Sudan University of Science and Technology – SUST
College of Engineering
Electronics Engineering Technology

Title is:

Oscilloscope

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Digital oscilloscopes can be classified into four types:

1. Digital storage oscilloscopes (DSO)
2. Digital phosphor oscilloscopes (DPO)
3. Mixed signal oscilloscopes (MSO)

Digital sampling oscilloscopes.

Digital Phosphor Oscilloscope (DPO) When comparing a DSO to a DPO, a DSO is a real-time sampling oscilloscope, while a DPO is has an additional 'frequency-of-occurrence' element which helps the signal to show a real third dimension. In DSO a high sampling rate ADC is used to seize the signals in a single acquisition.

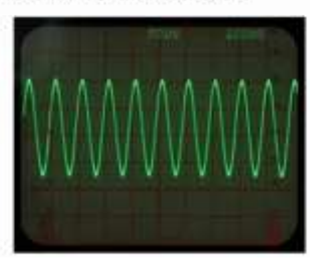
What does an oscilloscope measure?

Current. There are a few ways to use an oscilloscope to measure

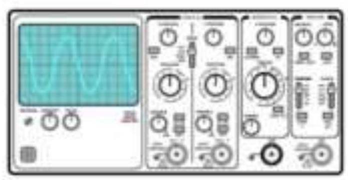
1. Current one would be to measure the voltage dropped across a shunt resistor
2. Sound It is possible to measure sound through an oscilloscope
3. Capacitance
4. DC Voltage.
5. Frequency.
6. Inductance

An oscilloscope (informally a scope) is a type of electronic test instrument that graphically displays varying electrical voltages as a two-dimensional plot of one or more signals as a function of time. The main purposes are to display repetitive or single waveforms on the screen that would otherwise occur too briefly to be perceived by the human eye. The displayed waveform can then be analyzed for properties such as amplitude, frequency, rise time, time interval, distortion, and others. Originally,

A Tektronix model 475A portable analog oscilloscope, a typical instrument of the late 1970s



calculation of these values required manually measuring the waveform against the scales built into the screen of the instrument. 1] Modern digital instruments may calculate and display these properties directly.



Oscilloscope showing a trace with standard inputs and controls

Typical display of an analog oscilloscope measuring a sine wave signal with 10 kHz. From the grid inherent to the screen together with the user-set parameters of the device shown at the upper display rim, the user may calculate the frequency and the voltage of the measured signal. Modern digital oscilloscopes automatically set the measurement parameters and calculate/display the signal values automatically.

An analog oscilloscope is typically divided into four sections: the display, vertical controls, horizontal controls and trigger controls. The display is usually a CRT with horizontal and vertical reference lines called the graticule. CRT displays also have controls for focus, intensity, and beam finder.

The vertical section controls the amplitude of the displayed signal. This section has a volts-per-division (Volts/Div) selector knob, an AC/DC/Ground selector switch, and the vertical (primary) input for the instrument. Additionally, this section is typically equipped with the vertical beam position knob.

The horizontal section controls the time base or "sweep" of the instrument. The primary control is the Seconds-per-Division (Sec/Div) selector switch. Also included is a horizontal input for plotting dual X-Y axis signals. The horizontal beam position knob is generally located

The trigger section controls the start event of the sweep. The trigger can be set to automatically restart after each sweep, or can be configured to respond to an internal or external event. The principal controls of this section are the source and coupling selector switches, and an external trigger input (EXT Input) and level adjustment.

In addition to the basic instrument, most oscilloscopes are supplied with a probe. The probe connects to any input on the instrument and typically has a resistor of ten times the oscilloscope's input impedance. This results in a 0.1 (-10x) attenuation factor; this helps to isolate the capacitive load presented by the probe cable from the signal being measured. Some probes have a switch allowing the operator to bypass the resistor when appropriate.|1)

Size and portability

Most modern oscilloscopes are lightweight, portable instruments compact enough for a single person to carry. In addition to portable units, the market offers a number of miniature battery-powered instruments for field service applications. Laboratory grade oscilloscopes, especially older units that use vacuum tubes, are generally bench-top devices or are mounted on dedicated carts. Special-purpose oscilloscopes may be rack-mounted or permanently mounted into a custom instrument housing.

Inputs

The signal to be measured is fed to one of the input connectors, which is usually a coaxial connector such as a BNC or UHF type. Binding posts or banana plugs may be used for lower frequencies. If the signal source has its own coaxial connector, then a simple coaxial cable is used; otherwise, a specialized cable called a "scope probe", supplied with the oscilloscope, is used.

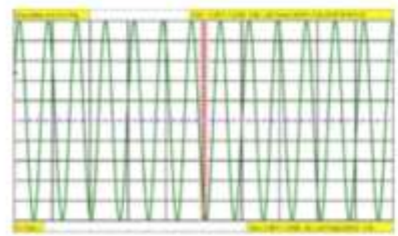
In general, for routine use, an open wire test lead for connecting to the point being observed is not satisfactory, and a probe is generally necessary.

General-purpose oscilloscopes usually present an input impedance of 1 megohm in parallel with a small but known capacitance such as 20 picofarads. 5]

This allows the use of standard oscilloscope probes. S Scopes for use with very high frequencies may have 50 S inputs. These must be either connected directly to a 50 h signal source or used with Zo or active probes.

Probes

Main article: Test probe § Oscilloscope probes



Computer model of the impact of increasing the timebase time/division

Open wire test leads (flying leads) are likely to pick up interference, so they are not suitable for low level signals. Furthermore, the leads have a high inductance, so they are not suitable for high frequencies. Using a shielded cable (i.e., coaxial cable) is better for low level signals. Coaxial cable also has lower inductance, but it has higher capacitance: a typical 50 ohm cable has about 90 pF per meter. Consequently, a one-meter direct (1x) coaxial probe loads a circuit with a capacitance of about 110 pF and a resistance of 1 megohm.

These select the horizontal speed of the CRT's spot as it creates the trace; this process is commonly referred to as the sweep. In all but the least-costly modern oscilloscopes, the sweep speed is selectable and calibrated in units of time per major graticule division.

Quite a wide range of sweep speeds is generally provided, from seconds to as fast as picoseconds (in the fastest) per division. Usually, a continuously-variable control (often a knob in front of the calibrated selector knob) offers uncalibrated speeds, typically slower than calibrated. This control provides a range somewhat greater than the calibrated steps, making any speed between the steps available.

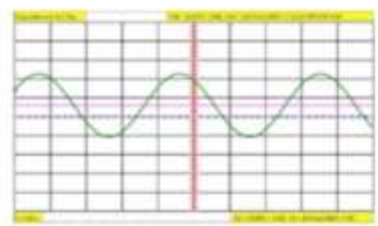
Hold off control

Some higher-end analog oscilloscopes have a hold off control. This sets a time after a trigger during which the sweep circuit cannot be triggered again. It helps provide a stable display of repetitive events in which some triggers would create confusing displays. It is usually set to minimum, because a longer time decreases the number of sweeps per second, resulting in a dimmer trace. See Hold off for a more detailed description.

Vertical sensitivity, coupling, and polarity controls

To accommodate a wide range of input amplitudes, a switch selects calibrated sensitivity of the vertical deflection. Another control, often in front of the calibrated selector knob, offers a continuously variable sensitivity over a limited range from calibrated to less-sensitive settings.

Vertical position control



Computer model of vertical position *y* offset varying in a sine wave

Often the observed signal is offset by a steady component, and only the changes are of interest. An input coupling switch in the "AC" position connects a capacitor in series with the input that blocks low-frequency signals and DC. However, when the signal has a fixed offset of interest, or changes slowly, the user will usually prefer "DC" coupling, which bypasses any such capacitor. Most oscilloscopes offer the DC input option. For convenience, to see where zero volts input currently shows on the screen, many oscilloscopes have a third switch position (usually labeled "GND" for ground) that disconnects the input and grounds it. Often, in this case, the user centers the trace with the vertical position control.

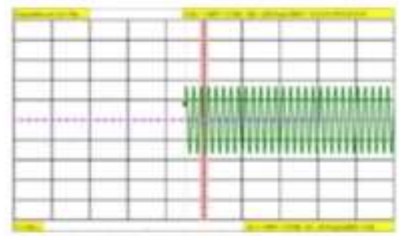
Better oscilloscopes have a polarity selector. Normally, a positive input moves the trace upward; the polarity selector offers an "inverting" option, in which a positive-going signal deflects the trace downward.

The vertical position control moves the whole displayed trace up and down. It is used to set the no-input trace exactly on the center line of the graticule, but also permits offsetting vertically by a limited amount. With direct coupling, adjustment of this control can compensate for a limited DC component of an input.

Horizontal sensitivity control

This control is found only on more elaborate oscilloscopes; it offers adjustable sensitivity for external horizontal inputs. It is only active when the instrument is in X-Y mode, i.e. the internal horizontal sweep is turned off.

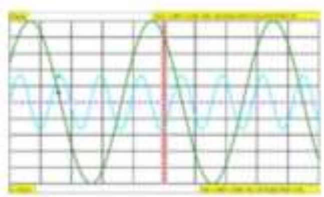
Horizontal position control



Computer model of horizontal position control from *x* offset increasing

Dual-trace controls

Further information: Oscilloscope § Dual and multiple-trace oscilloscopes



Dual-trace controls
green trace = $y = 30\sin(0.1t) + 0.5$
teal trace = $y = 30\sin(0.3t)$

Each input channel usually has its own set of sensitivity, coupling, and position controls, though some four-trace oscilloscopes have only minimal controls for their third and fourth channels.

Dual-trace oscilloscopes have a mode switch to select either channel alone, both channels, or (in some) an

X-Y display, which uses the second channel for X deflection. When both channels are displayed, the type of channel switching can be selected on some oscilloscopes; on others, the type depends upon time base setting. If manually selectable, channel switching can be free-running (asynchronous), or between consecutive sweeps. Some Philips dual-trace analog oscilloscopes had a fast analog multiplier, and provided a display of the product of the input channels.

Multiple-trace oscilloscopes have a switch for each channel to enable or disable display of the channel's trace.

Basic types of sweep

1. **Triggered sweep**

Type 465 Tektronix oscilloscope. This was a popular analog oscilloscope, portable, and is a representative example.

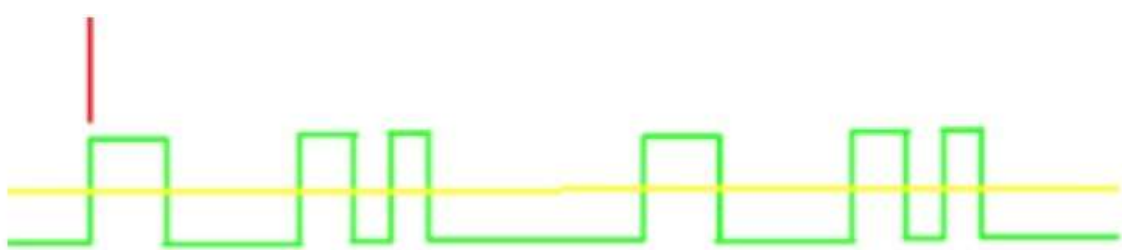
To display events with unchanging or slowly (visibly) changing waveforms, but occurring at times that may not be evenly spaced, modern oscilloscopes have triggered sweeps. Compared to older, simpler oscilloscopes with continuously-running sweep oscillators, triggered-sweep oscilloscopes are markedly more versatile.

Hold off

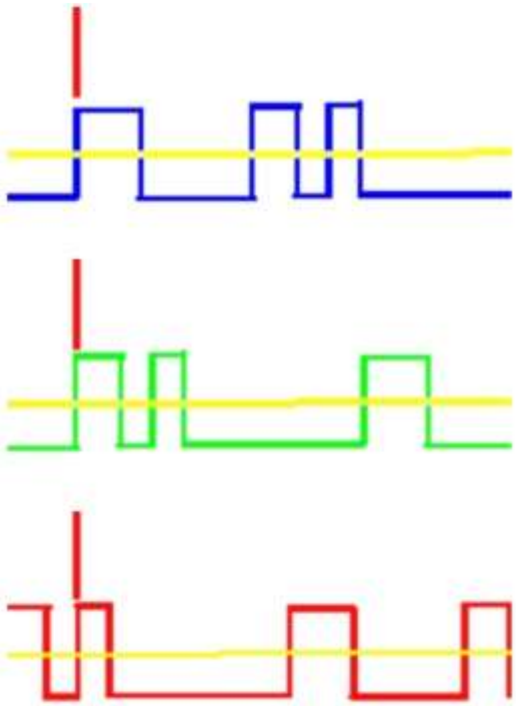
Trigger hold off defines a certain period following a trigger during which the sweep cannot be triggered again. This makes it easier to establish a stable view of a waveform with multiple edges, which would otherwise cause additional triggers.

Example

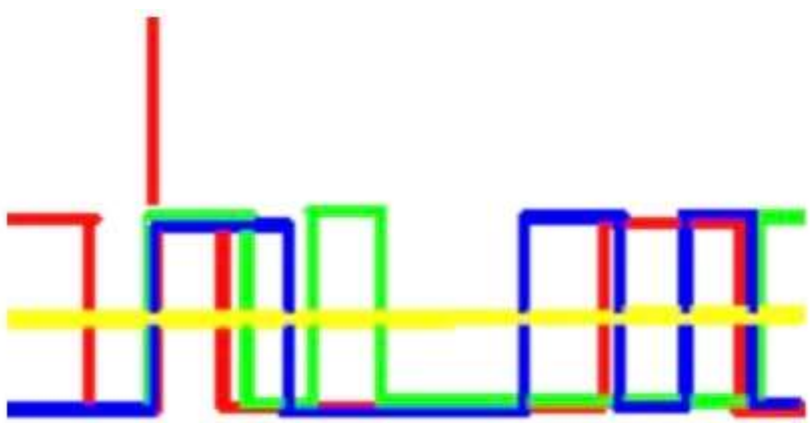
Imagine the following repeating waveform:



The green line is the waveform, the red vertical partial line represents the location of the trigger, and the yellow line represents the trigger level. If the scope was simply set to trigger on every rising edge, this waveform would cause three triggers for each cycle:



Assuming the signal is fairly high frequency, the scope display would probably look something like this:



On an actual scope, each trigger would be the same channel, so all would be the same color.

It is desirable for the scope to trigger on only one edge per cycle, so it is necessary to set the holdoff at slightly less than the period of the waveform. This prevents triggering from occurring more than once per cycle, but still lets it trigger on the first edge of the next cycle.