SNS COLLEGE OF ENGINEERING

Kurumbapalayam (Po), Coimbatore – 641 107

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE NAME : 23EET206 CONTROL SYSTEMS AND INSTRUMENTATION

II YEAR ECE /III SEMESTER

Unit 5-Oscilloscope, Signal Generator, Analyzer and Data Acquisition System

Topic 1 : Digital Storage Oscilloscope

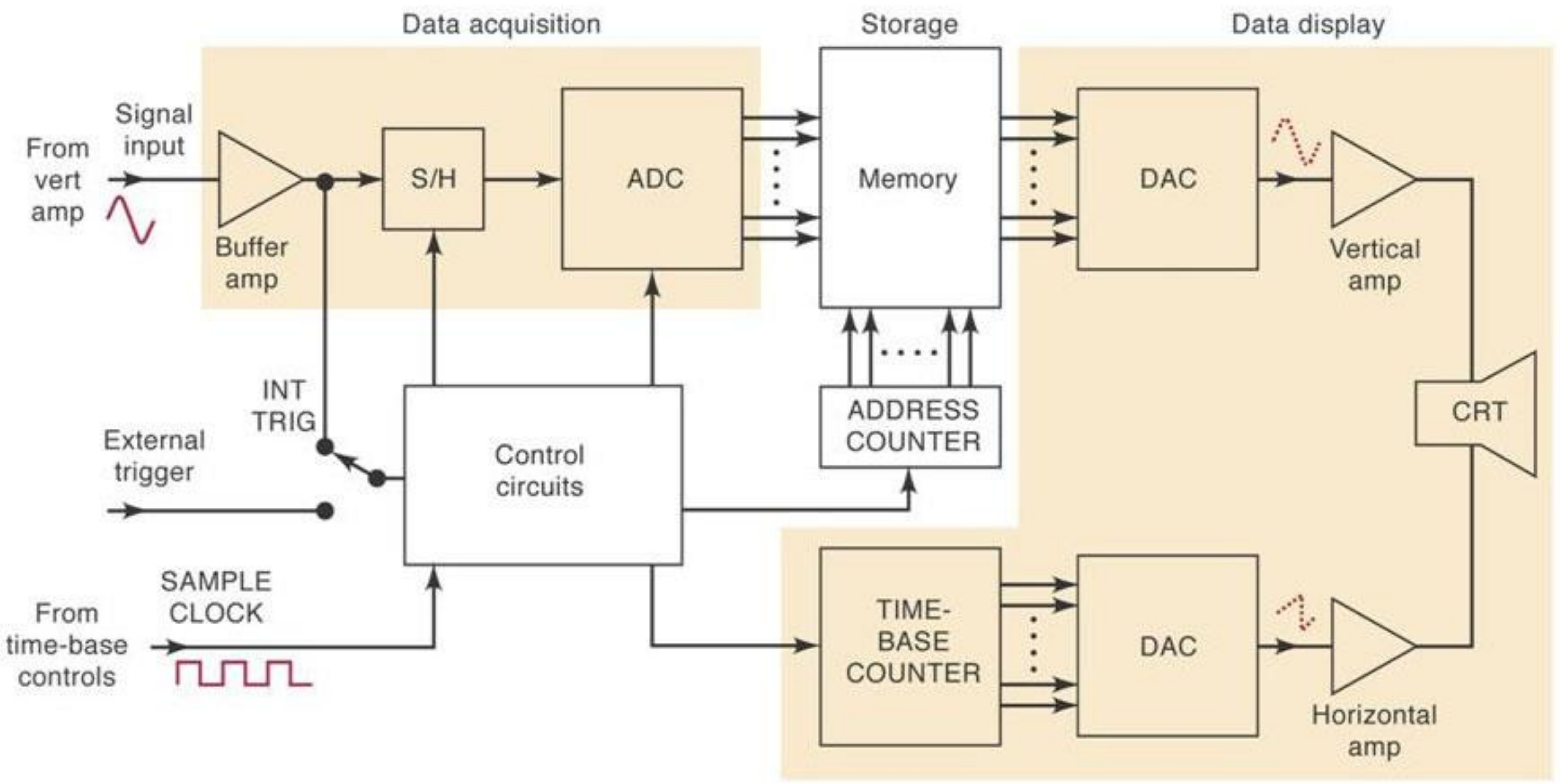
DIGITAL STORAGE OSCILLOSCOPE

- A **Digital Storage Oscilloscope** (**DSO**) is an oscilloscope which stores and analyses the input signal digitally rather than using analog techniques.
- It is now the most common type of oscilloscope in use because of the advanced trigger, storage, display and measurement features which it typically provides.
- In the analog storage (ASO)oscilloscope the input signals are stored in mesh storage and whenever the signal display is needed the electron beam(or)electron gun is activated which hits the mesh storage passing through a horizontal amplifier and finally displays the signal on CRT screen.

DIGITAL STORAGE OSCILLOSCOPE

- The stored signal can be used to display for up to few days as the signal has a tendency to fade away.
- In DSO the signals are stored in digital form rather than in analog form. The conversion of analog signals into digital/binary form can be achieved through Analog to digital conversion(ADC) technique. The converted signal is then stored in memory which acts as a storage unit in DSO. Whenever the signal is needed to display on CRT, the digital signal is reconstructed to analog form with the Digital to analog conversion (DAC) technique.

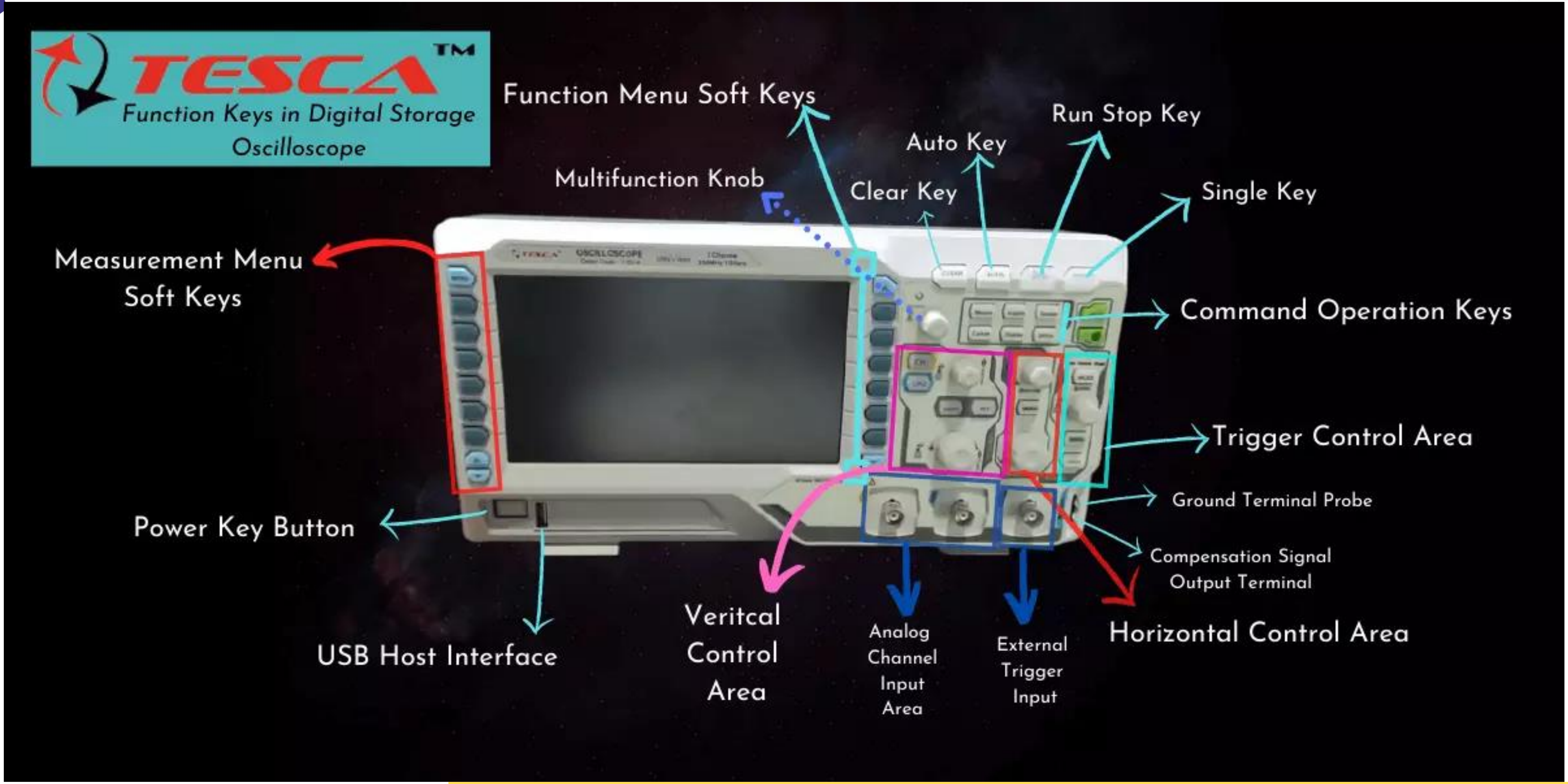
DIGITAL STORAGE OSCILLOSCOPE



DIGITAL STORAGE OSCILLOSCOPE

- When an analog signal is given as an input it passes through an attenuator circuit where the unwanted noise signals are attenuated and this clean signal is applied to a vertical amplifier which performs the sampling and converts the input into digital.
- The digitally converted analog signal is stored in memory, which we can use as many times as we want to display on CRT. And coming to control logic it controls the ADC(Analog to Digital converter) conversion and deflection amplifiers.
- Both vertical and horizontal deflection amplifiers are connected to a DAC(Digital to Analog converter) which deflects the beam of electrons and so the trace on the CRT screen.

DIGITAL STORAGE OSCILLOSCOPE



DIGITAL STORAGE OSCILLOSCOPE

- Are small and portable (200Gms to 2 Kgs)
- Have the highest bandwidths (~ 20 GHz)
- Have colour displays
- Provide ON screen measurements
- Have simple user interface
- Provide storage and printing
- PC connectivity, used as Automatic Test Equipment(ATE)
- high speed data acquisition system
- Cost/BW is low than Analog
- Memory Depth

MODES OF OPERATION

The digital storage oscilloscope works in three modes of operations. they are roll mode, store mode, and hold or save mode.

- **Roll Mode:** In roll mode, very fast varying signals are displayed on the display screen.
- **Store Mode:** In the store mode the signals stores in memory.
- **Hold or Save Mode:** In hold or save mode, some part of the signal will hold for some time and then they will be stored in memory.

CURSORS IN DSO

There are two types of Cursors in a DSO: Voltage Cursors & Time Cursors.

Voltage Cursors

Voltage cursors appear as horizontal lines on the display and measure the vertical parameters.

Time Cursors

Time cursors appear as vertical lines on the display and measure the horizontal parameters.

Automatic

The MEASURE Menu can take up to five automatic measurements. When you take automatic measurements, the oscilloscope does all the calculating for you. Because the measurements use the waveform record points, they are more accurate than the graticuleor cursor measurements.

Automatic measurements use readouts to show measurement results. These readouts are updated periodically as the oscilloscope acquires new data.

OSCILLOSCOPE SYSTEM AND CONTROL

Redesigning Common Mind & Business Towards Excellence

Build an Entrepreneurial Mindset Through Our Design Thinking FrameWork

A basic oscilloscope consists of three different systems – the vertical system, horizontal system, and trigger system. Each system contributes to the oscilloscope's ability to accurately reconstruct a signal.

The front panel of an oscilloscope is divided into three sections labeled **Vertical**, **Horizontal**, and **Trigger**. Your oscilloscope may have other sections, depending on the model and type.

When using an oscilloscope, you adjust settings in these areas to accommodate an incoming signal:

•**Vertical:** This is the attenuation or amplification of the signal. Use the volts/div control to adjust the amplitude of the signal to the desired measurement range.

•**Horizontal:** This is the time base. Use the sec/div control to set the amount of time per division represented horizontally across the screen.

•**Trigger:** This is the triggering of the oscilloscope. Use the trigger level to stabilize a repeating signal, or to trigger on a single event.

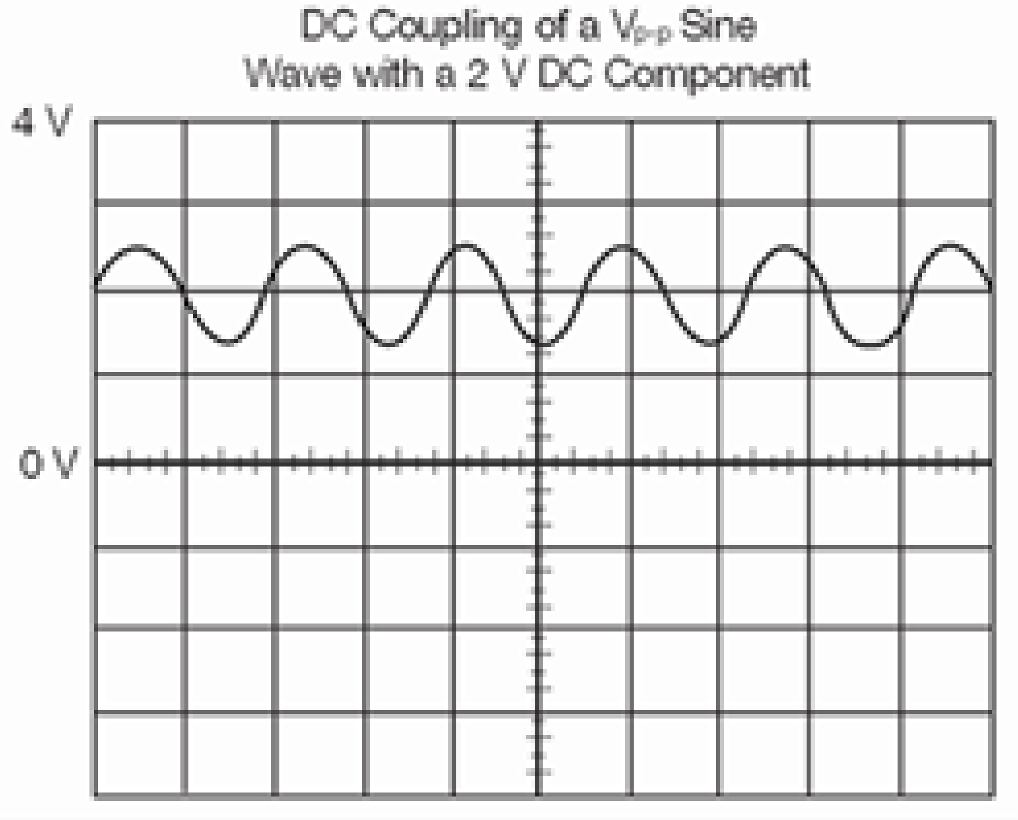
VERTICAL SYSTEM AND CONTROL

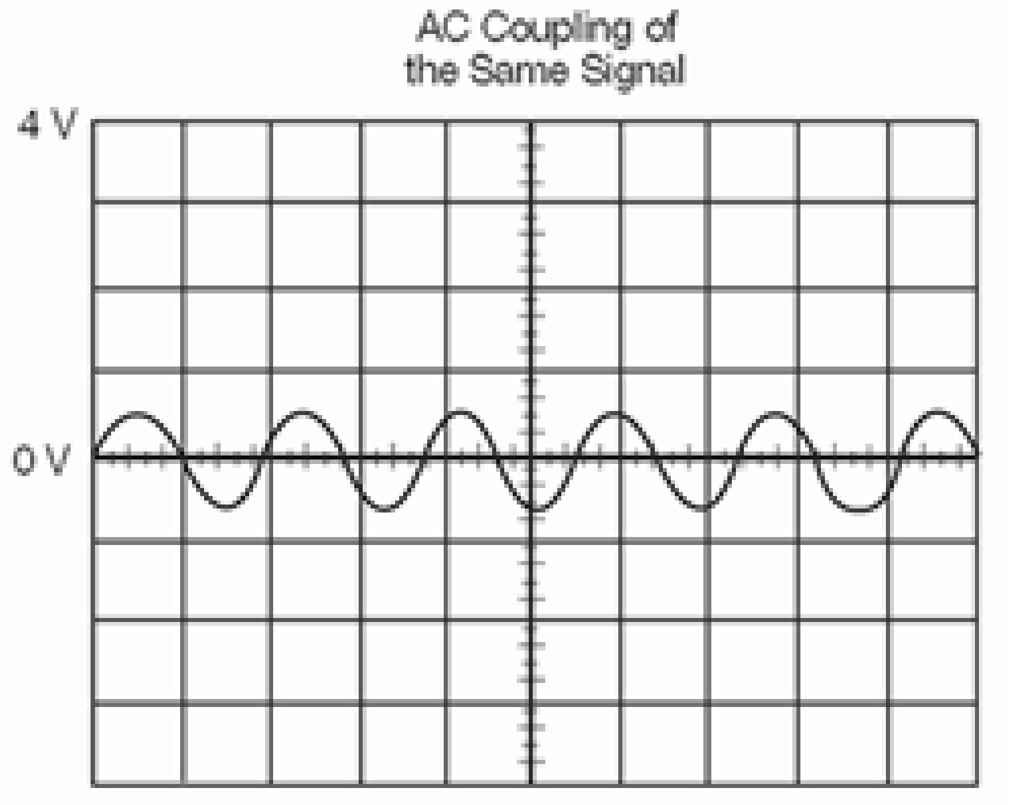
Vertical controls are used to position and scale the waveform vertically, set the input coupling, and adjust other signal conditioning. Common vertical controls include:

- Position
- Coupling: DC, AC, and GND
- Bandwidth: Limit and Enhancement
- Termination: 1M ohm and 50 ohm
- Offset
- Invert: On/Off
- Scale: Fixed Steps and Variable

VERTICAL SYSTEM - COUPLING

- Coupling refers to the method used to connect an electrical signal from one circuit to another. In this case, the input coupling is the connection from your test circuit to the oscilloscope.
- The coupling can be set to DC, AC, or ground. DC coupling shows all of an input signal. AC coupling blocks the DC component of a signal so that you see the waveform centered around zero volts.
- The AC coupling setting is useful when the entire signal (alternating current + direct current) is too large for the volts/div setting.





VERTICAL SYSTEM - COUPLING

- The ground setting disconnects the input signal from the vertical system, which lets you see where zero volts is located on the screen.
- With grounded input coupling and auto trigger mode, you see a horizontal line on the screen that represents zero volts.
- Switching from DC to ground and back again is a handy way of measuring signal voltage levels with respect to ground.

HORIZONTAL SYSTEM AND CONTROL

An oscilloscope’s horizontal system is most closely associated with its acquisition of an input signal. Sample rate and record length are among the considerations here. Horizontal controls are used to position and scale the waveform horizontally. Common horizontal controls include:

- Acquisition Sample Rate
- Time Base
- Search
- Z Axis
- Trigger Position
- Trace Separation
- Resolution
- Position and Seconds per Division
- Zoom/Pan
- XY Mode
- XYZ Mode
- Scale
- Record Length

ACQUISITION MODES OF DSO

- Acquisition modes control how waveform points are produced from sample points. Sample points are the digital values derived directly from the analog-to-digital converter (ADC). The sample interval refers to the time between these sample points.
- Waveform points are the digital values that are stored in memory and displayed to construct the waveform. The time-value difference between waveform points is referred to as the **waveform interval**.
- The sample interval and the waveform interval may or may not be the same. This fact leads to the existence of several different acquisition modes in which one waveform point is comprised of several sequentially acquired sample points. Additionally, waveform points can be created from a composite of sample points taken from multiple acquisitions, which provides another set of acquisition modes.

ACQUISITION MODES OF DSO

Sample

In this acquisition mode, the oscilloscope samples the signal in evenly spaced intervals to construct the waveform. This mode accurately represents signals most of the time(can result in aliasing).

Peak Detect

In this acquisition mode, the oscilloscope finds the highest and lowest values of the input signal over each sample interval and uses these values to display the waveform (to display narrow pulses, while noise can be higher in this mode).

Average

In this acquisition mode, the oscilloscope acquires several waveforms, averages them, and displays the resulting waveform (used to reduce random noise).

ACQUISITION MODES OF DSO

Hi-Res Mode: Like peak detect, hi-res mode is a way of getting more information in cases when the ADC can sample faster than the time base setting requires. In this case, multiple samples taken within one waveform interval are averaged together to produce one waveform point.

The result is a decrease in noise and an improvement in resolution for low-speed signals. The advantage of Hi-Res Mode over Average is that Hi-Res Mode can be used even on a single shot event.

Envelope Mode: Envelope mode is similar to peak detect mode. However, in envelope mode, the minimum and maximum waveform points from multiple acquisitions are combined to form a waveform that shows min/max accumulation over time.

Peak detect mode is usually used to acquire the records that are combined to form the envelope waveform.

ACQUISITION MODES OF DSO

Waveform Database Mode: In waveform database mode, the oscilloscope accumulates a waveform database that provides a three-dimensional array of amplitude, time, and counts.

Starting and Stopping the Acquisition System

One of the greatest advantages of digital oscilloscopes is their ability to store waveforms for later viewing.

To this end, there are usually one or more buttons on the front panel that allow you to start and stop the acquisition system. Additionally, you may want the oscilloscope to automatically stop acquiring after one acquisition is complete or after one set of records has been turned into an envelope or average waveform.

This feature is commonly called single sweep or single sequence and its controls are usually found either with the other acquisition controls or with the trigger controls.

SAMPLING

- Sampling is the process of converting a portion of an input signal into a number of discrete electrical values for the purpose of storage, processing, and/or display. The magnitude of each sampled point is equal to the amplitude of the input signal at the instant in time in which the signal is sampled.
- Sampling is like taking snapshots. Each snapshot corresponds to a specific point in time on the waveform. These snapshots can then be arranged in the appropriate order in time to reconstruct the input signal.
- In a digital oscilloscope, an array of sampled points is reconstructed on a display with the measured amplitude on the vertical axis and time on the horizontal axis.
- The input waveform appears as a series of dots on the screen. If the dots are widely spaced and difficult to interpret as a waveform, the dots can be connected using a process called interpolation.
- Interpolation connects the dots with lines or vectors. A number of interpolation methods are available that can be used to produce an accurate representation of a continuous input signal.

SAMPLING METHODS

- Real Time Sampling Method
- Equivalent Time Sampling Method
- Random Equivalent Time Sampling Method
- Sequential Equivalent Time Sampling Method

TRIGGERING SYSTEM AND CONTROL

- An oscilloscope's trigger function synchronizes the horizontal sweep at the correct point of the signal. This is essential for clear signal characterization. Trigger controls allow you to stabilize repetitive waveforms and capture single-shot waveforms.
- The trigger makes repetitive waveforms appear static on the oscilloscope display by repeatedly displaying the same portion of the input signal.
- Edge triggering, available in analog and digital oscilloscopes, is the basic and most common type. In addition to threshold triggering offered by both analog and digital oscilloscopes, many digital oscilloscopes offer numerous specialized trigger settings not offered by analog instruments.

TRIGGERING SYSTEM AND CONTROL

- These triggers respond to specific conditions in the incoming signal, making it easy to detect, for example, a pulse that is narrower than it should be. Such a condition is impossible to detect with a voltage threshold trigger alone.
- Advanced trigger controls enable you to isolate specific events of interest to optimize the oscilloscope's sample rate and record length. Advanced triggering capabilities in some oscilloscopes give you highly selective control.

TIME DOMAIN SPECIFICATION

Other advanced trigger functions include:

- Pattern Lock Triggering
- Serial Pattern Triggering
- A & B Triggering
- Search & Mark Triggering
- Trigger Correction
- Parallel Bus Triggering

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Thank You