# PW n°0: Discovery of wave generator and oscilloscope.

*Objectives* :

- Discovering wave generator and oscilloscope aparatus.
- Learning how to measure an amplitude, a frequency with the oscilloscope for a given signal.

## I. About materials and apparatus

**1)** A **wave generator** is a generator that can deliver alternative electric signals (Figure 1). In the present work we will discover the basic functions of the apparatus as controlling the form of the signal (sinusoidal, triangular, rectangular) its amplitude and frequency.

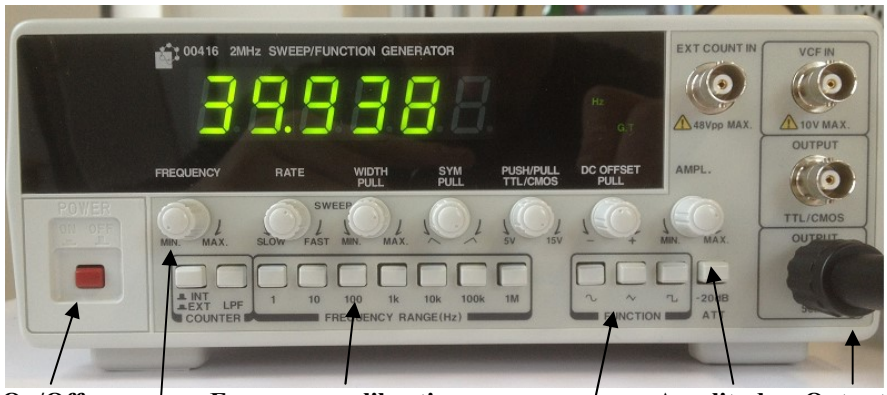


**Figure 1.**

**2)** An **oscilloscope** is a device that can show the temporal representation of one or two signals.

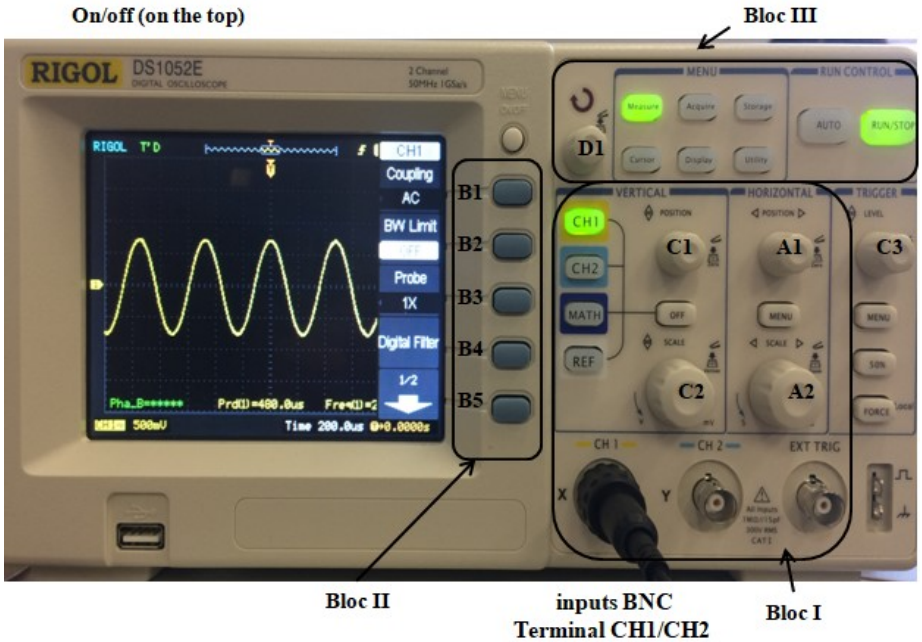


**Figure 2.**

**Basic description of Bloc I.**

The BNC inputs, denoted CH1 and CH2, correspond to the input channels (1) and (2). It is possible to see both signal but you have to select which signal you want to set-up by pressing button CH1 or CH2 buttons in Bloc I. On Figure 2 CH1 is selected. The positions of the signals can be vertically moved on the screen using **C1**. With buttons **C2** one can select the amplitude voltage sensitivity given by one square –or division- on the screen: it is the vertical sensitivity. Button **A1** can change the horizontal position of both signals and **A2** may select the time-basis, which is the time duration given by one division: it is the horizontal sensitivity.

The selected values can be read on the screen. By selecting CH1 or CH2 buttons, one can see signals's forms whose further settings can be done using buttons of **Bloc II.**

**Basic description of Bloc II.**

After selecting CH1, CH2 or MATHS in Bloc I one can precise several settings using buttons marked from **B1** to **B5**. In CH1 or CH2 menu one may set the types of signal: DC, AC, ground, reverse, etc. In the *MATH* menu one can perform mathematical operations between the two signals: addition, subtraction, etc.

**Basic Description of Bloc III.**

These buttons give access to different menus or functions. The menu *Measure* displays the value of the signal characteristics on the screen: voltage amplitude, frequency, period… The menu *Cursor* displays on the screen two horizontal or vertical cursors for performing measurements with the signals. The button *Auto* reset the selected settings.

# II. Manipulations

## II.1) Preliminary settings

- Turn on the oscilloscope. Select channel 1 by pressing CH1. In **bloc II** find the button *Coupling* and select the *Ground Coupling*. Using the **C1** wheel button, move the line and fix it at the zero value that is in the middle of the screen (line 0 V). The setting can be very precise since the value of the voltage appears in real time on the screen.
- Repeat the same operations for channel 2 by pressing CH2.

## II.2) Visualization of a DC Voltage

- Plug two cables in the BNC adapdator and in the outputs of the power supply. Turn on the DC Power supply. Turn the current button to the maximum and then the voltage button to obtain a 3V voltage. Plug the BNC adaptator in the BNC terminal CH1.
- Return to CH1 MENU and using **B1** select the *Direct coupling* to view a DC voltage.
- Using the **C2** button display a sensitivity of 1 V/division (1 divison=1 square) and observe the position of the signal on the screen.
- Press **B5 (1/2 bottom arrow)** to access to other functions and press *Invert on/off*. What happens? Reput the previous invert mode.
- In **Bloc III**, Press *Measure* and then select *Voltage* where you can select with the wheel button **D1** the different types of voltage between $V_{max}$, $V_{min}$, $V_{pp}$…. Select $V_{max}$ by pressing **D** : you can read the value of $V_{max}$ on the screen. If too many information stand on the screen you can press **B4**: *Clean* and repeat previous operations. It is possible also to press **B5** *Display All* that makes appear a list of physical sizes where you can read the values.
- Write the value of $V_{max}$ displayed in the screen. Is that different than the one given by the Power supply ? If yes why ? Calculate the relative difference $\frac{|V_{PS}-V_{osc}|}{|V_{PS}|} \times 100$.

## II.3) Visualization of a Alternative Sinusoidal Voltage

- Turn on the **wave generator** and select a signal with sinusoidal form. Set the calibration to 1 kHz and then the frequency to 1 kHz (as closed as you can : write the value given by the screen). Plug the BNC cable in the output and then in the CH1 chanel of the oscilloscope.
- Return to CH1 MENU and using **B1** select the *Alternative coupling* to view an AC voltage.
- Select a suitable sensitivity with button **C2** that permit to see the entire signal vertically.

- Choose a suitable time basis using button **A2** ; you need to visualize at least one whole period. If the signal is not stable, play with the wheel button **C3**. Appears on the screen the function TRIG LVL that indicates the vertical position of the Trigger. Move the trigger level (orange line) until reaching the low-limit of the maximum amplitude of the signal: it should stabilize the signal. Observe what happens when the cursor is above or below the maximum and minimum values of the signal.

## II. 3.1)Measure of period and amplitude

The interest of an oscilloscope is to observe the signal and to measure its characteristics. We define:

- $V_{pp}$ ( peak-to-peak) is the value between the maximum and the minimum of the signal amplitude.
- $V_{max}$ is the maximum value of the signal when its zero value is adjusted with the ground.
- $V_{rms}$ (root mean square) is define as $V_{rms} = V_{max} /\sqrt{2}$ .
- The period T and the frequency f=1/T.

Recopy and fill the tabular below when performing measurements in parts **II.3.1.a)** to **II.3.1.e).**

| | $V_{pp}$ | $V_{max}$ | $V_{rms}$ | T | f |
|---|---|---|---|---|---|
| Reading on screen | | | | | |
| Using cursor | | | | | |
| Using Measure mode | | | | | |
| Using Voltmeter | | | | | |

## II.3. 1. a) By reading screen using horizontal and vertical sensitivity

- Use buttons **A1** and **C1** to move the signal and make coincide the beginning of the cycle with the beginning of a screen division. With the horizontal and vertical sensivities given by buttons **C2** and **A2** estimate the values of $V_{pp}$, $V_{max}$ and the period T. Deduce the ones of $V_{rms}$ and f.

## II.3. 1. b) By using the cursors

- Press the *Cursor* mode in **Bloc III**. If the Mode is *Off*, switch it to *Manual* with **B1** and **D1** buttons. Two horizontal or vertical lines should appear. Press button **B2** *X* or *Y* to select horizontal or vertical lines. Then by moving D1 button you can modify the positions of the lines whose position can be read on the screen. By playing with **B4** or **B5** (curA---) or (curB---) you can select and move the other line using button **D1**. The value difference between the two cursors ($\Delta$X or $\Delta Y$ ) is given on the screen. It is thus possible to read precisely the voltage difference $\Delta Y$ or the time difference $\Delta$X between two levels.
- Use the *Cursor* mode to measure the values of $V_{pp}$, $V_{max}$ and the period T. Deduce the ones of $V_{rms}$ and f.

## II. 3.1. c) By using Measure Mode

- By pressing *Measure* mode in **Bloc III** you can have access to the values of different physical sizes by selecting the ones related to voltage with **B2** buttons or the ones related to the time with **B3** button. Then, by turning wheel button **D1** you can select the physical size of your choice and by pressing **D1** you can make appear its value on the screen. If too many information stand on the screen you can press **B4**: *Clean* and repeat previous operations. You may press also **B5** *Display All* that makes appear a list of physical sizes where you can read the values.
- Use the *Measure* mode to have access to the values of all physical sizes labeled in the tabular.

### II. 3.1. d) By using a voltmeter

- A voltmeter can have access to the values of the period T and the root mean square amplitude $V_{rms}$. With a BNC adaptator connect the voltmeter to the wave generator. Select the appropriate calibration to measure $V_{rms}$ and f. You thus can deduce $V_{pp}$, $V_{max}$ and T.

## II.3.2) Playing with wave generator parameters

- Modify the amplitude and the frequency delivered by the generator and observe how the oscilloscope signal changes. Modify the sensitivity with buttons **C2** and **A2** to observe a clear picture. Use the button **C3** *Trigger Level* to move the cursor on the screen and observe what happens when the cursor is above or below the maximum and minimum values of the signal.

## II.3) Visualization of an Alternative Triangular Voltage

- In the wave generator select a triangular signal form with a frequency of 1000 Hz and a peak-to-peak voltage of 10 V approximatively. Check that value by looking signal amplitude on the oscilloscope screen. Check that the *Alternative Coupling* is selected and if needed reput the zero with the *Ground Coupling*.

- Adjust the sensitivities **C2** and **A2** to observe at least two periods.
- Calculate the value of the positive slope of the triangular signal : $a=\Delta V/\Delta t$.You can use the *Cursor* mode to calculate the quantities $\Delta V$ and $\Delta t$ like depicted in Figure 3.

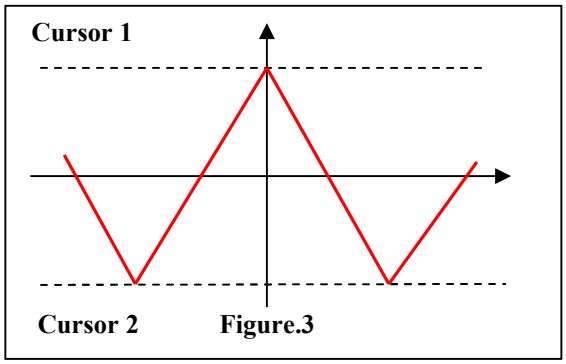

**Figure.3**

- For a triangular signal the root mean square amplitude is defined as : $V_{rms} = V_{max}/\sqrt{3}$ .Check this relation with the different methods seen in part II.

## II.3) Visualization of a Rectangular Voltage

- With the wave generator fix a rectangular voltage of maximum amplitude 2 V and frequency 400 Hz.
- Adjust the sensitivities **C2** and **A2** to observe at least two periods.
- Find the button SYM PULL in the generator and pull it. Turn it to the left or the right and observe the modification on the rectangular signal. Note the observations
- Press the button *Measure* and look the size *Duty+* and *Duty-* : Compare the value given by Duty-cycle and the shape of the rectangular signal.
- Repeat the operations with a triangular signal and with a sinusoidal signal.