

Table 1-1
Electrical Characteristics

Characteristics	Performance Requirements	
VERTICAL DEFLECTION SYSTEM		
Deflection Factor		
Range	2 mV/div to 5 V/div in a 1-2-5 sequence.	
DC Accuracy (NON STORE)		
+15°C to +35°C	Within ±2%.	
0°C to +50°C	Within ±3%. For 5 mV/div to 5 V/div VOLTS/DIV switch settings, the gain is set at a VOLTS/DIV switch setting of 10 mV/div. 2 mV/div gain is set with the VOLTS/DIV switch set to 2 mV/div.	
On Screen DC Accuracy (STORE)		
+15°C to +35°C	Within ±2%.	
0°C to +50°C	Within ±3%. STORE Mode gain set with the VOLTS/DIV switch set to 5 mV/div.	
Storage Acquisition Vertical Resolution	8 bits, 25 levels per division. 10.24 divisions dynamic range.	
Range of VOLTS/DIV Variable Control	Continuously variable between settings. Increases deflection factor by at least 2.5 to 1.	
Step Response (NON STORE)		
Rise Time		
0°C to +35°C		
5 mV/div to 5 V/div	3.5 ns or less.	
2 mV/div	4.4 ns or less.	
+35°C to +50°C		
5 mV/div to 5 V/div	3.9 ns or less.	
2 mV/div	4.4 ns or less. Rise time is calculated from: $\text{Rise Time} = \frac{0.35}{\text{Bandwidth } (-3 \text{ dB})}$	
Step Response (STORE Mode)		
Useful Storage Rise Time		
SAMPLE	Single Trace $\frac{\text{SEC/DIV} \times 1.6}{100} \text{ s}$	CHOP/ALT $\frac{\text{SEC/DIV} \times 1.6}{50} \text{ s}$
PEAKDET or ACCPEAK with SMOOTH	$\frac{\text{SEC/DIV} \times 1.6}{50} \text{ s}$	$\frac{\text{SEC/DIV} \times 1.6}{25} \text{ s}$
	Rise time is limited to 3.5 ns minimum with derating over temperature (see NON STORE Rise Time).	

Table 1-1 (cont)

Characteristic	Performance Requirements	
Aberrations (NON STORE and STORE In Default Modes) 2 mV/div to 50 mV/div	+4%, -4%, 4% p-p. 3% or less at 25°C with cabinet installed.	
0.1 V/div to 0.5 V/div	+6%, -6%, 6% p-p. 5% or less at +25°C with cabinet installed.	
1 V/div to 5 V/div	+12%, -12%, 12% p-p. 10% or less at +25°C with cabinet installed. Measured with a five-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. Vertically center the top of the reference signal.	
NON STORE Bandwidth (-3 dB) 0°C to +35°C 5 mV/div to 5 V/div	DC to at least 100 MHz.	
2 mV/div +35°C to +50°C 2 mV/div to 5 V/div	DC to at least 80 MHz. 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.	
NON STORE BW LIMIT (-3 dB)	20 MHz ±10%.	
AC Coupled Lower Cutoff Frequency	10 Hz or less at -3 dB.	
Useful Storage Performance RECORD, SCAN and ROLL Store Modes SAMPLE Acquisition, no AVERAGE 5 μs/div to 5 s/div EXT CLOCK (up to 1 kHz)	Single Trace $\frac{10}{\text{SEC/DIV}}$ Hz $\frac{\text{EXT}}{10}$ Hz	CHOP/ALT $\frac{5}{\text{SEC/DIV}}$ Hz $\frac{\text{EXT}}{20}$ Hz 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 20 MHz in Single trace and 10 MHz in CHOP or ALT at a SEC/DIV setting of 5 μs/div.) 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.
PEAK DETECT Sine-Wave Amplitude Capture (5% p-p maximum amplitude uncertainty) Pulse Width Amplitude Capture (50% p-p maximum amplitude uncertainty)	Single Trace and ALT 1 MHz 100 ns	CHOP 1 MHz $\frac{\text{SEC/DIV}}{50}$

Table 1-1 (cont)

Characteristics	Performance Requirements								
REPETITIVE Store Mode SAMPLE and AVERAGE 0.05 μ s/div 0.1 μ s/div 0.2 μ s/div to 2 μ s/div (5% maximum amplitude uncertainty)	<table border="0"> <tr> <td>Single Trace</td> <td>ALT</td> </tr> <tr> <td>100 MHz (-3 dB)^a</td> <td>100 MHz (-3 dB)^a</td> </tr> <tr> <td>100 MHz (-3 dB)^a</td> <td>60 MHz (-3 dB)</td> </tr> <tr> <td>$\frac{10}{\text{SEC/DIV}}$ Hz</td> <td>$\frac{5}{\text{SEC/DIV}}$ Hz</td> </tr> </table>	Single Trace	ALT	100 MHz (-3 dB) ^a	100 MHz (-3 dB) ^a	100 MHz (-3 dB) ^a	60 MHz (-3 dB)	$\frac{10}{\text{SEC/DIV}}$ Hz	$\frac{5}{\text{SEC/DIV}}$ Hz
Single Trace	ALT								
100 MHz (-3 dB) ^a	100 MHz (-3 dB) ^a								
100 MHz (-3 dB) ^a	60 MHz (-3 dB)								
$\frac{10}{\text{SEC/DIV}}$ Hz	$\frac{5}{\text{SEC/DIV}}$ Hz								
ACCPEAK 0.05 μ s/div to 5 s/div	Same as NON STORE Bandwidth.								
AVERAGE Mode Sweep Limit Weight of Last Acquisition Resolution	Adjustable from 1 to 2047 or NO LIMIT. 1/2, 1/4, 1/8, 1/16, 1/32, 1/64, 1/128, or 1/256 (MENU selections). AVERAGE mode default weight is 1/4. Assuming uncorrelated triggers and greater than 1 LSB of the 8-bit acquisition of vertical signal noise; the averaging weight for the first acquisition is 1, the averaging weight for the second acquisition is 1/2 and for n acquisitions is $1/2^{n-1}$. The MENU selects the least weight used. Maximum signal-to-noise improvement is achieved after $2 \times$ (weight factor) \times (expected acquisitions to fill).								
Frequency Response	Frequency response of the AVERAGE Storage Mode is a function of the number of triggered acquisitions added to the weighted average. Time jitter of a signal with respect to the sample clock will produce a low-pass filter characteristic of an averaged waveform.								
NON STORE CHOP Mode Switching Rate	500 kHz \pm 30%.								
STORE Chop Rate SAMPLE	50/(SEC/DIV) for sweep speeds from 5 s per division to and including 10 μ s per division.								
PEAK DETECT 5 μ s/div through 0.05 μ s/div	25/(SEC/DIV) for sweep speeds from 5 s per division to and including 20 μ s per division.								
A/D Converter Linearity	No CHOP mode; acts as in ALT.								
STORE Mode Cross Talk	Monotonic with no missing codes.								
STORE Mode Cross Talk	<2% measured in CHOP at 10 μ s/div and 10 mV/div using a 100 kHz square wave signal vertically centered and the other input coupling set to ground.								

^aOne-hundred MHz bandwidth is derated for temperature outside 0°C to 35°C and at 2 mV/div VOLTS/DIV as for NON STORE.

Table 1-1 (cont)


Characteristics	Performance Requirements
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.
Input Characteristics	
Resistance	1 M Ω \pm 2%.
Capacitance	20 pF \pm 2 pF.
Maximum Safe Input Voltage (CH 1 and CH 2) DC and AC Coupled 	See Figure 1-1 for maximum input voltage vs frequency derating curve. 400 V (dc + peak ac) or 800 V ac p-p at 10 kHz or less.
NON STORE Channel Isolation	Greater than 100 to 1 at 50 MHz.
STORE Channel Isolation	100 to 1 at 50 MHz.
POSITION Control Range	At least \pm 11 divisions from graticule center.
A/B SWP SEP Control Range (NON STORE Mode Only)	\pm 3.5 divisions or greater.
Trace Shift with VOLTS/DIV Switch Rotation	0.75 division or less; VOLTS/DIV Variable control in the CAL detent.
Trace Shift as the VOLTS/DIV Variable Control is Rotated	1 division or less.
Trace Shift with INVERT	1.5 divisions or less.

Table 1-1 (cont)


Characteristics	Performance Requirements		
TRIGGERING SYSTEM			
A 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
HF REJ Coupling	External trigger signal from a 50 Ω source driving a 50 Ω coaxial cable terminated in 50 Ω at the input connector. Reduces trigger signal amplitude at high frequencies by about 20 dB with rolloff beginning at 40 kHz \pm 15 kHz. Should not trigger with a one-division peak-to-peak 250 kHz signal when HF REJ is ON.		
P-P AUTO Lowest Usable Frequency	20 Hz with 1 division internal or 100 mV external.		
TV LINE			
Internal	0.35 div.		
External	35 mV p-p.		
TV FIELD	\geq 1 division of composite sync.		
B Trigger Sensitivity (Internal Only)	10 MHz	60 MHz	100 MHz
	0.35 div	1.0 div	1.5 div
EXT INPUT			
Maximum Input Voltage 	400 V (dc + peak ac) or 800 V ac p-p at 10 kHz or less. See Figure 1-1 for maximum input voltage vs frequency derating curve.		
Input Resistance	1 M Ω \pm 2%.		
Input Capacitance	20 pF \pm 2.5 pF.		
AC Coupled Lower Cutoff Frequency	10 Hz or less at -3 dB.		
LEVEL Control Range			
A Trigger (NORM)	May be set at any voltage level of the trace that can be displayed.		
INT	At least \pm 1.6 V, 3.2 V p-p.		
EXT, DC	At least \pm 16 V, 32 V p-p.		
EXT, DC+10	May be set at any point of the trace that can be displayed.		
B Trigger (Internal)	Increases NON STORE A Sweep holdoff time by at least a factor of 10. STORE holdoff 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.		
VAR HOLDOFF Control (NON STORE Holdoff)			
Acquisition Window Trigger Point			
PRETRIG	Seven-eighths of the waveform acquisition window is prior to the trigger (other trigger points are selectable via the MENU).		
POST TRIG	One-eighth of the waveform acquisition window is prior to the trigger (other trigger points are selectable via the MENU).		

Table 1-1 (cont)

Characteristics	Performance Requirements	
HORIZONTAL DEFLECTION SYSTEM		
NON STORE Sweep Rates		
Calibrated Range		
A Sweep	0.5 sec per division to 0.05 μ s per division in a 1-2-5 sequence of 22 steps. ^b	
B Sweep	50 ms per division to 0.05 μ s per division in a 1-2-5 sequence of 19 steps. ^b	
STORE Mode Ranges		
REPETITIVE	0.05 μ s per division to 2 μ s per division. ^c	
RECORD	5 μ s per division to 50 ms per division. ^c	
ROLL/SCAN	0.1 s per division to 5 s per division (A sweep only). ^c	
NON STORE Accuracy	Unmagnified	Magnified
+15°C to +35°C		
0.5 s/div to 0.1 μ s/div	Within $\pm 2\%$	Within $\pm 3\%$
0.05 μ s/div	Within $\pm 2\%$	Within $\pm 4\%$
0°C to +50°C		
0.5 s/div to 0.1 μ s/div	Within $\pm 3\%$	Within $\pm 4\%$
0.05 μ s/div	Within $\pm 3\%$	Within $\pm 6\%$
	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.	
STORE Accuracy	See Horizontal Differential Accuracy and Cursor Time Difference Accuracy.	
NON STORE Sweep Linearity		
0.5 s/div to 10 ns/div	Within ± 0.1 division.	
5 ns/div	Within ± 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		
(5 μ s/div to 5 s/div)	100 SEC/DIV Hz	50 SEC/DIV Hz
PEAKDET or ACCPEAK		
(20 μ s/div to 5 s/div)	10 MHz	10 MHz
REPETITIVE Store		
0.05 μ s/div to 1 μ s/div	20 MHz	20 MHz
2 μ s/div	10 MHz	10 MHz.

^bThe X10 MAG control extends the maximum sweep speed to 6 ns per division.

^cThe X10 MAG control extends the maximum sweep speed to 6 ns per division. The 4K COMPRESS control multiplies the SEC/DIV by 4.

Table 1-1 (cont)


Characteristics	Performance Requirements
External Clock	
Input Frequency	Up to 1 kHz.
Digital Sample Rate	10 MHz in ACCPEAK and PEAKDET, otherwise it is equal to the input frequency.
Store Rate	One data pair for every second falling edge.
Duty Cycle	10% or greater (100 μ s minimum hold time).
Ext Clock Logic Thresholds	TTL compatible.
Maximum Safe Input Voltage 	25 V (dc + peak ac) or 25 V p-p ac at 1 kHz or less.
Input Resistance	>20 k Ω .
STORE Mode Dynamic Range	10.24 divisions.
STORE Mode Resolution	
Acquisition Record Length	1024 or 4096 data points.
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 (NON STORE)	Start of the 10th division will position past the center vertical graticule line; 100th division in X10 magnified.
Horizontal Variable Sweep Control Range NON STORE	Continuously variable between calibrated settings of the SEC/DIV switch. Extends the A and the B Sweep speeds by at least a factor of 2.5 times over the calibrated SEC/DIV settings.
STORE	Horizontal Variable Sweep has no effect on the STORE Mode time base. Rotating the Variable SEC/DIV control out of the CAL detent position horizontally compresses a 4K point acquisition record to 1K 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.
Delay Time 0.5 μ s per division to 0.5 sec per division (A Sweep) Delay POSITION Range	Less than (0.5 div + 300 ns) to greater than 10 divisions. Delay Time is functional, but not calibrated, at A Sweep speeds faster than 0.5 μ s per division.
NON STORE Delay Jitter	One part or less in 5,000 (0.02%) of the maximum available delay time.

Table 1-1 (cont)

Characteristics	Performance Requirements
Delay Time Differential Measurement Accuracy (Runs After Delay only)	
+15°C to +35°C	±1% of reading, ±0.5% of full scale (10 div).
0°C to +50°C	±2% of reading, ±0.5% of full scale (10 div). Exclude delayed operation when the A and B SEC/DIV knobs are locked together at any sweep speed or when the A SEC/DIV switch is faster than 0.5 μs per division. Accuracy applies over the B DELAY TIME POSITION control range.
DIGITAL STORAGE DISPLAY	
Vertical	
Resolution	10 bits (1 part in 1024). Display waveforms are calibrated for 100 data points per division.
Differential Accuracy	Graticule indication of the voltage cursor difference is within 2% of the readout value, measured over the center six divisions.
POSITION Range	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.
Position Registration NON STORE to STORE	Within ±0.5 division at graticule center at VOLTS/DIV switch settings from 2 mV per division to 5 V per division.
CONTINUE to SAVE	Within ±0.5 division at VOLTS/DIV switch settings from 2 mV per division to 5 V per division.
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.
Storage Display Expansion Algorithm Error	±0.1% of full scale.
Storage Display Compression Algorithm Error	+0.16% of reading ±0.4% of full scale.
Horizontal	
Resolution	10 bits (1 part in 1024). Calibrated for 100 data points per division.
Differential Accuracy	Graticule indication of time cursor difference is within ±2% of the readout value, measured over the center eight divisions.
SAVE Mode Expansion Range Y-T Mode	10 times as determined by the X10 MAG switch.
Expansion Accuracy	Same as the Vertical.

Table 1-1 (cont)

Characteristics	Performance Requirements
DIGITAL READOUT DISPLAY	
CURSOR Accuracy	
Voltage Difference	Within $\pm 3\%$ of the ΔV readout value.
Time Difference	
RECORD or ROLL/SCAN SAMPLE or AVERAGE	± 1 display interval.
PEAKDET or ACCPEAK	± 2 display intervals.
REPETITIVE	
SAMPLE or AVERAGE	$\pm (2 \text{ display intervals} + 0.5 \text{ ns})$.
ACCPEAK	$\pm (4 \text{ display intervals} + 0.5 \text{ ns})$.
A display interval is the time between two adjacent display points on a waveform.	
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	Measured with a dc-coupled, five-division reference signal.
X-Axis	
+15°C to +35°C	Within $\pm 3\%$.
0°C to +50°C	Within $\pm 4\%$.
Y-Axis	Same as vertical deflection system.
NON STORE Bandwidth (-3 dB)	Measured with a five-division reference signal.
X-Axis	DC to at least 2.5 MHz.
Y-Axis	Same as vertical deflection system.
NON STORE Phase Difference Between X-Axis and Y-Axis Amplifiers	± 3 degrees or less from dc to 150 kHz. Vertical Input Coupling set to DC.
STORE Accuracy	
X-Axis and Y-Axis	Same as digital storage vertical deflection system.
Useful Storage Bandwidth	
RECORD and REPETITIVE Store Modes	$\frac{5}{\text{SEC/DIV}}$ Hz
STORE Mode Time Difference Between Y-Axis and X-Axis Signals	
RECORD, SCAN, and ROLL Modes	100 ns. The X-Axis signal is sampled before the Y-Axis signal.
REPETITIVE Store	$\frac{\text{SEC/DIV}}{100} \times 4$

Table 1-1 (cont)



Characteristics	Performance Requirements
PROBE ADJUST	
Output Voltage on PRB ADJ Jack	0.5 V \pm 5%.
Probe Adjust Signal Repetition Rate	1 kHz \pm 20%.
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 ac at 1 kHz or less.
Input Resistance	>10 k Ω .
POWER SUPPLY	
Line Voltage Range	90 Vac to 250 Vac.
Line Frequency	48 Hz to 440 Hz.
Maximum Power Consumption	85 watts (150 VA).
Line Fuse	2 A, 250 V, slow blow.
Primary Circuit Dielectric Requirement	Routine test to 1500 Vrms, 60 Hz, for 10 seconds without breakdown.
CRT DISPLAY	
Display Area	8 cm x 10 cm.
Standard Phosphor	P31.
Nominal Accelerating Voltage	14 kV.
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.
X and Y Plotter Outputs	
Pen Lift/Down	Fused relay contacts, 100 mA maximum.
Output Voltage Levels	500 mV per division \pm 10%. Center screen is 0 V \pm 0.2 division.
Series Resistance	2 k Ω \pm 10%.
4.2 V Output	4.2 V \pm 10% through 2 k Ω .

Table 1-2
Environmental Characteristics

Characteristics	Performance Requirements
Environmental Requirements	<p>Instrument meets the requirements of Tektronix Standard 062-2853-00, Class 5, except EMI.</p> <p>The instrument meets the following MIL-T-28800C requirements for Type III, Class 5 equipment, except where noted otherwise.</p>
Temperature	
Operating	0°C to +50°C (+32°F to +122°F).
Nonoperating	<p>−55°C to +75°C (−67°F to +167°F).</p> <p>Tested to MIL-T-28800C, 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 are performed before step 2 (−55°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.</p>
Altitude	
Operating	To 4,500 meters (15,000 feet). Maximum operating temperature decreases 1°C per 1,000 feet above 5,000 feet.
Nonoperating	To 15,000 meters (50,000 feet).
Humidity	
Operating and Nonoperating	5 cycles (120 hours) referenced to MIL-T-28800C 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.
EMI (electromagnetic interference)	<p>Meets radiated and conducted emission requirements per VDE 0871, Class B.</p> <p>To meet EMI regulations and specifications, use the specified shielded cable and metal connector housing with the housing grounded to the cable shield on the AUXILIARY CONNECTOR.</p>
Vibration	
Operating	15 minutes along each of three major axes at a total displacement of 0.015 inch p-p (2.4 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.
Shock	
Operating and Nonoperating	30 g, half-sine, 11 ms duration, three shocks per axis each direction, for a total of 18 shocks.

Table 1-3
Physical Characteristics

Characteristics	Description
Weight	See Figure 1-2 for dimensional drawing.
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	362 mm (14.3 in).
Without Handle	327 mm (12.9 in).
Depth	
With Front Cover	445 mm (17.5 in).
Without Front Cover	435 mm (17.1 in).
With Handle Extended	510 mm (20.1 in).

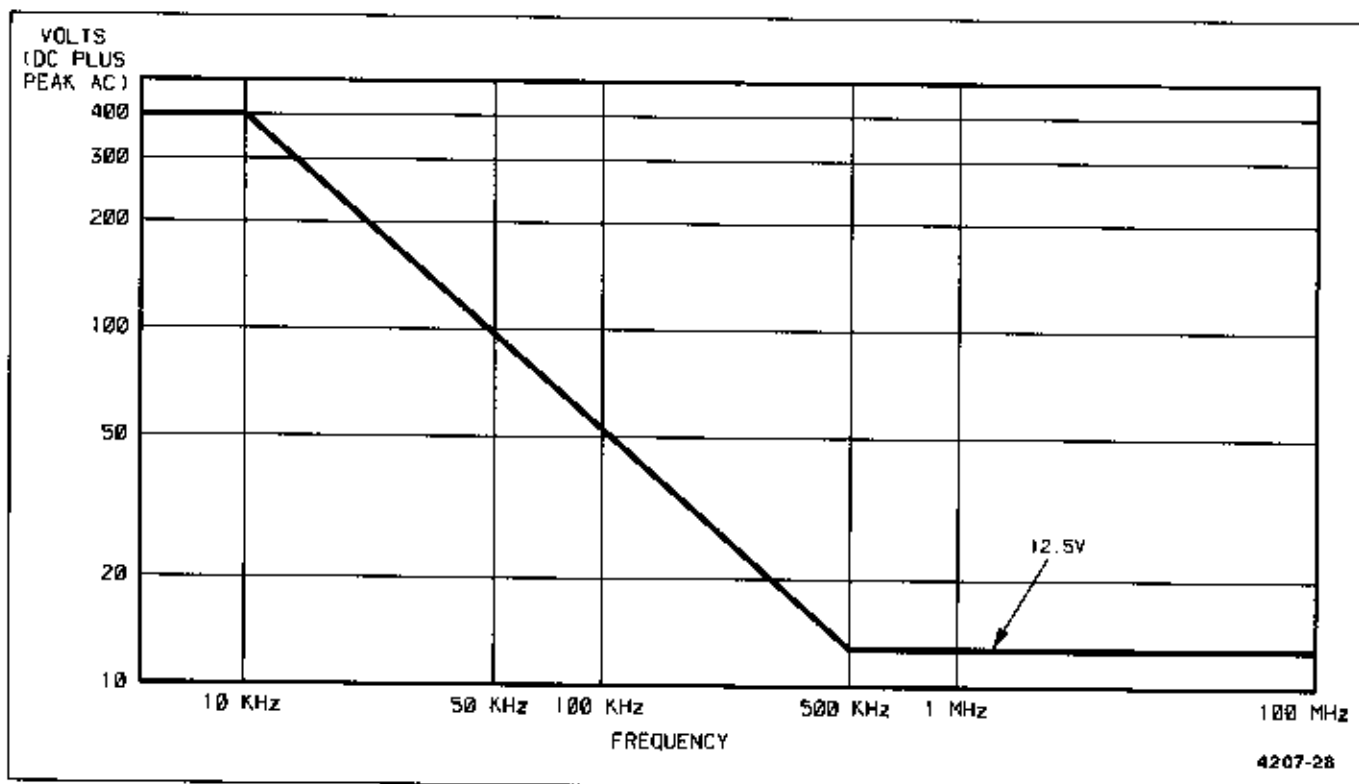
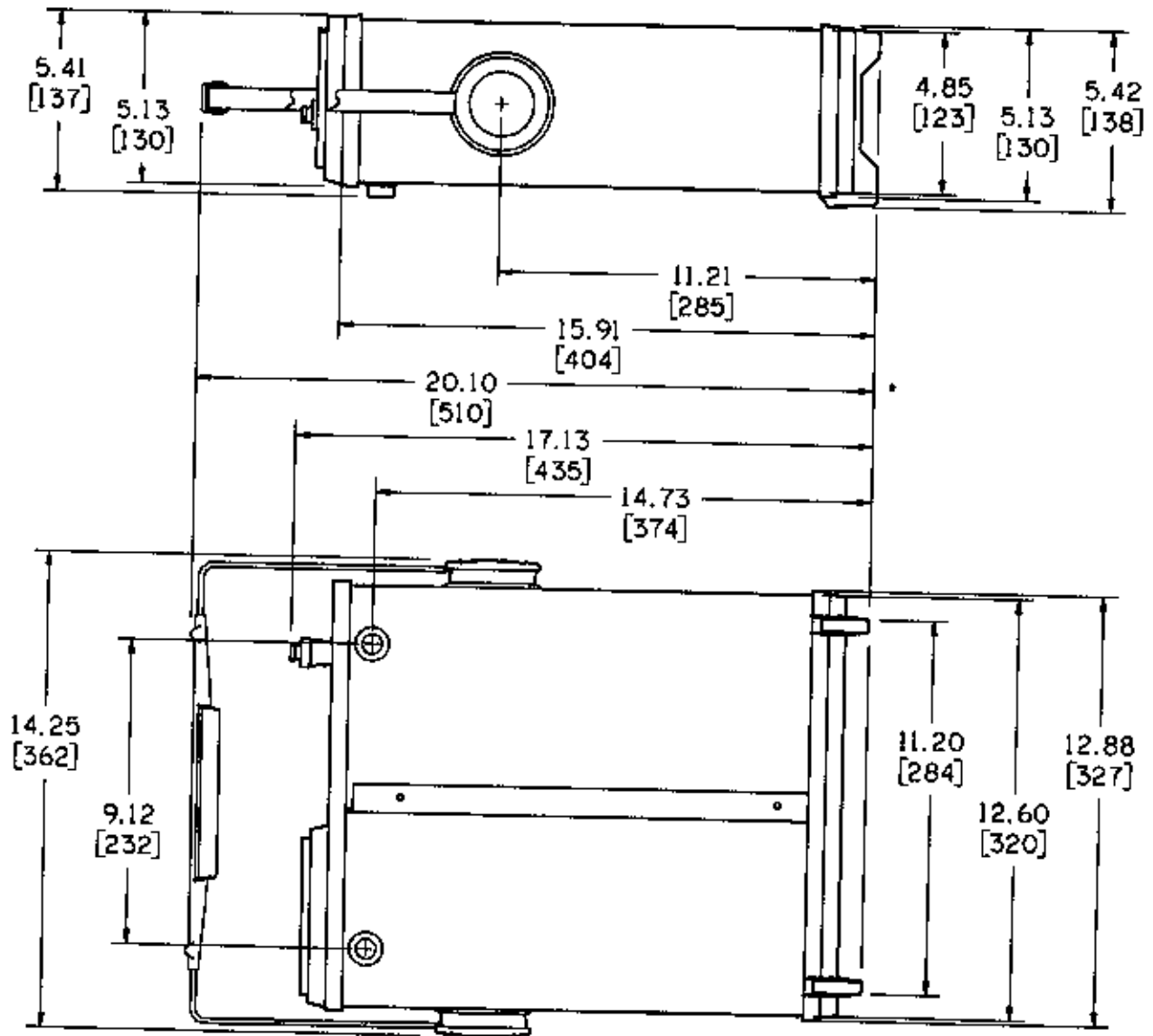


Figure 1-1. Maximum input voltage vs frequency derating curve for CH 1 OR X, CH 2 OR Y, and EXT INPUT connectors.



Dimensions are in inches [mm]

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Figure 1-2. Physical dimensions of the 2230 Oscilloscope.