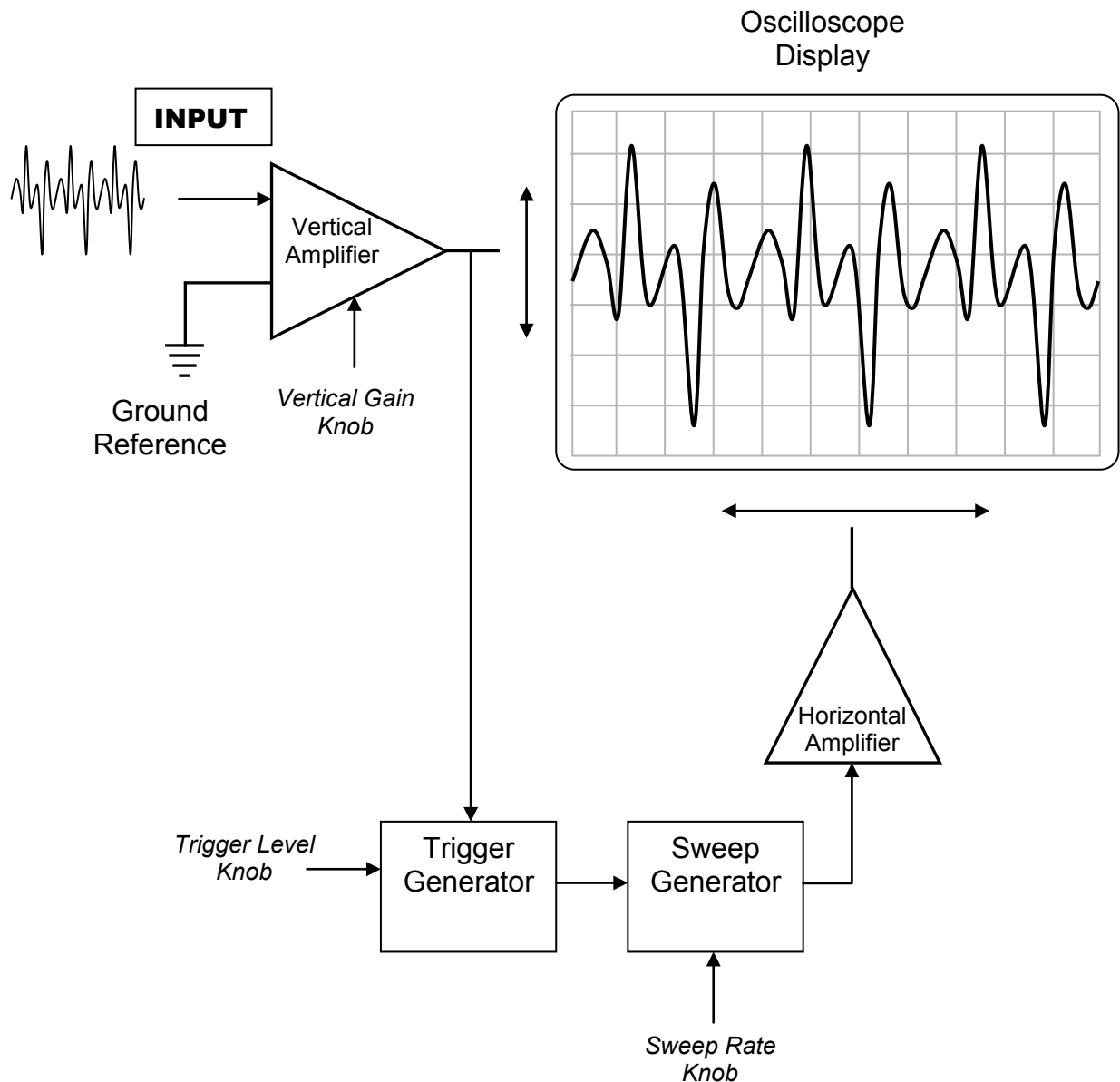


EELE 250: Oscilloscope Notes

In the lab we will use an *oscilloscope* to measure time-varying voltage waveforms. The oscilloscope is arguably the most fundamental measurement device in electrical engineering. The usefulness of the oscilloscope—or 'scope' for short—is due primarily to its ability to display electrical signal information directly in visual form. A simplified block diagram of a basic oscilloscope is shown here.



Although it may appear complicated, the basic oscilloscope is quite simple in concept:

- The vertical position, or *vertical deflection*, of the electron beam of a cathode ray tube (CRT) or the vertical position on a digital display screen is linearly proportional to the input *voltage*. The input voltage is measured between a particular circuit node and the oscilloscope's *ground* reference. A calibrated variable amplifier is used to boost low-level signals in order to produce a visible beam deflection. The input voltage can thus be determined by measuring

the amount of beam deflection for a particular input amplifier gain. Vertical deflection calibration is usually indicated as *volts per division*, where "division" refers to the grid lines etched roughly 1 cm apart on the face of the display screen.

- The *horizontal deflection* is controlled either by another input signal or more commonly by a calibrated *sweep generator*. The sweep generator moves the electron beam at a selectable, constant rate from left to right across the CRT screen, and then when it reaches the right edge of the screen, it jumps back to the left edge and waits for the sweep generator to trigger another sweep across the screen. This sweep cycle repeats over and over again, creating the impression of a "stop action" view of the waveform. The calibrated sweep rate is usually indicated as *time per division*, where "division" again refers to the grid lines on the display.

The oscilloscope's electrical inputs are usually utilized with a special attachment known as an *oscilloscope probe*. The probe has a pen-shaped end with a spring-loaded tip that connects to the circuit node of interest, and a short stub cable with an alligator clip that is used to connect the circuit's ground reference to the oscilloscope's ground reference.

The most common use of oscilloscopes is in the observation of *periodic* signals. Repetitive waveforms (oscillations) can be viewed by synchronizing the sweep generator with the repetition rate of the input signal. This is accomplished using a sweep *trigger generator* which starts the horizontal sweep when the input signal exceeds an adjustable voltage threshold. The trigger can be selected to occur for either a positive or negative slope at the threshold voltage.

Thus, by adjusting the vertical gain and the sweep speed, time varying input signals can be viewed directly as a voltage-vs.-time display.

Oscilloscopes have many other features for producing displays of particular types of signals. For example, most 'scopes have two or more independent input amplifiers for displaying two or more input signals simultaneously. Oscilloscopes often have the ability to display the electrical sum or difference of two waveforms, which is handy when trying to observe the voltage in a circuit across an element that does not have one end attached to the ground reference. For example, by using one input channel (CH1) to measure the voltage with respect to ground at node 1 and another channel (CH2) to measure the voltage with respect to ground at node 2, setting the 'scope's math function to subtract CH2 from CH1 allows the display of the voltage between node 1 and node 2.

Some special features will depend upon the instrument manufacturer and the sophistication of the 'scope itself. Some of these "advanced" features will be considered later in this course.