

IEEE Standard Specification of
**GENERAL-PURPOSE LABORATORY
CATHODE-RAY OSCILLOSCOPES**



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PURPOSE

The purposes of this Standard are 1) to document the minimum information that users of general-purpose laboratory cathode-ray oscilloscopes typically need, 2) to provide potential purchasers and others with a common means for making comparisons between instruments, and 3) to provide uniformity of information from manufacturers.

SCOPE

This Standard applies primarily to general-purpose laboratory cathode-ray oscilloscopes; it does not necessarily apply to specific kinds of oscilloscopes, such as those employing sampling techniques, nor to storage oscilloscopes, spectrum analyzers, television monitors, or other instruments using cathode-ray tube displays. Information for cathode-ray oscilloscopes designed or modified for specific applications and/or environments may require modification of certain listed information or the addition of more information.

SECTION I: INFORMATION TO BE PROVIDED IN A SPECIFICATION

- 1.1. Identification of oscilloscope.
 - 1.1.1. Name and/or type, model number, and manufacturer, where applicable.
 - 1.1.2. Fixed (i.e., rack-mounted), bench, or portable.
 - 1.1.3. Dimensions and weight.
 - 1.1.4. Power requirements.
 - 1.1.5. Operating temperature range.
 - 1.1.6. Special characteristics.
- 1.2. Performance.
 - 1.2.1. Minimum performance characteristics.
 - 1.2.1.1. Bandwidth.
 - 1.2.1.2. Step response.
 - 1.2.1.3. Deflection factors and their accuracy.
 - 1.2.1.4. Vertical linearity.
 - 1.2.1.5. Sweep times and their accuracy.
 - 1.2.1.6. Input resistance-capacitance characteristics.
 - 1.2.2. Additional performance characteristics (if applicable).
 - 1.2.2.1. Calibrator amplitudes and accuracy. Time calibrator accuracy, when applicable.

- 1.2.2.2. Common-mode rejection ratios of differential amplifiers.
- 1.2.2.3. Channel isolation for multichannel units.
- 1.2.2.4. Displayed noise.
- 1.2.2.5. Resolution.
- 1.2.2.6. Others as listed in Section III.

SECTION II: DEFINITIONS OF TERMS

Accelerating Voltage. The cathode-to-viewing-area voltage applied to a cathode-ray tube for the purpose of accelerating the electron beam.

Alternate Display. A means of displaying output signals of two or more channels by switching the channels in sequence.

Amplifier, Difference. See Differential Amplifier.

Amplifier, Differential. See Differential Amplifier.

Amplifier, Horizontal. See Horizontal Amplifier.

Amplifier, Intensity. See Intensity Amplifier.

Amplifier, Vertical. See Vertical Amplifier.

Amplifier, X-Axis. See Horizontal Amplifier.

Amplifier, Y-Axis. See Vertical Amplifier.

Amplifier, Z-Axis. See Z-Axis Amplifier and Intensity Amplifier.

Armed Sweep. See Single-Sweep Mode.

Astigmatism. In the viewing plane of the cathode-ray tube, any deviation of the indicating spot from a circular shape. (See also IEEE Standards Publication 160.)

Attenuator. A device for reducing the amplitude of a signal without deliberately introducing distortion. (See also IEEE Standards Publications 151 and 165.)

Automatic Triggering. A mode of triggering in which one or more of the triggering circuit controls are preset to conditions suitable for automatically displaying repetitive waveforms. The automatic mode may also provide a recurrent trigger or recurrent sweep in the absence of triggering signals.

Axis, Deflection. See Deflection Axes.

Balanced Circuit. A circuit in which two branches are electrically alike and symmetrical with respect to a common reference point, usually ground. For an applied signal difference at the input, the signal relative to the

reference at equivalent points in the two branches must be opposite in polarity and equal in amplitude.

Bandwidth. 1) The difference between the limiting frequencies of a continuous frequency band. 2) Of a device, the difference between the limiting frequencies within which performance with respect to some characteristic falls within specified limits. (IEEE Standards Publication 270.) 3) Of an oscilloscope, the difference between the upper and lower frequency at which the voltage or current response is 0.707 (-3 decibels) of the response at the reference frequency. Usually both upper and lower limit frequencies are specified rather than the difference between them. When only one number appears, it is taken as the upper limit.

Note 1: The reference frequency shall be 20 times the limit frequency for the lower bandwidth limit, and $1/20$ the limit frequency for the upper bandwidth limit. The upper and lower reference frequencies are not required to be the same. In cases where exceptions must be made, they shall be noted.

Note 2: This definition assumes the amplitude response to be essentially free of departures from a smooth rolloff characteristic.

Note 3: If the lower bandwidth limit extends to direct current, the response at direct current shall be equal to the response at the reference frequency, not -3 decibels from it.

(See also IEEE Standards Publications 165 and 188 and ANSI C42.65.)

Beam Finder. A provision for locating the spot when it is not visible.

Beam Locator. See Beam Finder.

Bezel. The flange or cover used for holding an external graticule or cathode-ray tube cover in front of the cathode-ray tube. It may also be used for mounting a trace recording camera or other accessory item.

Blanking. Extinguishing of the spot. Retrace blanking is the extinction of the spot during the retrace portion of the sweep waveform. The term does not necessarily imply blanking during the sweep holdoff interval or while waiting for a trigger in a triggered-sweep system.

Blanking, Chopped. See Chopping Transient Blanking.

Blanking, Transient. See Chopping Transient Blanking.

Brightness. The attribute of visual perception in accordance with which an area appears to emit more or less light. (IEEE Standards Publication 201.) See Luminance. (For a more complete definition see ANSI Z7.1.)

Calibrator. A signal generator whose output is used for purposes of calibration, normally either amplitude or time or both.

Cathode-Ray Oscilloscope. An oscilloscope employing a cathode-ray tube.

Cathode-Ray Tube Display Area. See Graticule Area.

Channel. A single path for transmitting electric signals, usually in distinction from other parallel paths. (See also ANSI C42.65 and IEEE Standards Publications 162, 171, and 270.)

Chopped Blanking. See Chopping Transient Blanking.

Chopped Display. A time-sharing method of displaying output signals of two or more channels with a single cathode-ray tube gun, at a rate that is higher than, and not referenced to, the sweep time/division.

Chopped Frequency. See Chopping Rate.

Chopping Rate. The rate at which channel switching occurs in chopped display operation.

Chopping Transient Blanking. The process of blanking the indicating spot during the switching periods in chopped display operation.

Circuit, Balanced. See Balanced Circuit.

Circuit, Push-Pull. See Balanced Circuit.

Common-Mode Rejection Ratio (CMRR). The ratio of the deflection factor for a common-mode signal to the deflection factor for a differential signal applied to a balanced circuit input.

Common-Mode Signal. The instantaneous algebraic average of two signals applied to a balanced circuit, both signals referred to a common reference.

Common-Mode Signal Maximum. The largest common-mode signal at which the specified common-mode rejection ratio is valid.

Compression. An increase in the deflection factor, usually as the limits of the quality area are exceeded. (See also IEEE Standards Publication 170.)

Deflection Axes (Vertical Deflection Axis, Horizontal Deflection Axis). The vertical trace obtained when there is a vertical deflection signal and no horizontal deflection signal, and the horizontal trace obtained when there is a horizontal deflection signal but no vertical deflection signal.

Deflection Blanking. Blanking by means of a deflection structure, in the cathode-ray tube electron gun which traps the electron beam inside the gun, to extinguish the spot, permitting blanking during retrace and between sweeps regardless of intensity setting.

Deflection Coefficient. See Deflection Factor.

Deflection Factor. The ratio of the input signal amplitude to the resultant displacement of the indicating spot (for example, volts/division). (See also IEEE Standards Publication 160.)

Deflection Polarity. The relation between the polarity of the applied signal and the direction of the resultant displacement of the indicating spot (conventionally a positive going voltage causes upward deflection or deflection from left to right).

Deflection Sensibility. The number of trace widths per volt of input signal that can be simultaneously resolved anywhere within the quality area.

Deflection Sensitivity. The reciprocal of the deflection factor (for example, divisions/volt). (See also IEEE Standards Publication 160 and IEC 50 (07).)

Delay Line. A passive transmission system intended to introduce a time delay. (See also IEEE Standards Publications 162 and 270 and IEC 50 (20).)

Delay Pickoff. A means of providing an output signal when a ramp has reached an amplitude corresponding to a certain length of time (delay interval) since the start of the ramp. The output signal may be in the form of a pulse, a gate, or simply amplification of that part of the ramp following the pickoff time.

Delay, Signal. See Signal Delay.

Delayed Sweep. 1) A sweep that is started after a defined interval of delay following a triggering pulse. 2) A mode of operation of a sweep, as defined above.

Delaying Sweep. A sweep used to delay another sweep. See Delayed Sweep.

Difference Amplifier. See Differential Amplifier.

Difference Signal. See Differential Signal.

Differential Amplifier. An amplifier whose output signal is proportional to the algebraic difference between two input signals. (See also ANSI C42.65.)

Differential Signal. The instantaneous algebraic difference between two signals.

Direct-Current Balance. An adjustment to avoid a change in direct-current level when changing gain.

Direct-Current Drift. See Stability.

Direct-Current Offset. A direct-current level that may be added to the input signal, referred to the input terminals.

Direct-Current Shift. A deviation of the displayed response to an input step, occurring over a period of several seconds after the input has reached its final value.

Display. The visual presentation on the indicating device of an oscilloscope. (See also IEEE Standards Publication 172.)

Drift. See Stability.

Dual-Beam Oscilloscope. An oscilloscope in which the cathode-ray tube produces two separate electron beams that may be individually or jointly controlled. See Multi-beam Oscilloscope.

Dual Trace. A multitrace operation in which a single beam in a cathode-ray tube is shared by two signal channels. See Alternate Display, Chopped Display, and Multitrace.

Expanded Sweep. See Magnified Sweep.

Expansion. A decrease in the deflection factor, usually

as the limits of the quality area are exceeded. (See also IEEE Standards Publication 170.)

External Sweep. A sweep generated external to the instrument.

External Trigger. A triggering signal introduced into the trigger circuit from an external source.

Floating Input. Circuits at the input of a differential deflection amplifier that provide rejection, with minimum distortion, of common-mode signals. Such signals must be defined for limits of amplitude, frequency content, and impedance balance to ground.

Fluorescence. Emission of light from a substance (a phosphor) during excitation by radiant energy.

Focus. Maximum convergence of the electron beam manifested by minimum spot size on the phosphor screen. (Note definition for astigmatism.)

Free-Running Sweep. A sweep that recycles without being triggered and is not synchronized by any applied signal.

Gated Sweep. A sweep controlled by a gate waveform. Also, a sweep that will operate recurrently (free-running, synchronized, or triggered) during the application of a gating signal.

Gaussian Response. A particular frequency response characteristic following the curve $y(f) = e^{-af^2}$. Typically, the frequency response approached by an amplifier having good transient response characteristics.

Geometry. See Pattern Distortion.

Graticule. A scale for measurement of quantities displayed on the cathode-ray tube of an oscilloscope.

Graticule Area. The area enclosed by the continuous outer graticule lines. Unless otherwise stated the graticule area shall be equal to or less than the viewing area. See also Quality Area and Viewing Area.

Guarded Input. A shielded input where the shield is driven by a signal in phase with and equal in amplitude to the input signal.

Holdoff. See Sweep Holdoff Interval.

Horizontal Amplifier. An amplifier for signals intended to produce horizontal deflection.

Incremental Sweep. A sweep that is not a continuous function, but that represents the independent variable in discrete steps. See also Stairstep Sweep.

Information Writing Speed. The oscilloscope-recorder characteristic that is a measure of the maximum number of spots of information per second that can be recorded and identified on a single trace. Test conditions must be specified.

Input Leakage Current. A direct current (of either

polarity) that would flow in a short circuit connecting the input terminals of an amplifier.

Input Resistance-Capacitance Characteristics. The direct-current resistance and parallel capacitance to ground present at the input of an oscilloscope.

Intensity. A term used to designate brightness or luminance of the spot. (For a more complete definition see ANSI Z7.1-1967.)

Intensity Amplifier. An amplifier for signals controlling the intensity of the spot.

Intensity Modulation. The process and/or effect of varying the electron beam current in a cathode-ray tube resulting in varying brightness or luminance of the trace. (See also IEEE Standards Publication 172.)

Internal Graticule. A graticule whose rulings are a permanent part of the inner surface of the cathode-ray tube faceplate.

Internal Triggering. The use of a portion of a deflection signal (usually the vertical deflection signal) as a triggering signal source.

Inverted Input. An input such that the applied polarity causes a deflection polarity opposite from conventional deflection polarity.

Jitter. An aberration of a repetitive display indicating instability of the signal or of the oscilloscope. It may be random or periodic and is usually associated with the time axis. See Stability. (See also IEEE Standards Publications 172 and 204 and ANSI C42.65.)

Leakage Current. See Input Leakage Current.

Line Triggering. Triggering from the power-line frequency.

Lissajous Figure. A special case of an X-Y plot in which the signals applied to both axes are sinusoidal functions. For a stable display the signals must be harmonics. Lissajous figures are useful for determining phase and harmonic relationships.

Lockout. See Sweep Lockout.

Luminance.—The luminance intensity of any surface in a given direction per unit of projected area of the surface as viewed from that direction. (IEEE Standards Publication 201. For a more complete definition see ANSI Z7.1-1967.)

Note: The term "luminance" is recommended for the photometric quantity that has been called brightness. Use of this term permits brightness to be used entirely with reference to sensory response. The photometric quantity has been confused often with the sensation merely because of the use of one name for two distinct ideas. Brightness will continue to be used properly in nonquantitative statements, especially with reference to sensations and perceptions of light.

Magnified Sweep. A sweep whose time per division has been decreased by amplification of the sweep waveform rather than by changing the time constants used to generate it.

Marker Signal. A signal introduced into the presentation for the purpose of identification, measurement, calibration, or comparison.

Maximum Common-Mode Signal. See Common-Mode Signal Maximum.

Minus Input. See Inverted Input.

Mixed Sweep. In a system having both a delaying sweep and a delayed sweep, a means of displaying the delaying sweep to the point of delay pickoff and displaying the delayed sweep beyond that point.

Modulation, Intensity. See Intensity Modulation.

Multibeam Oscilloscope. An oscilloscope in which the cathode-ray tube produces two or more separate electron beams that may be individually or jointly controlled. See Dual-Beam Oscilloscope.

Multitrace. A mode of operation in which a single beam in a cathode-ray tube is shared by two or more signal channels. See Dual Trace, Alternate Display, and Chopped Display.

Noise. Any extraneous electric disturbance tending to interfere with the normal display. (See also IEEE Standards Publication 168 and ANSI C42.65.)

Orthogonality. The deviation from 90 degrees of the angle between the horizontal deflection axis and the vertical deflection axis.

Oscillogram. A record of the display presented by an oscillograph (oscilloscope or mechanical recorder).

Oscillograph. An instrument that graphically plots one or more quantities as a function of another quantity, usually time. (See also IEC 50 (20).)

Note: This includes oscilloscopes and mechanical recorders.

Oscillography. The art and practice of utilizing the oscillograph (oscilloscope or mechanical recorder).

Oscilloscope. An oscillograph primarily intended for the immediate viewing of the graphic plot; most commonly used to denote a cathode-ray oscilloscope. (See also IEC 50 (20).)

Oscilloscope, Cathode-Ray. See Cathode-Ray Oscilloscope.

Overshoot. In the display of a step function (usually of time), that portion of the waveform which, immediately following the step, exceeds its nominal or final amplitude. (See also IEEE Standards Publication 204.)

Pattern Distortion. Any deformation of the pattern from its intended form. (IEC 151-14.) In an oscilloscope the intended form is rectilinear and rectangular. An oscilloscope control that affects pattern distortion may be labeled "pattern" or "geometry."

Persistence. The decaying luminosity of the lumi-