

Experiment 1
Use of Electronic Equipments

In this experiment you will be using several apparatus that you will frequently use throughout Physics 4B course.

1. Digital Multi-meter (DMM)
2. Low voltage power supply
3. Function Generator
4. Oscilloscope

Here is what you need to do in this lab:

- a. Use DMM to measure the resistance of a given resistor. You need to take any resistor from one of the resistor box and record the given value. Then you will use DMM to measure the resistance, record, and compare with the given value.
- b. Use DMM to measure your body resistance. Record. Specify which part of your body.
- c. Use DMM to calibrate the low voltage power supply. On the output panel there are few equal spaced lines with no indication the value of voltage output. You will measure the output voltage at each mark and record it. Notice the voltage increment and maximum value.
- d. Use DMM to measure current. Connect the DC power supply, the resistor, and the DMM in series. Make sure the power supply is turned off. Calculate the maximum voltage that is safe for your circuit. Keep the current smaller than 0.4 A, and power smaller than 0.5W.
- e. Use oscilloscope to “see” various wave functions generated by function generator. Measure the output voltage of the function generator and the frequency of the signal. Sketch the signal and label the voltage and period.

Recording:

Resistance:

Labeled _____, measured _____, % difference _____

Body resistance _____, Body part _____

DC power supply calibration:

1st mark _____, 2nd _____, 3rd _____, 4th _____
5th mark _____, 6th _____, 8th _____, 9th _____

Current Measurement

V= _____, I= _____, P = VI = _____ (< 0.5W?, if not, use a lower V, try again)

Measured I in circuit _____

Oscilloscope and Function Generator

Sketch what you see on oscilloscope for sine wave, square wave, and saw tooth wave.

Voltage _____, period _____, frequency measured on scope _____,

Frequency output from wave generator _____, % difference _____

The following material is from website www.cs.tcd.ie/courses/baict/bac/jf/labs/scope/oscilloscope

The Oscilloscope

What is an oscilloscope, what can you do with it, and how does it work? This section answers these fundamental questions.

The oscilloscope is basically a graph-displaying device - it draws a graph of an electrical signal. In most applications the graph shows how signals change over time: the vertical (Y) axis represents voltage and the horizontal (X) axis represents time. The intensity or brightness of the display is sometimes called the Z axis. (See Figure 1.) This simple graph can tell you many things about a signal. Here are a few:

- You can determine the time and voltage values of a signal.
- You can calculate the frequency of an oscillating signal.
- You can see the "moving parts" of a circuit represented by the signal.
- You can tell if a malfunctioning component is distorting the signal.
- You can find out how much of a signal is direct current (DC) or alternating current (AC).
- You can tell how much of the signal is noise and whether the noise is changing with time.

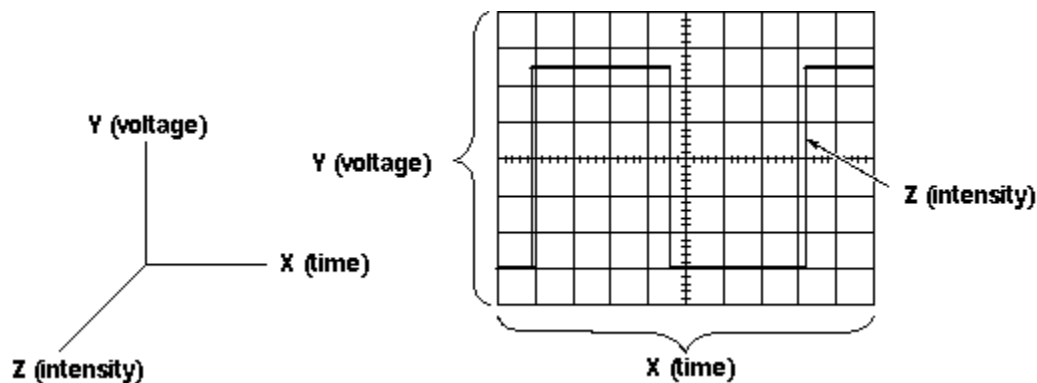


Figure 1: X, Y, and Z Components of a Displayed Waveform

An oscilloscope looks a lot like a small television set, except that it has a grid drawn on its screen and more controls than a television. The front panel of an oscilloscope normally has control sections divided into Vertical, Horizontal, and Trigger sections. There are also display controls and input connectors. See if you can locate these front panel sections in Figures 2 and 3 and on your oscilloscope.

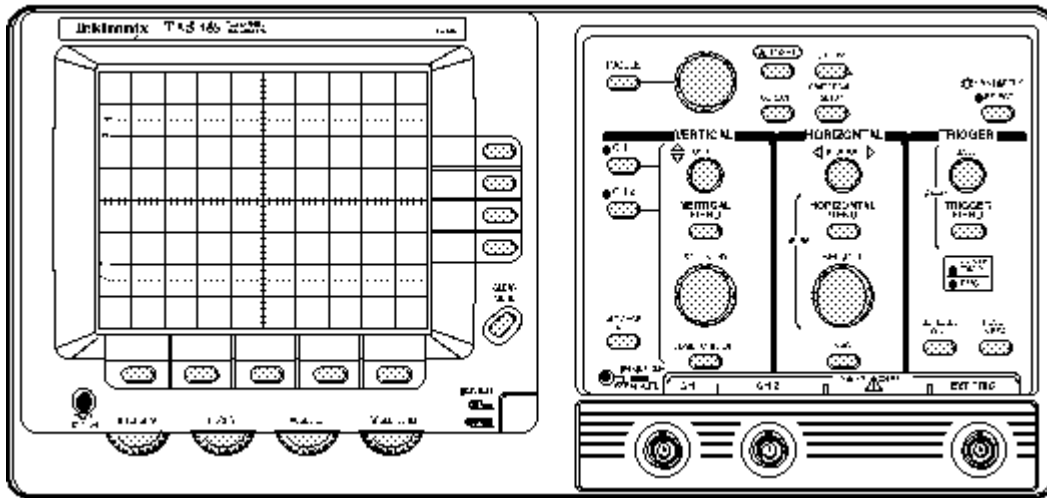


Figure 2: The TAS 465 Analog Oscilloscope Front Panel

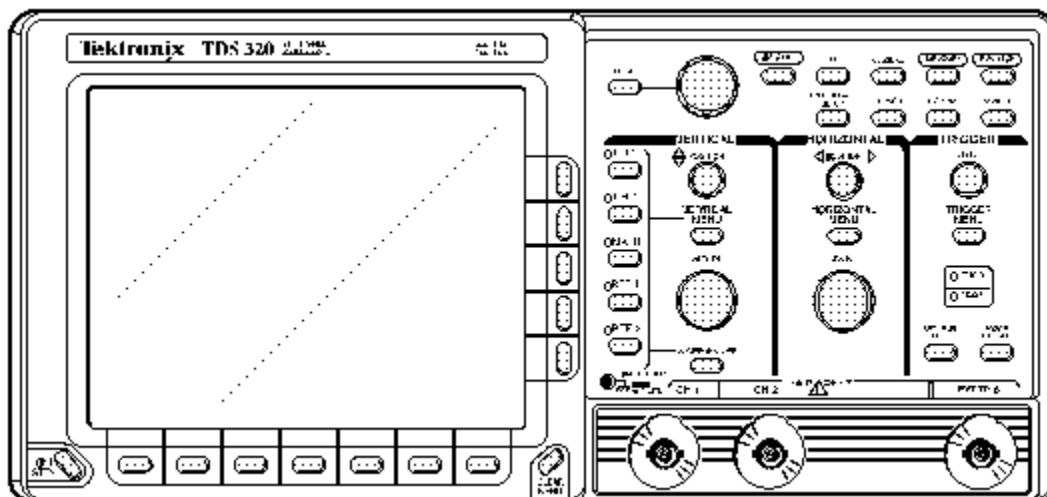


Figure 3: The TDS 320 Digital Oscilloscope Front Panel

What Can You Do With It?

Oscilloscopes are used by everyone from television repair technicians to physicists. They are indispensable for anyone designing or repairing electronic equipment.

The usefulness of an oscilloscope is not limited to the world of electronics. With the proper *transducer*, an oscilloscope can measure all kinds of phenomena. A transducer is a device that creates an electrical signal in response to physical stimuli, such as sound, mechanical stress, pressure, light, or heat. For example, a microphone is a transducer.

An automotive engineer uses an oscilloscope to measure engine vibrations. A medical researcher uses an oscilloscope to measure brain waves. The possibilities are endless.

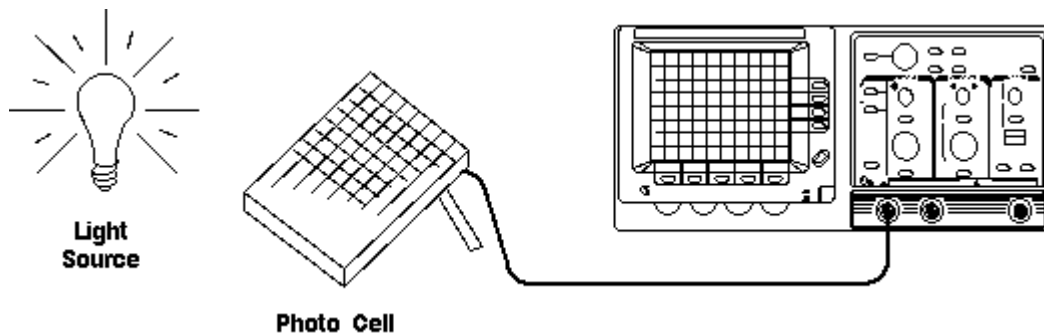


Figure 4: Scientific Data Gathered by an Oscilloscope

Analog and Digital

Electronic equipment can be divided into two types: analog and digital. *Analog* equipment works with continuously variable voltages, while *digital* equipment works with discrete binary numbers that may represent voltage samples. For example, a conventional phonograph turntable is an analog device; a compact disc player is a digital device.

Oscilloscopes also come in analog and digital types. An analog oscilloscope works by directly applying a voltage being measured to an electron beam moving across the oscilloscope screen. The voltage deflects the beam up and down proportionally, tracing the waveform on the screen. This gives an immediate picture of the waveform.

In contrast, a digital oscilloscope samples the waveform and uses an analog-to-digital converter (or ADC) to convert the voltage being measured into digital information. It then uses this digital information to reconstruct the waveform on the screen.

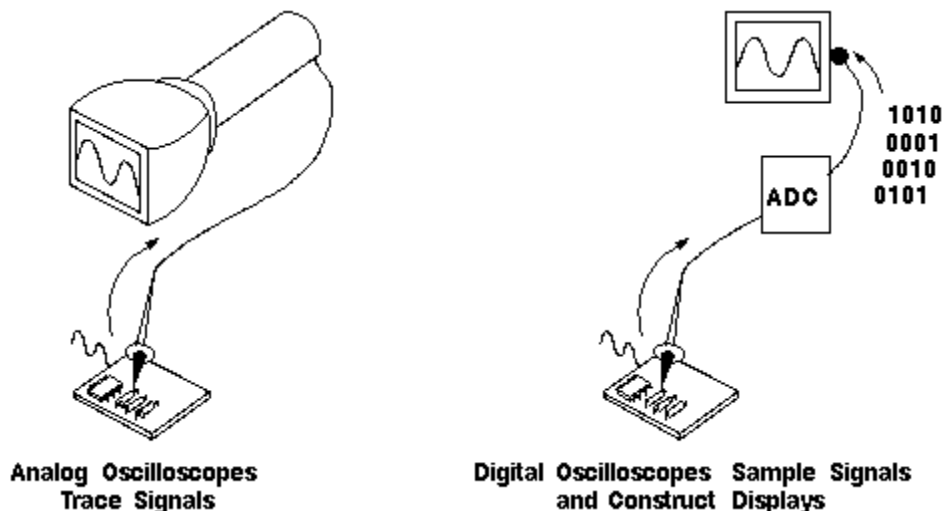


Figure 5: Digital and Analog Oscilloscopes Display Waveforms

For many applications either an analog or digital oscilloscope will do. However, each type does possess some unique characteristics making it more or less suitable for specific tasks.

People often prefer analog oscilloscopes when it is important to display rapidly varying signals in "real time" (or as they occur).

Digital oscilloscopes allow you to capture and view events that may happen only once. They can process the digital waveform data or send the data to a computer for processing. Also, they can store the digital waveform data for later viewing and printing.

How Does an Oscilloscope Work?

To better understand the oscilloscope controls, you need to know a little more about how oscilloscopes display a signal. Analog oscilloscopes work somewhat differently than digital oscilloscopes. However, several of the internal systems are similar. Analog oscilloscopes are somewhat simpler in concept and are described first, followed by a description of digital oscilloscopes.

Analog Oscilloscopes

When you connect an oscilloscope probe to a circuit, the voltage signal travels through the probe to the vertical system of the oscilloscope. Figure 6 is a simple block diagram that shows how an analog oscilloscope displays a measured signal.

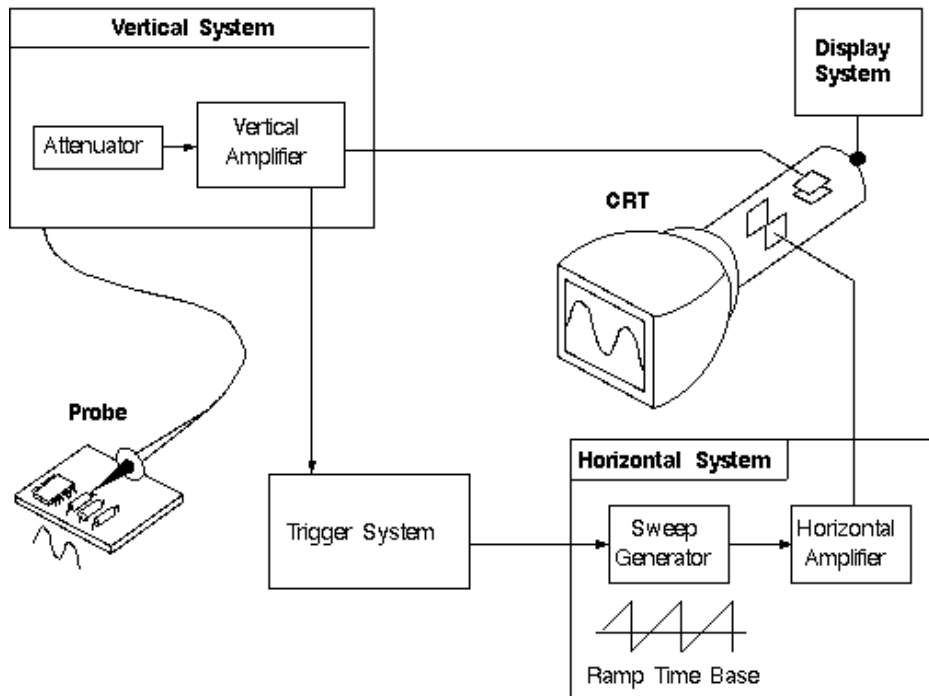


Figure 6: Analog Oscilloscope Block Diagram

Depending on how you set the vertical scale (volts/div control), an *attenuator* reduces the signal voltage or an *amplifier* increases the signal voltage.

Next, the signal travels directly to the vertical deflection plates of the cathode ray tube (CRT). Voltage applied to these deflection plates causes a glowing dot to move. (An electron beam hitting phosphor inside the CRT creates the glowing dot.) A positive voltage causes the dot to move up while a negative voltage causes the dot to move down.

The signal also travels to the trigger system to start or trigger a "horizontal sweep." Horizontal sweep is a term referring to the action of the horizontal system causing the glowing dot to move across the screen. Triggering the horizontal system causes the horizontal time base to move the glowing dot across the screen from left to right within a specific time interval. Many sweeps in rapid sequence cause the movement of the glowing dot to blend into a solid line. At higher speeds, the dot may sweep across the screen up to 500,000 times each second.

Together, the horizontal sweeping action and the vertical deflection action traces a graph of the signal on the screen. The trigger is necessary to stabilize a repeating signal. It ensures that the sweep begins at the same point of a repeating signal, resulting in a clear picture as shown in Figure 7.

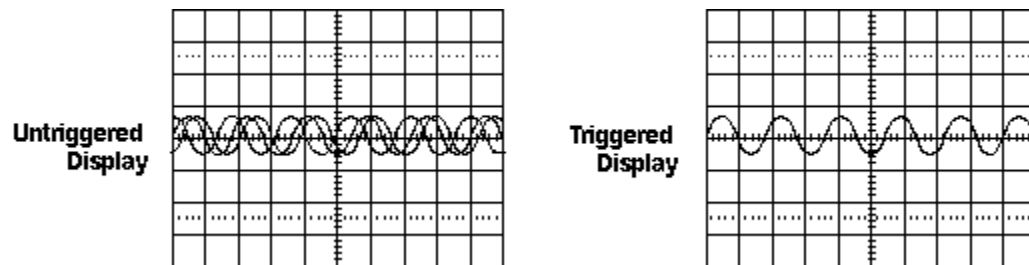


Figure 7: Triggering Stabilizes a Repeating Waveform

In conclusion, to use an analog oscilloscope, you need to adjust three basic settings to accommodate an incoming signal:

- The attenuation or amplification of the signal. Use the volts/div control to adjust the amplitude of the signal before it is applied to the vertical deflection plates.
- The time base. Use the sec/div control to set the amount of time per division represented horizontally across the screen.
- The triggering of the oscilloscope. Use the trigger level to stabilize a repeating signal, as well as triggering on a single event.

Also, adjusting the focus and intensity controls enables you to create a sharp, visible display.