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Tektronix
National Marketing Center
for Product Order Information, call
1-800-426-2200 ext 41
In Oregon call collect (503)627-9000 ext 41
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2235

OSCILLOSCOPE

SERVICE

INSTRUCTION MANUAL

Tektronix, Inc.
P.O. Box 500
Beaverton, Oregon 97077

Serial Number _____

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OPERATORS SAFETY SUMMARY

The general safety information in this part of the summary is for both operating and servicing personnel. Specific warnings and cautions will be found throughout the manual where they apply and do not appear in this summary.

Terms in This Manual

CAUTION statements identify conditions or practices that could result in damage to the equipment or other property.

WARNING statements identify conditions or practices that could result in personal injury or loss of life.

Terms as Marked on Equipment

CAUTION indicates a personal injury hazard not immediately accessible as one reads the markings, or a hazard to property, including the equipment itself.

DANGER indicates a personal injury hazard immediately accessible as one reads the marking.

Symbols in This Manual



This symbol indicates where applicable cautionary or other information is to be found. For maximum input voltage see Table I-1.

Symbols as Marked on Equipment



DANGER – High voltage.



Protective ground (earth) terminal.

A

ATTENTION – Refer to manual.

Power Source

This product is intended to operate from a power source that does not apply more than 250 volts rms between the supply conductors or between either supply conductor and ground. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.

Grounding the Product

This product is grounded through the grounding conductor of the power cord. To avoid electrical shock, plug the power cord into a properly wired receptacle before connecting to the product input or output terminals. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.

Danger Arising From Loss of Ground

Upon loss of the protective-ground connection, all accessible conductive parts (including knobs and controls that may appear to be insulating) can render an electric shock.

Use the Proper Power Cord

Use only the power cord and connector specified for your product.

Use only a power cord that is in good condition.

For detailed information on power cords and connectors see Figure 2-1.

Use the Proper Fuse

To avoid fire hazard, use only a fuse of the correct type, voltage rating and current rating as specified in the parts list for your product.

Do Not Operate in Explosive Atmospheres

To avoid explosion, do not operate this product in an explosive atmosphere unless it has been specifically certified for such operation.

Do Not Remove Covers or Panels

To avoid personal injury, do not remove the product covers or panels. Do not operate the product without the covers and panels properly installed.

SERVICING SAFETY SUMMARY

FOR QUALIFIED SERVICE PERSONNEL ONLY

Refer also to the preceding Operators Safety Summary.

Do Not Service Alone

Do not perform internal service or adjustment of this product unless another person capable of rendering first aid and resuscitation is present.

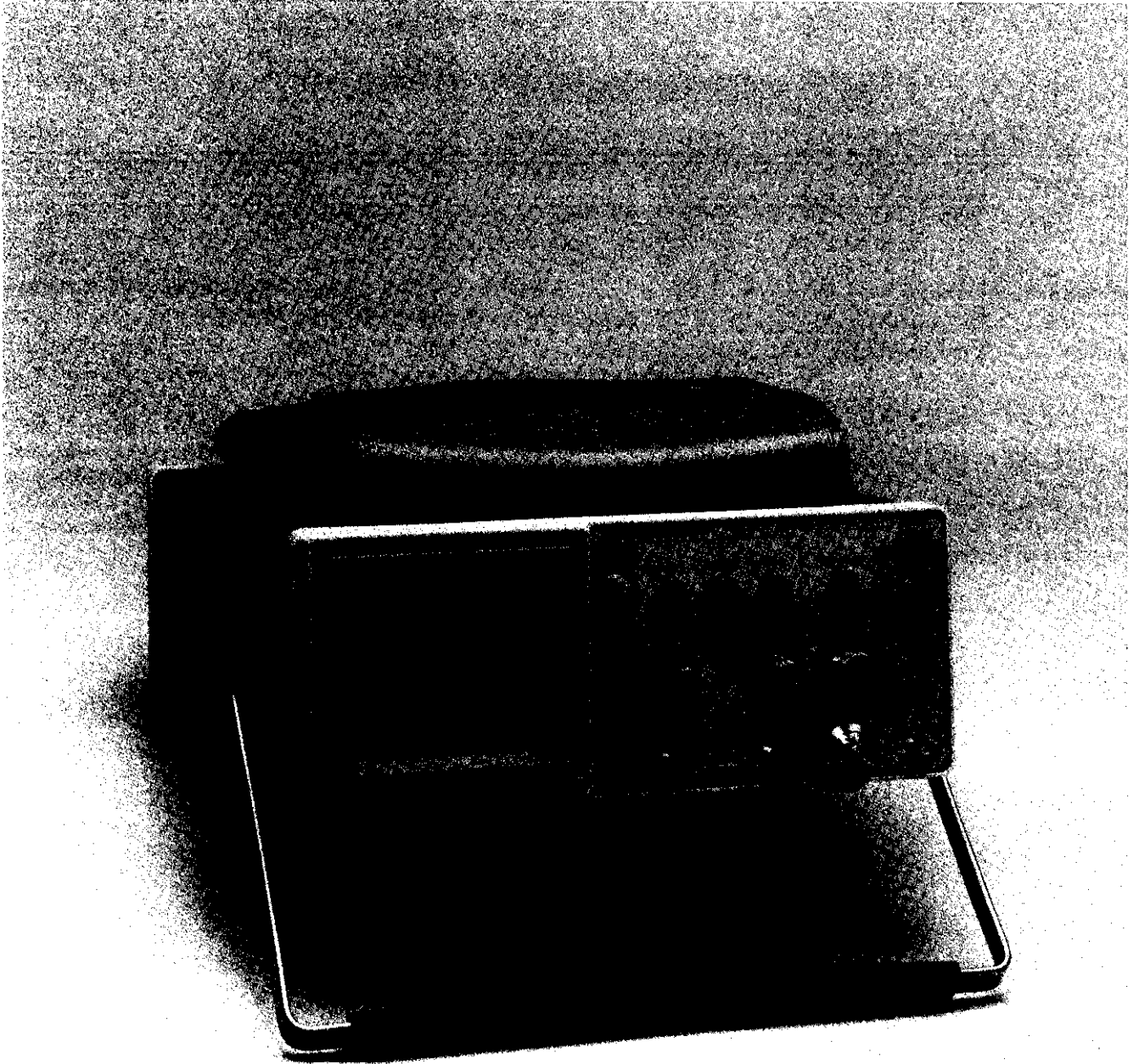
Use Care When Servicing With Power On

Dangerous voltages exist at several points in this product. To avoid personal injury, do not touch exposed **connections** or components while power is on.

Disconnect power before removing protective panels, **soldering**, or replacing components.

Power Source

This product is intended to operate from a power source that does not apply more than 250 volts rms between the supply conductors or between either supply conductor and ground. A protective ground connection by way of the grounding connector in the power cord is essential for safe operation.



SPECIFICATION

INTRODUCTION

The TEKTRONIX 2235 oscilloscope is a rugged, light-weight, dual-channel, **100-MHz** instrument that features a bright, sharply defined trace on an **80-** by **100-mm cathode-ray tube (crt)**. Its vertical system provides calibrated **deflection** factors from **2 mV** per division to **5 V** per division. Trigger circuits enable stable triggering over the full bandwidth of the vertical system. The horizontal system provides calibrated sweep speeds from **0.5 s** per division to **50 ns** per division along with delayed-sweep features for accurate relative-time measurements. A X10 magnifier extends the maximum sweep speed to **5 ns** per division.

ACCESSORIES

The instrument is shipped with the following standard accessories:

- | | |
|--------------------|------------------|
| 1 Operators Manual | 2 Probe packages |
| 1 Service Manual | |

For part numbers and further information about both standard and optional accessories, refer to the "Options and Accessories" section (Section 5) of this manual. Your Tektronix **representative, local** Tektronix Field Office, or Tektronix product catalog can also provide accessories information.

PERFORMANCE CONDITIONS

The following electrical characteristics (Table I-1) are valid for the 2235 when it has been adjusted at an ambient temperature between **+20°C** and **+30°C**, has had a warm-up period of at least 20 minutes, and is operating at an ambient temperature between **0°C** and **+50°C** (unless otherwise noted).

Items listed in the "Performance Requirements" column are verifiable qualitative or quantitative limits, while items listed in the "Supplemental Information" column are either explanatory notes, calibration setup descriptions, performance characteristics for which no absolute limits are specified, or characteristics that are impractical to check.

Environmental characteristics are given in Table I-2. The 2235 meets the requirements of **MIL-T-28800C**, paragraphs 4.5.5.1.3, 4.5.5.1.4, and 4.5.5.1.2.2 for Type **III**, Class 5 equipment, except where otherwise noted.


Physical characteristics of the instrument are listed in Table I-3.

**Table I-I
Electrical Characteristics**

Characteristics	Performance Requirements	Supplemental Information
VERTICAL DEFLECTION SYSTEM		
Deflection Factor		5 mV per division to 5 V per division gain is adjusted with VOLTWDIV switch set to 10 mV per division. 2 mV per division gain is adjusted with VOLTWDIV switch set to 2 mV per division
Flange	2 mV per division to 5 V per division in a 1-2-5 sequence	
Accuracy		
+15°C to +35°C	±2%.	
0°C to +50°C	±3%. ^a	
Range of VOLTWDIV Variable Control	Continuously variable between settings. Increases deflection factor by at least 2.5 to 1.	
Step Response		Rise time is calculated from the formula: 0.35 Bandwidth (-3 dB)
Rise Time		
0°C to +35°C		
5 mV per Division to 5 V per Division	3.5 ns or less. ⁸	
2 mV per Division	3.9 ns or less. ⁸	
+35°C to +50°C		
5 mV per Division to 6 V per Division	3.9 ns or less. ⁷	
2 mV per Division	4.4 ns or less. ⁷	
Aberrations		Measured with 5-division reference signal, centered vertically, from a 50 Ω source driving a 50 Ω coaxial cable terminated in 50 Ω at the input connector with the VOLTWDIV Variable control in the CAL detent.
Positive-Going Step		
2 mV per Division to 0.5 V per Division	+4%, -4%. 4% p-p.	
1 V per Division to 5 V per Division	+12%, -12%, 12% p-p. ^a	
Bandwidth (-3 dB)		Measured with a vertically centered 6-division reference signal from a 50 Ω source driving a 60 Ω coaxial cable that is terminated in 50 Ω, both at the input connector and at the probe input, with the VOLTWDIV Variable control in the CAL detent.
0°C to +35°C		
5 mV per Division to 5 V per Division	Dc to at least 100 MHz.	
2 mV per Division	Dc to at least 90 MHz.	
+35°C to +50°C		
5 mV per Division to 5 V per Division.	Dc to at least 90 MHz. ⁸	
2 mV per Division	Dc to at least 80 MHz. ⁸	
AC Coupled Lower Limit	10 Hz or less at -3 dB. ^a	

^aPerformance Requirement not checked in Service Manual.

Table I-I (cont)

Characteristics	Performance Requirements	Supplemental Information
VERTICAL DEFLECTION SYSTEM		
Bandwidth Limiter	Upper limits (-3 dB) bandpass at 20 MHz \pm 10%.	
Chop Mode Switching Rate	500 kHz \pm 30%. ^a	
Input Characteristics		
Resistance	1 M Ω \pm 2%. ^a	
Capacitance	20 pF \pm 2 pF. ^a	
Maximum Safe Input Voltage 	See Figure I-I for derating curve.	
DC Coupled	400 V (dc + peak ac) or 800 V ac p-p to 10 kHz or less. ⁸	
AC Coupled	400 V (dc + peak ac) or 800 V ac p-p to 10 kHz or less. ^a	
Common-Mode Rejection Ratio (CMRR)	At least 20 to 1 at 50 MHz.	Checked at 10 mV per division for common-mode signals of 6 divisions or less with VOLTS/DIV Variable control adjusted for best CMRR at 50 kHz.
Input Current	1.0 nA or less (0.5 division trace shift at 2 mV per division). ^a	
Trace Shift with Attenuator Rotation	0.75 division or less. ^a	VOLTS/DIV Variable control in CAL detent.
Trace Shift as VOLTS/DIV Variable Control is Rotated	1.0 division or less. ^a	
Trace Shift with Invert	1.5 division or less. ^a	
Channel Isolation	Greater than 100 to 1 at 50 MHz.	
POSITION Control Range	At least \pm 11 division from graticule center.	

^aPerformance Requirement not checked in Service Manual.

Table I-I (cont)

Characteristics	Performance Requirements	Supplemental Information
TRIGGERSYSTEM		
A TRIGGER Sensitivity P-P AUTO and NORM/TV LINE Modes		External trigger signal from a 50 Ω source driving a 50 Ω coaxial cable terminated in 50 Ω at the input connector.
	10 MHz 60 MHz 100 MHz	
	0.3 div 1.0 div 1.5 div	
	35 mV 120 mV 200 mV	
Internal		
External		
Lowest Useable Frequency in P-P AUTO Mode	20 Hz with 1.0 division internal or 100 mV external. ⁸	
TV FIELD Mode	1.0 division of composite sync. ⁸	
B TRIGGER Sensitivity (Internal Only)	10 MHz 60 MHz 100 MHz	
	0.3 div 1.0 div 1.5 div	
EXT INPUT		
Maximum Input Voltage A	400 V (dc + peak ac) or 600 V ac p-p at 10 kHz or less (see Figure 1-1). ^a	
Input Resistance	1 MΩ ± 2%. ^a	
Input Capacitance	20 pF ± 2.5 pF. ^a	
AC Coupled	10 Hz or less at lower -3 dB point. ^a	
LEVEL Control Range		
A TRIGGER (NORM)		
INT	Can be set to any point of the trace that can be displayed. ^a	
EXT, DC	At least ± 1.6 V, 3.2 V p-p.	
EXT, DC ÷ 10	At least ± 16 V, 32 V p-p. ^a	
B TRIGGER		
Internal	Can be set to any point of the trace that can be displayed.*	
VAR HOLDOFF Control	Increases A Sweep holdoff time by at least a factor of 10. ^a	
Trigger View System		
Deflection Factor		
Internal	Same as vertical.	
External		
AC and DC	100 mV per division.	
DC ÷ 10	1 V per division.	
Accuracy	± 20%.	
Delay Difference Between EXT INPUT and Either Vertical Channel	Less than 2.0 ns. ^a	

^aPerformance Requirement not checked in Service Manual.

Table I-I (cont)

Characteristics	Performance Requirements		Supplemental Information
HORIZONTAL DEFLECTION SYSTEM			
Sweep Rate			
Calibrated Range			
A Sweep	0.5 s per division to 0.05 μ s per division in a 1-2-5 sequence. X10 magnifier extends maximum sweep speed to 5 ns per division.		
B sweep	50 ms per division to 0.05 μ s per division in a 1-2-5 sequence. X10 magnifier extends maximum sweep speed to 5 ns per division.		
Accuracy	Unmagnified	Magnified	Sweep accuracy applies over the center 8 divisions. Exclude the first 25 ns of the sweep for magnified sweep speeds and anything beyond the 100th magnified division.
+15°C to +35°C	±2%	±3%	
0°C to +50°C	±3% ^a	±4% ^a	
POSITION Control Range	Start of sweep to 10th division will position past the center vertical graticule line in X1 or 100th division in x10.		
Sweep Linearity	±5%.		Linearity measured over any 2 of the center 8 divisions. With magnifier in X10, exclude the first 25 ns and anything past the 100th division.
Variable Control Range	Continuously variable between calibrated settings. Extends the A and B sweep speeds by at least a factor of 2.5.		
Sweep Length	Greater than 10 division.		
A/B SWP SEP Range	± 3.5 divisions or greater.		
Delay Time	Applies to 0.5 μ s per division and slower.		Delay time is functional but not calibrated at sweep settings above 0.5 μ s per division.
Dial Control Range	<0.5 + 300 ns to >10 divisions.		
Jitter	One part or less in 20,000 (0.005%) of the maximum available delay time.		
Differential Time Measurement Accuracy			Exclude delayed operation when A and B SEC/DIV knobs are locked together et any sweep speed or when A SEC/DIV switch is at 0.5 μ s per division or faster. Accuracy applies over the B DELAY TIME POSITION control range.
+15°C to +35°C	± 1% + 0.015 major dial division		
0°C to +50°C	± 2% + 0.015 major dial division.*		

*Performance Requirement not checked in Service Manual.

Table 1-1 (cont)

Characteristics	Performance Requirements	Supplemental Information
X-Y OPERATION (XI MAGNIFICATIC		
Deflection Factors	Same as Vertical Deflection System (with VOLTS/DIV Variable controls in CAL detent).	
Accuracy		Measured with a dc-coupled, 5-division reference signal.
X-Axis		
+15°C to +35°C	± 3%.	
0°C to +50°C	± 4%. ^a	
Y-Axis	Same as Vertical Deflection System.*	
Bandwidth (-3 dB)		Measured with a 5-division reference signal.
X-Axis	Dc to at least 3 MHz.	
Y-Axis	Same as Vertical Deflection System. ^a	
Phase Difference Between X- and Y-Axis Amplifiers	± 3° from dc to 150 kHz. ^a	With do-coupled inputs.
PROBE ADJUST		
Output Voltage of PROBE ADJUST Jack	0.5 v ± 5%.	
Repetition Rate	1 kHz ± 20%. ^a	
Z-AXIS INPUT		
Sensitivity	5 V causes noticeable modulation. Positive-going input decreases intensity.	Useable frequency range is dc to 20 MHz.
Maximum Safe Input Voltage	30 V (dc + peak ac) or 30 VC p-p ec at 1 kHz or less. ^a	
Input Resistance	10 kg ± 10%. ^a	
POWER SOURCE		
Line Voltage Ranges	90 v to 250 V. ^a	
Line Frequency	48 Hz to 440 Hz. ^a	
Maximum Power Consumption	40 W (70 VA). ^a	
Line Fuse	1.0 A. 250 V. slow-blow.	
CATHODE-RAY TUBE		
Display Area	80 by 100 mm. ^a	
Standard Phosphor	P 31.	
Nominal Accelerating Voltage	14 kV. ^a	

*Performance Requirement not checked in Service Manual.

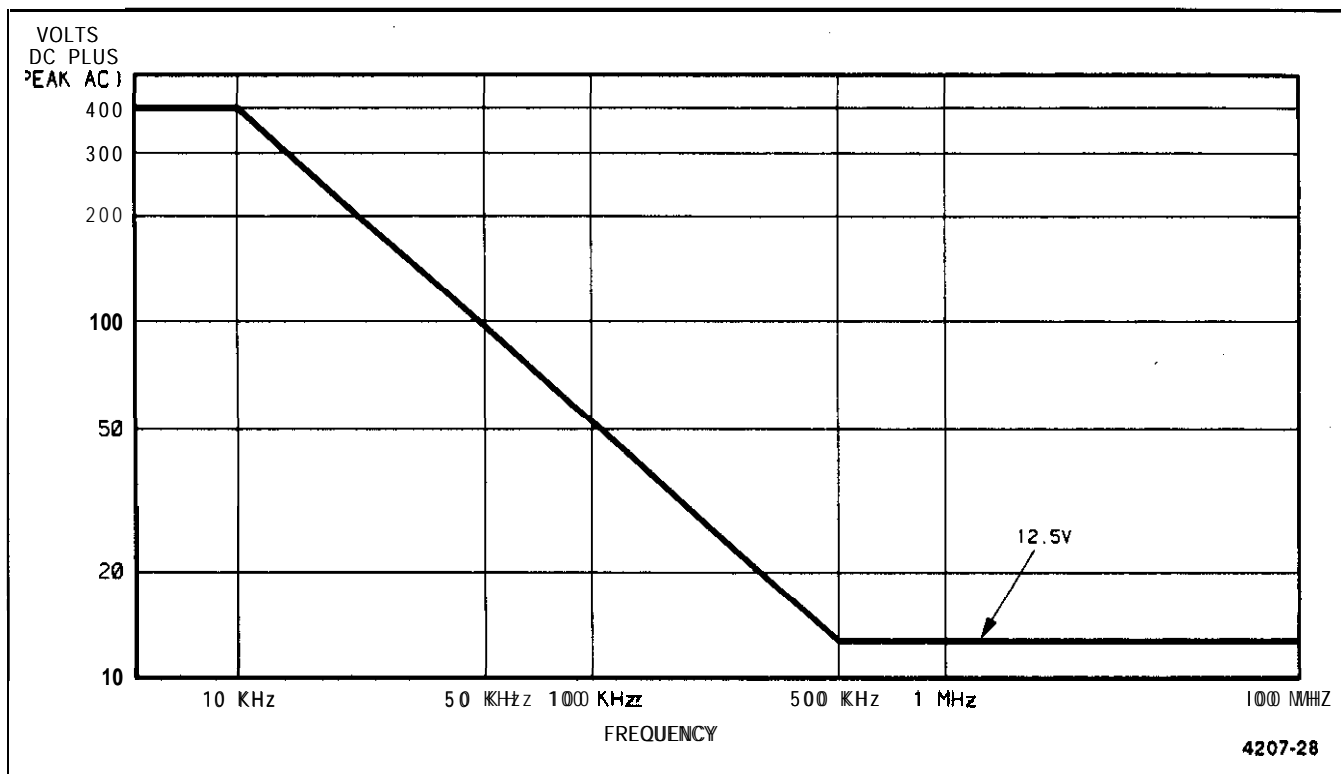


Figure 1-1. Maximum input voltage vs. frequency derating curve for CH 1 OR X, CH 2 OR Y, and EXT INPUT connectors.

Table I-2
Environmental Characteristics

Characteristics	Description
	<p style="text-align: center;">NOTE</p> <p><i>The instrument meets the requirements of MIL-T-28800C, paragraphs 4.5.5.1.3, 4.5.5.1.4, and 4.5.5.1.2.2 for Type III, Class 5 equipment, except where otherwise noted.</i></p>
Temperature	
Operating	0°C to +50°C (+32°F to +122°F).
Nonoperating	-55°C to +75°C (-67°F to +167°F). Tested to MIL-T-28800C paragraphs 4.5.5.1.3 and 4.5.5.1.4. except in 4.5.5.1.3 steps 4 and 5 (0°C operating test) are performed ahead of step 2 (-55°C nonoperating test). Equipment shall remain off upon return to room ambient during step 6. Excessive condensation shall be removed before operating during step 7.
Altitude	
Operating	To 4,500 m (15,000 ft). Maximum operating temperature decreased 1 °C per 1,000 ft above 5,000 ft.
Nonoperating	To 15,000 m (50,000 ft).
Humidity (Operating and Nonoperating)	5 cycles (120 hours) referenced to MIL-T-28800C paragraph 4.5.5.1.2.2 for Type III, Class 5 instruments. Operating and non-operating at 95% +0% to -5% relative humidity. Operating at +50°C and +30°C. Non-operating at +30°C to +60°C.
Vibration (Operating)	15 minutes along each of 3 major axes at a total displacement of 0.015 inch p-p (2.4 g's at 55 Hz) with frequency varied from 10 Hz to 55 Hz to 10 Hz in 1-minute sweeps. Hold for 10 minutes at 55 Hz in each of the 3 major axes. All major resonances must be above 55 Hz.
Shock (Operating and Nonoperating)	30 g's, half-sine, 11-ms duration, 3 shocks per axis each direction. for a total of 18 shocks.
EMI	Meets radiated and conducted emission requirements per VDE 0871 Class B.

Table 1-3
Physical Characteristics

Characteristic	Description
Weight With Power Cord	
With Cover, Probes, and Pouch	7.1 kg (15.7 lb).
Without Cover, Probes, and Pouch	6.1 kg (13.5 lb).
Domestic Shipping Weight	6.2 kg (13.0 lb).
Height	
With Feet and Handles	137 mm (5.4 in).
Width	
With Handle	360 mm (14.2 in).
Without Handle	327 mm (12.9 in).
Depth	
With Front Cover	445 mm (17.5 in).
Without Front Cover	440 mm (17.3 in).
With Handle Extended	511 mm (20.1 in).