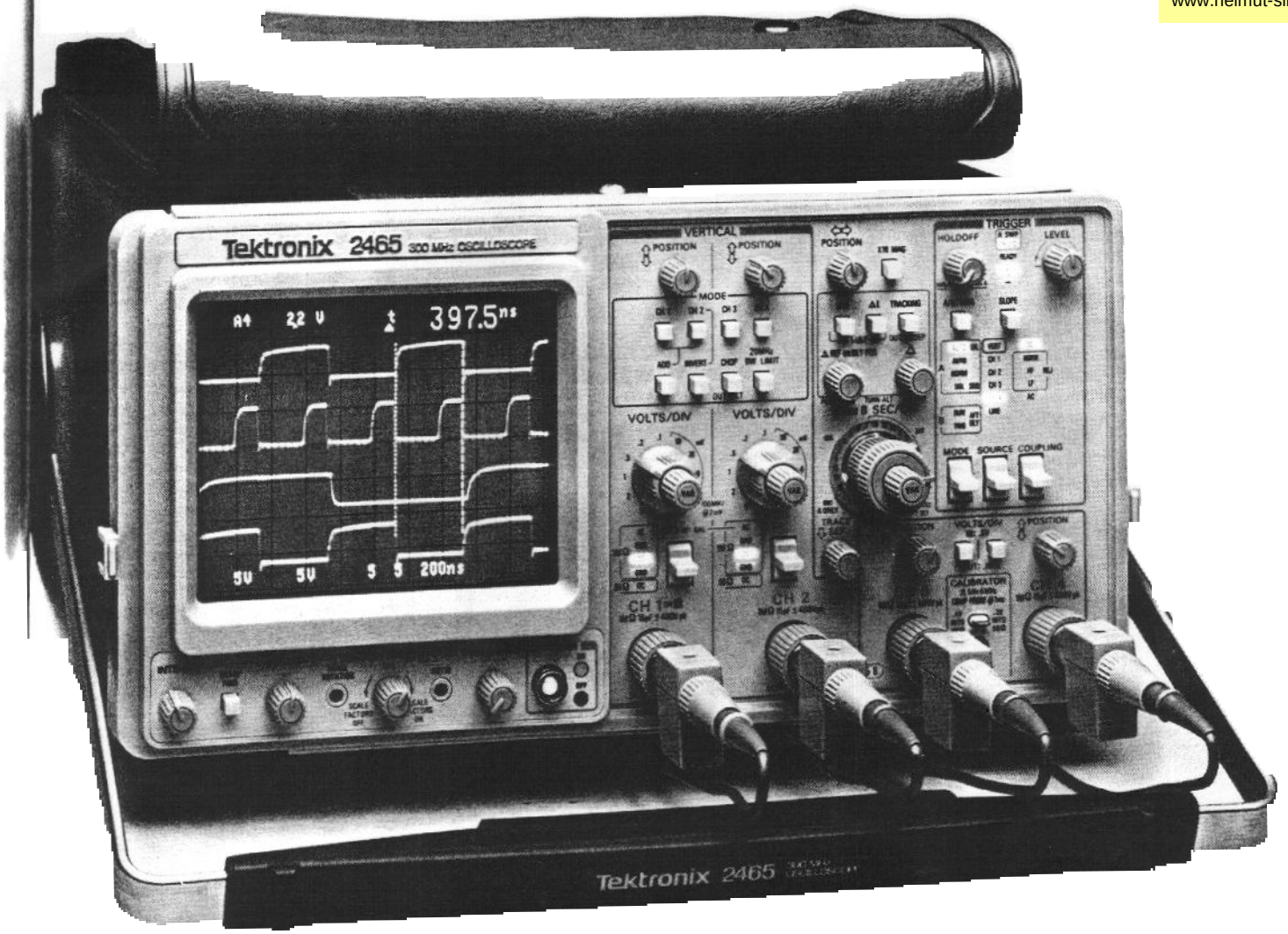
300 MHz AND 150 MHz FOUR TRACE OSCILLOSCOPES



2465/2445

- 300 MHz Bandwidth at the Probe Tip (2465)
- 150 MHz Bandwidth at the Probe Tip (2445)
- 500 ps/div Sweep Rate (2465)
- 1 ns/div Sweep Rate (2445)
- Time Interval Resolution to 20 ps
- Four Independent Channels
- 2 mV/div Vertical Sensitivity
- ΔVolts, ΔTime Cursors
- CRT Readout
  - Scale Factors
  - Trigger Level
  - Voltage, Time, Frequency, Phase and Ratio Measurements
  - Mode Indicators
- Adjustable Channel 1/Channel 2 Delay Matching
- Advanced Triggering System Featuring the "Hands Off" Auto Level Trigger
- Minimum Triggering Bandwidth of 500 MHz (2465) and 250 MHz (2445)
- B Sweep Displays the A Sweep Trigger Event
- 50 Ω/1 MΩ Inputs with 50 Ω Protection
- Calibrated Horizontal Variable
- Three Channel X-Y Display
- Rugged Design
- Three Year Warranty—Five Year Option

The new 300 MHz 2465 and 150 MHz 2445 represent the state-of-the-art and a higher standard in value for today's portable oscilloscopes. They make better measurements faster than any previous portable oscilloscopes. Cursors avoid interpretation errors and increase operator productivity. Four channels give complete views to simplify complex measurements. The front panel Channel 1/Channel 2 delay matching adjustment eliminates the effects of probe and vertical channel delay differences.

The 2465/2445 provide 1% horizontal accuracy and 2% vertical accuracy for greater measurement confidence. On-screen vertical and horizontal cursors deliver immediate measurements of voltage, time, frequency, ratio and phase with CRT readout. CRT readouts also include: scale factors for easy setup and interpretation of waveforms, including a calibrated horizontal variable; trigger level readout for predictable triggering on logic signals and transient events; and mode indicators, such as add, invert, bandwidth limit, and more.

2400 Series scopes can trigger on any or all of the four channels. The new Auto Level mode provides "hands off" triggering on any pulse width or waveform at repetition rates down to 50 Hz. Single Sequence Trigger mode sequentially sweeps through each channel displayed when triggered, then flashes the CRT readouts and graticule illumination.

The B sweep can display any portion of the A sweep, including the A sweep trigger event. This provides accurate delay and delta time measurements from the "first pulse" and allows the user to examine the A trigger event in detail.

In strong testimony of the incomparable reliability of the 2000 Family oscilloscopes, Tek offers the industry's first three year warranty: All labor and parts, including CRT, excluding probes. And then, beyond the "basic three years" of warranty coverage, Tek will extend your service coverage up to five years, offering you a choice of three practical service plans to meet your specific service needs.

CHARACTERISTICS

Characteristics are common to the 2445/2465 except where indicated.

VERTICAL DEFLECTION SYSTEM

Vertical Display Modes — CH 1, CH 2, CH 3, CH 4, Add (CH 1 + CH 2); Invert (CH 2 only); Alternate and Chopped. Bandwidth Limit (20 MHz).

CHANNEL 1 AND CHANNEL 2

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

Accuracy — +15°C to +35°C: Within 2% for ≤5 div signals, centered vertically. −15°C to +15°C and +35°C to +55°C: Add 1% to +15°C to +35°C range.

ΔV Accuracy (Using Cursors Over the Entire Graticule Area) — +15°C to +35°C: ±1.25% of reading +0.03 div. −15°C to +15°C and +35°C to +55°C: Add 1% of reading to +15°C to +35°C range.

ΔV Range — ±8 times Volts/Div setting.

Variable Range — Continuously variable between Volts/Div switch settings. Extends 5 V/div deflection factor to at least 12.5 V/div.

Frequency Response (3 dB Bandwidth and Risetime*1) — With a 6 div signal, terminated 50 Ω, with Var Volts/Div in calibrated detent.

2465	Volts/Div Setting	With Standard Accessory Probe or Internal 50 Ω Termination
−15°C to +35°C	5 mV or greater	Dc to 300 MHz, 1.17 ns
+35°C to +55°C	5 mV or greater	Dc to 250 MHz, 1.4 ns
−15°C to +55°C	2 mV	Dc to 100 MHz, 3.5 ns
2445		
−15°C to +35°C	5 mV or greater	Dc to 150 MHz, 2.33 ns
+35°C to +55°C	5 mV or greater	Dc to 100 MHz, 3.5 ns
−15°C to +55°C	2 mV	Dc to 80 MHz, 4.5 ns

**1 Risetime calculated from: Bandwidth x Risetime = 0.35*

Ac Coupled Lower −3 dB Point — With 1X Probe: 10 Hz or less. With 10X Probe: 1 Hz or less.

Common-Mode Rejection Ratio — At least 20:1 at 50 MHz for common-mode signals of 8 div or less, with Var Volts/Div control adjusted for best CMRR at 50 kHz at any Volts/Div setting ≥5 mV. At least 20:1 at 20 MHz at 2 mV/div.

Channel Isolation — For an 8 div Input Signal from 2 mV/div to 500 mV/div, with Equal Volts/Div Settings on Both Channels: 100:1 or greater attenuation of the deselected channel at 100 MHz; 50:1 or greater attenuation at 300 MHz (150 MHz for 2445).

CH 1 to CH 2 Signal Delay — The displayed delay is adjustable through a range of at least ±500 ps.

Input Z (1 MΩ) — 1 MΩ ±0.5% shunted by 15 pF, ±2 pF. The maximum input voltage is 400 V (dc + peak ac); 800 V p-p ac at 10 kHz or less.

Input Z (50 Ω) — 50 Ω ±1%, with a vswr from dc to 300 MHz of 1.3 to 1 or less. The maximum input voltage is 5 V RMS, or 0.5 W/s during any 1 s interval for instantaneous voltages from 5 V to 50 V.

Cascaded Operation — CH 2 Signal Out is coupled into CH 1 input. Bandwidth is dc to 50 MHz or greater and the deflection factor is 400 μV/div ±10%.

CHANNEL 3 AND CHANNEL 4

Deflection Factor — 0.1 V/div and 0.5 V/div ±10%.

Input Z — 1 MΩ ±1%, shunted by 15 pF ±3 pF.

Maximum Input Voltage — 400 V (dc + peak ac); 800 V p-p ac at 10 kHz or less.

Frequency Response (Bandwidth and Risetime)*1

2465	With Standard Accessory Probe (−3 dB)	With 50 Ω External Termination
−15°C to +35°C	Dc to 300 MHz 1.17 ns	Dc to 300 MHz, (−4.7 dB) 1.4 ns
2465		
+35°C to +55°C	Dc to 250 MHz 1.4 ns	Dc to 250 MHz, (−4.7 dB) 1.75 ns
2445		
−15°C to +55°C	Dc to 150 MHz 2.33 ns	Dc to 150 MHz, (−3 dB) 2.33 ns

**1 With a 6 div signal, from a 50 Ω terminated source.*

Channel Isolation — 50:1 or greater attenuation of the deselected channel at 100 MHz with an 8 div input signal.

ALL CHANNELS

Low Frequency Linearity — 0.1 div or less compression or expansion of a 2 div, center-screen signal when positioned anywhere within the graticule area.

Bandwidth Limiter — Reduces upper 3 dB bandpass to a limit of 13 MHz to 24 MHz.

Vertical Signal Delay — At least 30 ns of the signal is displayed before the triggering event is displayed on the A sweep for settings ≥10 ns/div. At least 10 ns of delay is displayed at 5 ns/div for the 2465.

Chopped Mode Switching Rate — 2.5 MHz ±0.2% from 2 μs/div to 20 μs/div (1.25 MHz dual channel cycle rate). At All Other Sweep Speeds: 1 MHz ±0.2% (500 kHz dual channel cycle rate).

HORIZONTAL DEFLECTION SYSTEM

Horizontal Display Modes — A, A Intensified, B Delayed, Alternate (A Intensified and B Delayed), B ends A for increased intensity in the delayed mode. For X-Y operation Channel 1 supplies the X-axis (horizontal) deflection.

A Sweep Time Base Range

2465: 0.5 s/div to 5 ns/div in a 1-2-5 sequence of 25 steps. X10 Mag feature extends maximum sweep speed to 500 ps/div.

2445: 1 s/div to 10 ns/div in a 1-2-5 sequence of 25 steps. X10 Mag feature extends maximum sweep speed to 1 ns/div.

B Sweep Time Base Range

2465: 50 ms/div to 5 ns/div in a 1-2-5 sequence of 22 steps. X10 Mag feature extends maximum sweep speed to 500 ps/div.

2445: 50 ms/div to 10 ns/div in a 1-2-5 sequence of 21 steps. X10 Mag feature extends maximum sweep speed to 1 ns/div.

Variable Time Control — Continuously variable and calibrated between settings of the Sec/Div switch. Extends slowest A sweep speed to 1.5 s/div. Operates in conjunction with the A Sec/Div switch when A and B are locked together; operates in conjunction with the B Sec/Div switch when A and B are not locked together.

Timing Accuracy*1

	Unmagnified	Magnified
A and B Sweep*2	±(0.7% of time interval +0.6% of full scale)	±(1.2% of time interval +0.6% of full scale)
ΔTime*3	±(0.5% of time +0.3% of full scale)	±(1% of time inteval +0.3% of full scale)

**1 +15° C to +35° C, Sec/Div set to 0.1 s/div or faster.*
**2 Time intervals measured at vertical center with Sec/Div Var in detent (0.6% of full scale is 0.06 div).*
**3 Time intervals measured with cursors, anywhere on the graticule (A sweep only).*

CALIBRATED SWEEP DELAY

ΔTime Accuracy — Time intervals measured with delayed B Sweep with both delays set at 0.5% or more of full scale from minimum delay (no "?" displayed in readout): ±0.3% of time interval +0.1% of full scale.

Delay Accuracy — A Sweep Trigger Point to Start of B Sweep: ±(0.3% of delay setting +0.6% of full scale)—+0 ns, −25 ns.

ΔTime Readout Resolution

2465: Greater of either 10 ps or 0.025% full scale.
2445: Greater of either 20 ps or 0.025% full scale.

ΔTime Range — ±10 times the A Sec/Div switch setting.

Delay Pickoff Jitter — Within 0.004% (one part or less in 25,000) of the maximum available delay, plus 100 ps.

Delay Time Position Range — 0 to 9.95 times the A Sec/Div switch setting. Main sweep triggering event is observable on delayed sweep with minimum delay setting.

TRIGGERING

The minimum p-p signal amplitude for stable triggering is stated for CH 1 or CH 2 source. The signal amplitude for CH 3 or CH 4 source is one-half of CH 1 or CH 2 source specification. For multiple channel source (Alternate Vertical Mode) add 1 div to the single channel source specification.

Dc Coupled — 0.35 div from dc to 50 MHz, increasing to 1 div at 500 MHz (250 MHz for 2445).

Noise Reject Coupled — A voltage level-sensing hysteresis window defined by two levels of p-p signal amplitude. For signals within the vertical bandwidth, triggering *will not* occur (signal reject) with ≤0.4 div. Stable triggering *will* occur with ≤1.2 div from dc to 50 MHz, increasing to 3 div at 500 MHz (250 MHz for 2445).

Ac Coupled — 0.35 div from 60 Hz to 50 MHz, increasing to 1 div at 500 MHz (250 MHz from 2445). Attenuates signals below 60 Hz.

HF Reject Coupled — 0.5 div from dc to 30 kHz.

LF Reject Coupled — 0.5 div from 80 kHz to 50 MHz, increasing to 1 div at 500 MHz (250 MHz for 2445).

Jitter — Less than 50 ps at 300 MHz with A and B Sec/Div set for 5 ns/div sweep and 10X Mag on (100 ps at 150 MHz and 10 ns/div for 2445).

Level Control Range — CH 1 or CH 2: ±18 times the Volt/Div setting. CH 3 or CH 4: ±9 times the Volts/Div setting.

Level Control Readout and Range Accuracy (for Triggering Signals with Transition Times >20 ns) — CH 1 or CH 2 Source (Dc Coupled): +15°C to +35°C is within ±[3% of setting +3% of p-p signal +0.2 div +(0.5 mV x probe attenuation factor)]. −15°C to +55°C (excluding +15°C to +35°C) add (1.5 mV x probe attenuation factor). For noise reject coupled add ±0.6 div to the dc coupled specification. CH 3 or CH 4 Source (Dc Coupled): Within ±[3% of setting +4% of p-p signal +0.1 div +(0.5 mV x probe attenuation factor)]. For noise reject coupled add 0.3 div.

Slope Selection — Conforms to trigger-source waveform or ac power-source waveform.

Auto Level Mode Maximum Triggering Signal Period — With A Sec/Div Switch Setting less than 10 ms: At least 20 ms. A Sec/Div Switch Setting from 10 ms to 50 ms: At least four times the A Sec/Div switch setting. A Sec/Div Switch Setting from 100 ms to 500 ms: At least 200 ms.

Auto Mode Maximum Triggering Signal Period — With A Sec/Div Switch Setting Less than 10 ms: At least 80 ms. A Sec/Div Switch Setting from 10 ms to 50 ms: At least 16 times the A Sec/Div switch setting. A Sec/Div Switch Setting from 100 ms to 500 ms: At least 800 ms.

Auto Level Mode Trigger Acquisition Time — 8 to 100 times the Auto Level mode maximum triggering-signal period, depending on the triggering-signal period and waveform.

A Trigger Holdoff — An adjustable control permits a stable presentation of repetitive complex waveforms. Extends A sweep holdoff to at least 10 times Sec/Div setting. Fully clockwise B sweep ends A sweep.

X-Y OPERATION

CH [illegible] supplies the X-axis (horizontal) deflection signal; and any or all of the vertical channels (incl[illegible]

X Axis Deflection Factor — Range: Same as CH [illegible]

[illegible]

Input Z — Same as CH [illegible]

Phase Difference Between X and Y with 20 MHz Bandwidth Limit Off — 1° [illegible]

X Axis Low-Frequency Linearity — 0.2 div or less compression or expansion of a 2 div, center-screen signal when positioned within the display area.

CURSOR AND FRONT PANEL DISPLAY

Cursor Position Range — ΔV: At least the center 7.6 vertical div. ΔTime: At least the center 9.6 horizontal div.

Power Down Memory — At power down the front panel settings will be stored in memory (EAROM) providing ≤10 s of operating time has occurred.

Z-AXIS INPUT

Sensitivity — Positive voltage decreases intensity. Dc to 2 MHz: +2 V blanks a maximum intensity trace. 2 MHz to 20 MHz: +2 V modulates a normal intensity trace.

Input Resistance — 9 kΩ ±10%.

Maximum Input Voltage — ±25 V peak; 25 V p-p ac at 10 kHz or less.

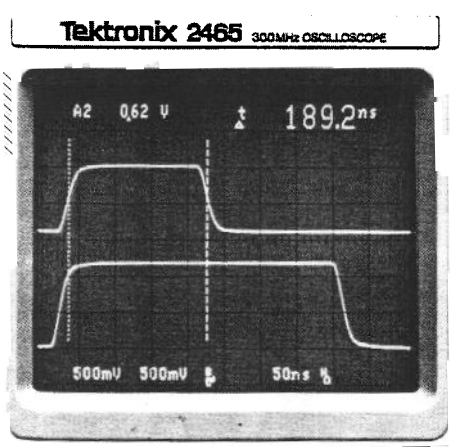
SIGNAL OUTPUTS

Calibrator — Output Voltage and Current: 0.4 V ±1% into a 1 MΩ load, 0.2 V ±1.5% into a 50 Ω load, or 8 mA ±1.5% into a short circuit, with A Sec/Div switch set to 1 ms/div. Repetition Period: Two times the A Sec/Div switch setting within the range of 200 ns to 200 ms. Accuracy is ±0.1% measured with the Sgl Seq A Trigger Mode selected. Symmetry: Duration of high portion of output cycle is 50% of the output period ±(lesser of 500 ns or 25% of period). Jitter of Pulse Period or Pulse Width: 10 ns or less.

CH 2 Signal Out — Output Voltage: 20 mV/div ±10% into 1 MΩ, 10 mV/div ±10% into 50 Ω. Offset: ±10 mV into 50 Ω when dc balance has been performed within ±5°C of the operating temperature.

A Gate Out and B Gate Out — Output Voltage: 2.4 V to 5 V positive going pulse, starting at 0 V to 0.4 V. Output Drive: Will supply 400 μA during HI state; will sink 2 mA during LO state.

CRT READOUT AND WAVEFORM INFORMATION



Your eyes never have to leave the screen to obtain front panel settings and meaurement results.

In the CRT example above, the top area of the display provides trigger source, trigger voltage level, and Δtime results. The lower area displays the selected volts/div and seconds/div scale factors and that bandwidth limit and holdoff are activated.

DISPLAY

CRT — 80 mm x 100 mm (8 cm x 10 cm).

Standard Phosphor — GH (P31) is standard.

Nominal Accelerating Potential — 16 kV.

AC POWER SOURCE

Voltage Ranges — 115 V: 90 V to 132 V. 230 V: 180 V to 250 V.

Source Frequency — 48 Hz to 440 Hz.

Power Consumption — Typical: 70 W (140 VA). Maximum: 120 W (180 VA).

ENVIRONMENTAL CHARACTERISTICS

The 2465/2445 Oscilloscopes meet or exceed the environmental requirements of MIL-T-28800C for Type III, Class 3, Style C equipment, tested for humidity 4.5.5.1.2.2, low temperature 4.5.5.1.3 and high temperature 4.5.5.1.4.

Safety — UL 1244 and CSA approval.

Electromagnetic Compatibility — Meets MIL-STD-461B Part 2.

Temperature — Operating: −15°C to +55°C. Nonoperating: −62°C to +85°C.

Altitude — Operating: To 4600 m (15,000 ft). Maximum operating temperature decreases 1°C for each 1,000 ft above 5,000 ft. Nonoperating: To 15 200 m (50,000 ft).

Humidity — Operating and Nonoperating: Stored at 95% relative humidity for 5 cycles (120 hours) from +30°C to +60°C, with operational performance checks at +30°C and +55°C.

Dripproof — With Cover On: Meets MIL-T-28800C Para. 4.5.5.5.3.

Vibration — Operating: 15 minutes along each of three axes at a total displacement of 0.025 inch p-p (4 g at 55 Hz), with frequency varied from 10 Hz to 55 Hz in one-minute sweeps. Held 10 minutes at each major resonance, or if none existed, held 10 minutes at 55 Hz (75 minutes total test time).

Shock — Operating and Nonoperating: 50 g's, half-sine, 11 ms duration, three shocks on each face, for a total of 18 shocks.

Transit Drop — Not in Shipping Package: 12 inch drop on each corner and each face (MIL-T-28800C, para 4.5.5.4.2).

Bench Handling — With and Without Cabinet Installed: MIL-STD-810C, Method 516, Procedure V (MIL-T-28800C, para 4.5.5.4.3).

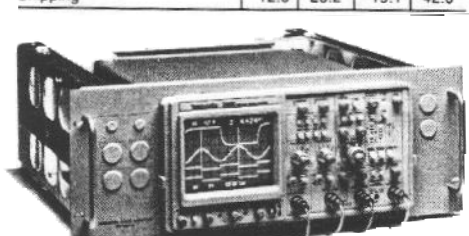
Topple — Operating and Cabinet Installed: Set on rear feet and allowed to topple over onto each of four adjacent faces.

Packaged Transportation Drop — Meets the limits of the National Safe Transit Association Test Procedure 1A-B-2; 10 drops of 36 inches.

Packaged Transportation Vibration — Meets the limits of the National Safe Transit Association Test Procedure 1A-B-1; excursion of 1 inch p-p at 4.63 Hz (1.1 g) for 30 minutes.

PHYSICAL CHARACTERISTICS

	Cabinet		Option 1R Rackmount	
Dimensions	mm	in	mm	in
Width			483	19.0
(with handle)	330	13.0		
Height			178	7.0
(with feet/pouch)	190	7.5		
(without pouch)	160	6.3		
Depth			419	16.5
(with front panel cover)	434	17.1		
(with handle extended)	505	19.9		
Weights	**kg**	**lb**	**kg**	**lb**
Net (w/o accessories & pouch)	9.3	20.5	13.3	29.3
(with accessories & pouch)	10.2	22.4	14.2	31.2
Shipping	12.8	28.2	19.1	42.0



Rackmount 2465 Option 1R, comes complete with slide-out chassis tracks.

INCLUDED ACCESSORIES

Two P6131 10X 1.3 m probes with accessories (010-6131-01); ziploc accessory pouch (016-0537-00); blue plastic CRT filter (378-0199-00); clear plastic CRT filter (378-0208-00); snap accessory pouch (016-0692-00); 2 A-250 V fuse (159-0021-00); front cover (200-2742-00); power cord (161-0104-00). 2445 operator manual; service manual; and reference card. 2465 operator manual; service manual; and reference card. Option 1R: Rackmounted instruments also include mounting hardware and slide out assemblies, does not include pouch.

ORDERING INFORMATION

2465 300 MHz Oscilloscope
2445 150 MHz Oscilloscope

INSTRUMENT OPTIONS

The 2465 and 2445 oscilloscopes can be configured with the following factory installed options

Option 1R — Configure Oscilloscope for Rackmount

Option 11 — Rear Panel Probe Power Connectors (2465 Only)

Option 22 — Two Additional P6131 Probes

2465 Option 1R and Option 11 Extender Cables — Order 020-0103-00.

2465/2445 Option 1R Extender Cables — Order 020-0104-00.

INTERNATIONAL POWER CORDS AND PLUG OPTIONS

Option A1 — Universal Euro 220 V/16 A, 50 Hz

Option A2 — UK 240 V/13 A, 50 Hz

Option A3 — Australian 240 V/10 A, 50 Hz

Option A4 — North American 240 V/15 A, 60 Hz

Option A5 — Switzerland 220 V/10 A, 50 Hz

***WARRANTY-PLUS* SERVICE PLANS—Refer to page 41**

M1 — (2465) 2 Calibrations
M1 — (2445) 2 Calibrations
M2 — (2465) 2 Years Service
M2 — (2445) 2 Years Service
M3 — (2465) 2 Years Service and 4 Calibrations
M3 — (2445) 2 Years Service and 4 Calibrations

OPTIONAL ACCESSORIES

Protective Waterproof Blue Vinyl Cover — Order 016-0720-00

Probe Package — P6131 for Use with Channels 3 or 4. Order 010-6131-01

P6230 — 10X Bias/Offset Active Probe. Order 010-6230-01

Rackmounting Conversion Kit — Order 016-0691-00

Rear Support Kit — For Use with Rackmounted Instruments required to meet MIL-T-28800C. Order 016-0096-00

Polarized Collapsible Viewing Hood — Order 016-0180-00

Folding Light Shielding Viewing Hood — Order 016-0592-00

Collapsible Binocular Viewing Hood — Order 016-0566-00

Oscilloscope Camera — See C-30B Option 01.

SCOPE-MOBILE Cart — See 200D or 200C.

Carrying Strap — Order 346-0199-00

Additional accessories begin on page 421.