

**2467B**  
**2467BHD**

**2465B**  
**2445B**

# Analog Oscilloscopes

200 MHz to 400 MHz

With compliments  
Helmut Singer Elektronik

*Convenient and  
easy setup and  
measurements.*

## 2445B/2465B

- Four Channels
- Up to 400 MHz Bandwidth
- Up to 500 ps/div Timing Resolution
- Auto Setup
- Automatic Measurements
- Save and Recall Front-panel Setups
- Cursor Measurements
- 1% Timing Accuracy
- 3 Year Warranty

## 2467B

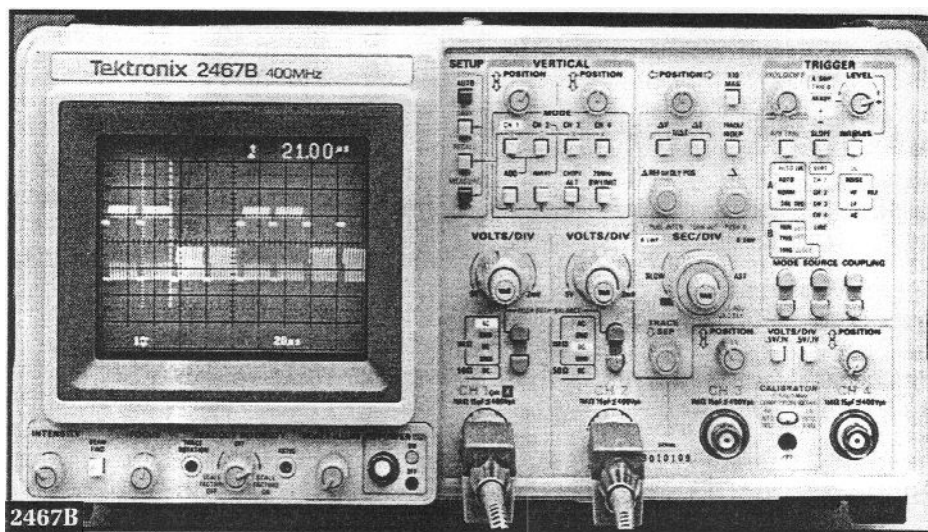
- Includes all the 2465B functionality
- Bright Microchannel Plate Display (MCP)

## 2467BHD

- Includes all of the above 2465B functionality plus a MCP Display
- Opt. 5H Tri-level Sync Triggering for HDTV Video Signals
- Opt. 06 Counter/Timer/Trigger

## APPLICATIONS

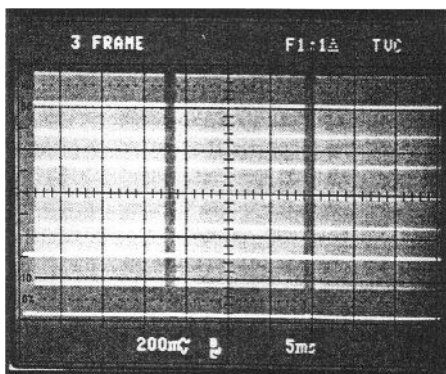
- Troubleshooting (2400B Series)
- Laser and Radar Pulses (2400B Series)
- Video Equipment Design (2467BHD)
- Disk Drive Testing (2467B)
- Advanced Imaging (2467BHD)
- Service (2400B Series)



## Power of Analog

Recognizing that digital and analog scopes have different strengths, Tektronix designs and manufactures both analog and digitizing oscilloscopes so you can choose the right scope for your application and budget.

Although digital scopes feature many attractive capabilities, for a variety of applications analog scopes offer unique benefits that most digitizing scopes can't match.



## Grey Scaling and Persistence

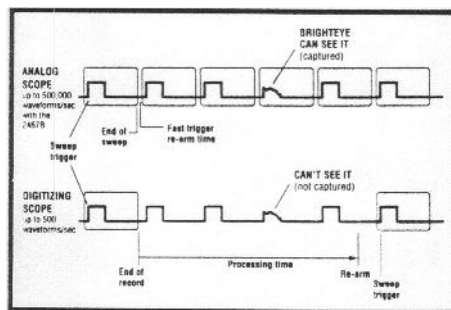
With an analog display, faster signals appear fainter than slower signals. Called grey scaling, this phenomenon gives important clues about relative frequencies when analyzing mixes or overlaid signals like video waveforms.

Or when an event only occurs occasionally in a repetitive signal, the anomaly will fade quicker and look dimmer than the rest of the waveform. This persistence effect reveals critical information when analyzing and debugging complex analog designs, such as switching power supplies.

## Real-Time Display

The display on an analog scope responds instantly to changing signal conditions. Unlike digital scopes that need to acquire and process signal information before displaying, analog scopes simply attenuate or amplify the input signal directly onto the display.

As a result, analog scopes can trigger on many more waveforms per second than a digital scope. For instance, the 2467 BrightEye acquires up to 500,000 waveforms/sec. As a result, an analog scope updates its display so quickly that you literally see waveform behavior as it happens.



To order, contact your  
local sales office (listed  
on pages 536-539).



The 2467B, 2465B, and  
2445B comply with Opt.  
10 with IEEE Standard  
488.1-1987, and with  
Tektronix Standard  
Codes and Formats.

With compliments

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# Analog Oscilloscopes

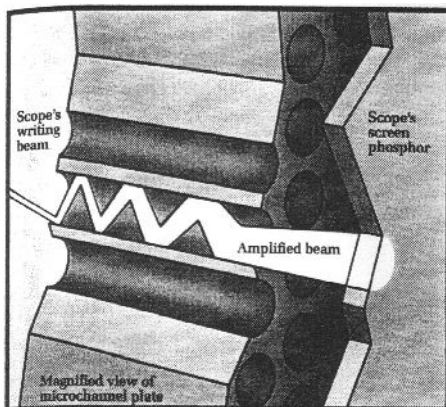
## 200 MHz to 400 MHz

**2467B**  
**2467BHD**

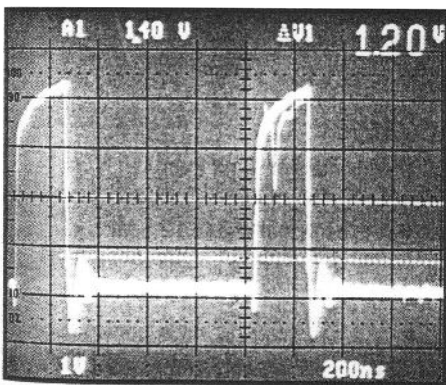
**2465B**  
**2445B**

### BrightEye® Display

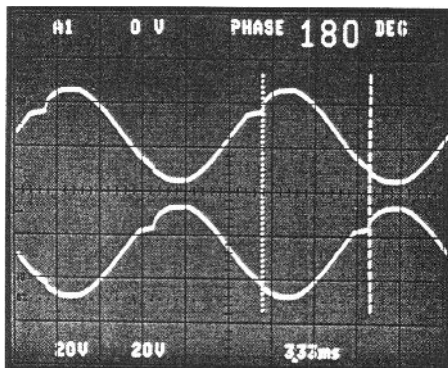
Sometimes grey scaling and persistence create such faint signals, you can have difficulty seeing them on ordinary scopes. In response to this problem, the 2467B BrightEye® includes a revolutionary new display, the microchannel plate (MCP), that can increase the intensity of a dim waveform up to a thousand times.



This MCP technology makes it possible to see a single sweep even at 500 psec/div without a viewing hood. Even those difficult to find logic errors or metastability problems in a repetitive signal environment are easily seen.



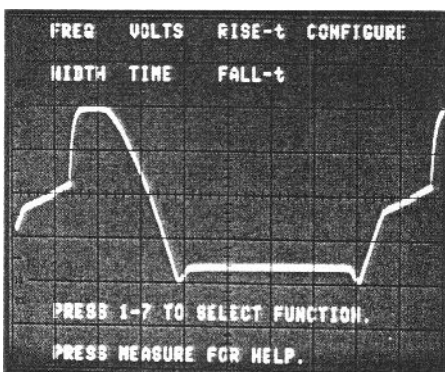
Metastability in this flip-flop occurs only once in a million normal cycles, yet it is clearly visible due to the 2467B's high visible writing speed.



With the delta-time and voltage cursors, you can measure a waveform's parameters including phase.

### Fully Independent Cursors

Fully independent delta-time and voltage cursors with readouts streamline display measurements.



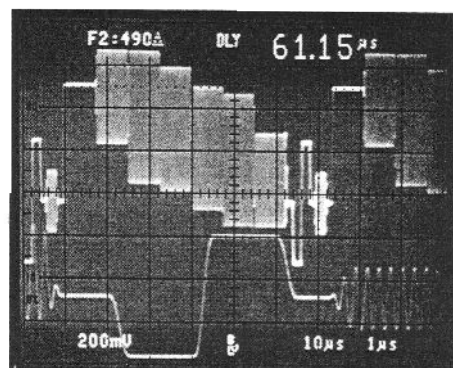
Select from a variety of automatic measurement choices included with all the 2400B series scopes.

### The Simplicity of Automated Control

2400B series automates several key functions so you can easily access the powerful capabilities of these scopes.

### STRAIGHTFORWARD SETUP

To quickly locate and display undefined or complex signals, simply press AUTO SETUP. This function automatically triggers, scales and positions waveforms from any or all of the input channels.



The 2467BHD automatically triggers on tri-level sync pulses used in high-definition video signals. Note: Line Count Readout Displays Field 2 - Line #490.

### ADVANCED TRIGGERING

With a complete selection of trigger modes, the 2400B series scopes can display any signal regardless of its complexity. The auto level function maintains a stable waveform display even as input signals change so you can view variable-voltage signals clearly without irritating jitter.

To noticeably improve the accuracy of timing measurements, press the INIT @50% selection and the scope will maintain the trigger level at the input signal's 50% voltage level.

Choose AC or DC coupling and reject high or low frequencies or noise to clarify the waveform display.

### HDTV Analysis Made Easy

Built on the 2467B BrightEye platform, the 2467BHD applies the power of MCP technology to the acquisition of high-definition video signals.

The 400 MHz 2467BHD can automatically recognize tri-level sync pulses on any of the proposed HDTV standards, including 1250/50, 1125/60 and 1050/60 formats.

This scope, by including option 5H, clearly displays high-definition video signals with an unequalled frequency response flatness rating of  $\pm 2\%$  over the first 30 MHz. To display signals even more clearly, you can significantly attenuate noise or clock frequency interference with the 50 MHz bandwidth limit selection.

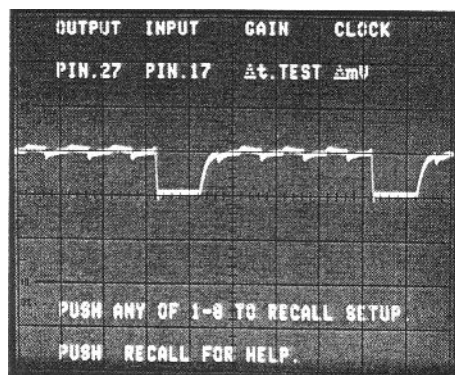
A built-in counter/timer/trigger (Option 06) will help you make vital timing measurements as accurately as possible. And with its 500 ps/div sweep rate, the 2467BHD will capture and display a high-definition signal's fastest transients.

*Continued on next page.*

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# Analog Oscilloscopes

200 MHz to 400 MHz



Create measurement sequences using the front panel controls for semi-automated testing.

## Streamlined Front-Panel Setups

Just press SAVE SETUP to save a front-panel setup instead of recreating it again and again. The scope instantly stores all front panel information, including intensity, cursor locations and control settings. And you label each setup with a descriptive name.

The 2400B series scopes will retain up to 30 front-panel setups in non-volatile memory until you decide to replace or delete them.

## Easy Automation

With built-in sequencing, you can develop a custom test series without writing a line of code. First save and label a series of front-panel setup, each representing a step in the test procedure. Then link the steps in any order you want.

To execute your custom test series, press STEP to sequence through the individual steps. This is extremely useful for manufacturing evaluation and device characterization. You'll appreciate the ease and efficiency of the 2400B series automatic sequencing.

## 2400B Series Options

The following options are not retrofittable on standard products after purchase.

### VIDEO WAVEFORM MEASUREMENT SYSTEM (OPTION 05)

Tailors the 2445B, 2465B and 2467B for applications involving broadcast and cable television, graphics displays and raster-scan systems. It enables CRT readout of the line number of field selected for triggering, so the operator knows exactly what the display represents.

**Sync Separation:** Stable sync separation from sync-positive or sync-negative composite video on systems with 525 to 1280 lines, 50 Hz or 60 Hz, interlaced or noninterlaced.

**Trigger Modes:** Lines, FLD 1, FLD 2, ALT (FLD 1/FLD 2).

**Back Porch Clamp:** Within 1.0 div of the ground reference.

### HIGH-DEFINITION TELEVISION (OPTION 5H)

Only available with the 2467B scope and standard in the 2467BHD, this option lets you trigger on tri-level sync pulses, automatically senses the HDTV standard being used and autoselects itself accordingly.

**Stable Sync Separation:** From tri-level and bi-level sync-positive or sync-negative composite or component video on systems with 525 to 1280 lines per frame, 50 Hz or 60 Hz field rate, interlaced or non interlaced.

**HD Video Triggering Modes:** Lines, FLD 1, FLD 2, ALT (FLD 1/FLD 2), and the Active Video Mode.

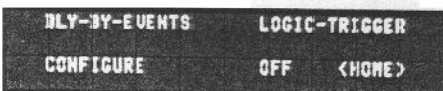
**Standard TV Presets:** Lines, fields, frames, line select, active video, horizontal blanking, vertical blanking, pixel and TSG triggering.

**Bandwidth Limiter:** Reduces the upper -3 dB to 50 MHz.

**Frequency Response (-3 dB 400 MHz) Flatness:**  $\pm 1\%$  for 50 kHz to 100 MHz,  $\pm 1\%$ -2% for 10 MHz to 20 MHz,  $\pm 2\%$  for 20 MHz to 30 MHz.

### Counter/Timer/Trigger (CTT) (Option 06) And CTT/Word Recognizer (Option 09)

These options feature a crystal-controlled time-base with 0.001% accuracy. Option 09 adds a word recognizer. Useful when probing TTL-compatible logic families, this 17-bit word recognizer is operable up to 20 MHz with an external clock and up to 10 MHz with the internal clock.



These options also feature a 7-digit CRT readout display for Frequency (0.5 Hz to 150 MHz), Period (6.66667 ns to 2 s), Totalize (to 9,999,999) and Delay by Events triggering (up to 4,194,303).

### GPIO Interface (Option 10)

Functions implemented include SH1, AH1, T6, L3, SR1, RL1, CD1, E1, DT0, C0 and PP0.

## Characteristics

For more detailed specifications, contact any Tektronix Sales Office or authorized Tektronix distributor near you.

### VERTICAL SYSTEM

**Deflection Factor:** 2 mV/div to 5 V/div, continuously variable between V/div settings (CH 1 and CH 2). 100 mV/div and 500 mV/div (CH 3 and CH 4).

**Deflection Factor Basic Accuracy:**  $\pm 2\%$ , measured at any V/div with a 4- or 5-div signal, centered on screen (CH 1 and CH 2),  $\pm 10\%$  (CH 3 and CH 4) between 15°C and 35°C.

**Frequency and Step Tr Response**  
(-3 dB Bandwidth)/(Tr = 0.35/BW)

Instrument	BW/Rise Time
2445B	200 MHz/1.75 ns
2465B/2467B/2467BHD	400 MHz/0.875 ns ( $\geq 5$ mV/div), and 350 MHz/1 ns (2 mV/div)

Measured with a standard accessory probe or internal 50  $\Omega$  termination.

**Bandwidth Limiter:** Reduces upper -3 dB to 20 MHz for 2445B, 2465B and 2467B. Reduces upper -3 dB to 50 MHz for 2467BHD.

**Input Coupling and Max Voltage:** (1 M $\Omega$ ) AC, DC, GND; Max input voltage: 400 V (DC + peak AC). (50  $\Omega$ ) Max input voltage: 5 V RMS average for 1 sec,  $\pm 50$  V peak.

**Input R and C:** 1 M $\Omega$   $\pm 5\%$  and 15 pF  $\pm 2$  pF or 50  $\Omega$  (nominal).

**Channel Isolation:**  $\geq 100:1$  at 100 MHz,  $\geq 50:1$  at nominal bandwidth (CH 1, CH 2),  $\geq 50:1$  at 100 MHz (CH 3, CH 4).

**AC-Coupled Lower -3 dB Point:** 10 Hz or less, 1 Hz or less with standard accessory probe.

**Chop Mode Switching Rate:** 2.5 MHz  $\pm 0.2\%$  (20  $\mu$ s/div to 2  $\mu$ s/div). 1 MHz  $\pm 0.2\%$  for all other sweep speeds.

### A Sweep Timing Accuracy

For 100 ms/div and faster settings,  $+15^\circ\text{C}$  to  $+35^\circ\text{C}$ , X10 magnification not enabled.

Method	Accuracy
A Sweep	$\pm(0.7\%$ of time interval +0.6% of full scale)
$\Delta T$ using cursors	$\pm(0.5\%$ of time interval +0.3% of full scale)
$\Delta T$ using delay	$\pm(0.3\%$ of time interval sweep +0.1% of full scale +200 ps)
Delay from A trig to B sweep	$\pm(0.3\%$ of time interval +0.6% of full scale +0 to -25 ns)

# Analog Oscilloscopes

## 200 MHz to 400 MHz

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### HORIZONTAL SYSTEM

**Display Modes:** A (main sweep), A INTENSified, ALTERNate, A INTEN with B (delayed sweep) and B. In X-Y mode, CH 1 provides X-axis (horizontal) deflection.

**A Sweep Time Base Range:** 2445B: 500 ms/div to 10 ns/div (to 1 ns/div with X10 magnification). 2465B/2467B/2467BHD: 500 ms/div to 5 ns/div (to 500 ps/div with X10 magnification).

**B Sweep Time Base Range:** 2445B: 50 ms/div to 10 ns/div (to 1 ns/div with X10 magnification).

**2465B/2467B/2467BHD:** 50 ms/div to 5 ns/div (to 500 ps/div with X10 magnification).

**Variable Timing Control:** Continuously variable and calibrated (add 2% of time interval timing accuracy) between SEC/DIV settings. Extends slowest A Sweep to 1.5 s/div. Change the A sweep's sec/div setting with the A display mode selected. Change the B sweep's sec/div with INTEN, ALT and B Modes selected. When VAR control is out of detent, the  $\Delta T$  cursors measure RATIO (with 5 divisions being 100%) and  $1/\Delta T$  cursors measure PHASE (five divisions being 360°).

**Displayed CH 2 Signal Delay with Respect to CH 1:** Adjustable  $\pm 500$  ps.

**Delay Jitter:** Within 0.004% (one part or less in 25,000) of maximum available delay plus 50 ps (2445B/2465B). Within 0.01% (one part or less in 10,000) of maximum available delay plus 100 ps (2467B/2467BHD).

### ACCURACY SPECIFICATIONS FOR AUTOMATIC MEASUREMENTS

(Excluding 2467BHD counter measurements—see Opt. 06 for specs.)

For +15°C to +35°C, specifications are based on noise less than 0.1% of a peak-to-peak input waveform.

**Period:** 0.5% + 500 ps + jitter error.

**Volts:** 5% + 5 mV + (0.5 mV times probe attenuation) + signal aberrations + 1 LSD to 1 MHz (minimum width at peak amplitude  $\leq 10$  ns).

**Rise time, Fall time:** 5% + 3 ns (for transition times greater than 5 ns). These rise and fall times are based on measurements of 20% to 80%, extrapolated to 10% and 90% (pulse overshoot and pulse undershoot less than 5% of peak-to-peak signal).

**Time A-B (from % to %):** 0.5% + 3 ns (+ 0.5 ns if measuring from CH 1 to CH 2) + 5% of start event + 5% of stop event transition times.

**Time A-B (between two voltages):** 0.9% + 3 ns (+ 0.5 ns if measuring from CH 1 to CH 2) + 5% of start event + 5% of stop event transition.

**Pulse Width:** 0.9% + 1 ns + jitter error + 2X offset error (transition times less than 10% of measured interval).

### TRIGGERING

**A and B Trigger Coupling:** DC, Noise Reject, HF Reject, LF Reject, AC.

**Trigger Level Range:**  $\pm 18$  times V/div setting for CH 1 and CH 2.  $\pm 9$  times V/div setting for CH 3 and CH 4.

**Trigger Sensitivity to 50 MHz from CH 1 or CH 2:** 0.35 div DC coupled;  $\leq 1.2$  div noise reject coupled; 0.5 div from DC to 30 kHz HF reject coupled; 0.5 divs from 80 kHz LF reject coupled; 0.35 divs from 60 Hz AC coupled.

For above 50 MHz, DC, LF reject and AC coupling, the triggering signal requirement increases to 1.5 divs at 500 MHz (2465B/2467B/2467BHD) and at 250 MHz (2445B).

For noise reject coupling above 50 MHz, the triggering signal requirement increases to 4.5 divs at 500 MHz (2465B/2467B/2467BHD) and at 250 MHz (2445B).

**Triggering Sensitivity from CH 3 or CH 4:** One half the CH 1 or CH 2 requirements.

**LEVEL Control Range:**  $\pm 18$  times the V/div setting for CH 1 or CH 2;  $\pm 9$  times the V/div setting for CH 3 or CH 4.

**LEVEL Readout Basic Accuracy:**  $\pm 3\%$  of setting + 3% of p-p signal + 0.2 div + 0.5 mV + (0.5 mV times probe attenuation factor)] for CH 1 or CH 2;  $\pm 3\%$  of setting + 4% of p-p signal + 0.1 div + (0.5 mV times probe attenuation factor)] for CH 1 or CH 2.

Basic accuracies apply from +15°C to +35°C and are measured with triggering signals having transition times greater than 20 ns with 1 M $\Omega$  input, DC trigger coupling.

### X-Y OPERATION

**X-Axis Deflection Factor Range, Variable Range, and Accuracy:** Same as CH 1.

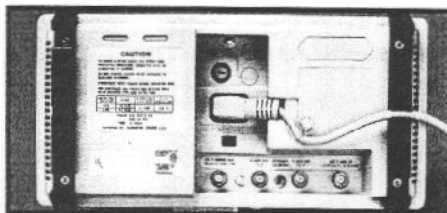
**X-Axis Bandwidth:** DC to 3 MHz.

**Phase Difference Between X and Y:**  $\leq 1^\circ$  from DC to 1 MHz.  $\leq 3^\circ$  from 1 MHz to 2 MHz.

### OTHER SIGNAL INPUTS AND OUTPUTS

**Inputs include:** Z-axis and AUTO/SETUP control.

**Outputs include:** CH 2 Signal Out, A Gate Out, B Gate Out and Calibrator/Probe Compensation output.



### DISPLAY

**Graticule Size:** 2445B/2465B: 80 mm x 100 mm 2467B/2467BHD: 68 mm x 85 mm.

**Standard Phosphor:** GH(P31).

**Cursors:**  $\Delta$ Volts,  $\Delta$ Time,  $1/\Delta$ Time, Ratio, Phase, and %.

### POWER REQUIREMENTS

**Line-Voltage Ranges:** 115 V: 90 to 132 VAC. 230 V: 180 to 250 AC.

**Line Frequency:** 48 to 440 Hz.

**Maximum Power Consumption:** 120 W (180 VA) for a fully optioned instrument.

### ENVIRONMENTAL AND SAFETY

The 2400B scopes meet the environmental conditions described in MIL-T-28800D for Type III, Class 3, Style D equipment as specified below. Other environmental specifications are available.

**Temperature:** -15°C to +55°C (operating); -62°C to +85°C (non-operating).

**Humidity:** Operating and non-operating, up to 95% RH at or below +40°C; to 75% RH from +41° to +50°C.

**Altitude:** 15,000 ft (op); 50,000 ft (non-op).

**Safety:** UL 1244 Listed, CSA 556B certified.

### PHYSICAL CHARACTERISTICS

	2445B/ 2465B	2467B/ 2467BHD	Rackmount <sup>1</sup>
<b>Dimensions</b>	<b>mm/in.</b>	<b>mm/in.</b>	<b>mm/in.</b>
Width w/handle	338/13.3	338/13.3	483/19.0
Height with feet & pouch	190/7.5	190/7.5	178/7.0
w/o pouch	160/6.3	160/6.3	
Depth with front cover	434/17.1	472/18.6	419/16.5
Handle extended	508/20.0	533/21.0	
<b>Weight</b>	<b>kg/lb</b>	<b>kg/lb</b>	<b>kg/lb</b>
Net with accessories and pouch	10.2/22.5	10.9/24.0	4.0/8.8
w/o accessories & pouch	9.3/20.5	9.7/21.3	
Domestic Shipping	12.8/28.2	14.6/32.1	6.3/13.8

<sup>1</sup>Weight of conversion kit only. Rear support kit weight is an additional 6.3 kg/13.8 lb.

Continued on next page.

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**2467BHD**

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# Analog Oscilloscopes

## 200 MHz to 400 MHz

### ORDERING INFORMATION

#### 2467B

400 MHz Oscilloscope with Microchannel Plate Display.

**Includes:** Four P6137 10x Probes with Accessories fuse (159-0021-00); Banana Plug/Binding Post Adapter (134-0016-01); Snap Accessory Pouch (016-0692-01); Operators Manual (070-6861-01); Front cover (200-3199-01).

#### 2465B

400 MHz Oscilloscope

#### 2445B

200 MHz Oscilloscope **Both include:** Two P6137 10x Probes with Accessories

Fuse (159-0021-00); Banana Plug/Binding Post Adapter (134-0016-01); Snap Accessory Pouch (016-0692-01); Operators Manual (070-6860-00); CRT Filter/Clear (378-0208-00); Front Cover (200-3199-01); Power Cord (161-0104-00).

#### 2467BHD (Special Configuration for Video)

400 MHz HDTV Oscilloscope

**Includes:** same as 2467B plus: CCIR Graticule Filter (378-0270-01); NTSC Graticule Filter (378-0270-02); Polarized Viewing Hood (016-0180-00); Three 75  $\Omega$  Terminators (011-0055-00).

**Instrument Options are not retrofittable after purchase.**

**Opt. 05** – Video Waveform Measurement System for bi-level sync formats.

**Opt. 5H** – High-Definition Television (2467B only). Available also as the 2467BHD oscilloscope.

**Opt. 06** – Counter/Timer/Trigger.

**Opt. 09** – Counter/Timer/Trigger with Word Recognizer.

**Opt. 10** – IEEE-488 GPIB Interface.

**Opt. 11** – Rear panel probe power. For P6201 and P6202A. (Cannot be ordered with Opt. 09).

**Opt. B1** – Service Manual for standard 2465B and 2467B (070-6863-00) and for standard 2445B (070-6862-00).

**Opt. B2** – Service Manual for any of the above options, including the 2467BHD (070-6864-00).

**Opt. 1R** – Instrument configured for rackmount. Includes slideout assemblies.

**Opt. 1T** – Transit Case (202-0302-00) with telescoping handle and retractable wheels.

**Opt. 22** – Two additional matching probes (P6137). (standard with 2467B and 2467BHD).

#### INTERNATIONAL POWER PLUG OPTIONS

**Opt. A1** – Universal Euro, 220 V, 50 Hz.

**Opt. A2** – United Kingdom, 240 V, 50 Hz.

**Opt. A3** – Australian, 240 V, 50 Hz.

**Opt. A4** – North American, 240 V, 60 Hz.

**Opt. A5** – Swiss, 220 V, 50 Hz.

See General Customer Information Section for additional description.

#### WARRANTY-PLUS SERVICE OPTIONS

**Opt. M2** – Repair Protection

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**Opt. M8** – Calibration Service

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#### SOFTWARE

Additional information in the Software section.

**EZ-TEST PC Test Development Software** – Requires GPIB-equipped instruments; used with Tektronix 2402A or IBM PC/XT/AT and compatibles (computer must also have GPIB). Order S45F030.

#### PROBES

See Page 423 for complete Probe selection.

#### Passive (1 M $\Omega$ ) –

10X, 400 MHz, compact tip. Order P6137.

**Active** – 1X, 10X, 100X FET Probe, 900 MHz. Order P6201.

**Low Impedance (50  $\Omega$ )** – 10X Low Impedance, 3.5 GHz, 1X, 20X, 100X. Order P6156 Opt. 28.

**Current** – 50A MHz, 20A (DC + pk AC). Order AM 503S.

15 MHz, 100A (DC + pk AC) Order AM 503S Opt. 03.

15A (p-p). Order P6021.

6A (p-p). Order P6022.

**High Voltage** – 120 MHz, 1500 V pk. Order P6009.

75 MHz, 40 kV pk. Order P6015A Opt. 1R.

**Differential** – Order P6046.

**Digital Timing Demodulator** – Order TVC501.

#### CARTS

**Portable Instrument** – Order K212.

**with Plotter Shelf** – Order K212 Opt. 22.

#### CAMERAS

**High Performance** – Order C-9.

**Digitizing** – Order DCS01 Opt. 2A.

#### ADDITIONAL ACCESSORIES

**Optical to Electrical Converters** – 450-1050 nanometers, 700 MHz (requires 1103 Probe Power Supply). Order P6701A.

450-1050 nanometers, 250 MHz, High Gain, (requires 1103 Probe Power Supply). Order P6711.

1000-1700 nanometers, 500 MHz (requires 1103 Probe Power Supply). Order P6703A.

1100-1700 nanometers, 300 MHz, High Gain, (requires 1103 Probe Power Supply). Order P6713.

**Power Supply** – For up to two optical probes. Order 1103.

**Isolator** – Two independently-isolated channels, 20 MHz, 3000 VAC. Order A6902B Opt. 02.

**Ground Isolation Monitor** – Order A6901.

**SMT Interconnects** – SMT KlipChip™ for surface-mount devices (requires 013-0202-02). Order SMGK52.

SOIC Engineering Kit Small Outline Integrated Circuits (8, 14, 16, 20, 24 pins). Order SMCK1.

PLCC Engineering Kit Plastic Leader Chip Carriers (20, 28, 44, 52, 68, 84 pins). Order SMQK1.

**Carrying Cases** – Telescoping handle, retractable wheels. Order 202-0302-00.

**Carrying Strap** – Over-the-shoulder. Order 346-0119-00.

**Rackmount Conversion Kit** – Order 016-0825-01.

**Cables** – GPIB, Double Shield Low EMI.

(1 m) – Order 012-0991-01.

(2 m) – Order 012-0991-00.

(3 m) – Order 012-0991-02.

**Viewing Hood** – Collapsible Polaroid. Order 016-0180-00.

**Manuals** – Service

(2465B, 2467B, 2467BHD). Order 070-6863-00.

(2445B). Order 070-6864-00.

(Scope Opt.). Order 070-6864-00.

To order, contact your local sales office (listed on pages 536-539).



Table 6-2  
Option 01 (DMM) Electrical Characteristics

Characteristics	Performance Requirements
DC VOLTS	
Accuracies by Range	
+18°C to +28°C	
200 mV to 200 V	$\pm(0.03\% \text{ of reading} + 0.01\% \text{ of full scale})$ .
500 V	$\pm(0.3\% \text{ of reading} + 0.04\% \text{ of full scale})$ .
-15°C to +18°C and +28°C to +55°C	
200 mV to 200 V	Add $\pm(0.003\% \text{ of reading} + 0.001\% \text{ of full scale})/^{\circ}\text{C}$ below 18°C or above 28°C.
500 V	Add $\pm(0.003\% \text{ of reading} + 0.004\% \text{ of full scale})/^{\circ}\text{C}$ below 18°C or above 28°C.
Common Mode Rejection Ratio	>100 dB at dc: >80 dB at 50 and 60 Hz, with 1 k $\Omega$ imbalance.
Normal Mode Rejection Ratio	>60 dB at 50 and 60 Hz.
Resolution	1 part in 20,000 of full scale except 0.1 V on 500 V range.
Step Response Time	
Manual Range	Less than 1 second.
Auto Range	Less than 2 seconds.
Input Resistance	
200 mV and 2 V Ranges	>1 G $\Omega$ or 10 M $\Omega$ , $\pm 1\%$ .
20 V to 500 V Ranges	10 M $\Omega$ $\pm 1\%$ .
Input Bias Current at 23°C Ambient Temperature	Less than 10 pA.
Reading Rate	Approximately 3 per second.

With compliments

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Table 6-2 (cont)

Characteristics	Performance Requirements
<b>AC VOLTS</b>	
Accuracies by Range	Crest Factor $\leq 4$ .
+18°C to +28°C	
200 mV to 200 V	Input signal between 5% and 100% of full scale.
40 Hz to 10 kHz	$\pm(0.6\% \text{ of reading} + 0.1\% \text{ of full scale})$ .
20 Hz to 40 Hz and 10 kHz to 20 kHz	$\pm(1\% \text{ of reading} + 0.1\% \text{ of full scale})$ .
20 kHz to 100 kHz	$\pm(5\% \text{ of reading} + 0.1\% \text{ of full scale})$ .
500 V	Input signal between 100 V and 500 V.
40 Hz to 10 kHz	$\pm(0.6\% \text{ of reading} + 0.2\% \text{ of full scale})$ .
20 Hz to 40 Hz and 10 kHz to 20 kHz	$\pm(1\% \text{ of reading} + 0.2\% \text{ of full scale})$ .
20 kHz to 100 kHz	$\pm(5\% \text{ of reading} + 0.2\% \text{ of full scale})$ .
-15°C to +18°C and +28°C to +55°C	
200 mV to 200 V	Input signal between 5% and 100% of full scale.
40 Hz to 10 kHz	$\pm(0.8\% \text{ of reading} + 0.1\% \text{ of full scale})$ .
20 Hz to 40 Hz and 10 kHz to 20 kHz	$\pm(1.3\% \text{ of reading} + 0.1\% \text{ of full scale})$ .
20 kHz to 10 kHz	$\pm(6\% \text{ of reading} + 0.1\% \text{ of full scale})$ .
500 V	Input signal greater than 100 V and less than 500 V.
40 Hz to 10 kHz	$\pm(0.8\% \text{ of reading} + 0.3\% \text{ of full scale})$ .
20 Hz to 40 Hz and 10 kHz to 20 kHz	$\pm(1.3\% \text{ of reading} + 0.3\% \text{ of full scale})$ .
20 kHz to 100 kHz	$\pm(6\% \text{ of reading} + 0.3\% \text{ of full scale})$ .
Common Mode Rejection Ratio	$>60$ dB from dc to 60 Hz, with 1 k $\Omega$ imbalance.
Resolution	1 part in 20,000 of full scale except 0.1 V on 500 V range.

Table 6-2 (cont)

Characteristics	Performance Requirements
<b>AC VOLTS (cont)</b>	
Response Time	
Manual Range	Less than 2 seconds.
Auto Range	Less than 3 seconds.
Input Impedance	1 M $\Omega$ $\pm$ 1% in parallel with less than 100 pF.
dBV, dBm	
Accuracy	dB readings are calculated from AC VOLTS measurements.
Resolution	0.01 dB.
<b>HI OHMS</b>	
Accuracies by Range	
+18°C to +28°C	
2 k $\Omega$ to 2 M $\Omega$	$\pm$ (0.1% of reading + 0.01% of full scale).
20 M $\Omega$	$\pm$ (0.5% of reading + 0.01% of full scale).
-15°C to +18°C and +28°C to +55°C	
2 k $\Omega$ to 200 k $\Omega$	Add $\pm$ (0.01% of reading + 0.001% of full scale)/°C above 28°C or below 18°C.
2 M $\Omega$	Add $\pm$ (0.01% of reading + 0.001% of full scale)/°C above 28°C or below 18°C $\pm$ 2% of reading per 10% relative humidity above 70% relative humidity.
20 M $\Omega$	Add $\pm$ (0.05% of reading + 0.001% of full scale)/°C above 28°C or below 18°C $\pm$ 2% of reading per 10% relative humidity above 70% relative humidity.
Voltage at Full Scale	Approximately 2 V.
Maximum Open Circuit Voltage	Less than 6 V.
Resolution	One part in 20,000 of full scale.

## Performance Characteristics

Table 6-2 (cont)

Characteristics	Performance Requirements
HI OHMS (cont)	
Measuring Current by Range	
2 k $\Omega$	Approximately 1 mA.
20 k $\Omega$	Approximately 0.1 mA.
200 k $\Omega$	Approximately 10 $\mu$ A.
2 M $\Omega$	Approximately 1 $\mu$ A.
20 M $\Omega$	Approximately 0.1 $\mu$ A.
Response Time	
2 k $\Omega$ to 2 M $\Omega$	
Manual Range	Less than 1 second.
Auto Range	Less than 2 seconds.
20 M $\Omega$ Range	Less than 5 seconds.
Reading Rate by Range	
2 k $\Omega$ to 2 M $\Omega$	Approximately 3 per second.
20 M $\Omega$	Approximately 1.5 per second.

Table 6-2 (cont)

Characteristics	Performance Requirements
LO OHMS	
Accuracies by Range	
+18°C to +28°C	
200 $\Omega$	$\pm(0.1\%$ of reading $\pm 0.1\%$ of full scale).
2 k $\Omega$ to 200 k $\Omega$	$\pm(0.1\%$ of reading $\pm 0.01\%$ of full scale).
- 2 M $\Omega$	$\pm(0.25\%$ of reading $\pm 0.01\%$ of full scale).
-15°C to +18°C and +28°C to +55°C	
200 $\Omega$ to 20 k $\Omega$	Add $\pm(0.01\%$ of reading $\pm 0.001\%$ of full scale)/°C above 28°C or below 18°C.
200 k $\Omega$	Add $\pm(0.01\%$ of reading $\pm 0.001\%$ of full scale)/°C above 28°C or below 18°C $\pm 2\%$ of reading per 10% relative humidity above 70% relative humidity.
2 M $\Omega$	Add $\pm(0.025\%$ of reading $\pm 0.001\%$ of full scale)/°C above 28°C or below 18°C $\pm 2\%$ of reading per 10% relative humidity above 70% relative humidity.
Voltage at Full Scale	Approximately 0.2 V.
Maximum Open Circuit Voltage	Less than 6 V.
Measuring Current by Range	
200 $\Omega$	Approximately 1 mA.
2 k $\Omega$	Approximately 0.1 mA.
20 k $\Omega$	Approximately 10 $\mu$ A.
200 k $\Omega$	Approximately 1 $\mu$ A.
2 M $\Omega$	Approximately 0.1 $\mu$ A.
Resolution	1 part in 20,000 of full scale.
Response Time	
Manual Range	Less than 1 second.
Auto Range	Less than 2 seconds.
Reading Rate	Approximately 3 per second.

## Performance Characteristics

Table 6-2 (cont)

Characteristics	Performance Requirement
<b>AMPS</b>	
DC Accuracy	
+18°C to +28°C	$\pm(0.1\% \text{ of reading} + 0.02\% \text{ of full scale})$ .
-15°C to +18°C and +28°C to +55°C	$\pm(0.15\% \text{ of reading} + 0.06\% \text{ of full scale})$ .
AC Accuracy	
20 Hz to 5 kHz sinewave	
+18°C to +28°C	$\pm(0.6\% \text{ of reading} + 0.1\% \text{ of full scale})$ .
-15°C to +18°C and +28°C to +55°C	$\pm(0.7\% \text{ of reading} + 0.15\% \text{ of full scale})$ .
5 kHz to 10 kHz sinewave	
+18°C to +28°C	$\pm(2.5\% \text{ of reading} + 0.1\% \text{ of full scale})$ .
-15°C to +18°C and +28°C to +55°C	$\pm(2.6\% \text{ of reading} + 0.15\% \text{ of full scale})$ .
Response Time	
Manual Range	Less than 1 second.
Auto Range	Less than 2 seconds.
Input Resistance by Range	
100 $\mu$ A	Approximately 1.0 k $\Omega$ .
1 mA	Approximately 100.0 $\Omega$ .
10 mA	Approximately 10.5 $\Omega$ .
100 mA	Approximately 1.5 $\Omega$ .
1 A (1000 mA)	Approximately 0.5 $\Omega$ .
Maximum Input Current	1 A.
Resolution	1 part in 10,000 of full scale.

Table 6-2 (cont)

Characteristics	Performance Requirements
<b>CONTINUITY</b>	
Response Time	Approximately 0.1 second.
Threshold Resistance	$10\ \Omega \pm 1\ \Omega$ .
<b>TEMPERATURE</b>	
Accuracy	
+18°C to +28°C Ambient Temperature	$\pm(2\% \text{ of reading} + 1.5^\circ\text{C})$ .
-15°C to +18°C and +28°C to +55°C Ambient Temperature	$\pm(2\% \text{ of reading} + 2.0^\circ\text{C})$ .
Probe Tip Measurement Range	-62°C to +230°C in one range.
Resolution	0.1°C or 0.1°F.
<b>ADDITIONAL CHARACTERISTICS</b>	
Warmup time to Meet Electrical Specification	45 minutes.
Maximum Voltage between Inputs from either Input to Ground	
DC to 20 kHz	500 V rms; 700 V peak.
Above 20 kHz	$10^7\ \text{V}\cdot\text{Hz}$ .

**NOTE**

*For AMPS modes, maximum voltage between inputs is limited by maximum input current.*

