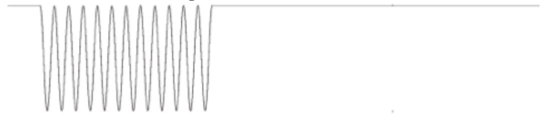
Practical Session n°2: ULTRASONIC WAVES

The vibration of vocal cords, or the one of a membrane of a loudspeaker, creates sound waves. The human ear perceives sounds with frequencies between 20 Hz and 20,000 Hz. Ultrasounds are similar in nature to sounds but ultrasonic frequencies are greater than 20,000 Hz, the approximate upper limit of human hearing.
An ultrasound emitter emits an ultrasonic wave with the same frequency as the one of the voltage applied at its terminals.
An ultrasound receiver turns the ultrasonic wave, at the place it is located, into a voltage with the same frequency as the one of the ultrasonic wave.
The ultrasound emitter can emit: - ultrasonic salvos (see part I)
- periodic waves (see part II)

salvo: short signal which can be drawn as follow :



I. Emission of salvos: measuring the speed of propagation of ultrasounds in the air

1 – Starting up the emitter and displaying the emitted signals

- Supply the emitter with a DC voltage of 12 V.
- Display the signal of the emitter connecting the *test* and *ground* terminals of the emitter to the channel 1 (CH1) of the Digital Storage Cathode Ray Oscilloscope (C.R.O.).
- Set the time base on 2.0 ms/div and the gain (vertical sensitivity)on 5 V/div.
- Set the emitter in order to get rapid salvos.
- Turn the button corresponding to the cyclic ratio of the emitter in order to get narrow salvos on the scope screen.

2 - Displaying the signals received by the receivers

- Place the two receivers, side by side, at about 25 cm from the emitter.
- Press the TRIG MENU key and then Select CH1 in the SOURCE menu (to set the triggering on the signal received by the 1rst receiver).
- Set the timebase on 200 μs/div.
- Connect the receivers to channels CH1 and CH2 of the C.R.O. with a gain equal to 200 mV/div.
- Press on the CH2 key to display the channel 2 on the screen. (You can observe simultaneously the 2 channels on the screen.)
- Adjust the vertical position of each trace displayed on the scope screen in order to see them separately.

<u>Questions</u>:

a) Draw a diagram of the set up of the experiment
b) Draw the shape of the obtained signals.
c) Suggest a method to determine the speed of ultrasounds.
d) Carry out this method.
e) Carry out three other measurements of the speed of ultrasounds with the indications given by your teacher.
f) Determine the average value of the speed of ultrasounds from your measurements.

II. Emission of periodic waves

Set up

<u>Remark</u>: For this experiment, the ultrasound emitter is one of the previous ultrasound receivers supplied with a AC supply.
Place the receiver onto a rail. Place the emitter in front of the receiver.
Connect the AC supply to the emitter.
Set the supply: sinusoidal signal; frequency: 39.8 kHz ; amplitude: 3.0V (that means 6.0V peak to peak).
Display the signal of the emitter on channel 1 (CH1) of the C.R.O.
Display the signal of the receiver on channel 2 (CH2).
Record the settings of the C.R.O. (timebase and gain)

<u>Questions</u>:

a) Draw the shape of the curves you get on the scope screen.
Compare those two curves (shape, period).
b) Measure the period of the receiver. Deduce its frequency.
c) Move the receiver away from the emitter. *What can you observe?*
d) Locate the positions at which the emitter and the receiver are in phase (see question 2a of the hola discovery).
Comparing with the hola (question 2b), determine the λ distance which separates those two positions.
<u>Remark</u> : In the case of a sinusoidal wave, this λ distance is called wavelength.
e) Using the relation obtained at the 3d question of the hola and knowing the speed of ultrasounds, calculate the wavelength of the signals.