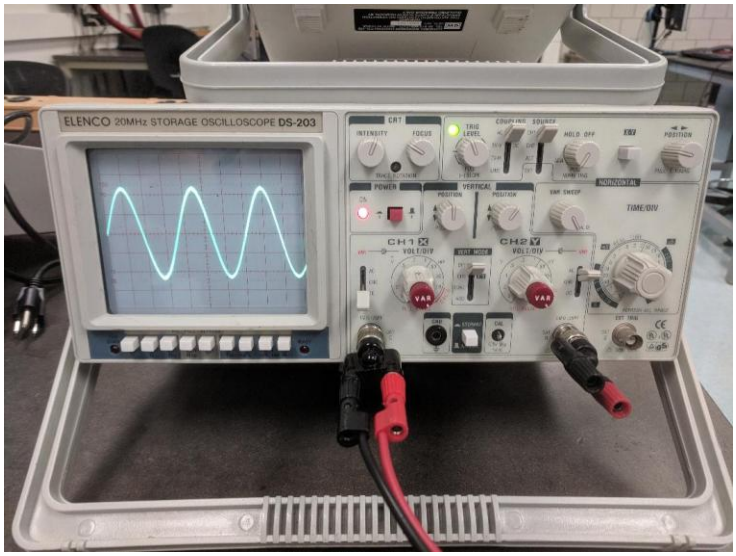
Stony Brook University

Department of Physics and Astronomy
Introductory Physics Laboratories
PHY 122

PHY 122 The Oscilloscope



Elenco DS 203

The Elenco DS-203 is an analog, Cathode Ray Tube (CRT) oscilloscope with 20 MHz bandwidth and 1 milliVolt sensitivity. It also has 2 channels of digital storage each of which can hold 2048 8-bit words, sampled at up to 10 MegaSamples per second.

The following instructions create a good starting point for any measurement using the oscilloscope. For any specific measurement, you will adapt the settings as needed.

With the oscilloscope directly in front of you, set the controls as follows:

→ The white buttons below the display screen on the left should all be in the out position.

The controls to the right of the screen should be adjusted as given below (cw means clockwise):

INTENSITY:	mid-range (line pointing up)
FOCUS:	mid-range
TRIGGER LEVEL:	mid-range
COUPLING:	AC position
SOURCE:	CH 1 position
HOLDOFF:	MIN (ccw) position, knob pushed in
XY:	button to the OUT position
POS:	mid-range
POWER:	button to the OUT position
POS ^ (Ch 1):	mid-range, knob pushed in
POS ^ (Ch 2):	mid-range, knob pushed in
VAR SWEEP:	calibrated (cw) position
AC AND DC (Ch 1)	switch to DC position
CH 1 knob:	set to 1 V(olt), VAR knob in CAL (cw) position
VERT MODE:	CH 1 position
CH 2 knob:	set to 1 V(olt), VAR knob in CAL (cw) position
AC GND DC (Ch 2):	set to DC position
TIME/DIV knob:	set to 0.1 (s) position
STORAGE/ ANALOG:	button to the OUT (ANALOG) position

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Background

The oscilloscope is a very widely used laboratory instrument frequently used to give a visual display of time-varying voltages. While some oscilloscopes now use liquid-crystal displays (LCDs), many (including the Elenco DS-203) still use a CRT. Cathode-ray tubes were invented more than a century ago, and you will be most familiar with them from older televisions and computer monitors.

Roughly, a CRT works as follows. Within an evacuated tube (see Fig. 2), a heated filament (much like the filament of an electric lightbulb) and a series of accelerating and focusing electrodes serve as the source of a well-collimated beam of electrons; this assembly is called an electron gun. These electrons are shot towards the phosphor-coated, inside front surface (i.e., the viewing screen) of the tube, causing a visible spot to appear where the electrons strike the surface. Also within the CRT are pairs of metal plates which, when an electric field is established between one or the other pair, can deflect the electron beam horizontally or vertically. This moves the visible spot to any desired point on the screen. In Fig. 2 note that vertical and horizontal refer, respectively, to the direction of the electric field between the plates and, therefore, in which plane the electrons are being deflected. The actual plates are, of course, perpendicular to the direction of the deflecting electric field.

The oscilloscope can be thought of as a voltmeter that plots voltage (vertical axis) vs. time (horizontal axis). The information given by the oscilloscope is read from the front screen much as you would read information from a graph. Here, the x-axis (horizontal) plots time and the y-axis (vertical) plots voltage.

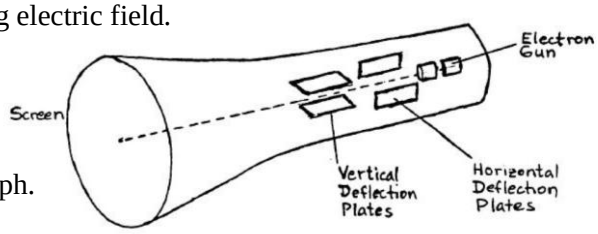

Figure 2 A schematic of a Cathode Ray Tube

When reading the oscilloscope you need to think about how to define where the origin (0,0) lies on the screen. On the graphs you've drawn previously the origin has obviously been where your two axes intersect, but with the oscilloscope the position of a trace on the screen can be adjusted and the â€œzero pointâ€• of a particular variable needs to be defined.

You can define the origin (0,0) to be at any intersection on the screen and read the signal with respect to that origin. For some experiments in this course you will want to consider the origin as the lower left corner of the screen. For others you may want to choose the center of the screen. For this lab is it most convenient to consider the time (horizontal) zero point to be at the first horizontal mark on the left side of the screen and the voltage (vertical) zero point to be at the central line going across the screen. On your sketches of measured signals it is important to show where your origin is and what is the scale of each box so that you can correctly interpret your measurements.

Notice that the oscilloscope screen has evenly spaced horizontal and vertical lines that form a grid over which the signal will be displayed. The scale of each axis is important for telling you the voltage and time duration of your signal. The TIME/DIV knob and the VOLT/DIV knob on the control panel set, respectively, the horizontal and vertical scales, and you can (and will!) be adjusting them to observe different â€œsignalsâ€• (voltage vs. time variations) well. The setting for each of these knobs tells you how much time or voltage each large division represents.
For example, if the TIME/DIV knob is set to 1 microSecond (μs) , then the horizontal side of a box represents 1 μs. Since there are five tick marks in each box, each tick mark on the horizontal axis represents 1/5 as much, 0.2 μs. The same principle applies to voltage. If VOLT/DIV is set at 10 V, each vertical side of a box represents 10 V, and each small tick mark represents 1/5 as much, 2 V.

NOTE! The TIME/DIV and VOLT/DIV knobs tell you the value of an entire box, not the small tick marks inside the box!