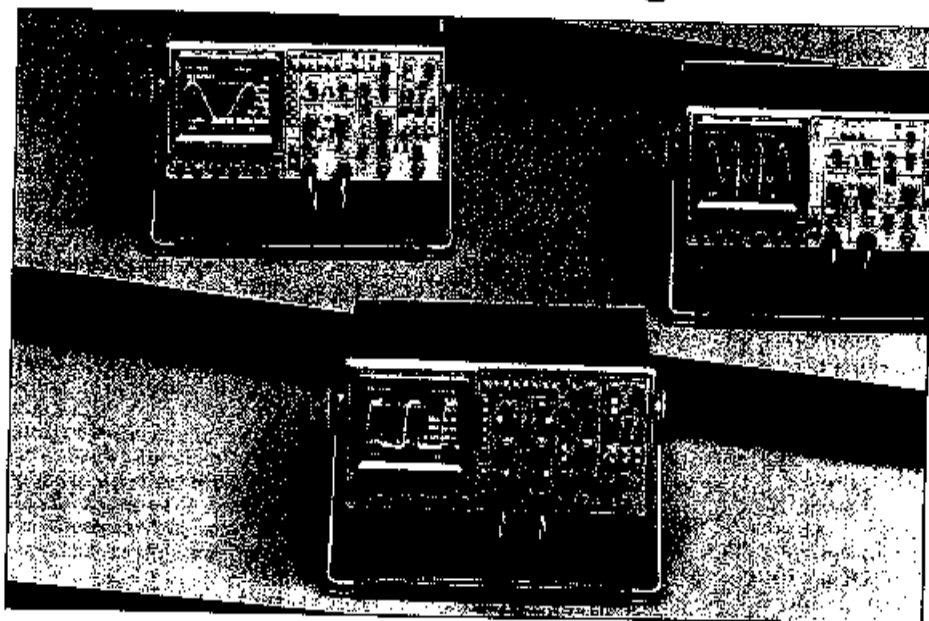


2240 Series Portable Analog Oscilloscopes



NEW 2245A/ 2246A/2247A

TYPICAL APPLICATIONS

- Logic Design and Repair
- Communications
- Power Supply Design
- Manufacturing

BENEFITS

- 3 Year Warranty—5 Year Optional
- UL Listed, CSA Certified
- Measurement Productivity

FEATURES

- 100 MHz Bandwidth, 4 Channels
- Auto Setup
- On-Screen Scale-Factor Readouts
- SmartCursors™ Track Voltmeter Measurements and Trigger Level and Ground (2246A/2247A)
- Time Measurements with Cursors
- Store/Recall of 20 Front-Panel Setups (2246A/2247A)
- Volt, Time, 1/Time Cursors
- Meets or Exceeds MIL-T-28800D for Harsh Environments (2248 Opt 1Y and 2246 Mod A)

- Hands-Off Voltmeter Measurements \pm Peak, Peak to Peak Gated \pm Peak, Gated Peak to Peak, DC (2246A/2247A)
- Automatic Rise/Fall Time Measurements (2247A)
- Automatic Propagation Delay Time Measurements (2247A)
- Integrated Counter Timer (2247A)
- Gated Counter Measurements (2247A)
- Delayed Sweep Cursors (2247A)
- Frequency Ratio Measurements (2247A)
- Operator Error Messages

Higher Performance, Lower Price

The performance/price ratio for portable oscilloscopes has been substantially upgraded. No other portable scope can offer the range of productivity enhancing features and performance characteristics at a comparable low price as that offered by the Tektronix 2245A, 2246A and 2247A.

Features That Promote Productivity

Auto setup of the front panel automatically adjusts vertical, horizontal, triggering and display controls to display the waveform, no matter where they were

previously set. Store and recall 20 battery-backed front panel configurations, which aid in repetitive measurements (2246A and 2247A).

More Triggering Flexibility

Hands-free triggering, made possible by the Auto-Level mode, automatically places a stable display of almost any waveform on screen. The LF, HF, and Noise Reject modes, together with a 10-to-1 holdoff range, deliver stable triggering on complex waveforms. The built-in TV Line and TV Field triggering capability extends measurements to most video-related applications with performance for the broadcast industry.

Performance Plus

The New 2245A, 2246A, and 2247A oscilloscopes have low-noise vertical systems that produce sharp, bright traces. Their 2-ns time base and 100-MHz bandwidth bring out the details on high-speed signals and render measurements with good timing resolution.

Low-level signal measurements are easily managed by the 2 mV/div vertical sensitivity (2 mV bandwidth is 90 MHz) and by trigger sensitivity that extends to 0.35 div at 25 MHz (1.0 div at 150 MHz).

Voltage Measurements With the Push of a Button

A pushbutton-activated measurement system on the 2246A and 2247A enhances productivity even more. This scope quickly turns out virtually hands-off measurements of +peak, -peak, peak-to-peak, dc, and gated volts, all with the convenience of on-screen readout of values.

If more visual indication is desired, the unique cursor system can provide feedback showing exactly where on the waveform an automatic measurement is being made. These feedback cursors, when selected, even show ground and trigger-level locations.

There is also the ability to use cursors manually to make point-to-point time and voltage measurements. This includes time-interval measurements between a point on the reference waveform and a point on any of four other displayed waveforms.

Counter/Timer Productivity

The new 2247A delivers the crystal controlled timing accuracy and extra measurement productivity power you need for digital systems. Frequency, period, and width are measured directly from the scope's vertical inputs. Time intervals can be measured with push-button ease. The 2247A is easily set up to perform gated time measurements; this allows the user to select specific start and stop points for the counter measurement.

Automatic measurements are key in improving measurement productivity. The 2247A can automatically measure rise and fall times (both 10-90% and 20-80%) and propagation delay times. These measurement setups can be saved in the scope's store/recall memory, either to be recalled later or used as part of a sequence. Recalled measurements are then completely automatic and require no operator intervention.

With the Totalize mode, you can record the passing of unusual events or verify a burst of events on any vertical channel. Frequency Ratio can be useful in comparing the frequencies of two input signals.

Cursors after delay are possible on the 2247A, allowing accurate measurements to be made of expanded waveforms.

Coupled with all these advanced measurement capabilities are user aids to further simplify operation, such as; user prompting and providing status and error messages to guide instrument setup.

The 2247A provides high accuracy and resolution measurements. It also provides an external time base input so you can provide your own time base standard to further increase accuracy.

Three-Year Warranty

The 2245A, 2246A, and 2247A are covered by the Tektronix three-year instrument warranty, making ownership more cost effective than ever.

CHARACTERISTICS

Characteristics are common to the 2245A, 2246A and 2247A, except where indicated.

VERTICAL SYSTEM

Display Modes—CH 1, CH 2, CH 3, CH 4, Add (CH 1+CH 2), Invert (CH 2), Alternate and Chopped display switching for all channels, and 20-MHz bandwidth limiting

CHANNEL 1 AND CHANNEL 2

Frequency Response (−3 dB Bandwidth)—100 MHz: 0 to 35°C; 90 MHz: 35 to 50°C (100 MHz 35 to 55°C).^{**}

AC Coupled Lower −3 dB Frequency—10 Hz or less with 1X probe. 1 Hz or less with standard accessory 10X probe.

Rise Time—≤3.5 ns for temperatures from 0 to +35°C. ≤3.9 ns for temperatures from +35 to +50°C (rise times calculated from: $t_r = 0.35/BW$).

Deflection Factor Range—2 mV/div to 5 V/div in a 1-2-5 sequence of 11 steps.

Maximum Error—±2% 15 to 35°C (add ±1% from 0 to 15°C and from 35 to 50°C).

Variable Range—Continuously variable between Volts/Div step settings. Increases step setting by at least 2.5 V/div.

Uncalibrated Indicators—> symbol appears on-screen when deflection factor is between calibrated Volts/Div step settings.

Channel Isolation—50 dB or more attenuation of deselected channel at 10 MHz. 34 dB or more at 100 MHz (measured with an eight div input signal and equal Volts/Div settings on both channels from 2 mV/div to 0.5 V/div).

CH 2 Signal Delay With Respect to CH 1—<200 ps difference (400 ps^{**}).

Input Characteristics—1 MΩ ±1% (2%^{**}) shunted by 20 pF ±0.5 pF (±2 pF^{**}). Maximum Input Voltage: 400 V (dc-peak ac); 600 V ac p-p at 10 kHz or less.

Common-Mode Rejection Ratio (ADD Mode With CH 2 Inverted)—At least 10:1 at 50 MHz. (for common-mode signals of eight div or less and with Var Volts/Div control adjusted for best CMRR at 50 kHz at any Volts/Div setting). (25:1 at 10 MHz; 10:1 at 100 MHz^{**}).

Trace Drift—Between Volts/Div Step Settings: 0.2 div or less. Var Volts/Div Rotated Between Extremes: 1 div or less. Inverting CH 2: 1 div or less. Between Gnd and DC Input Coupling: <0.5 mV from 0 to +35°C; <2 mV from 35 to 50°C.

Position Range—At least ±11 div from graticule center (±10 div^{**}).

CHANNEL 3 AND CHANNEL 4

Frequency Response—Same as CH 1 and CH 2.

Rise Time—Same as CH 1 and CH 2.

Deflection Factor—Settings: 0.1 V/div and 0.5 V/div.

Maximum Error—Same as CH 1 and CH 2.

CH Isolation—34 dB or more attenuation of deselected channel at 100 MHz (measured with an eight div input signal).

CH 4 Signal Delay With Respect to CH 3—<200 ps difference (<400 ps^{**}).

Input Characteristics—1 MΩ ±1% (2%^{**}) shunted by 20 pF ±0.5 pF (±2 pF^{**}). Max Input Voltage: 400 V (dc+peak ac); 800 V p-p ac at 10 kHz or less.

Trace Shift—Between Volts/Div Settings: 1 div or less.

Position Range—Same as CH 1 and CH 2.

^{**} 2246 Option 1Y/2Y (Mod A)

ALL CHANNELS

Low Frequency Linearity—≤0.06 div compression or expansion of a 2 div, center-screen signal when positioned anywhere within the graticule area.

Bandwidth Limit—Reduces upper −3 dB bandpass to a limit of 17 to 23 MHz. (15 to 25 MHz^{**}).

Trace Separation Range—±4 div.
Chop Mode Switching Rate—625 kHz ±10%.
CH 3 or CH 4 Signal Delay With Respect to Either CH 1 or CH 2—<400 ps difference. (800 ps^{**}).

HORIZONTAL SYSTEM

Display Modes—A (main sweep), A Alternate with B (delayed sweep), and B. In X-Y mode, CH 1 provides X-axis (horizontal) deflection.
A Sweep Time Base Range—0.5 s/div to 20 ns/div in a 1-2-5 sequence of 24 steps. X10 magnification extends fastest sweep rate to 2 ns/div.

B Sweep Time Base Range—5 ms/div to 20 ns/div in a 1-2-5 sequence of 21 steps. X10 magnification extends fastest sweep rate to 2 ns/div.

Variable Timing Range—Continuously variable between Sec/Div calibrated step settings. Extends slowest A sweep and B sweep speeds by a factor of a least 2.5 times. Affects the A Sec/Div setting with the A display mode; affects the B Sec/Div setting with the Alt and B modes.

A Sweep Timing Accuracy^{**}

Range	Unmagnified	Magnified
+15 to +35°C	±2%	±3%
0 to +15°C		
+35 to −50°C	±3%	±4%

Linearity—±5% over any two of the center eight div, on both unmagnified and magnified displays (2245A/46A/47A only).

Delay Time—Range: <0.1 div to >10 div of the A sweep. (Maximum value does not exceed end of the A sweep.) Jitter: 1:20,000 p-p (0.005%) (viewed over two seconds).

ΔTime—Range: 0 to >9.9 div to right of the delay time setting (does not exceed end of the A sweep) Accuracy: ±0.5% of reading +1% of one A sweep div (±1% of reading −1% of one A sweep div).^{**}

TRIGGERING

Trigger Sensitivity from CH 1, CH 2, CH 3, CH 4 Source.

DC Coupled—0.25 div or greater triggers from dc to 25 MHz, increasing to 1 div at 150 MHz (100 MHz^{**}).

Noise Reject Coupled—0.8 div or more triggers; 0.5 div or less does not trigger.

HF Reject Coupled—0.25 div or greater triggers from dc to 50 kHz; 0.25 div or less does not trigger above 50 kHz.

LF Reject Coupled—0.35 div or greater triggers from 100 kHz to 25 MHz; 0.85 div or greater does not trigger from dc to 10 kHz.

^{**} Applies over the center eight div. Excludes the first 0.25 div of the magnified sweep and sweep beyond the 100th magnified div.

AC Coupled—0.36 div or greater triggers from 50 Hz and 25 MHz; 0.36 div or less does not trigger from dc to 5 Hz.

For dc, LF Reject, and ac coupling above 25 MHz, triggering signal requirement increases to 1.0 div at 150 MHz (100 MHz^{*1}).

Trigger Sensitivity From TV Line or TV Field Source—0.5 div or more of composite sync achieves stable display.

Lowest Usable Frequency With Auto Level Function—10 Hz.

Level Control Range—±20 div (referenced to the selected source).

Level Readout Accuracy—±(0.3% of reading + 0.1 div).

Variable Holdoff Range—Increases the A sweep holdoff time by at least a factor of 10 (factor of 2^{*1}).

X-Y OPERATION

Deflection Factors—Same as vertical system (Var Volts/Div in calibrated detent).

Maximum Error

Range	Y-Axis	X-Axis
15 to 35°C	±2%	±3%
0 to +15°C		
35 to 50°C	±3%	±4%

X-Axis -9 dB Bandwidth—3 MHz or more.
Phase Difference Between X and Y—≤3° (for dc coupled signals from dc to 50 kHz with bandwidth limit off) (100 kHz^{*1}).

FRONT PANEL DISPLAY

Auto Set Up—Adjusts Vertical, Horizontal, Trigger, and Intensity controls for all displayed channels (2245A/46A/47A only).

Controls—Separate A Intensity, B Intensity, Readout Intensity, Focus, Beam Finder, Trace Rotation, and Scale Illumination.

CRT—8×10 cm internal graticule. Markings: 8 major div vertically and 10 major div horizontally, with auxiliary markings.

Standard Phosphor—GH (P31).

Y-Axis Orthogonality—≤0.1 div over eight verticals div; no adjustment.

FRONT PANEL SETUP MEMORY

(2246A/2247A only)

Lithium Battery—Memory retains ≥3 years.

Memory—20 front panel setups max. Can be configured in multiple sequences.

CURSOR FUNCTIONS

Function	Accuracy
Sec; 1/Sec; Phase;	±0.5%
ΔTime; Δ1/Time; ΔPhase	of reading ±0.02 horizontal div
Volts: Ground Volts (2246A/2247A ^{*1})	±0.5% of reading +0.02 vertical div + HF display errors
Track Measurement, Trig Level, Ground	±0.05 vertical div

^{*1} 2246 Option 1Y, 2Y, and Mod A.

EXTERNAL Z-AXIS INPUT

Active Region Lower Threshold—≤1.8 V.
Signal Required to Blank Sweep-Related L Trace—≥3.8 V; -V decreases sensitivity.

Input Resistance to Ground—10 kΩ ±10%.

Maximum Input Voltage—30 V (dc-peak ac) or ≤30 V ac p-p at 1 kHz.

CALIBRATOR OUTPUT

Voltage Into 1-MΩ Load—0.5 V ±2% (=0.1^{*1}).

Repetition Rate—1 kHz ±10%.

Overshoot—≤0.1%.

POWER REQUIREMENTS

Line Voltage Range—90 to 250 V ac.

Line Frequency—48 to 445 Hz.

Fuse Rating—2 A, 250 V, slow-blow.

Maximum Power Consumption—100 W (155 VA).

ENVIRONMENTAL

Environmental requirements qualify the electrical and mechanical specifications. When not rackmounted, the instrument meets the applicable environmental capabilities of a Type III, Class 3, Style D instrument as prescribed by MIL-T-28800D.

Ambient Temperature—Operating: 0 to +50°C. Nonoperating: -50 to -75°C.

Altitude—Operating: To 4500 m (15,000 ft). Maximum operating temperature decreases 1°C for each 300 m (1,000 ft) above 1500 m (5000 ft). Nonoperating: to 15 250 m (50,000 ft).

Vibration—Operating: 15 minutes along each of three axes, 0.025 inch p-p displacement. 10 to 65 Hz in one minute sweeps. Held for 10 minutes at 55 Hz (4.0 g's at 55 Hz).

Humidity—Operating and Nonoperating: 95%, five cycles (120 hours) referenced to MIL-T-28800D, Paragraph 4.5.5.1.2.2 for Type III, Class 3.

Shock—Operating and Nonoperating: 30 g, half sine, 11-ms duration; three shocks on each face, for a total of 18 shocks, MIL-T-28800D.

Bench Handling Test—4 inch drop per MIL-7-28800-D par 4.5.5.4.3.

Transportation Drop and Vibration—Meets the limits of National Safe Transit Assoc. procedure 14-13-1.

EMC—Meets VDE0871B for radiated and conducted emissions.

IY/Mod A EMC—Improved EMC performance available in Opt IY-Mod A (Refer to Operator's manual).

PHYSICAL CHARACTERISTICS

Dimensions	mm		in.	
Width w/handle	362		14.6	
Height w/feet & pouch	177		7.0	
w/o pouch	164		6.4	
Depth w/front cover	445		17.5	
w/handle extended	521		20.5	
Weight ~		kg		lb
Net w/accessories & pouch	8.9		9.6	
w/o accessories & pouch	7.9		17.4	

^{*2} Cursor position on waveform vs readout displayed value.

NEW 2246A/2247A

With Voltmeter

DC Volts—Accuracy: ±0.3% of reading (+0.02 div). Normal Mode Rejection Ratio: >50 dB at 50 and 60 Hz.

+ Peak and - Peak Volts—Accuracy: ± (2% of reading + 0.1 div) [±(2% of reading + 15% of one vert div + 1.5 mV^{*1})] for signals from 25 Hz to 25 MHz. Gated Region Minimum Width: ≤(0.2 div - 50 ns).

P-P Volts—Accuracy: (±2% of reading - 0.1 div) [±(2% of reading + 15% of one vert div + 1.5 mV^{*1})]. For signals from 25 Hz to 25 MHz. -3dB from 25 to 100 MHz. Gated Region Minimum Width: ≤(0.2 div - 50 ns).

NEW 2247A

With Counter/Timer

Time Base Accuracy—Short-term error: 10 ppm (0.001%). Long-term drift: 2 ppm change per year.

Frequency—Range: 0.01 Hz to 100 MHz. Maximum resolution: 0.00000001 Hz. Maximum accuracy: Up to time base accuracy. Can be gated.^{*2,*3,*4}

Period—Range: 100 s to 10 ns. Maximum resolution: 0.1 fs. Accuracy: Up to time base accuracy. Can be gated.^{*2,*3,*4}

Width—Range: 100 sec to 5 ns. Maximum Resolution: 1 ps. Maximum accuracy: Up to time base accuracy ±2 ns. Can be gated.^{*2,*3,*4}

Totalize—Range: 0 to 999999999 events.

Gated Events—Range: 0.000001 to 999999999.0, averaged^{*4}

Frequency Ratio—Range 0.00000001 to 99999999.

Delta Time—Counter/Timer is used when the horizontal mode is ALT or B. Range: 0 to > ±5 sec. Maximum resolution: 1 ps. Maximum accuracy: Up to time base accuracy ±100 ps.^{*4}

1/Delta Time—Counter/Timer is used when the horizontal mode is ALT or B. Range 0.2 Hz to 10 GHz.^{*3}

Rise/Fall Time—Range: 0 to >5 sec. Maximum Resolution: 1 ps. Accuracy: Up to time base accuracy ±2 ns.^{*4}

Propagation Delay Time—Range: 0 to > ±5 sec. Maximum Resolution: 4 ps. Maximum accuracy: Up to time base accuracy ±100 ps. Selectable set zero reference.^{*4}

External Clock Input—10.1 kΩ, ac coupled. Sensitivity: 1 Vp-p. Max input V: 35 V dc peak ac. Allowable frequencies: 1.0, 5.0, and 10.0 MHz.

^{*1} Ranges, resolutions, and accuracies can be degraded due to gating errors and a smaller number of automatic averages made during a gated frequency, period, or width measurement. For complete formula specifications see operator's manual.

^{*2} For complete accuracy and resolution error formula specifications see operator's manual.