Appendix B: Specification

This appendix begins with a *General Product Description* of the traits of the 2221A Digital Storage Oscilloscope. The *Characteristic Tables*, which list instrument characteristics and the requirements that correspond to them, follow.

General Product Description

The TEKTRONIX 2221A Digital Storage Oscilloscope is a portable, dual-channel oscilloscope suitable for use in a variety of test and measurement applications. It combines analog real-time (**NON-STORE** mode) and digital storage (**STORE** mode) capabilities to provide a 100 MHz analog bandwidth and up to a 100 Megasample/second digital sampling rate.

Vertical System

The vertical system offers the following features:

- Calibrated deflection factors from 2 mV to 5 V per division for both channels

- Variable **VOLTS/DIV** gain control that increases the deflection factor at least 2.5 to 1 for any **VOLTS/DIV** setting of either channel

- Vertical display modes **CH 1**, **CH 2**, and **BOTH**, with a choice in **BOTH** of **ADD**, **ALT**, or **CHOP**

- Bandwidth limiting that reduces bandwidth of the vertical amplifier system and the trigger system to 20 MHz

Horizontal System

The horizontal system offers the following features:

- Calibrated **SEC/DIV** settings that range from 0.5 s to 50 ns per division

- Variable **SEC/DIV** control to increase the non-store sweep time per division up to four times the calibrated time per division set by the **SEC/DIV** switch

- Horizontal magnification by X10 (extends the fastest sweep-speed time of 50 ns per division to 5 ns per division)

Digital Storage System

The digital storage offers the following features:

- Sampling at a maximum rate of 100 megasamples per second with both channels sampled simultaneously

- Glitch-catching capabilities for glitch widths as narrow as 10 ns

- Acquisition of waveforms in any of four acquisition modes: **SAMPLE**, **AVERAGE**, **ACCPEAK**, and **PEAKDET** (peak detect is available only at **SEC/DIV** settings slower than 2 μs)

- Maximum stored record lengths per waveform of either 4096 bytes (4 K) for single-channel acquisitions or 2048 bytes (2 K) for dual-channel acquisitions (**ALT** or **CHOP**)

- Four calibrated storage time bases of 1, 2, and 5 s per division for low-frequency signal acquisitions using **X10 STORE ONLY** button

- Compression of the 4 K acquisition record into a 1 K acquisition record using the Variable **SEC/DIV** control (4 K Compress mode)

- Storage of up to three 1 K records (512 data points per waveform when dual-channel records are stored) or one 4 K record (2 K per waveform when dual-channel acquisitions are stored) in the **SAVE REF** memory

User Interface

An internal microprocessor provides front panel control and feedback on control settings.

Front Panel Controls — This oscilloscope uses a combination of front-panel buttons, knobs, and on-screen menus to control its many functions. The front-panel controls are grouped according to function: vertical, horizontal, trigger, setup, and acquisition.

Almost all **NON-STORE** (analog real-time) and **STORE** mode functions are set using front panel controls, which allows them to be quickly adjusted. Some setup functions, such as **SETUP ACQ** and **DISPLAY**, are set indirectly using menus.

Display — An internal microprocessor reads the front-panel controls to determine their settings and generates on-screen readouts of many of those settings. Settings are displayed for the following controls:

- **VOLTS/DIV** knobs and **AC-GND-DC** switches for both channels

- **SEC/DIV** knob

- Voltage and Time **CURSOR** measurement readouts (on **STORE** Mode displays only)

- Trigger **LEVEL** knob

Additional readout information is displayed when in **STORE** (digital) mode. Shown are the acquisition mode, names of any **SAVE REF** memories displayed, **SAVE** if **SAVE/CONT** is so set, and **SWEEP LIMIT** if it is active.

Since all information just listed is read out on screen, it appears on all hard-copies made by the oscilloscope. Therefore, your waveform plots will also document the setup and measurement information associated with the waveform.

Measurement Features

You can measure voltage or time on both **NON-STORE** (analog) and **STORE** (digital) waveforms using the graticule. For **STORE** mode waveforms, you can also measure voltage and time using **CURSORS**. (Waveforms can be current acquisitions or **SAVE REF** acquisitions.)

The cursors are toggled to any displayed waveform of interest and then positioned using the **CURSORS** knob to any two points of interest on the waveform. The ΔV and ΔT readouts indicate the voltage difference and timing difference between the positions of the cursors.

For 4 K acquisition records, the **CURSORS** knob also scrolls the record back and forth horizontally, so any 1 K portion can be viewed on screen. (The screen can only display 1 K record points.)

Options and Accessories

For part numbers and information about both standard and optional accessories, refer to *Options and Accessories* which begins on page A-1 of this manual. Your Tektronix representative, local Tektronix Field Office, or Tektronix products catalog can also provide additional accessories information.

Performance Conditions

The following electrical characteristics (Table A-4) are valid when the instrument has been adjusted at an ambient temperature between +20° C and +30° C (+68° F and 86° F), has had a warm-up period of at least 20 minutes, and is operating at an ambient temperature between 0° C and +50° C (32° F and 122° F), unless otherwise noted.

Characteristic Tables

The characteristics listed in the tables that follow are valid when the performance conditions listed above are met. Items listed in the "Performance Requirements" column are verifiable qualitative or quantitative limits that define the measurement capabilities of the instrument.

Environmental characteristics are given in Table A-5 on page A-22. This instrument meets the requirements of MIL-T-28800D for Type III, Class 5 equipment, except where noted otherwise.

Physical characteristics of the instrument are listed in Table A-6 on page A-23.

Table A-4: Electrical Characteristics

Characteristics	Performance Requirements
Vertical Deflection System	
Deflection Factor	
Range	2 mV per division to 5 V per division in a 1-2-5 sequence.
DC Accuracy (NON-STORE)	
+15° C to +35° C	±2%.
0° C to +50° C	±3%.[1]
	For 5 mV per division to 5 V per division **VOLTS/DIV** switch settings, the gain is set at a **VOLTS/DIV** switch setting of 10 mV per division.
	2 mV per division gain is set with the **VOLTS/DIV** switch set to 2 mV per division.
On Screen DC Accuracy (STORE)	
+15° C to +35° C	±2%.
0° C to +50° C	±3%.[1]
	Gain set with the **VOLTS/DIV** switch set to 5 mV per division.
Storage Acquisition Vertical Resolution	8-bits, 25 levels per division. 10.24 divisions dynamic range.[1]
Range of **VOLTS/DIV** Variable control	Continuously variable between settings. Increases deflection factor by at least 2.5 to 1.

[1]**Performance Requirement not checked in manual.**

Table A-4: Electrical Characteristics (Cont.)

Characteristics	Performance Requirements	
NON-STORE Bandwidth (−3 dB)		
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 80 MHz	
+35° C to +50° C		
2 mV per division to 5V per division	DC to at least 80 MHz[1]	
	Measured with a vertically centered six-division reference signal, from a 50 Ω source driving a 50 Ω coaxial cable terminated in 50 Ω at the input connector; with the **VOLTS/DIV** Variable control in the **CAL** detent.	
BW LIMIT (−3dB)	20 MHz ±10%	
AC Coupled Lower Cutoff Frequency	10 Hz or less at −3 dB[1]	
Step Response (NON-STORE Mode)		
Rise Time		
0° C to +35° C		
5 mV per division to 5 V per division	3.5 ns or less.[1]	
2 mV per division	4.4 ns or less.[1]	
+35° C to +50° C		
5 mV per division to 5 V per division	3.9 ns or less.[1]	
2 mV per division	4.4 ns or less.[1]	
	Rise time is calculated from: $$Rise\ Time = \frac{0.35}{Bandwidth\ (-3\ dB)}$$	

Step Response (STORE Mode)[1]		
Useful Storage Rise Time	**Single Trace**	**Dual Trace (CHOP/ALT)**
SAMPLE	$\dfrac{SEC/DIVsetting \times 1.6}{100}\ sec$	$\dfrac{SEC/DIVsetting \times 1.6}{50}\ sec$
PEAKDET or ACCPEAK with SMOOTH	$\dfrac{SEC/DIVsetting \times 1.6}{50}\ sec$	$\dfrac{SEC/DIVsetting \times 1.6}{25}\ sec$
	Rise time is limited to 3.5 ns minimum with derating over temperature (see NON-STORE Rise Time).	

[1] **Performance Requirement not checked in manual.**

Table A-4: Electrical Characteristics (Cont.)

Characteristics	Performance Requirements		
Aberrations (NON-STORE and STORE in Default Modes)			
2 mV per division to 50 mV per division	+4%, −4%, 4% p-p		
0.1 V per division to 0.2 V per division	+6%, −6%, 6% p-p		
0.5 V per division	+6%, −6%, 6% p-p[1]		
1 V per division to 5 V per division	+12%, −12%, 12% p-p[1]		
	Measured with a five-division positive-going reference signal, from a 50 Ω coaxial cable terminated in 50 Ω at the input connector with the **VOLTS/DIV** Variable control in the **CAL** detent. Vertically center the top of the reference signal. Set Trigger **SLOPE** switch to positive.		
Useful Storage Performance[2]			
RECORD, SCAN and ROLL Store Modes			
SAMPLE Acquisition, no AVERAGE			
		Single Trace	**CHOP/ALT**
1 μs per division to 5 s per division		$\dfrac{10}{SEC/DIV\ setting}\ Hz^{1}$	$\dfrac{5}{SEC/DIV\ setting}\ Hz^{1}$
EXT CLOCK (up to 100 kHz)		$\dfrac{EXT}{10}\ Hz^{1}$	$\dfrac{EXT}{20}\ Hz^{1}$
PEAK DETECT			
Sine Wave Amplitude Capture (5% p-p maximum amplitude uncertainty)	10 MHz[1]		
Pulse Width Amplitude Capture (50% p-p maximum amplitude uncertainty)	10 ns		

[1] **Performance Requirement not checked in manual.**

[2] **Useful storage performance is limited to the frequency where there are 10 samples per sine wave signal period at the maximum sampling rate. (Maximum sampling rate is 100 MHz.) This yields a maximum amplitude uncertainty of 5%. Accuracy at the useful storage bandwidth limit is measured with respect to a six-division 50 kHz reference sine wave**

Table A-4: Electrical Characteristics (Cont.)

Characteristics	Performance Requirements	
REPETITIVE Store Mode		
SAMPLE and AVERAGE	**Single Trace**	**CHOP/ALT**
0.05 μs per division	100 MHz (−3 dB)[3]	100 MHz (−3 dB)[3]
0.1 μs per division	100 MHz (−3 dB)[1,3]	50 MHz (−3 dB)[1]
0.2 μs per division to 2 μs per division (5% maximum amplitude uncertainty)	$\dfrac{10}{SEC/DIV\ setting} Hz$[1]	$\dfrac{5}{SEC/DIV\ setting} Hz$[1]
ACCPEAK		
0.05 μs per division to 5 s per division	Same as NON-STORE Bandwidth	
AVERAGE Mode		
Sweep Limit	Adjustable from 1 to 998,000 or NO LIMIT. May be set in increments of 1 from 1 to 200; 2 from 202 to 1000; 10 from 1010 to 2000; 20 from 2020 to 10,000; 100 from 10,100 to 20,000; 200 from 20,200 to 100,000; 1,000 from 101,000 to 200,000; 2,000 from 202,000 to 998,000.[1]	
Weight of Last Acquisition	$\frac{1}{1}$, $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$, $\frac{1}{16}$, $\frac{1}{32}$, $\frac{1}{64}$, $\frac{1}{128}$, or $\frac{1}{256}$ (MENU selections). AVERAGE mode default weight is $\frac{1}{4}$.[1]	
NON-STORE CHOP Mode Switching Rate	500 kHz ± 30%[1]	
A/D Converter Linearity	Monotonic with no missing codes[1]	
Analog CH1/CH2 Delay Match	±1.0 ns[1]	
NON-STORE Common-Mode Rejection Ratio (CMRR)	At least 10 to 1 at 50 MHz. Checked at 10 mV per division for common-mode signals of six divisions or less with the **VOLTS/DIV** Variable control adjusted for the best CMRR at 50 kHz.	
Input Current	1 nA or less (0.5 division or less trace shift when switching between DC and GND input coupling with the **VOLTS/DIV** switch set to 2 mV per division).[1]	
Input Characteristics		
Resistance	1 MΩ ± 2%[1]	
Capacitance	20 pF ± 2pF[1]	

[1]Performance Requirement not checked in manual.

[3]One hundred MHz bandwidth derated for temperatures outside 0° C to +35° C and at 2 mV per division VOLTS/DIV setting as for NON-STORE.

Table A-4: Electrical Characteristics (Cont.)

Characteristics	Performance Requirements		
Maximum Safe Input Voltage (CH 1 and CH 2)	See Figure A-1 on page A-21 for maximum input voltage versus frequency derating curve.		
DC and AC Coupled ⚠	400 V (DC + peak AC) or 800 VAC p-p at 10 kHz or less.[1]		
Channel Isolation **STORE** and **NON-STORE**	Greater than 100 to 1 at 50 MHz		
POSITION Control Range	At least ±11 divisions from graticule center.		
Trace Shift with **VOLTS/DIV** Switch Rotation	0.75 division or less; **VOLTS/DIV** Variable control in the **CAL** detent.[1]		
Trace Shift as the **VOLTS/DIV** Variable Control is Rotated	1 division or less[1]		
Trace Shift with **INVERT**	1.5 divisions or less[1]		
Trigger System			
Trigger Sensitivity			
P-P AUTO and **NORM**	**10 MHz**	**60 MHz**	**100 MHz**
Internal	0.35 div	1.0 div	1.5 div
External	40 mV	120 mV	150 mV
	External trigger signal from a 50 Ω source driving a 50 Ω coaxial cable terminated in 50 Ω at the input connector.		
HF REJ Coupling	Should not trigger with a one division peak-to-peak 250 kHz signal when HF REJ is ON.		
	Reduces trigger signal amplitude at high frequencies by about 20 dB with rolloff beginning at 40 kHz ±25%.		
LF REJ Coupling	Should not trigger with a 0.35 division peak-to-peak 25 kHz signal when LF REJ is on.		
	Attenuates signals below 40 kHz (−3 dB point at 40 kHz ±25%).		
P-P AUTO Lowest Usable Frequency (Non-Store Mode only)	20 Hz with 1 division internal or 100 mV external[1]		
P-P AUTO Lowest Usable Frequency (Store Mode only)	500 Hz with 1 division internal or 100 mV external[1]		

[1]**Performance Requirement not checked in manual.**

Table A-4: Electrical Characteristics (Cont.)

Characteristics	Performance Requirements
TV LINE	
Internal	0.35 div[1]
External	35 mV p-p[1]
TV FIELD	$\geq$ 1 division of composite sync[1]
EXT INPUT Maximum Input Voltage ⚠	400 V (DC + peak AC) or 800 VAC p-p at 10 kHz or less.[1] See Figure A-1 on page A-21 for maximum input voltage versus frequency derating curve.
Input Resistance	1 MΩ $\pm$ 2%[1]
Input Capacitance	20 pF $\pm$ 2.5 pF[1]
AC Coupled Lower Cutoff Frequency	10 Hz or less at -3 dB[1]
LEVEL Control Range	
Trigger (NORM)	
INT	May be set at any voltage level of the trace that can be displayed.[1]
EXT, DC	At least $\pm$ 1.6 V, 3.2 V p-p.
EXT, DC $\div$ 10	At least $\pm$ 16 V, 32 V p-p.[1]
VAR HOLDOFF Control[4] (**NON-STORE** Holdoff)	Increases sweep holdoff time by at least a factor of 10.
Trigger Level Readout Accuracy +15° C to + 35° C	$\pm$(0.3 division, +5% of reading) Applies to $\pm$10 divisions from zero volts.
Acquisition Window Trigger Points	
Pretrigger	Seven-eighths of the waveform acquisition window is prior to the trigger (other trigger points are selectable via the MENU).

[1]**Performance Requirement not checked in manual.**

[4]**Holdoff in STORE mode is a function of microprocessor activity and the pretrigger acquisition. The VAR HOLDOFF control maintains some control over the STORE holdoff by preventing a new trigger from being accepted by the storage circuitry until the next (or current, if one is in progress) NON-STORE holdoff has completed.**

Table A-4: Electrical Characteristics (Cont.)

Characteristics	Performance Requirements		
Midtrigger	One-half of the waveform acquisition window is prior to the trigger (other trigger points are selectable via the MENU).		
Post Trigger	One-eighth of the waveform acquisition window is prior to the trigger (other trigger points are selectable via the MENU).		
Point-Selectable Triggering	**PRETRIG**[1]	**MIDTRIG**[1]	**POST TRIG**[1]
1 K Record Length	128	512	896
4 K Record Length	512	2048	3584

Horizontal Deflection System

NON-STORE Sweep Rates

Calibrated Range	0.5 sec per division to 0.05 μs per division in a 1-2-5 sequence of 22 steps.[5]

STORE Mode Ranges

REPETITIVE	0.05 μs per division to 0.5 s per division.[1,6]
RECORD	1 μs per division to 50 ms per division.[1,6]
ROLL/SCAN	0.1 s per division to 5 s per division.[1,6]

NON-STORE Accuracy	**Unmagnified**	**Magnified**
+15° C to +35° C		
0.5 s per division to 0.1 μs per division	±2%	±3%
0.05 μs per division	±2%	±4%
0° C to +50° C		
0.5 s per division to 0.1 μs per division	±3%[1]	±4%[1]
0.05 μs per division	±3%[1]	±6%[1]

Sweep accuracy applies over the center eight divisions. Exclude the first 40 ns of the sweep for magnified sweeps and anything beyond the 100th magnified division.

[1]Performance Requirement not checked in manual.
[5]The X10 MAG control extends the maximum sweep speed to 5 ns per division.
[6]The 4k COMPRESS control multiplies the SEC/DIV by 4.

Table A-4: Electrical Characteristics (Cont.)

Characteristics	Performance Requirements	
STORE Accuracy	See Horizontal Differential Accuracy and Cursor Time Difference Accuracy.[1]	
NON-STORE Sweep Linearity		
0.5 s per division to 10 ns per division	±0.1 division.	
5 ns per division	±0.15 division. Linearity measured over any two of the center eight divisions. Exclude the first 40 ns and anything past the 100th division of the X10 magnified sweeps.	
Digital Sample Rate	**Single Trace**	**CHOP/ALT**
SAMPLE (1 μs per division to 5 s per division)	$\dfrac{100}{SEC/DIV\ setting}Hz$[1]	$\dfrac{50}{SEC/DIV\ setting}Hz$[1]
PEAKDET or ACCPEAK (1 μs per division to 5 s per division)	100 MHz[1]	100 MHz[1]
REPETITIVE Store (0.05 μs per division to 0.5 μs per division)	100 MHz[1]	100 MHz[1]
External Clock		
Input Frequency		
Slow	DC to 1 kHz	
Fast	DC to 100 kHz	
Digital Sample Rate	100 MHz in ACCPEAK and PEAKDET, otherwise it is equal to the input frequency.[1]	
Screen Update Rate		
Slow	One data pair for every second falling clock edge.[1]	
Fast	Varies with record length and sweep speed.[1]	
Duty Cycle	10% or greater (5 μs minimum pulse width).[1]	
Ext Clock Logic Thresholds	Logic Thresholds are TTL compatible.	
Maximum Safe Input Voltage ⚠	25 V (DC + peak AC) or 25 V $_{p-p}$ AC at 1 kHz or less.[1]	
Input Resistance	Greater than 3.5 kΩ (LSTTL compatible).[1]	

[1]**Performance Requirement not checked in manual.**

Table A-4: Electrical Characteristics (Cont.)

Characteristics	Performance Requirements
STORE Mode Resolution	
Acquisition Record Length	1024 or 4096 data points.[1]
Single Waveform Acquisition Display	1024 data points (100 data points per division across the graticule area).
CHOP or **ALT** Acquisition Display	512 data points (50 data points per division across the graticule area).
Horizontal **POSITION** Control Range	Start of the 10th division will position past the center vertical graticule line in X1; start of the 100th division will position past the center vertical graticule line in X10 magnified and **NON-STORE**.
Horizontal Variable Sweep Control Range	
NON-STORE	Continuously variable between calibrated settings of the **SEC/DIV** switch. Extends each sweep speed by at least a factor of 2.5 times over the calibrated **SEC/DIV** setting.
STORE	Horizontal Variable Sweep has no affect on the STORE Mode time base. Rotating the Variable **SEC/DIV** control out of the **CAL** detent position horizontally compresses a 4 K point acquisition record to 1 K points in length, so that the whole record length can be viewed on screen. Screen readout is altered accordingly.
Displayed Trace Length	
NON-STORE	Greater than 10 divisions.
STORE	10.24 divisions.[1]

[1]**Performance Requirement not checked in manual.**

Digital Storage Display

Vertical	
Resolution	10 bits (1 part in 1024).[1]
	Display waveforms are calibrated for 100 data points per division.
Position Registration	
NON-STORE to **STORE**	±0.5 division at graticule center at **VOLTS/DIV** switch settings from 2 mV per division to 5 V per division.
CONTINUE to **SAVE**	±0.5 division at **VOLTS/DIV** switch settings from 2 mV per division to 5 V per division.

Table A-4: Electrical Characteristics (Cont.)

Characteristics	Performance Requirements
SAVE Mode Expansion or Compression Range	Up to 10 times as determined by the remaining **VOLTS/DIV** switch positions up or down.
	2 mV per division acquisitions cannot be expanded, and 5 V per division acquisitions cannot be compressed.
	Any portion of a stored waveform vertically magnified or compressed up to 10 times can be positioned to the top and to the bottom of the graticule area.
Storage Display Expansion Algorithm Error	±0.1% of full scale[1]
Storage Display Compression Algorithm Error	+0.16% of reading ±0.4% of full scale.[1]
Horizontal	
Resolution	10 bits (1 part in 1024).[1] Calibrated for 100 data points per division.
Differential Accuracy	Graticule indication of time cursor difference is ±2% of the readout value, measured over the center eight divisions.
SAVE Mode Expansion Range (YT mode)	10 times as determined by the X10 MAG switch.
Expansion Accuracy	Same as the Vertical.[1]

[1] **Performance Requirement not checked in manual.**

Table A-4: Electrical Characteristics (Cont.)

Characteristics	Performance Requirements
Digital Readout Display	
CURSOR Accuracy	
Voltage Difference	±3% of the ΔV readout value, ±0.4% of full scale (10 divisions). Applies within center 6 divisions.
Time Difference	
RECORD or ROLL/SCAN	
SAMPLE or AVERAGE	±1 display interval.[7]
PEAKDET or ACCPEAK	±2 display interval.[1,7]
REPETITIVE	
SAMPLE or AVERAGE	±(2 display interval + 0.5 ns).[1,7]
ACCPEAK	±(4 display interval + 0.5 ns).[1,7]
X-Y Operation (X1 Magnification Only)	
Deflection Factors	Same as vertical deflection system with the **VOLTS/DIV** Variable controls in the **CAL** detent position.
NON-STORE Accuracy[8]	
X-Axis	
+15° C to +35° C	±3%
0° C to +50° C	±4%[1]
Y-Axis	Same as vertical deflection system.[1]
NON-STORE Bandwidth (−3 dB)[8]	
X-Axis	DC to at least 2.5 MHz.
Y-Axis	Same as vertical deflection system.[1]
NON-STORE Phase Difference Between X-Axis and Y-Axis Amplifiers	±3 degrees from DC to 150 kHz.[1] Vertical Input Coupling set to DC.
STORE Accuracy	
X-Axis and Y-Axis	Same as digital storage vertical deflection system.[1]

[1]**Performance Requirement not checked in manual.**

[7]**A display interval is the time between two adjacent display points on a waveform.**

[8]**Measured with a DC-coupled, five-division reference signal.**

Table A-4: Electrical Characteristics (Cont.)

Characteristics	Performance Requirements
Useful Storage Bandwidth	
RECORD and REPETITIVE Store Modes	$\dfrac{5}{SEC/DIV\ setting}\ Hz$[1]
STORE Mode Time Difference Between Y-Axis and X-Axis Signals	
RECORD, SCAN, and ROLL Modes	± 1.0 ns[1]
REPETITIVE Store	$\dfrac{SEC/DIV\ setting}{100} \times 4$[1]
Probe Adjust	
Output Voltage on **PRB ADJ** Jack	0.5 V $\pm$5%
Probe Adjust Signal Repetition Rate	1 kHz $\pm$20%[1]
Z-Axis	
Sensitivity (**NON-STORE** Only)	5 V causes noticeable modulation. Positive-going input decreases intensity. Usable frequency range is DC to 20 MHz.
Maximum Input Voltage ⚠	30 V (DC + peak AC) or 30 V p-p at 1 kHz or less.[1]
Input Resistance	Greater than 10 kΩ.[1]
X-Y Plotter Output	
Maximum Safe Applied Voltage, Any Connector Pin ⚠	25 V (DC + peak AC) or 25 V p-p AC at 1 kHz or less.[1]
X and Y Plotter Outputs	
Pen Lift/Down	Fused relay contacts, 100 mA maximum.[1]
Output Voltage Levels	500 mV per division $\pm$20%. Center screen is 0 V $\pm$1 division. Measured with a DC-coupled, five-division reference signal.
Series Resistance	2 kΩ $\pm$10%[1]

[1]**Performance Requirement not checked in manual.**

Table A-4: Electrical Characteristics (Cont.)

Characteristics	Performance Requirements
Power Supply	
Line Voltage Range	90 VAC to 250 VAC[1]
Line Frequency	48 Hz to 440 Hz[1]
Maximum Power Consumption	85 watts (150 VA)[1]
Line Fuse	2 A, 250 V, slow blow[1]
Primary Circuit Dielectric Requirement	Routine test to 1500 V $_{rms}$, 60 Hz, for 10 seconds without breakdown.[1]
CRT Display	
Display Area	8 cm X 10 cm.[1]
Standard Phosphor	P31[1]
Nominal Accelerating Voltage	14 kV[1]
4.2 V Output	±10% through 2 kΩ.[1]
Memory	
Power-Down	
Battery Voltage	Memory retained for battery voltages greater than 2.3 V.[1]
Data Retention	Memory maintained at least 6 months without instrument power.[1]
Battery Life	Power-down data retention specification shall be maintained for 3 years without battery change.
Power-Down Detection	
Threshold	Fail asserted for supply drop to less than 4.5 V.[1] Reset held until supply is greater than 4.75 V.[1]
Reset Delay	Power-down interrupt to reset delay ≥ 1 ms.[1]

[1]**Performance Requirement not checked in manual.**

Table A-4: Electrical Characteristics (Cont.)

Characteristics	Performance Requirements
	GPIB Option
GPIB Requirements	Complies with ANSI/IEEE Standard 488-1978.[1]
	RS-232-C Option
RS-232-C Requirements	Complies with EIA Standard RS-232-C.[1]
Baud Rates	
Available Rates	110, 300, 600, 1200, and 2400 baud.[1]
Accuracy	< 1% error.[1]

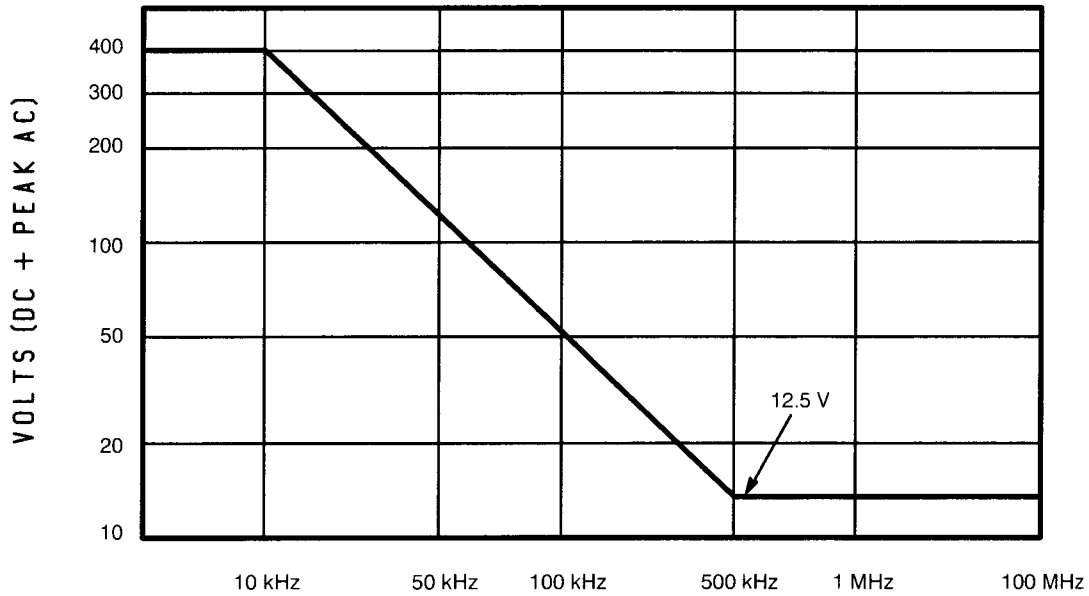[1]Performance Requirement not checked in manual.

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

Table A-5: Environmental Characteristics

Characteristics	Performance Requirements
Environmental Requirements	The instrument meets the following MIL-T-28800D requirements for Type III, Class 5, Style D equipment, except where noted otherwise.[1]
Temperature	
Operating	0° C to +50° C (+32° F to +122° F)[1]
Nonoperating	−40° C to +71° C (−40° F to +160° F)[1]
	Tested to MIL-T-28800D, para 4.5.5.1.3 and 4.5.5.1.4, except that in para 4.5.5.1.3 steps 4 and 5 (−10° C operating test) are performed before step 2 (−40° C nonoperating test). Equipment shall remain off upon return to room ambient temperature during step 6. Excessive condensation shall be removed before operating during step 7.
Altitude	
Operating	To 4,500 meters (13,716 feet)[1]
	Maximum operating temperature decreases 1° C per 1,000 feet above 5,000 feet.
Nonoperating	To 15,240 meters (50,000 feet)[1]
	Exceeds requirements of MIL-T-2880D, para 4.5.5.2.
Humidity	
Operating and Nonoperating	5 cycles (120 hours) referenced to MIL-T-28800D para 4.5.5.1.2.2 for Type III, Class 5 instruments. Operating and nonoperating at 95%, −5% to +0%, relative humidity. Operating, +30° C to +50° C; nonoperating, +30° C to +60° C.[1]
EMI (electromagnetic interference)	Meets radiated and conducted emission requirements per VDE 0871, Class B.[1]
	To meet EMI regulations and specifications, use a double shielded cable and metal connector housing with the housing grounded to the cable shield on the AUXILIARY CONNECTOR.
Vibration	
Operating	15 minutes along each of three major axes at a total displacement of 0.015 inch p-p (2.3 g at 55 Hz) with frequency varied from 10 Hz to 55 Hz to 10 Hz in one-minute sweeps. Hold for 10 minutes at 55 Hz in each of the three major axes. All major resonances are above 55 Hz.[1]
	Meets requirements of MIL-T-22800D, para 4.5.5.3.1.

[1]**Performance Requirement not checked in manual.**

Table A-5: Environmental Characteristics (Cont.)

Characteristics	Performance Requirements
Shock	
Operating and Nonoperating	30 g half-sine, 11 ms duration, three shocks per axis each direction, for a total of 18 shocks.[1]
	Meets requirements of MIL-T-22800D, para 4.5.5.4.1, except limited to 30 g.
Bench Handling Test	Each edge lifted four inches and allowed to free fall onto a solid wooden bench surface.[1]
	Meets requirements of MIL-T-22800D, para 4.5.5.4.3.

[1]**Performance Requirement not checked in manual.**

Table A-6: Physical Characteristics[9]

Characteristics	Performance Requirements
Weight	
With Power Cord, Cover, Probes, and Pouch	9.4 kg (20.7 lb).
With Power Cord Only	8.2 kg (18 lb).
Domestic Shipping Weight	12.2 kg (26.9 lb).
Height	137 mm (5.4 in).
Width	
With Handle	360 mm (14.2 in).
Without Handle	328 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).

[9]**See Figure A-2 on page A-24 for a dimensional drawing.**

137 mm
(5.41 in.)

130 mm
(5.13 in.)

123 mm
(4.85
in.)

130 mm
(5.13 in.)

138 mm
(5.42
in.)

285 mm (11.21 in.)

404 mm (15.91 in.)

511 mm (20.10 in.)

435 mm (17.3 in.)

374 mm (14.73 in.)

362 mm
(14.25 in.)

232 mm
(9.12 in.)
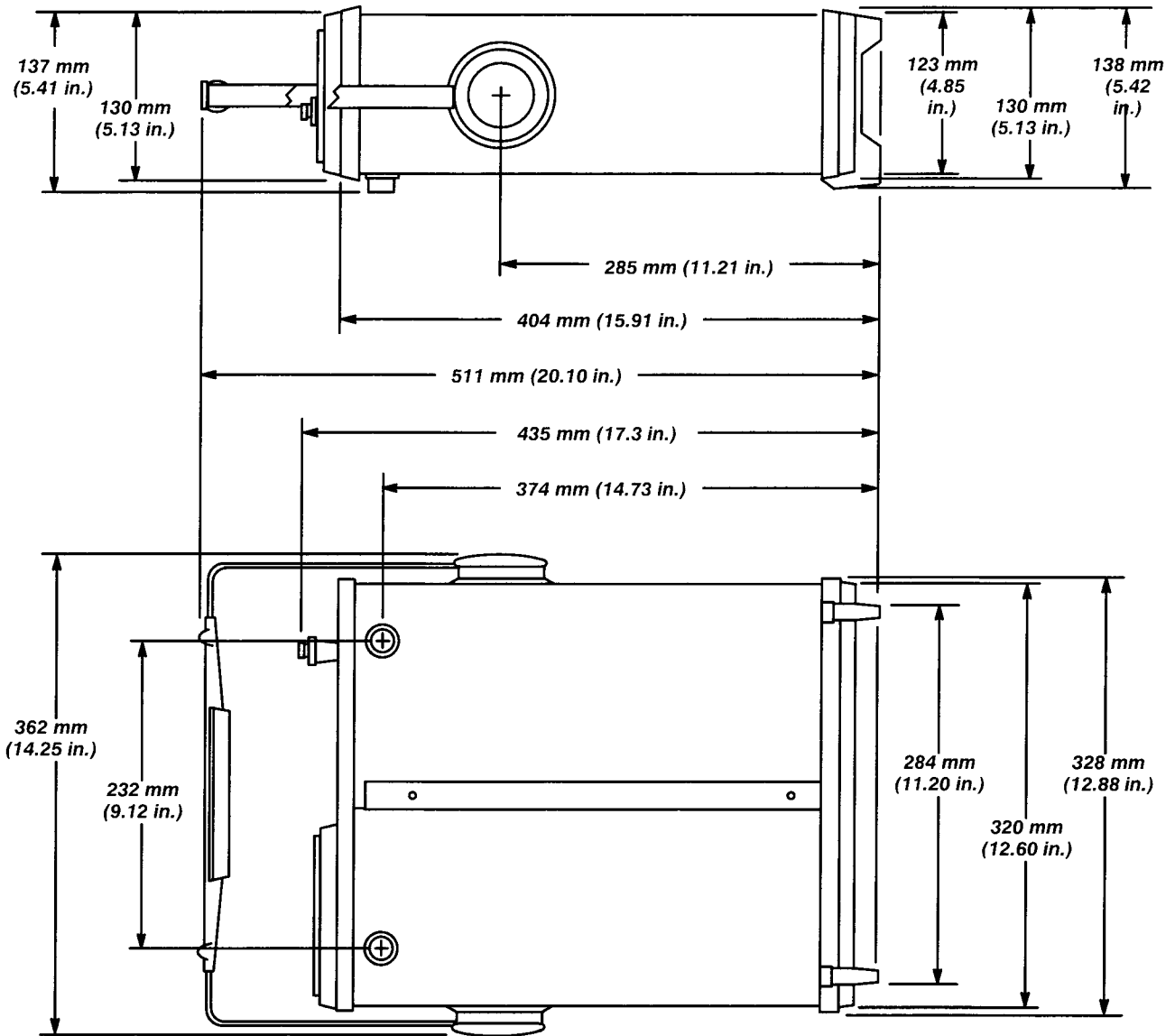
284 mm
(11.20 in.)

320 mm
(12.60 in.)

328 mm
(12.88 in.)

Figure A-2: Physical dimensions of the 2221A Digital Storage Oscilloscope