Lab 8: Oscilloscope & Function Generator

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1. Introduction

On this laboratory experiment you will be introduced to the oscilloscope and the function generator, two important tools in the analysis of circuits that operates with voltages and currents that variate with time.

2. Objectives

1. Identify and adjust the operating controls of a basic oscilloscope.
2. Observe the internal calibration voltage of the oscilloscope.
3. Identify the features and controls of the function generator.
4. To operate the function generator and observe output waveforms on the oscilloscope.

3. Equipment Required

1. Oscilloscope
2. Function Generator

4. Before the Lab

4.1 Oscilloscope

The digital oscilloscope, also known as a **scope**, is a complex electronic device that combines software and hardware to acquire, process, and display signals. In some models, they can even store the captured signals. The digital oscilloscope is one of the basic instruments for measuring AC quantities. It has the ability not only to measure AC quantities such as frequency and voltage but also to display the waveform from which these quantities are derived.

The oscilloscope draws a graph on a tin display panel or LCD screen and a grid of lines is etched on the faceplate to serve as a reference for measurements. This is referred to as the **graticule.**

Most lab oscilloscopes are **dual-trace** (2- channel) scopes, but four channel scopes are also available. The two traces are developed on the screen by electronic switching. This makes it possible to observe simultaneously two time-varying waveforms.

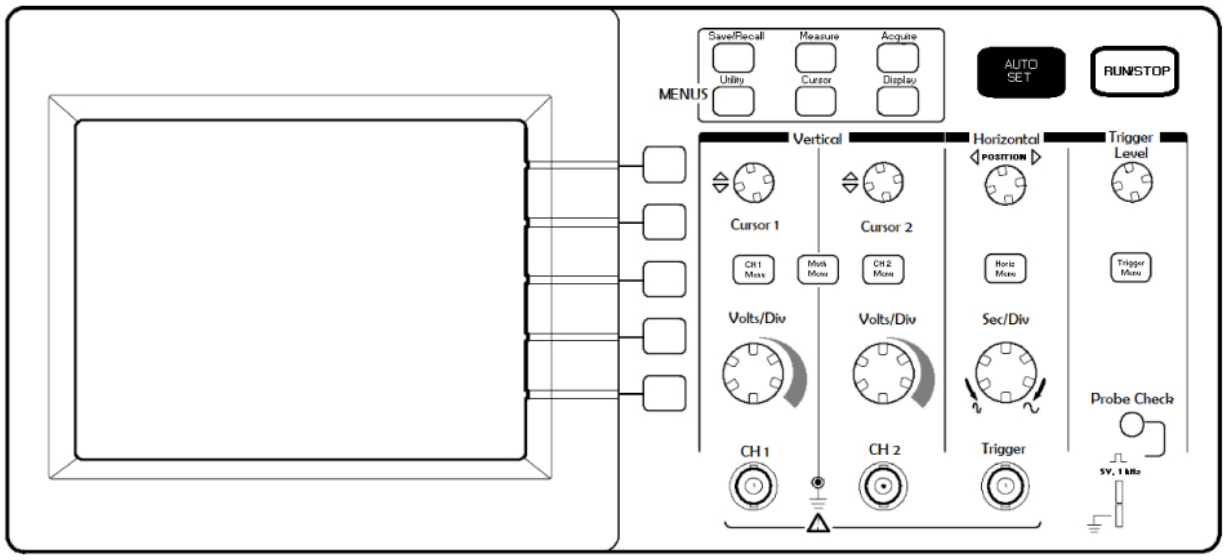


Figure 1.- An Oscilloscope

Vertical Controls

CH1, CH2, Cursor 1, and Cursor 2: Position the waveforms vertically on the screen.

CH1 and CH2 Menu: Display the vertical menu selections and toggle the display of the channel waveform ON and OFF.

Volts/Division: This sets the vertical sensitivity of each channel. The graticule is divided up into centimeter squares and each centimeter will represent a certain voltage

	depending on the volts/div setting. This is used to adjust the height of the waveform to obtain an accurate measurement. There is also a variable volts/division incorporated into this control to allow for a fine adjustment of the vertical height. Normally this control is in the position (fully clockwise) which means the control is now calibrated to the volts/div specified on the main control.
MATH Menu:	Displays all math operations available with the signals of CH1 and CH2. Also toggles the display of the math waveform ON and OFF.
Horizontal Controls	
Position:	Adjusts the horizontal position of CH1, CH2, and MATH waveforms on the screen.
HORIZ Menu:	Displays the horizontal menu.
Sec/Div:	Allows the selection of the horizontal scale factor (time/div) to display the waveforms on the screen.
Trigger Controls	
Trigger Level:	Sets the amplitude level the signal must cross to be acquired.
TRIG Menu:	Displays the Trigger Menu
Menu and Control Buttons	
Save/Recall:	Displays the Save/Recall Menu for all setups and waveforms.
Measure:	Displays the automated measurement menu.
Acquire:	Displays the modes to acquire waveforms menu.
Display:	Displays the display modes menu.
Cursor:	Displays all cursor menus. The vertical position controls are displayed to allow the measurement of time differences. The horizontal position controls are displayed to allow the measurement of voltage differentials.

4.2 Function Generator

A function generator produces variable frequency AC voltage waves. The waveforms can be sinusoidal, square, or triangular with frequencies from a few hertz to the megahertz range. A function generator is used for testing and experimentation where different AC waves at varying frequencies are required.

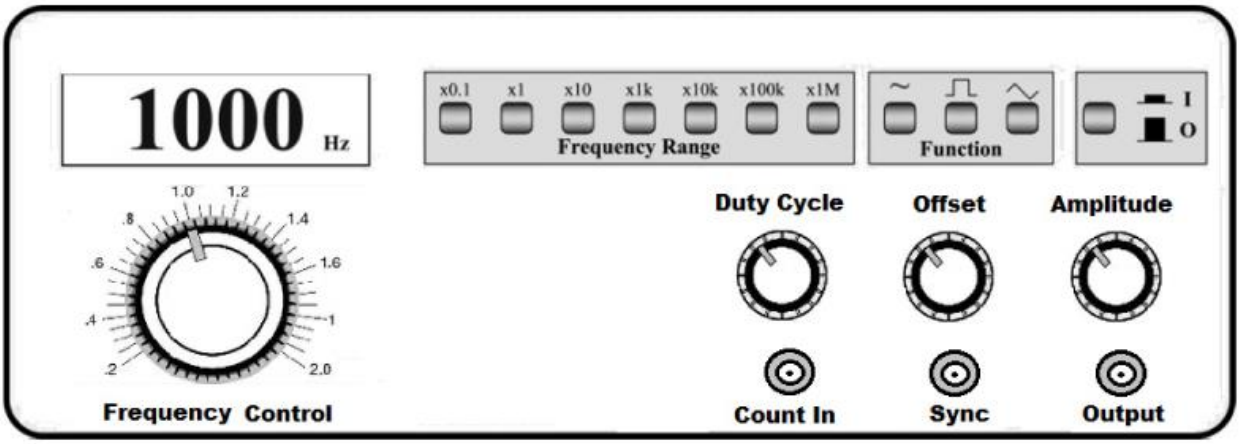


Figure 2.- A function generator.

Operating controls

Waveform selector: Selects either sine, square, or sawtooth waveform. Sometimes called the switch.

Output Level: Controls the amplitude of the output voltage.

Range Switch: Usually a series of push buttons to select the output frequency range.

Frequency Control: Provides for an exact setting of frequency within the selected range with a rotary control. Often *coarse* and *fine* options are provided.

Output Jack: Where the waveform selected by the function switch is available.

5. Development

5.1 Oscilloscope Operation

1. With the power to the oscilloscope off, examine the front panel noting the types and functions of each control and jack.

2. Power on the oscilloscope and connect the probe to CH1. To do so, align the slot of the probe to the CH1 BNC connector, push, and twist to the right to lock the scope probe in place. Connect the probe tip to the PROBE CHECK connectors.

3. Push the AUTO SET button. After a few seconds, you should see a square wave present on the screen of the oscilloscope. Adjust the Volt/Div and time base on the scope; this signal should be approximately 5 V_{pp} at a frequency of 1 kHz.

4. Push the CH1 MENU button twice to remove channel 1 from the display and proceed to disconnect the CH1 probe tip from the PROBE CHECK connector. Now connect the second oscilloscope probe between the CH2 and the PROBE CHECK connector to verify its operation. Sketch the waveform in Figure 4a.

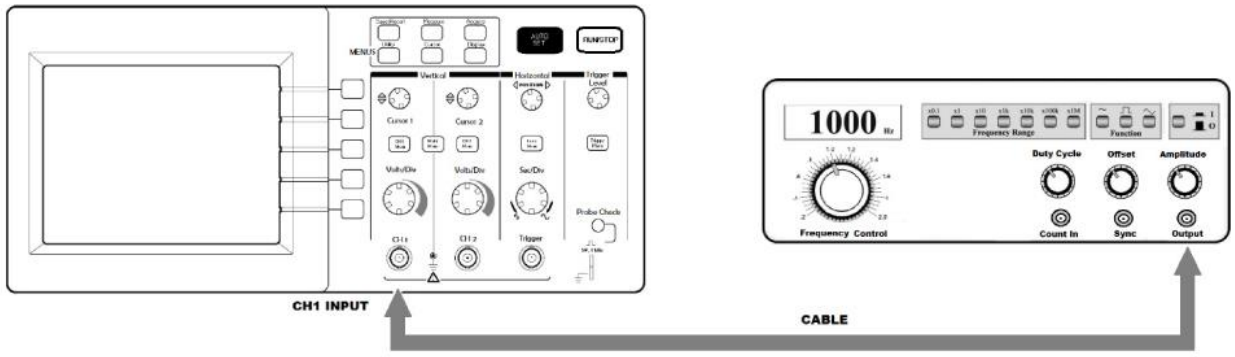
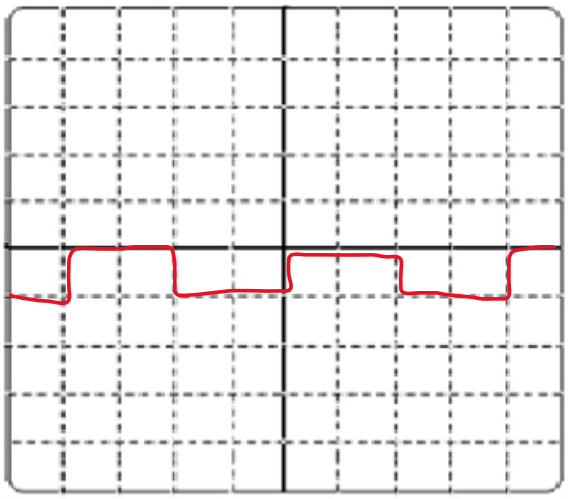
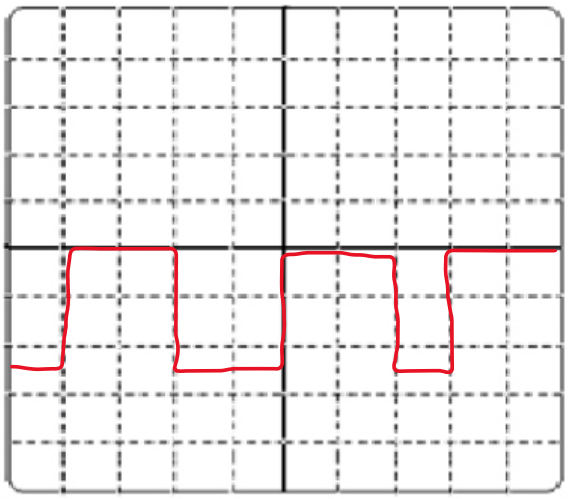


Figure 3.- Connection between oscilloscope and function generator

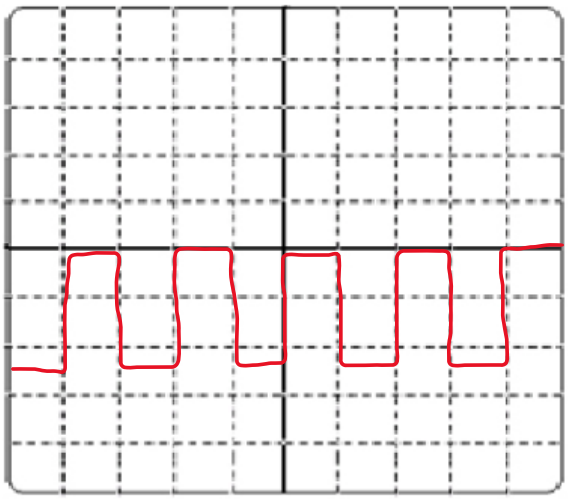
5. Change the Volt/Div control to 2V/Div and observe the effect on the waveform. Sketch the waveform in Figure 4b.
6. Change the time base Sec/Div control to 0.5 ms/div and observe the effect on the waveform. Sketch the waveform in Figure 4c.



a)
CH2:_____5_____V/Div
Time Base _____250_____ µs/Div



b)
CH2:_____2_____V/Div
Time Base _____250_____ µs/Div



c)
CH2:_____2_____V/Div
Time Base _____500_____ µs/Div

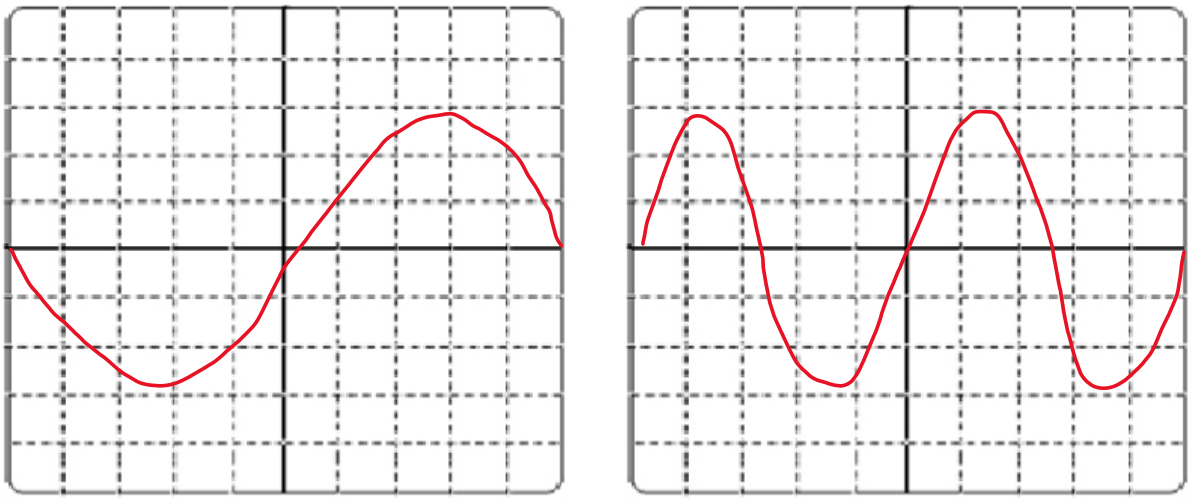
Figure 4.- Oscilloscope Operation

5.2 Function Generator

1. Examine your function generator, noting the controls and output connections.

2. Connect the output of the function generator to the CH1 input of the oscilloscope as shown in Figure 3. Turn on the function generator. Set the function generator to sine (~) output with a frequency of 1000 Hz. Adjust the output voltage level to the middle of its range.

3. Observe the oscilloscope and adjust the sec (time)/div control to display one cycle across the width of the screen. Adjust the volts/div control for a waveform height of approximately six divisions from peak-to-peak. Sketch the waveform displayed in Figure 5a.



a)
CH1: 2 V/Div
Time Base 400 µs/Div

b)
CH1: 2 V/Div
Time Base 100 µs/Div

Figure 5.- Sine wave

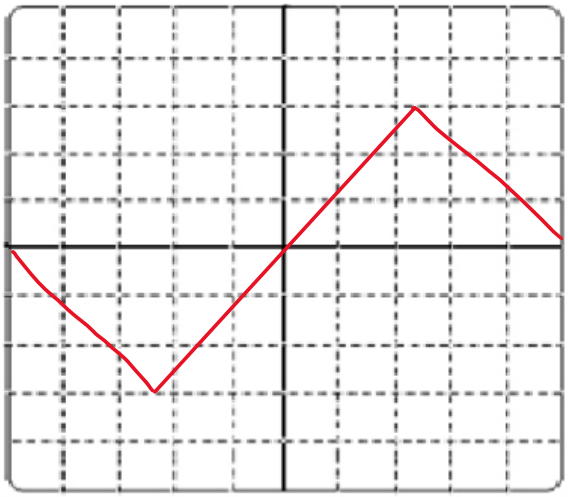
4. Change the frequency to 2000 Hz. Do not change the sec (time)/div control. Centre the display vertically and horizontally and readjust the height to six divisions if necessary. Sketch the waveform displayed in Figure 5b.

5. Change back to 1000 Hz frequency and set the function switch to produce a triangular wave output. Do not change the sec (time)/div control. Centre the display vertically and horizontally and readjust the height to six divisions, if necessary. Sketch the waveform displayed in Figure 6a.

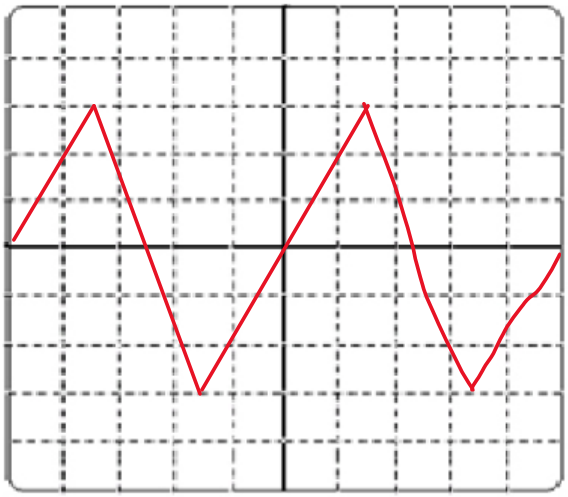
6. Repeat step 4 for the triangular wave. Sketch the waveform displayed in Figure 6b.

7. Change back to 1000 Hz frequency and set the function switch to produce a square wave output. Do not change the sec (time)/div control. Center the display vertically and horizontally and readjust the height to six divisions, if necessary. Sketch the waveform displayed in Figure 6c.

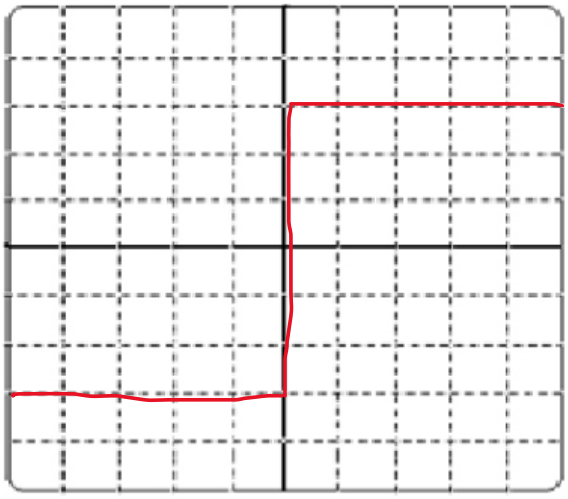
8. Repeat step 4 for the square wave. Sketch the waveform displayed in Figure 6d.



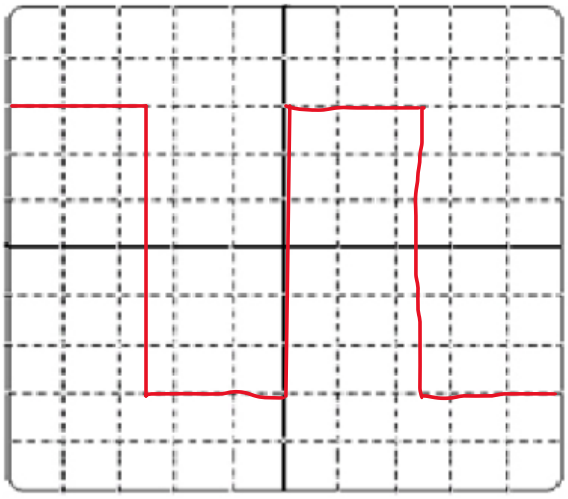
a)
CH1: 2 V/Div
Time Base 100 µs/Div



b)
CH1: 2 V/Div
Time Base 100 µs/Div



c)
CH1: 2 V/Div
Time Base 100 µs/Div



d)
CH1: 2 V/Div
Time Base 100 µs/Div

Figure 6.- a) Triangle wave at 1kHz, b) triangle wave at 2kHz, c) square wave at 1kHz, and d) square wave at 2kHz.

6. After the Lab

1. In procedure step 6, the sec (time)/div control was changed from its original setting. Describe the effect this had on the number of cycles displayed?

   The original setting had 250 microseconds per division, which was doubled to 500 microseconds per division. This also doubled the number of cycles displayed on the oscilloscope.

2. Refer to Question 1. Was the frequency of the calibration waveform changed when changes were made to the sec (time)/div setting in step 6? Explain your answer.

   No, the frequency of the waveform did not change when adjusting the seconds per division because this setting only affects the horizontal scale factor, as stated in the pre-lab section.

3. Referring to your oscilloscope, which controls affect the following?

   a) The height of the displayed waveform: Volts/Div

   b) The number of cycles displayed: Sec/Div

   c) The starting point of the waveform: Horizontal Position

   d) The position of the waveform: Vertical/Horizontal Position

   e) Engaging the sweep generator: Trigger Level

4. In your own words, discuss the relationship between the number of cycles displayed on the screen and the frequency setting of the function generator (with a constant sec (time)/div setting). Refer to your data.

   Based off the data we recorded in the lab, the number of cycles displayed changes by the same factor as the frequency. For example, the frequency being doubled resulted in the number of cycles that were displayed on the oscilloscope to also be doubled.