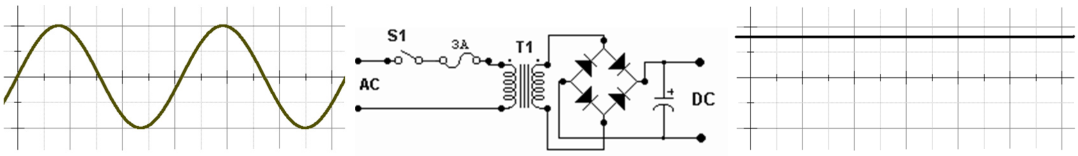
Lab. Script 1

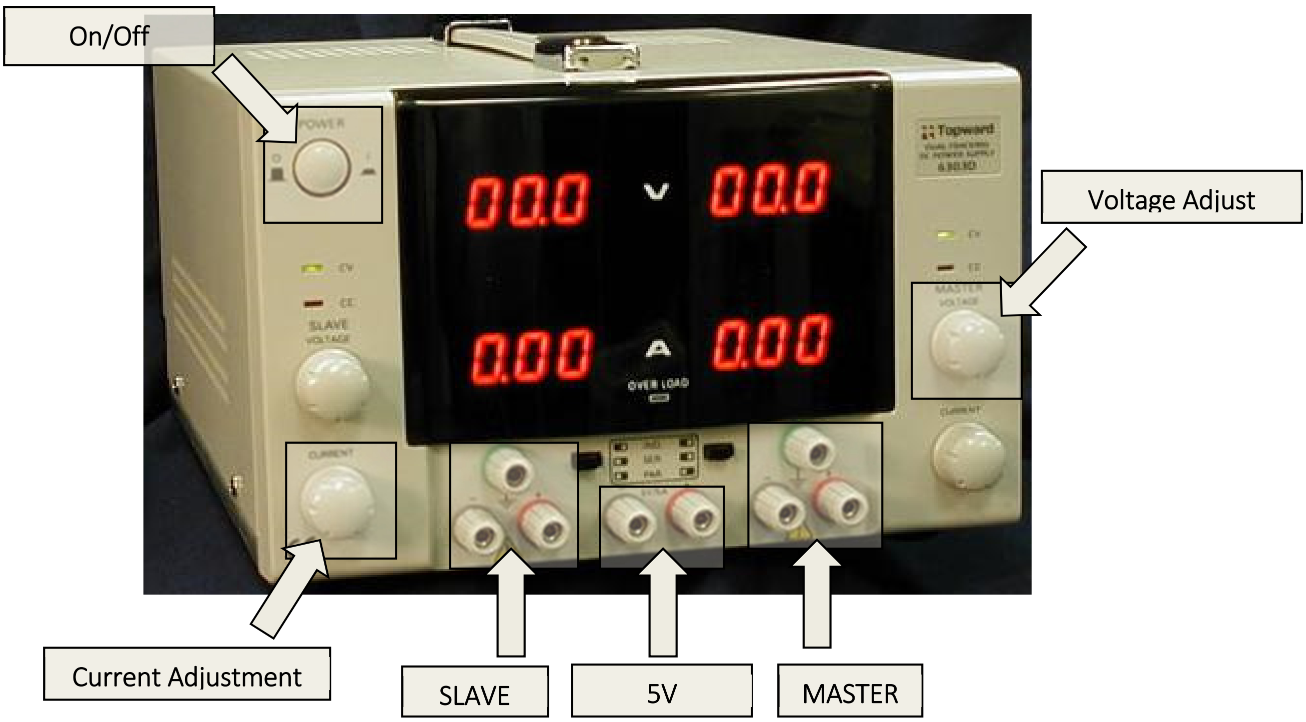
Introduction to the laboratory equipment

Power Supply

This device has as main role the conversion of the sinusoidal electric voltage from the grid electrical distribution point (AC) into a time-invariant (DC) voltage. The following figure illustrates this procedure.



Currently, in our laboratory, one can find regulated power supplies such as the one represented in the figure below.



This power supply possesses three different output channels: two variable voltage sources and one fixed.

The two adjustable voltage sources can be used to establish an output voltage that range from 0V to 30V. Each one of the two channels, one designated by master and the other by slave, has three terminals identified with the colours red, black and green. The terminal with larger potential is the red (positive) and the reference terminal (ground) is identified by the colour black.

Each one of the two adjustable outputs can be adjusted to an arbitrary output voltage, between the above mentioned range, by rotating clockwise or counter-clockwise the Master or Slave knob. In order to prevent damage to the circuit under test it is possible to limit the maximum current supplied by the power supply. This task is done by rotating the Current Adjustment knob to the appropriate set point. Both voltage and current supplied by this source can be visualized through a couple of digital displays. For each channel the upper display shows the voltage and the bottom one the delivered current.

In this curricular unit this device will be used to power the digital circuits assembled during the classes. Those circuits require a DC voltage in order to properly work. In particular they will need a DC voltage of 5V. This value is delivered, without any calibration required, through its 5V output channel.

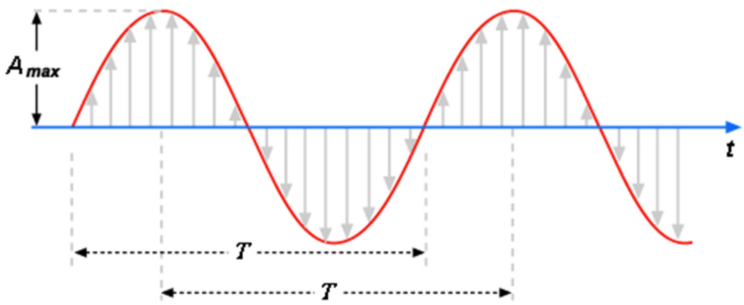
There is also a set of switches that enable the power supply to be connected in several different modes. However details about this functionality are outside the scope of this curricular unit.

Signal Generator

The objective of the signal generator (or function generator) is to generate electric signals whose amplitude will change in time according to one of three possible mathematical functions: the triangular, sinusoidal and square waveforms.

Independently of the wave shape selected there is a set of characteristics that can be manipulated by the signal generator: The wave amplitude and the wave frequency.

Those concepts are illustrated in the next figure.

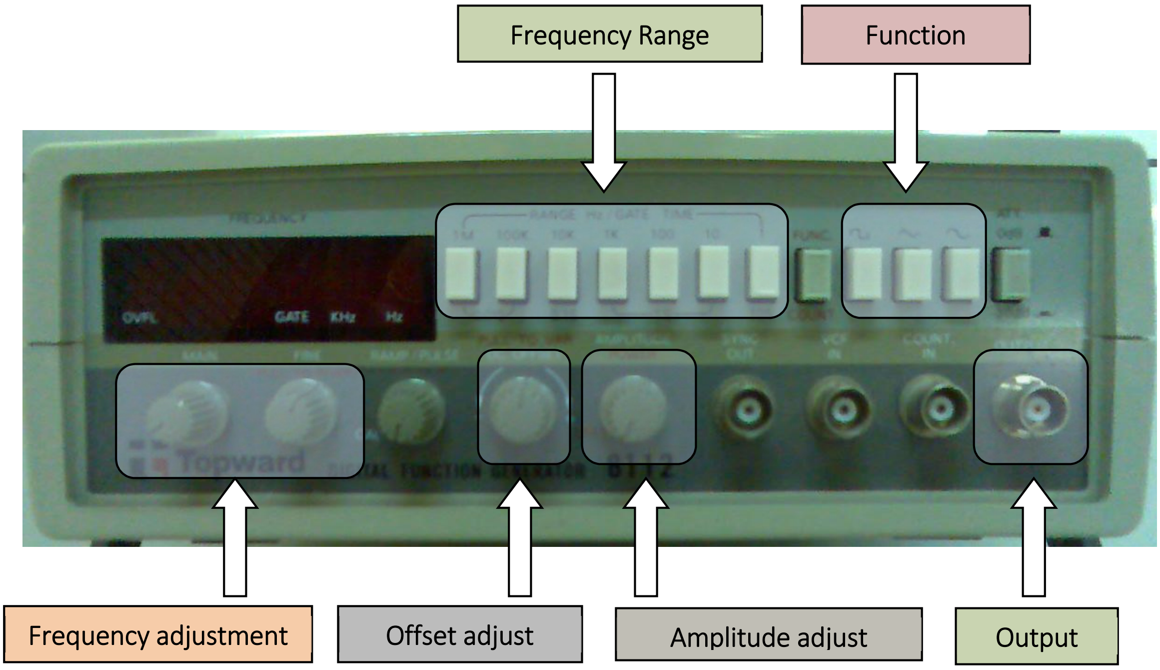


The x-axis represents the time (for example in seconds) and the y-axis the voltage (in volts). The maximum signal amplitude (in this case with sinusoidal shape), denoted by A_{max}, represents the higher voltage value that the signal can attain. This value is also known by peek value.

The signal frequency is related to its repeating velocity. Related to the frequency is the signal time period. The signal period, represented in the above figure by the T letter, represents the repeating time interval. The relation between both the frequency (*f*) and the period is described by the following mathematical equality:

$$\boxed{f = \frac{1}{T}}$$

One of the available signal generator device that can be found in the lab facilities is manufactured by the TOPWARD company and has the reference 6112. Its external appearance is presented in the figure below.



The signal amplitude generated at the output terminal (the BNC socket identified in the figure) is regulated by the amplitude knob. The output signal frequency is established by a multiplicative factor, selected within a given range, and the desired output value tuned using both the MAIN and FINE knobs.

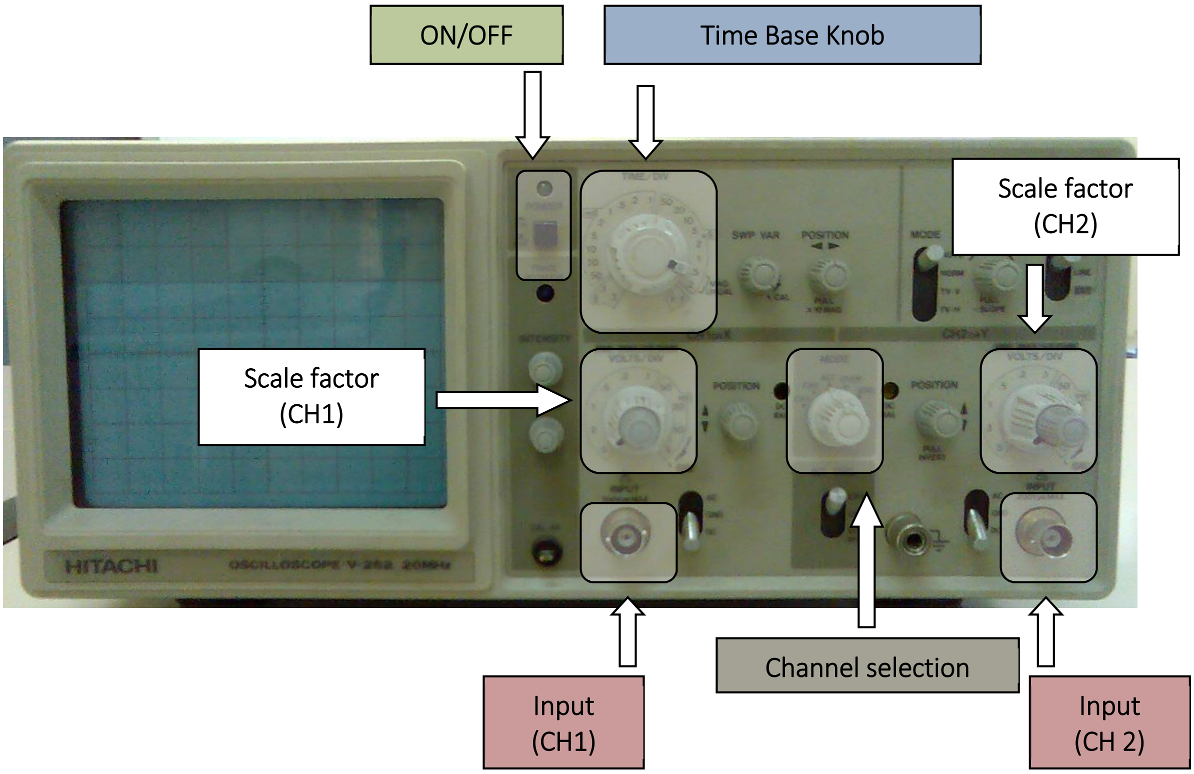
The three top right switches are used to select one of the three available waveforms: square, sinusoidal and triangular.

In this curricular unit this device will be used to generate square waves with a peek-to-peek voltage of 5V and an average value of 2,5V. This signal type will be used to drive the clock input of sequential digital circuits.

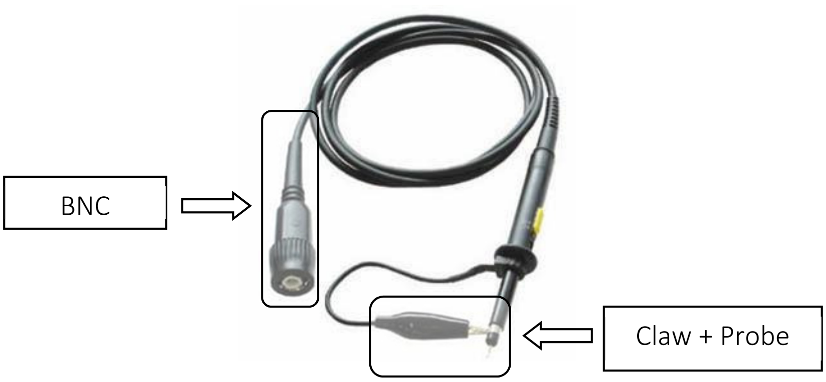
Oscilloscope

The oscilloscope is the most complex device available in the laboratory bench. The full understanding of its capabilities is way beyond the scope of this curricular unit. In this context only a small set of its functionalities will be addressed.

The oscilloscope is a device that is able to show the applied signal voltage evolution as a function of time. There are several types of different oscilloscopes but all of them share some common features regarding the available user controls. The wave is presented in a screen and its aspect can be controlled by changing the time base knob or the voltage per division knob. Both controls are indicated in the next figure.

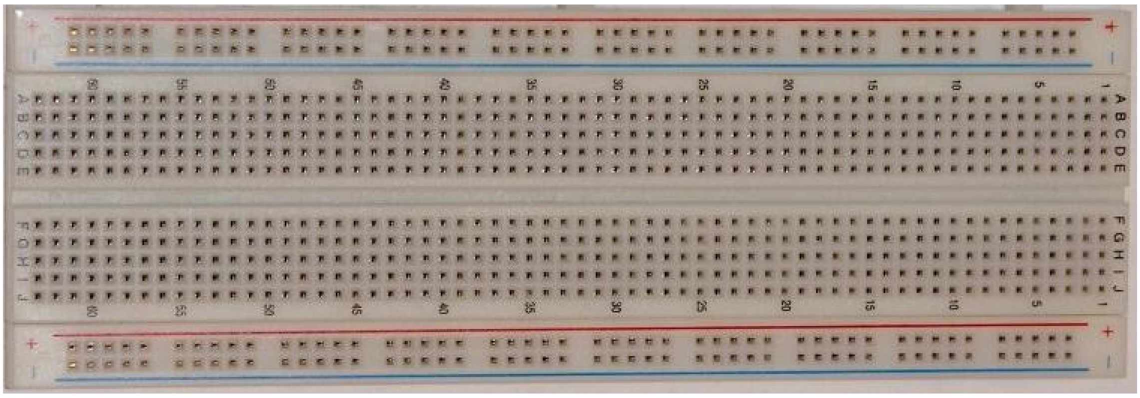


The signal is feed to one of the two oscilloscope inputs through the probes. One end of the probe is composed by a BNC connector and the other by a claw and a probing point. In a circuit the crocodile claw is usually connected to the ground and the probing point to the place at the circuit where the desired signal is generated. The following figure shows the typical aspect of an oscilloscope probe.

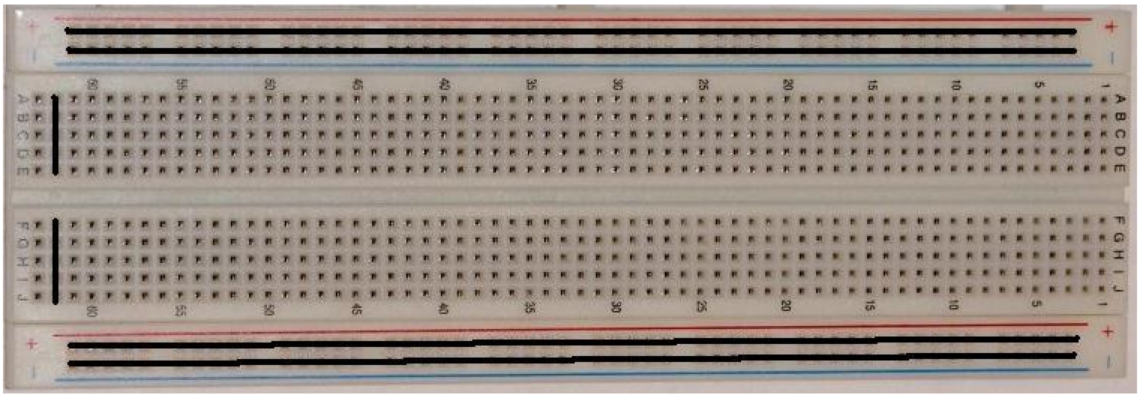


Breadboard

In this curricular unit, the electrical connection between the several electronic components that composes the hardware circuit, will be held in a breadboard. A breadboard is an electronic circuit support structure that consists on a matrix of dots connected electrically connected between them according to a fixed layout. The following image illustrates the external aspect of one such board.



Internally this board has a set of metallic springs that clamp the electronic components in place and allows its electric connection. The figure below shows how the connections are internally performed. Along its upper and lower board section the points are electrically tied leading to horizontal electric lines.



On the other hand, the two middle board section has its points connected along vertical lines. Usually each line is composed by five points. Notice that there is no electrical connection between two columns of different board sections. That is the upper vertical segment and the lower vertical segment illustrated in the above figure are not electrically connected.

Final Remarks

The laboratory equipment is a highly sensible material. You should handle it with care. Hence you must pay attention to the following points:

- Do not switch the devices between benches without the proper consent of the laboratory technician or the teacher;
- Do not leave the equipment ON after its use;
- Do not scratch the oscilloscope screens with pens and pencils;
- The oscilloscope probes and connectors must be handled with care avoiding its premature wear out.

During the classes students are responsible for all the material they have available on their bench. Any misconduct will be severely handled according to the IPB pedagogic rules.

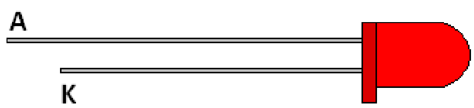
Activities

PART I

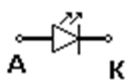
1. Connect the oscilloscope and proceed to calibration.
2. Link the oscilloscope claw (Channel 1) to the black claw of the signal generator and the probe point to the red claw.
3. Generate a sinusoidal signal with 3 V peak-to-peak and a frequency of 1 kHz. Notice the signal aspect when you change both the oscilloscope time base and the voltage scale.
4. Replace the sinusoidal signal by a triangular and square wave.
5. Measure the frequency and amplitude of a sinusoidal signal using the oscilloscope.
6. Using the signal generator offset knob generate a square wave with a 5 V peak-to-peak amplitude and an average value of 2.5V.
7. Connect the power supply output to the oscilloscope output. Notice the wave format. Conclude about what you are seeing
8. Change the output voltage of the power supply and compare the value presented by the digital voltmeter with the value read directly using the oscilloscope.

PART II

An LED is an electronic device with the particularity of emitting light when directly polarized. There are commercially available LED with many different external forms and colours. During our lab. classes we will use the one with the following format:



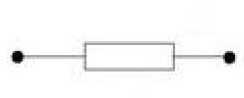
This component is identified in an electronic schematic by the symbol:



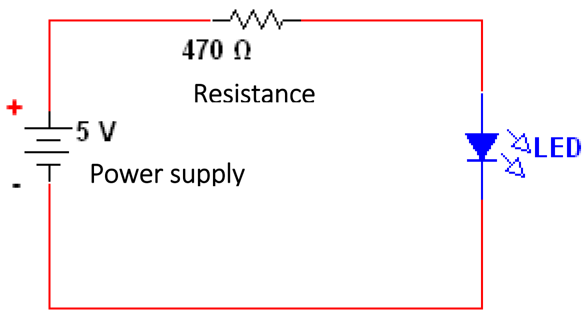
The correct behaviour of this devices requires it to be directly polarized. That is the anode terminal (A) must be held at a potential higher than the cathode terminal (K).

The resistance is an electronic component that can reduce the current in a branch of an electric circuit. The usual external aspect of the electric resistance we will use during the classes is illustrated in the figure below:

Its electronic symbol has the following form:



Now using the components and the available breadboard assembler the following circuit:



a) Replace the resistance of 470Ω (yellow/violet/brown) by the resistance of 1KΩ (brown/black/red). Turn on again the circuit. What can you observe?
b) Now replace the power supply by the signal generator. Calibrate it such as to generate a square wave with 10V peak to peak, 2 Hz frequency and a 5V offset. See the effect of increasing the signal frequency.