

SPECIFICATION

Introduction

The 485/R485 is a general-purpose, environmentalized, high-performance, portable, wide-band oscilloscope which has a dual-channel vertical amplifier with selectable input impedance (DC to 350 MHz bandwidth with 50 Ω input impedance; DC to 250 MHz bandwidth with 1 M Ω input impedance). The 485 has a 1 ns sweep rate, stable triggering to bandwidth limits and calibrated X-Y capabilities. Delayed sweep has calibrated delay time, can be triggered after delay and can be displayed with the intensified main sweep in an alternate sweep switching display. Additional features are X10, X100 probe scale factor readout, 8 div X10 div graticule area, small spot size and high writing rate. A 20 MHz bandwidth limiter, 1 MHz and 1 kHz fast-rise calibrator and autofocus are also included. The 50 Ω input is automatically disconnected from excessive voltages. An external trigger view feature is also provided. The 485-1 and 485-2 have no external trigger view. The 485-2 has only 50 Ω vertical input impedance.

ELECTRICAL CHARACTERISTICS

VERTICAL DEFLECTION SYSTEM (2 identical channels)

Selectable Input Impedance

50 Ω within 0.5%. VSWR \leq 1.25:1 on 5 mV/div and 10 mV/div, 1.15:1 from 20 mV to 5 V/div to 350 MHz.

1 M Ω within 1% paralleled by approximately 20 pF.

Bandwidth¹ and Risetime² (VARIABLE gain CALIBRATED³) From 50 Ω Terminated Source —15°C to +35°C

From 50 Ω terminated source —15°C to +35°C.

50 Ω DC to at least 350 MHz, 1 ns

1 M Ω DC to at least 250 MHz, 1.4 ns

¹ Bandwidth (BW) measured at —3 dB down.

² Risetime calculated from 0.35/BW. From +35°C to +55°C, BW is 300 MHz for 50 Ω and 200 MHz for 1 M Ω .

³ See Fig. 1-1 for effect of VARIABLE gain control.

Input Coupling Selection

AC; DC; GND (provides zero reference, precharges coupling capacitor, disconnects 50 Ω load in 50 Ω mode).

Lower —3 dB Point (AC coupling from 50 Ω source)

50 Ω input, 1 kHz or less.

1 M Ω input 1X, 10 Hz or less.

Deflection Factor

5 mV/div to 5 V/div in 10 calibrated steps (1:2.5 sequence), accurate within 2%. Uncalibrated, continuously variable between steps to at least 12.5 V/div. Lights at edge of knob skirts indicate correct deflection factor for 1X, 10X and 100X probes.

Gain can be recalibrated at front panel. 1 M Ω BAL is available at bottom panel to eliminate step attenuator shift above 10 mV/div, in the 1 M Ω mode.

Display Modes

Channel 1; Alternate; Chopped (approximately 1 MHz rate); Added; X-Y (CH 1 —Y and CH 2 —X); Channel 2 (+Up or Inverted).

Internal Trigger Source

Normal (displayed signal), Channel 1 or Channel 2 signal.

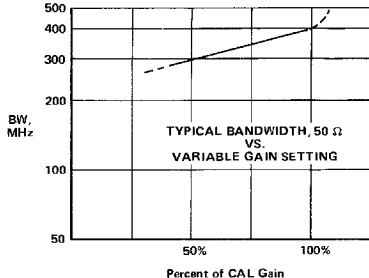


Fig. 1-1. Typical Bandwidth, 50 Ω vs. Variable Gain Setting

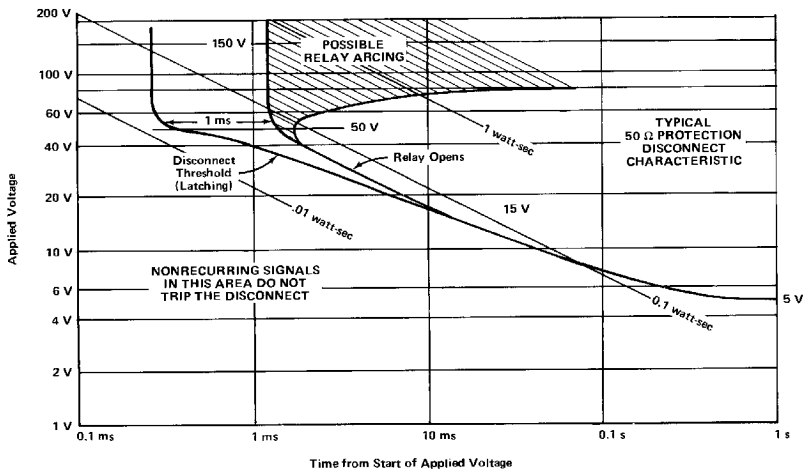


Fig. 1-2. Typical 50 Ω Protection Disconnect Characteristic.

50 Ω Protection

Internal detection circuitry automatically disconnects excessive signals of up to 50 V. The disconnected condition is indicated, and has manual reset.

Maximum Input Voltage

50 Ω Disconnect occurs for voltages that exceed approximately 5 V RMS continuous or 0.1 watt-second for instantaneous voltages of 5 V to 50 V.

Repeated application of voltages in excess of 50 volts and greater than 0.1 watt-second will cause deterioration of K1S1 relay contacts, due to arcing. Signals in excess of 150 volts will damage the instrument.

1 MΩ-DC coupled 250 V (DC + peak AC), 500 V P-P to 1 kHz. AC coupled 500 V (DC + peak AC), 500 V P-P to 1 kHz.

Common Mode Rejection

Added Mode with Channel 2 inverted. At least 10:1 at 50 MHz for 8-division signal after adjusting CH 2 gain for best CMR at 50 kHz and 20 mV/div.

Bandwidth Limiter

Limits to approximately 20 MHz the Vertical Amplifier and Internal Trigger signals.

Channel Isolation

At least 30:1 at 350 MHz.

A Ext Trigger Display (R485 and 485 only)

Momentary pushbutton in VERT MODE area enables display of EXT A Trigger when A source is in EXT position. Deflection factor is approximately 50 mV/div. Risettime is approximately 1.5 ns. Delay match to CH 1 or CH 2 input is within 0.5 ns at 50% amplitude. Triggering level is within 0.5 div of center-screen.

Probe Power

Two 4-pin connectors at the rear of the instrument provide power suitable for optional active probes such as the P6201.

PROBE PERFORMANCE

(Probes are Optional Accessories)

Type	Atten.	Input Impedance	Lower -3 dB point (maximum)	Bandwidth with 485 (minimum)	Temperature Range for this Bandwidth Specification
For Use With 50 Ω Input					
P6056	010-6056-03 – 6 ft. 010-6056-05 – 9 ft.	10X	500 Ω 1 pF	200 Hz 350 MHz	
P6057	010-6057-03 – 6 ft. 010-6057-05 – 9 ft.	100X	5 k Ω 1 pF	20 Hz 350 MHz	-15°C to +35°C
P6201 (FET Probe)	010-6201-01 – 6 ft.	1X Plug- On 10X 100X	100 k Ω 3 pF 1 M Ω <1.5 pF 1 M Ω <1.5 pF	10 Hz 1 Hz 10 Hz	330 MHz 0°C to +35°C
For Use With 1 MΩ Input					
P6053A	010-6053-01 – 3 1/2 ft. 010-6053-03 – 6 ft. 010-6053-05 – 9 ft.	10X	1 M Ω 9.5 pF 1 M Ω 12 pF 1 M Ω 13.5 pF	1 Hz 250 MHz 250 MHz 200 MHz	-15°C to +35°C

A and B TRIGGERING

A Trigger Mode

NORMAL.

Sweep runs only when triggered.

AUTOMATIC.

Sweep free-runs in the absence of a triggering signal and for signals below 20 Hz.

SINGLE SWEEP.

Sweep runs one time on the first triggering event after pressing the reset selector.

B Trigger Mode

B RUNS AFTER DELAY TIME.

Starts automatically at the end of the delay time.

B TRIGGERABLE AFTER DELAY TIME.

Runs when triggered. The B (delayed) sweep runs once, in each of these modes, following the A sweep delay time.

Time Base A and B Trigger Sensitivity

Trigger Mode	To 50 MHz	At 350 MHz
DC Int	0.3 div	1.5 div
DC Ext	20 mV	100 mV
AC	Signals below 16 Hz are attenuated.	
LF Reject	Signals below 16 kHz are attenuated.	
HF Reject	Signals below 16 Hz and above 50 kHz are attenuated.	

Level and Slope

Internal, permits selection of triggering point at any level on the positive and negative slope of the displayed waveform. External, level is adjustable through at least ± 0.5 V for either polarity (± 5 V for EXT $\div 10$).

A Source

Internal, Line, External, External $\div 10$.

B Source

B runs after Delay Time, Internal, External, External $\div 10$.

External Inputs

1 M Ω paralleled by approximately 20 pF. Maximum input voltage 500 V (DC + peak AC), 500 V P-P to 1 kHz.

Jitter

Less than 0.1 ns at 350 MHz and 1 ns/div.

HORIZONTAL DEFLECTION**Time Base A and B**

1 ns/div to 0.5 s/div in 27 calibrated steps (1-2-5 sequence). Uncalibrated, A is continuously variable between steps and to at least 1.25 s/div.

Time Base A and B Sweep Accuracy (Center 8 screen divisions)

Sweep Rate	+15°C to +35°C	-15°C to +55°C
1 ns/div to 20 ns/div	$\pm 3\%$	$\pm 5\%$
50 ns/div to 0.1 s/div	$\pm 2\%$	$\pm 4\%$
0.2 s/div to 0.5 s/div	$\pm 3\%$	$\pm 5\%$

Display Modes

A, A INTENSified during B delayed, ALTERNate display of A INTEN and B (delayed sweep). Only A sweep is displayed for A sweep rates of 1, 2 and 5 ns/div.

Minimum Sweep Holdoff (A Trigger Holdoff in Norm detent)

A Time Setting	
1 ns/div to 0.1 μ s/div	Less than 0.4 μ s.
0.2 μ s/div	Less than 1.0 μ s.
0.5 μ s/div to 0.5 s/div	Less than 2 times the A TIME/DIV setting.

A Trigger Holdoff

Adjustable control permits a stable presentation of repetitive complex waveforms. The control covers at least the time of one full sweep for sweeps faster than 0.2 s/div.

B Ends A

The A sweep is reset at the end of the B sweep to allow the fastest possible sweep repetition rate for increased trace intensity in the delayed sweep mode.

CALIBRATED SWEEP DELAY**Delay Time Range**

0 to 9.9 times the Delay Time/Div settings of 10 ns/div to 0.5 s/div.

Differential Delay Time Accuracy (+15°C to +35°C)

Exclude the first (above 0.0) 1.0 turn or the first 40 ns of the DELAY dial.

DELAY TIME Setting	
10 ns/div and 20 ns/div	\pm (1% of measurement +0.2% of full scale ³)
50 ns/div to 1 ms/div	\pm (0.5% of measurement +0.1% of full scale)
2 ms/div to 0.5 s/div	\pm (1% of measurement +0.1% of full scale)

³ Full scale is 10X the Delay Time/Div Setting.

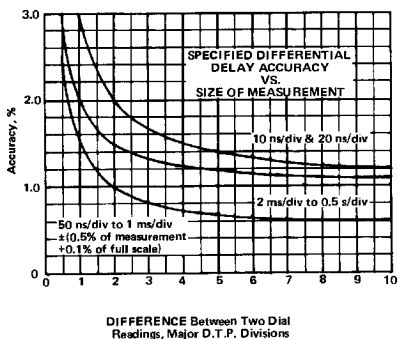


Fig. 1-3. Specified Differential Delay Accuracy vs. Size of Measurement.

Jitter

Less than 0.005% (one part in 20,000) of full scale plus 0.2 ns. (Wrap-around cover must be in place.)

X-Y

Full Sensitivity

(CH 1 Vert, CH 2 Horizontal.) 5 mV/div to 5 V/div in 10 calibrated steps (1-2-5 sequence) accurate within 2%. Gain can be recalibrated at front panel.

Y Performance

Identical to CH 1. See Vertical Deflection.

X-Axis Bandwidth

DC to 4 MHz (with 10 div reference signal).

X-Y Phase Match (Full BW and BW Limit)

Within 3° to 4 MHz.

X-Gain Match to CH 2

+15°C to +35°C: 1%

-15°C to +55°C: 3%

CRT

TEKTRONIX CRT

4-inch rectangular tube; 8X 10 divisions (0.8 cm/div) display area. P31 phosphor normally supplied; P11 optional without extra charge. 21 kV accelerating potential.

Photographic Writing Speed

At least 3 div/ns for standard P31 phosphor; at least 6 div/ns for optional P11 phosphor (with the TEKTRONIX C-31-R Camera and POLAROID 10,000 ASA film).

Auto Focus

Automatically maintains beam focus for all intensity settings. (Intensified zone and EXT Z axis are not auto-focused).

Graticule

Internal, no parallax. Variable edge-lighting. Markings for measurement of risetime. Graticule is dark with illumination off.

Beam Finder

Limits display within graticule area.

External Z-Axis

Risetime 15 ns. Input R 500 Ω. +0.2 V (DC to 20 MHz) blanks trace of average intensity. +2 V (DC to 2 MHz) blanks maximum intensity trace.

Beam Current Limit

Automatically limits the average beam current to protect the CRT phosphor. (Limits average current to 20 μA for sweep rates faster than 50 ms/div; 5 μA for 50 ms/div and slower sweep rates and for X-Y. Backup system shuts down power supply if average current reaches approximately 30 μA.)

CALIBRATOR

Two-Frequency Fast-Rise Calibrator

Accuracies	+15°C to +35°C	-15°C to +55°C
5 V amplitude to 1 M Ω load	0.5%	1%
0.5 V amplitude to 50 Ω \pm 0.5% load	1%	1.5%
50 mA amplitude to optional BNC accessory current loop	1%	1.5%
Selectable Frequency of 1 MHz and 1 kHz	0.25%	0.5%

Output Resistance

450 Ω

Risetime

Positive edge into 50 Ω , less than 1 ns. Overshoot and ringing less than 2% into 50 Ω at 1 GHz bandwidth.

1 kHz Duty Cycle

49.8% to 50.2%

OTHER CHARACTERISTICS

Signal Outputs

Positive gates from both time bases (approximately 4 V), and a positive-going Sawtooth from Time Base A (approximately 10 V). Gates and Sawtooth are approximately 0.5 V amplitude into 50 Ω .

Power Requirement

Two-position line voltage selector 115 V (90 V to 136 V) and 230 V (180 V to 272 V) 48 to 440 Hz. 60 watts maximum at 115 V and 60 Hz. 0.9 A maximum at 115 V and 60 Hz. Line fuse: 3 A fast.

Cooling

Quiet, filtered, forced-air ventilation. Fan speed increases smoothly with increasing ambient temperature.

ENVIRONMENTAL CHARACTERISTICS

Ambient Temperature

Operating: -15°C to +55°C

Storage: -35°C to +75°C

Altitude

Operating: to 15,000 feet. Maximum allowable ambient temperature decreased by 1°C per 1000 feet from 5,000 to 15,000 feet.

Nonoperating: to 50,000 feet.

Vibration⁵

Operating: 15 minutes along each of the three axis, 0.025 inch peak-to-peak displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1-minute cycles.

Shock⁵

Operating and Nonoperating: 30 g's, one half sine, 11-ms duration, 2 shocks per axis in each direction for a total of 12 shocks.

Electromagnetic Interference

(With 485 EMI modification option 4). Meets interference requirements of MIL-1-618D: power line conducted, 150 kHz to 25 MHz; radiated, 150 kHz to GHz.

Humidity

Operating and Storage: 5 cycles (120 hours) to 95% relative humidity referenced to MIL-E-16400F (par. 4.5.9 through 4.5.9.5.1, class 4).

Dimensions and Weight

Height: 6 and 9/16 inches.

Width: (with handle) 12 inches.

Depth (including panel cover): 18 and 1/2 inches.

Depth (handle extended): 20 and 5/8 inches.

Net weight (without accessory case and panel cover): 21 pounds.

Net weight (with panel cover, accessory case and accessories): 24 pounds.

Domestic shipping weight: 31 pounds.

Export-packed weight: 42 pounds.

⁵R485 strapped to table, not mounted in rack.