Oscilloscope Controls

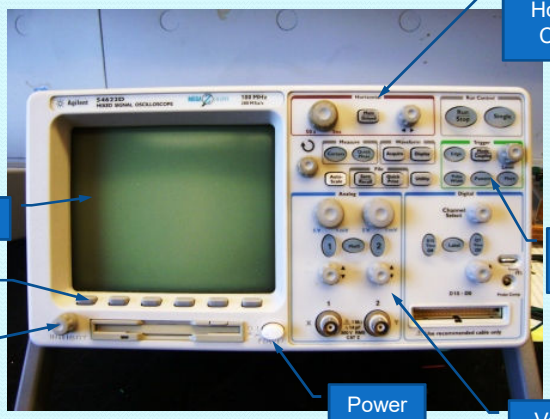
Lesson 12 EET 150

Scope Controls Learning Objectives

- In this lesson you will:
- learn the location and function of oscilloscope controls.
- see block diagrams of analog and digital oscilloscopes.
- see how different input coupling affects displayed signals.
- learn how to set oscilloscope controls to make measurements
- learn how to set the triggering controls to stabilize a scope display.
- examine scope probe operation.
- see how to compensate a scope probe.
- determine how scope bandwidth affects measurement accuracy

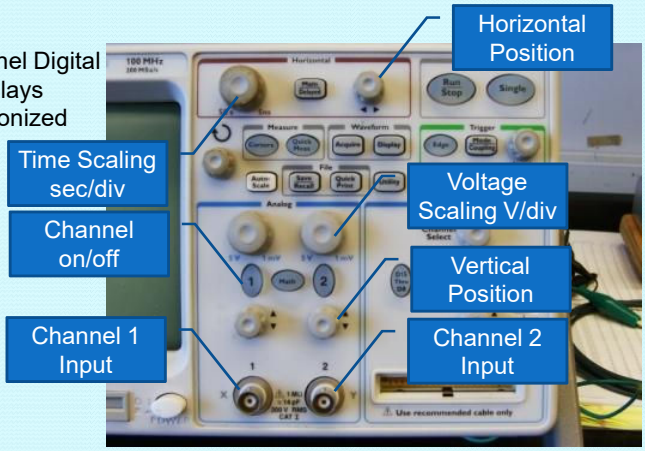
Agilent 54622D Scope Controls

Dual Trace Digital Storage scope with digital signal monitoring.

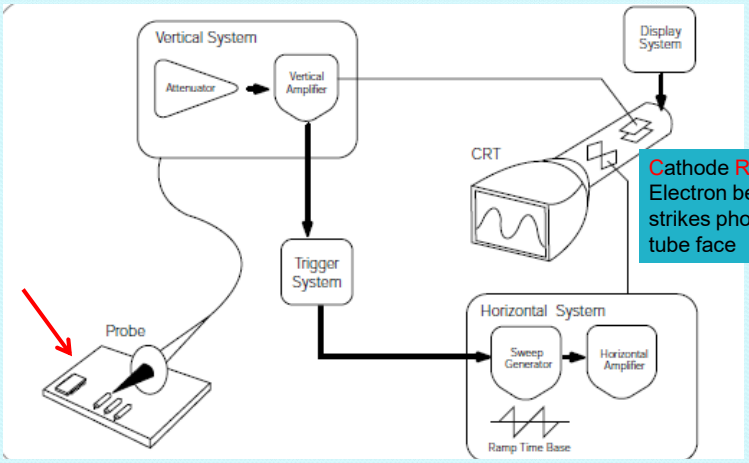


Vertical and Horizontal Scale Controls Agilent 54622D Scope

Dual Channel Digital Scope displays two synchronized signals

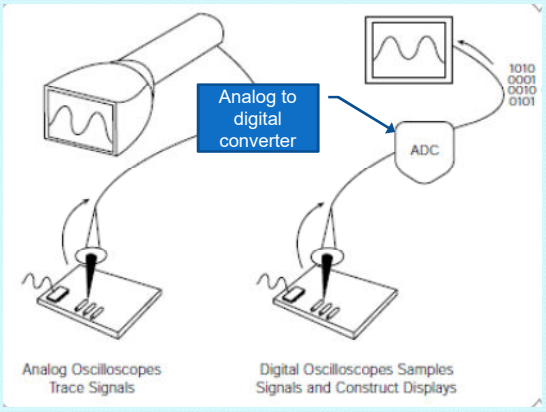


Inside an Analog Scope



Cathode Ray Tube
Electron beam strikes phosphor on tube face

Digital Scopes vs Analog Scopes



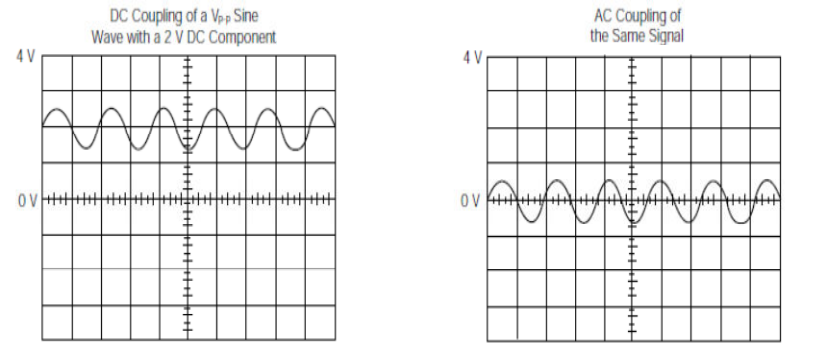
Measured voltage turned into series of samples

Samples stored and displayed on screen

Performance limited by sampling rate

One-time events captured and displayed. Not possible with analog scopes

Vertical Input Coupling
Ac or Dc Setting



DC coupling passes both ac and dc voltages

AC coupling passes only ac part of signal

Setting the Oscilloscope for Measurement

Connect probe(s) to scope input (1x or 10x)
- 10x expands range increases accuracy

Adjust screen display (brightness and focus)

Adjust vertical gain to expected range of input
- If range unknown set to maximum

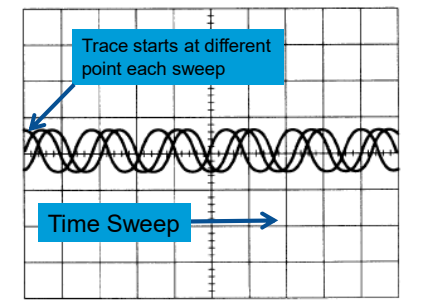
Select proper coupling of input
- Ac coupling blocks dc signal and passes ac only
- Dc coupling passes both ac and dc signals

Adjust time scaling to expected range of input signal

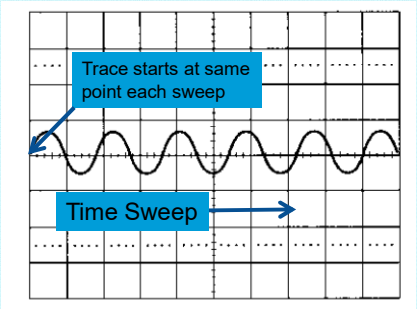
Set triggering source and level

Scope Triggering Basics

A properly triggered scope will have a stable screen display



Un-triggered Display



Triggered Display

Trigger Level and Slope

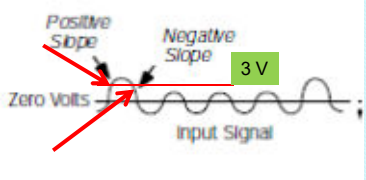
Trigger controls compare the signal edge to user-set levels and polarity (+/- slope)

Trigger Level – determines where on signal edge the trigger point occurs

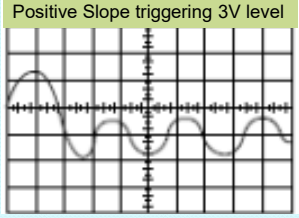
Trigger Slope – determines whether trigger point occurs on rising or falling edge.

Trigger Level and Slope

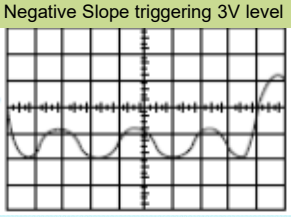
Trigger level and slope example



Positive Slope triggering 3V level



Negative Slope triggering 3V level



Trigger Sources

Input Channels
- Input used to start time sweep
- Most commonly used

Power Source (Line Trigger)
- Trigger signal derived from power line of scope
- Ideal for triggering signals based on “wall power”
- Locks on signal that are multiples of 60 Hz

External Source
- Signal not derived from inputs
- Additional signal must be applied

Trigger Modes

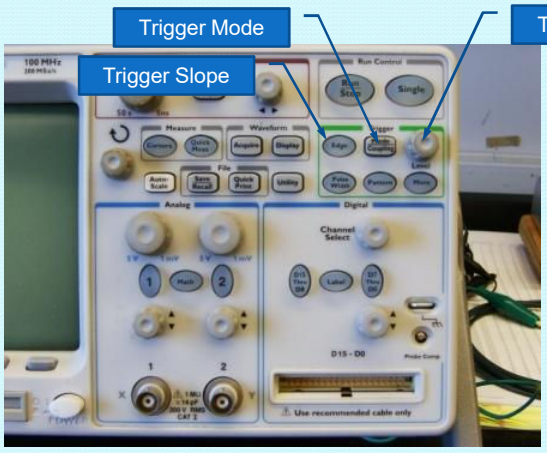
Trigger Mode – determines how and when the scope displays the signal

Common Trigger Modes

Auto – causes scope to sweep trace without input signal applied. Display does not disappear when signal removed. Most commonly used setting

Normal – only causes scope to sweep trace when signal is applied at has appropriate trigger level and slope. With no input, no display on analog scope or frozen display on digital scope.

Triggering Controls Agilent 54622D

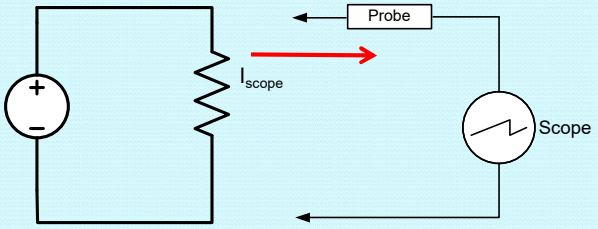


Edge and Mode buttons produce menu choices above function keys on the display

Scope Probes

Probes connect the scope to the circuit under test

Connecting any instrument to an electric/electronic circuit changes the measured value

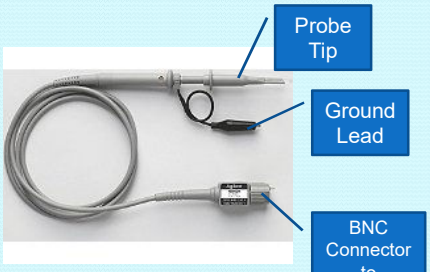


Scope and probe draw current changing the circuit

Scope Probes

10x probes draw less current from circuit under test

10x probes give best results



Probe kit

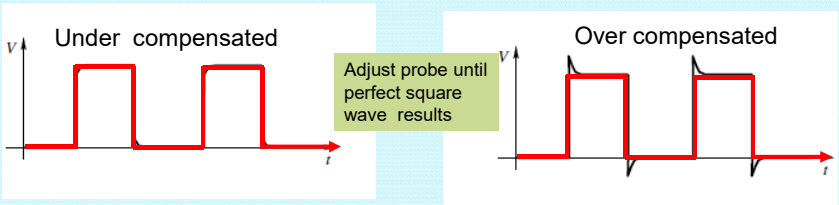
Probe kit

Probe Compensation

10x probes must be adjusted to give best performance. This is called probe compensation.

10x probe forms a voltage divider with parallel capacitance. An adjustable capacitor eliminates this effect.

Square wave test signal used to make necessary adjustment



High frequencies reduced

Low frequencies reduced

Scope Frequency Response

Scope must have sufficient frequency response (Bandwidth) to accurately reproduce signals.

Lack of bandwidth prevents scope from displaying rapidly changing signals

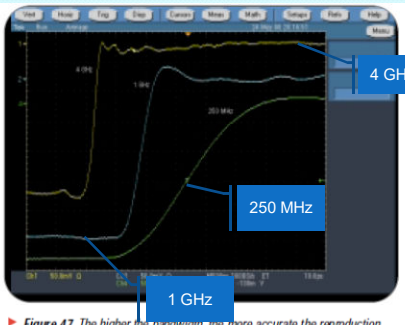


Figure 47. The higher the bandwidth, the more accurate the reproduction of your signal, as illustrated with a signal captured at 250 MHz, 1 GHz and 4 GHz bandwidth levels.

Limited bandwidth effects
lack of frequency resolution
distorted amplitude
lost signal edges
lost signal details

Five Times Rule

Required Bandwidth = 5 x highest measured frequency

Oscilloscope Controls

End Lesson 12 EET 150

Coming Next: Electrical Connections