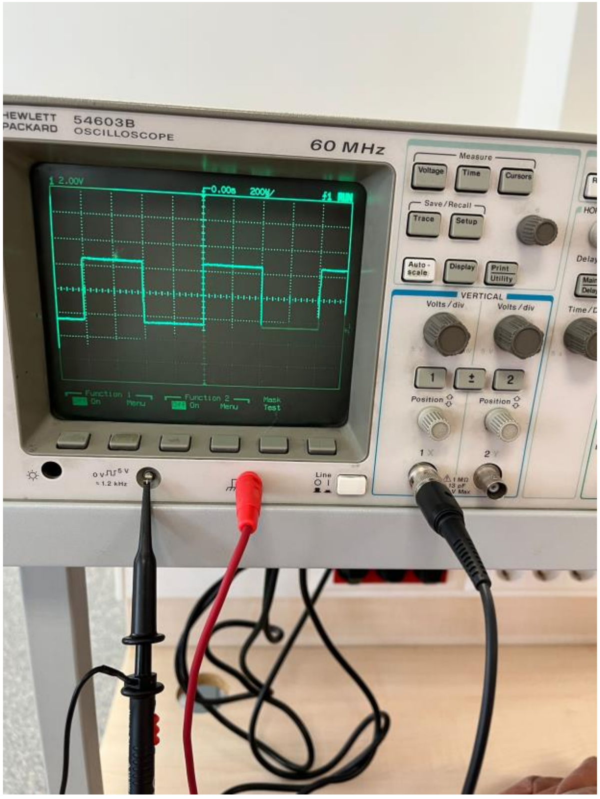
LAB WORK:

1. The oscilloscope probe (10x) was connected to the Channel 1 input socket, and compensated with the help of the compensation signal of the oscilloscope and a plastic tool that was included in the oscilloscope probe set. As can be seen from the figure below (Fig 1.1), the ends of the compensation signal (which ideally is a square wave) were uneven and had spikes.



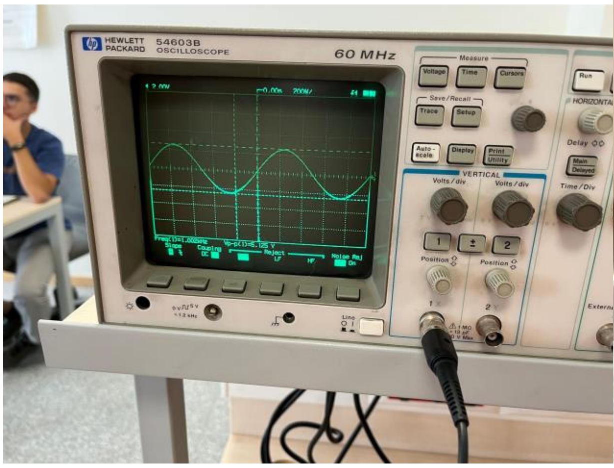
Fig(1.1)

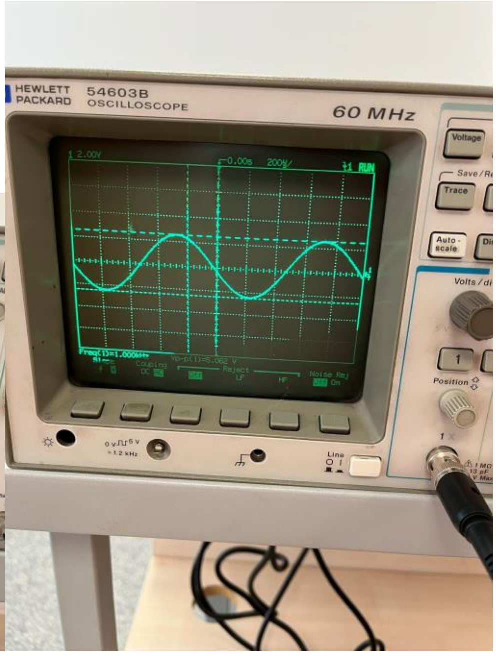
The oscilloscope probe was then compensated by rotating it with the plastic tool mentioned above. The final state of the compensation signal was in the form of a proper square wave (even on the sides, consisting of straight lines) (Fig 1.2).



Fig(1.2)

2. A sinusoidal wave with a peak-to-peak voltage of 5 Volts (5 Vpp) and a frequency of 1kHz was generated. The wave was generated so that it has no DC component. The oscilloscope was used to monitor the signal, and positive edge triggering and negative edge triggering were applied and the results were compared (Figs 2.1 and 2.2)

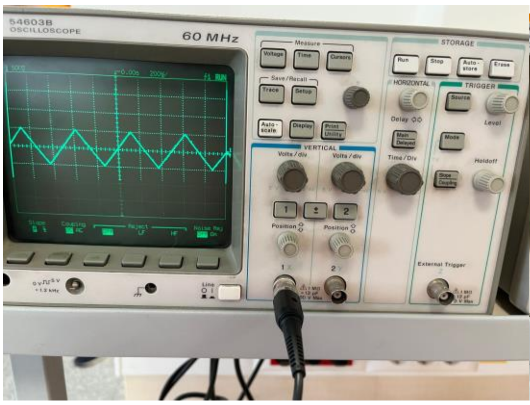


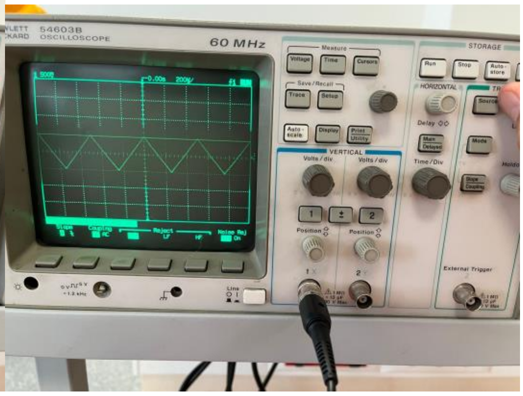


Fig(2.1) (Positive) Fig(2.2) (Negative)

With positive edge triggering, the wave was seen to be ascending in the far left hand side of the oscilloscope screen. With negative edge triggering, the wave was seen to be descending at the same point. The waveform was observed to be symmetrical with a vertical symmetry axis between the two triggering settings.

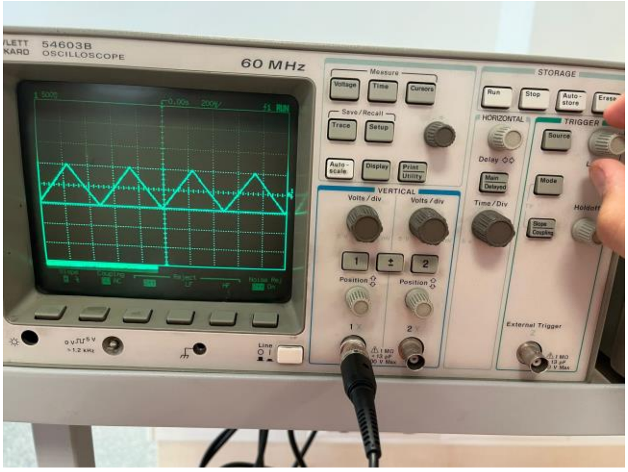
3. A triangular wave with 1 Vpp voltage and 2 kHz frequency was generated. While the trigger knob was being turned, the waveform was observed to be moving on the grid accordingly. If the trigger knob was turned to the left, the waveform moved to the right, and if the knob was turned to the right, the waveform moved to the left (Figs 3.1, 3.2).





Fig(3.1) Fig(3.2)

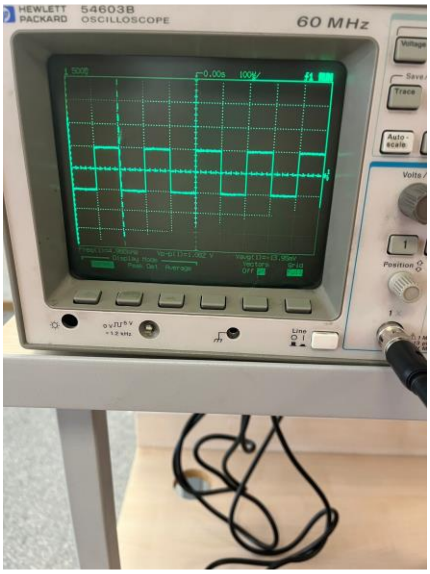
Although it was not possible to capture in pictures taken, it was also observed that when the trigger line exceeds the waveform from the top or the bottom, the waveform becomes unstable. It was easier to observe the waveform with the trigger line intersecting it (Fig 3.3).



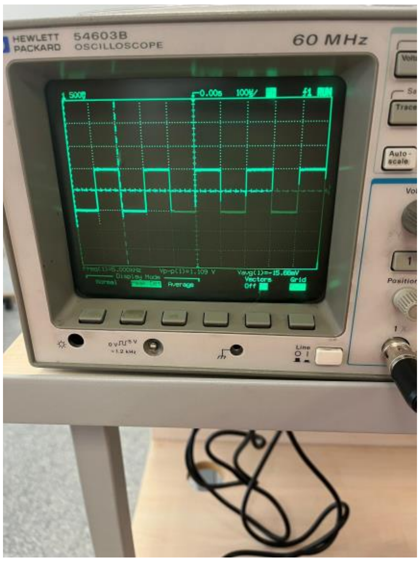
Fig(3.3)

The concept of triggering can be summed up as a set of criteria needed for the waveform being observed to remain stable on the oscilloscope screen. As mentioned above, if the trigger line exceeds the waveform, it is harder to observe the waveform as it becomes unstatic.

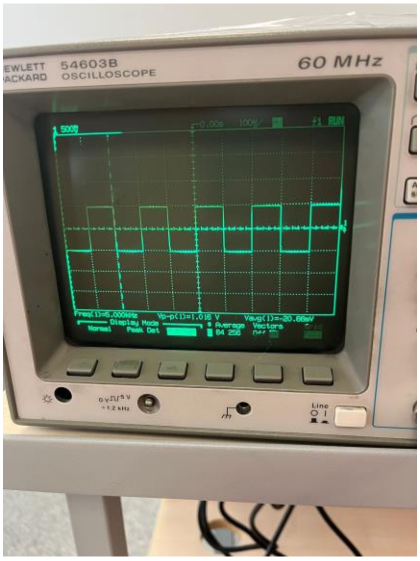
4. A 1 Vpp square wave with 5 kHz frequency was generated, and all three acquisition modes (sample (normal), peak detect, and average) were used and the results were examined.



Sample(Normal) Acquisition



Peak Detect Acquisition



Average Acquisition

The sample (normal) mode is the most ordinary acquisition mode. The oscilloscope selects points at regular intervals and draws the wave by "connecting the dots". The sample mode is usable only if the wave repeats itself.

The average mode, as the name suggests, averages multiple images of the waveform and draws the wave. It can be used to cancel out randomly generated noise, as random noise is not constant and cancels itself out when averaged.

In peak detect mode, the oscilloscope uses the peak (min-max) value sample points taken on two different waveform intervals and draws the wave with the sample points taken.

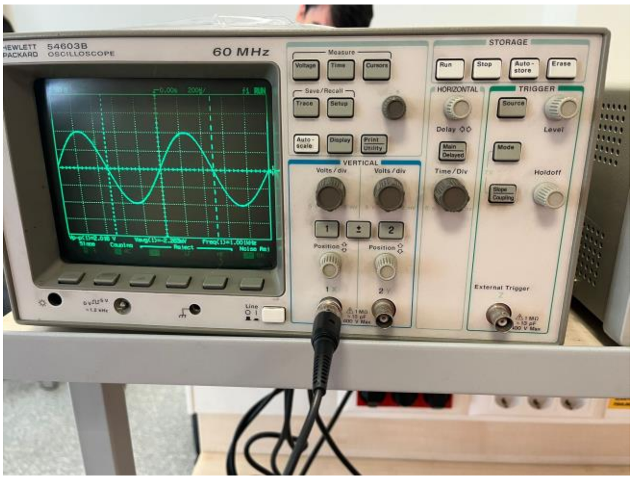
What is a Digital-to-Analog Converter (DAC)?

A DAC is a data converter that takes digital data as input and gives an analog output. A compact disc player is a DAC. It converts digital signals to what we hear coming from the CD player (human voice, etc.).

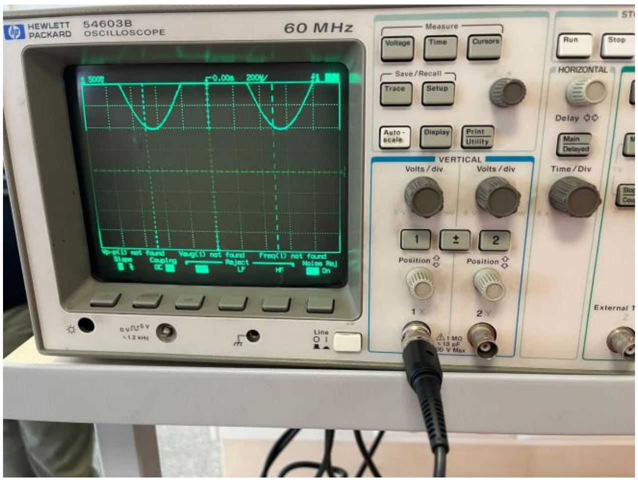
What is an Analog-to-Digital Converter (ADC)?

An ADC is a data converter (used in oscilloscopes) that creates digital information from analog input. While an analog signal is continuous and variable (i.e., human voice), a digital signal has discrete time and discrete amplitude (audio signals going from a microphone to speakers, therefore a microphone is an ADC).

5. A 2 Vpp sinusoidal wave with 1 kHz frequency was generated, and a DC offset of 1 V was applied. AC and DC couplings were used, and the results were compared. Ideally, there should be a vertical difference of 1 V between the peaks of DC and AC waves (DC wave being higher) (Figs 5.1 and 5.2), but because of minor mistakes and defects in the oscilloscope that was used, the vertical difference observed was smaller than 1 V, but there was a difference nevertheless.



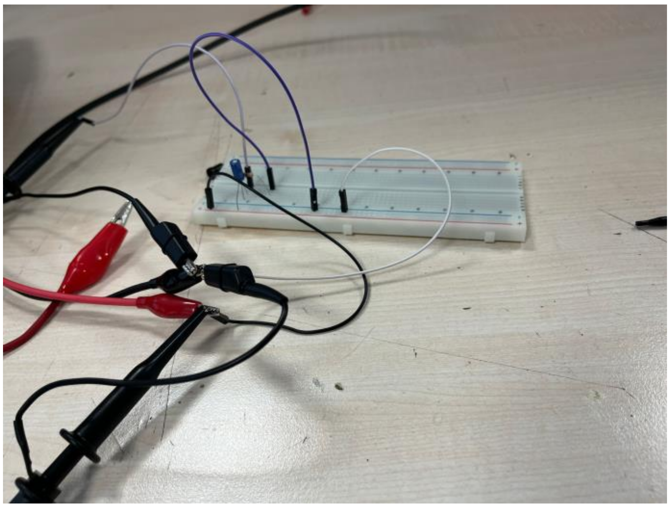
Fig(5.1)



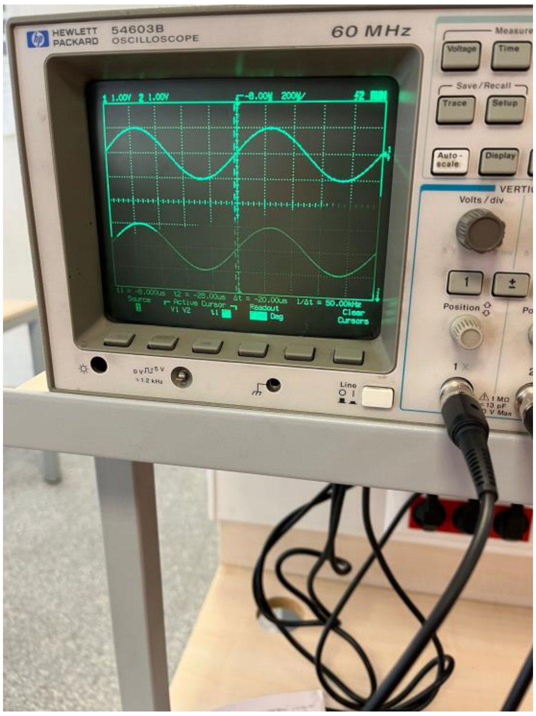
Fig(5.2)

6. A breadboard is a tool that is used to design temporary circuits for purposes like testing them. It is solderless, so it is suitable for temporary prototypes of circuits. There are sets of holes on a breadboard. When laid down horizontally, the top and bottom rows of holes are connected horizontally, while the middle rows are connected veritcally with metal strips.

A circuit with a capacitor and a resistor (Fig 6.1) was built on a breadboard as shown in the lab assignment manual, and the ground cables were connected. Two probes (X and Y, Channel 1 for X and Channel 2 for Y) were used in the making of the circuit, hence the two waveforms (Fig 6.2).

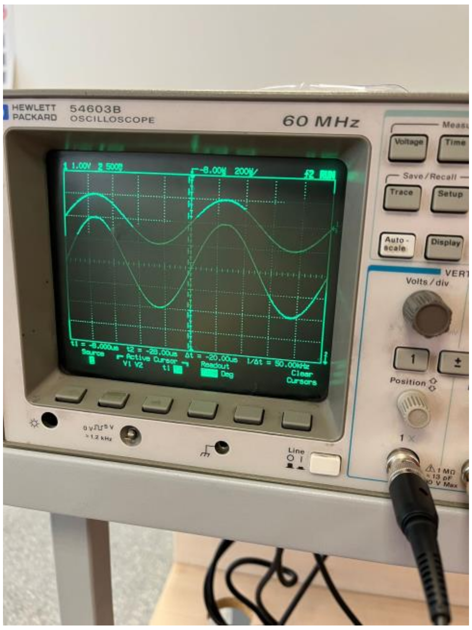


Fig(6.1)

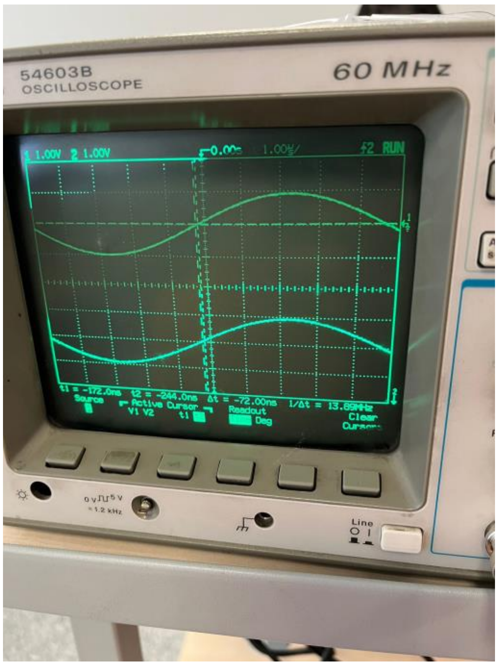


Fig(6.2)

A 2 Vpp sinusoidal wave with frequency 1 kHz was applied to the X signal. The signal coming out of the circuit was set as the Y signal. Then, the time delay between the waveforms were seen to be 20 us (microseconds) using cursors on the oscilloscope (Fig 6.3). Then, the frequency was increased to 100 kHz, and the time delay between the waveforms then read 72 ns (nanoseconds) Fig(6.4).



Fig(6.3)



Fig(6.4)

After seeing different time delays for different frequency values, the phase differences were calculated using the formula:

Phase Difference = $\Delta t * 2\pi * F$

F being the frequency and Δ t being the time delay between waveforms.

For 1 kHz and 20 microseconds, the phase difference is calculated to be 7.2 degrees, and for 100 kHz and 72 nanoseconds, the phase difference is calculated to be 2.6 degrees. It can be observed from the experiment that as frequency increases, the phase difference decreases because as frequency increases, the capacitor behaves more and more like a regular wire.

Conclusion:

In this experiment, the skills required to examine waves with an oscilloscope, to generate desired waves using a signal generator, to use a breadboard and build a circuit on one were obtained, and to analyse and use information gathered from such waves and circuits were learned. Minor mistakes occured with some measurements, and in some parts the equipment used had minor defects. The reason for those could be because of the oscilloscope probe or the signal generator.