STATE-OF-THE-ART MEASUREMENT CAPABILITY IN A VERSATILE, PLUG-IN OSCILLOSCOPE SYSTEM
INTRODUCTION

The 180 Oscilloscope system establishes a new standard for high-performance, general-purpose, high-frequency plug-in design that allows you to match your oscilloscope to your particular application. These small, reliable, accurate, oscilloscopes have been proven in applications varying from laboratory to production line, to flight line checkout, to ship board testing, to exacting measurements of computer memories. This system is designed to meet today's requirements and still provide capabilities for future growth with its selection of mainframes and plug-ins.

MAINFRAMES

The wide selection of mainframes starts with the 180A/AR conventional display, for general purpose measurements up to 100 MHz bandwidths. Fast rise times of low rep rate signals may be integrated up to bright traces with the variable persistence and storage displays and 100 MHz bandwidth capability of the 181A/AR. A large screen CRT also with 100 MHz bandwidth capability is available in the 182A. The large screen is particularly useful for multi-trace displays or when viewing from a distance.

Very high frequency displays are available in the 183A/B mainframes that provide a writing speed of 4 cm/ns. The 1830A vertical plug-in provides 250 MHz real time bandwidth with 10 mV deflection factors. 183C/D mainframes allow selection of a reduced scan of 3 x 5 cm with 8 cm/ns writing speed or the 6 x 10 cm display with 4 cm/ns writing speed. These writing speeds are achieved with ASA 10,000 film, P31 phosphor, f/1.3 lens, 1:0.5 object-to-image ratio, and repeatable pulsed flood-gun fogging. Refer to 183A/B and 183C/D data sheets for more information about these mainframes and related plug-ins.

50 MHz MEASUREMENTS

Models 1801A and 1804A provide precision measurements to 50 MHz with a wide selection of standard and delaying time bases. For dual channel displays, the 1801A provides deflection factors from 5 mV/div to 20 V/div with constant bandwidth on all ranges. Lower deflection factors, as low as 1 mV/div are available with Model 1801A Option 001 and a vertical signal output offers 500μV/div deflection factor with cascaded channels.

Fast trouble-shooting and reduced design times of logic circuits are provided by the four channel 1804A vertical amplifier. Versatile triggering controls allow you to select any channel as the reference for time correlation measurements or direct comparison of input/output pulses in spite of time delays.
100 MHZ MEASUREMENTS

Model 1802A dual channel vertical plug-in provides accurate measurements of fast rise times and high frequency signals. For general purpose probing with minimum circuit loading, a selection of active or passive probes with shunt capacitance as low as 0.7 pF is available. The 10 mV/div deflection factor extends to 100 MHz which allows full bandwidth, dual channel, low level measurements.

SPECIALTY MEASUREMENTS

With a Model 1815A or 1815B plug-in and a remote sampling head, any 180 system mainframe can be used for 35 ps rise time time domain reflectometry (TDR) measurements or single channel 12.4 GHz sampling displays. TDR provides a fast, direct readout technique for viewing the electrical characteristics of transmission lines, connectors, and locating faults in wideband systems.

Dual channel sampling to 1 GHz is available in the easy-to-use 1810A plug-in. This plug-in features simplified front-panel controls that look and operate like the controls on real time instruments which reduces familiarization time and possible measurement errors.

Easy and precise measurements are provided by the 1803A dc/offset plug-in in the low drift 180 mainframes. Offset voltages can be measured with a comparison accuracy to 0.5%, and in the differential mode, the high CMRR of 86 dB will withstand a 10 volt common mode signal on the 1 mV/div range.

SYSTEMS and MANUFACTURING

The 180 system rack mount models are ideal for systems and manufacturing applications. These mainframes are only 5¼-inches high, which saves valuable space and the wide selection of plug-ins allows a system to be tailored to fit the application.

RUGGEDIZED OSCILLOSCOPE

A 180 system has been developed to meet the extreme environmental military requirements. The system, including mainframe, plug-ins, and front panel cover with accessories, is available as the AN/USM-281A. This oscilloscope is covered in the separate AN/USM-281A data sheet.
### Mainframes

<table>
<thead>
<tr>
<th>Model No.</th>
<th>Description</th>
<th>Price</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>180A</td>
<td>Cabinet style for up to 100 MHz real time plug-ins</td>
<td>$895</td>
<td>Page 6</td>
</tr>
<tr>
<td>180AR</td>
<td>5¼-inch high rack/bench style version of 180A</td>
<td>$995</td>
<td>Page 6</td>
</tr>
<tr>
<td>181A</td>
<td>Cabinet style, variable persistence and storage CRT, 100 MHz</td>
<td>$1950</td>
<td>Page 5</td>
</tr>
<tr>
<td>181AR</td>
<td>5¼-inch high rack/bench style version of 181A</td>
<td>$2025</td>
<td>Page 5</td>
</tr>
<tr>
<td>182A</td>
<td>Large screen, 100 MHz cabinet style</td>
<td>$950</td>
<td>Page 6</td>
</tr>
<tr>
<td>183A</td>
<td>Cabinet style, &gt;500 MHz bandwidth, 4 cm/ns writing speed</td>
<td>$1850</td>
<td>See 183A/B data sheet</td>
</tr>
<tr>
<td>183B</td>
<td>5¼-inch high rack/bench style, version of 183A</td>
<td>$1925</td>
<td>See 183A/B data sheet</td>
</tr>
<tr>
<td>183C</td>
<td>Cabinet style, &gt;500 MHz bandwidth, selectable scan, 4 or 8 cm/ns writing speed</td>
<td>$2500</td>
<td>See 183C/D data sheet</td>
</tr>
<tr>
<td>183D</td>
<td>5¼-inch high rack/bench style, version of 183C</td>
<td>$2600</td>
<td>See 183C/D data sheet</td>
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### Vertical Plug-ins

<table>
<thead>
<tr>
<th>Model No.</th>
<th>1801A</th>
<th>1802A</th>
<th>1803A</th>
<th>1804A</th>
<th>1806A</th>
<th>1830A</th>
<th>1831A/B</th>
<th>1810A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bandwidth (MHz)</td>
<td>50 (75 cascaded)</td>
<td>100 (30)</td>
<td>50 (30)</td>
<td>50</td>
<td>0.5</td>
<td>250</td>
<td>&gt;600</td>
<td>1 GHz</td>
</tr>
<tr>
<td>Min. deflection factor/div</td>
<td>5 mV (500μV Opt 001 cascaded)</td>
<td>10 mV (1 mV cascaded)</td>
<td>5 mV (1 mV)</td>
<td>20 mV</td>
<td>100μV</td>
<td>10 mV</td>
<td>~6 V</td>
<td>2 mV</td>
</tr>
<tr>
<td>Channels</td>
<td>2 (1 cascaded Op 001)</td>
<td>2 (1 cascaded Op 01)</td>
<td>1 (diff)</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>1831A, 1 (diff)</td>
<td>1831B, 1 single ended</td>
</tr>
<tr>
<td>Differential input</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes (with dc offset)</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>1831A</td>
</tr>
<tr>
<td>Price</td>
<td>$680</td>
<td>$1200</td>
<td>$950</td>
<td>$1050</td>
<td>$675</td>
<td>$900</td>
<td>1831A, $375</td>
<td>1831B, $950</td>
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### Time Base Plug-ins

<table>
<thead>
<tr>
<th>Model No.</th>
<th>1820A</th>
<th>1821A</th>
<th>1822A</th>
<th>1840A</th>
<th>1841A</th>
<th>1810A</th>
<th>1815A/B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ext trig</td>
<td>150 MHz</td>
<td>100 MHz</td>
<td>150 MHz</td>
<td>&gt;500 MHz</td>
<td>&gt;500 MHz</td>
<td>&gt;1 GHz</td>
<td>35 ps calibrated rise time TDR, 12.4 GHz sampling</td>
</tr>
<tr>
<td>Int trig</td>
<td>120 MHz</td>
<td>75 MHz</td>
<td>120 MHz</td>
<td>250 MHz</td>
<td>250 MHz</td>
<td>1 GHz</td>
<td>Requires sampling head and tunnel diode</td>
</tr>
<tr>
<td>Sweep speeds/div</td>
<td>5 ns - 2s</td>
<td>10 ns - 1s</td>
<td>5 ns - 1s</td>
<td>1 ns - 0.1s</td>
<td>1 ns - 0.1s</td>
<td>100 ps (expanded)-50ns</td>
<td></td>
</tr>
<tr>
<td>Delayed and mixed sweep</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
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<tr>
<td>Price</td>
<td>$450</td>
<td>$500</td>
<td>$900</td>
<td>$650</td>
<td>$1150</td>
<td>$1650</td>
<td>$2250-3300 (depending on sampling head)</td>
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### Plug-in and Mainframe Compatibility Chart

<table>
<thead>
<tr>
<th>MAINFRAME</th>
<th>180A</th>
<th>180AR</th>
<th>181A</th>
<th>181AR</th>
<th>182A</th>
<th>183A/B</th>
<th>183A/B/C/D</th>
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<tr>
<td>180A/AR</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>181A/AR</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>182A</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<td>183A/B/C/D</td>
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<tr>
<th>MAINFRAME</th>
<th>180A</th>
<th>180AR</th>
<th>181A</th>
<th>181AR</th>
<th>182A</th>
<th>183A/B</th>
<th>183A/B/C/D</th>
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<td>180A/AR</td>
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<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>181A/AR</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>182A</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>183A/B/C/D</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<table>
<thead>
<tr>
<th>TIME BASE PLUG-INS</th>
<th>1820A</th>
<th>1821A</th>
<th>1822A</th>
<th>1840A</th>
<th>1841A</th>
<th>1810A</th>
</tr>
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<tbody>
<tr>
<td>1820B</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>1821B</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>1822A</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>1840A</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>1841A</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>1810A</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

* 35 ps Rise Time TDR, 12.4 GHz Sampling
* Single Channel Sampling
* 1 GHz, Dual Channel Sampling
180 SYSTEM MAINFRAMES

VARIABLE PERSISTENCE and STORAGE MODEL 181A/AR

Models 181A (cabinet style) and 181AR (rack style) mainframes have the same basic operating features of the 180 models with the added versatility of a storage/variable persistence CRT. Operating features of the storage tube are: 8 x 10 division internal graticule (1 div = 0.95 cm); selection of normal or variable persistence and storage operation; and two storage writing speed modes.

181A/AR SPECIFICATIONS

CATHODE-RAY TUBE AND CONTROLS

TYPE: post-accelerator storage tube; 8.5kV accelerating potential; aluminized P31 phosphor.

GRATICULE: 8 x 10 div internal graticule, 0.2 div subdivisions on major axes. 1 div = 0.95 cm. Front panel adjustment aligns trace with graticule.

BEAM FINDER: returns trace to CRT screen regardless of setting of horizontal or vertical controls.

INTENSITY MODULATION: approx. +2V, ≥50 ms pulse width (≤10 MHz CW) blanks trace of normal intensity. Input R, 5100 ohms.

PERSISTENCE

Normal: natural persistence of P31 phosphor (approx. 40 μs).

Variable: from <0.25 μs to 1 min.

STORAGE WRITING SPEED

Write Mode: >20 div/ms.

Max. Write Mode: >1000 div/ms.

BRIGHTNESS: >200 foot Lumberts.

STORAGE TIME: from Write mode to Store, traces may be stored at reduced intensity for >1 hour. To View mode, traces may be viewed at normal intensity for >1 minute. From Max. Write mode to Store, traces may be stored at reduced intensity for >5 minutes. To View mode, traces may be stored at normal intensity for >15 seconds.

ERASE: manual, pushbutton erasure takes approx. 300 ms.

EXTERNAL AMPLIFIER

Bandwidth: dc-coupled, dc to 5 MHz; ac-coupled, 6 Hz to 5 MHz.

Deflection Factor: 1 V/div in X1, 0.2 V/div in X5; 0.1 V/div in X10.

Dynamic Range: ±20 V.

Maximum Input: 600 V dc (ac-coupled input).

Input RC approx. 1 megohm shunted by approx. 30 pF.

INTERNAL SWEEP

MAGNIFIER: X5, X10; accuracy, ±5% (with 3% accuracy time base).

GENERAL

CALIBRATOR

Type: approx. 1 kHz square wave, 3 μs rise time.

Amplitude: 10Vpp; accuracy, ±1%

OUTPUTS: four rear panel emitter follower outputs for main and delayed gates, main and delayed sweeps or vertical and horizontal outputs when used with TDR/Sampling plug-ins. Maximum current available, ±3 mA. Will drive impedances ≥1000 ohms without distortion.

WEIGHT (without plug-ins)

Model 181A (Cabinet): net, 24 lb (10.9 kg); shipping, 40 lb (18.1 kg).

Model 181AR (Rack): net, 26 lb (11.8 kg); shipping, 40 lb (18.1 kg).

ENVIRONMENT (operates within specifications over the following ranges): Temperature, 0° to +55°C; Humidity, 95% relative humidity to 40°C; Altitude, to 15,000 ft; Vibration, vibrated in three planes for 15 min. each with 0.010 inch excursion, 10 to 55 Hz.

POWER: 115 or 230 V ±10%, 48 to 440 Hz; <115 watts at normal line with plug-ins. Max. mainframe power, 225 VA.

ACCESSORIES FURNISHED: 7½ ft. power cord; Model 10176A mesh contrast filter, rack mounting hardware and two probe holders (HP P/N 5050-0666) are supplied with rack models.

PRICE (mainframe less plug-ins)

Model 181A Oscilloscope, Cabinet Style Mainframe $1950.

Model 181AR Oscilloscope, Rack Style Mainframe $2025.

OPTIONS (order by Option number)

CONVENTIONAL and LARGE SCREEN MODELS 180A/AR and 182A

Models 180A (cabinet style) and 180AR (rack style) mainframes contain the basic functional circuits for either 50 MHz or 100 MHz bandwidth plug-ins, as well as for TDR and sampling. Each contains a post-accelerator CRT with its associated power and control circuits and the power supplies required to power 1800-series plug-ins. Basic operating features are: 8 x 10 division (1 div = 1 cm) internal graticule; internal flood gun for scale illumination; X5 and X10 sweep magnifier; external horizontal input; and two calibrator outputs of 250 mV and 10 V.

Model 182A plug-in oscilloscope mainframe adds large screen, 100 MHz bandwidth to the proven 180 oscilloscope system. The parallax free, internal graticule is 8 x 10 divisions with each division equal to 1.29 cm, which makes it easier to view displays from a distance. This larger CRT area, 66% larger than 8 x 10 cm displays, also improves viewing of displays such as four-channel, differential/dc-offset, and time domain reflectometer measurements.

Another feature of this mainframe is its design for maintainability. Plug-in circuit modules that connect to a printed circuit mother board almost eliminate internal cabling, which increases reliability and makes it easier and quicker to get an instrument back into service. For example, the horizontal amplifier is on a plug-in circuit board that includes a section of front panel with knobs and switches mounted on it. This allows a complete, pre-tested board to be quickly installed, which keeps instrument down-time to a minimum. Also, the function of major circuit areas, test points, and adjustment values are printed on the circuit boards so a knowledgeable technician can easily adjust or repair the circuits.

180A/AR SPECIFICATIONS

CATHODE-RAY TUBE AND CONTROLS

TYPE: post-accelerator, 12 kV accelerating potential; aluminized P31 phosphor (other phosphors available, see Options); safety glass faceplate.

GRATICULE: 8 x 10 div internal graticule, 0.2 div sub-divisions on major axis, 1 div = 1 cm. Front panel adjustment aligns trace with graticule. Scale control illuminates CRT phosphor for viewing with hood or taking photographs.

BEAM FINDER: returns trace to CRT screen regardless of setting of horizontal, vertical, or intensity controls.

INTENSITY MODULATION: approx 1-2 V, ≥50 ns pulse width (≤10 MHz CW) blanks trace of normal intensity. Input R, 5100 ohms.

HORIZONTAL AMPLIFIER

EXTERNAL INPUT

Bandwidth: dc-coupled, dc to 5 MHz; ac-coupled, 5 Hz to 5 MHz.

Deflection Factor: 1 V/div in X1; 0.2 V/div, in X5; 0.1 V/div, in X10.

Vernier provides continuous adjustment between ranges.

Dynamic Range: ±20V.

Maximum Input: 600 V dc (ac-coupled input).

Input RC: approx 1 megohm shunted by approx 30 pF.

INTERNAL SWEEP

Magnifier: X5, X10; accuracy, ±5% (with 3% accuracy time base).

GENERAL

CALIBRATOR

Type: approx 1 kHz square wave, 3 μs rise time.

Amplitude: two outputs, 250 mV p-p and 10 V p-p; accuracy, ±1%.

OUTPUTS: four rear panel emitter follower outputs for main and delayed gates, main and delayed sweeps or vertical and horizontal outputs when used with TDR/Sampling plug-ins. Maximum current available, ±3 mA. Will drive impedances ≥1000 ohms without distortion.

(Specifications continued on following page.)
180 SYSTEM MAINFRAMES
CONVENTIONAL and LARGE SCREEN MODELS 180A/AR and 182A

DIMENSIONS: see outline drawings.

ENVIRONMENT: (operates within specifications over the following ranges): Temperature. -28°C to +65°C; Humidity, to 95% relative humidity to 40°C. Altitude, up to 15,000 ft; Vibration: vibrated in three planes for 15 min. each with 0.010 inch excursion, 10 to 55 Hz.

WEIGHT (without plug-ins):
Model 180A (Cabinet): net 24 lb (10.9 kg); shipping, 36 lb (16.3 kg).
Model 180AR (Rack): net, 26 lb (11.8 kg); shipping, 40 lb (18.1 kg).

POWER: 115 or 230 V ±10%, 48 to 440 Hz, <110 watts with plug-ins at normal line. Max. mainframe power, 200 VA.

ACCESSORIES FURNISHED: 7½ ft power cord, Model 10179A mesh contrast filter; rack mounting hardware and 2 probe holders (HP P/N 5050-0446) are also supplied with the 180 AR rack model.

PRICE (mainframe less plug-ins):
Model 180A Oscilloscope, Cabinet Style Mainframe $895.
Model 180A Opt 010 Oscilloscope, Cabinet Style Mainframe $845.
Model 180AR Oscilloscope, Rack Style Mainframe $995.
Model 180AR Opt 010 Oscilloscope, Rack Style Mainframe $945.

OPTIONS (order by option number):
002: aluminized P2 phosphor in lieu of P31 phosphor, no charge.
007: aluminized P7 phosphor in lieu of P31 phosphor, no charge.
010: mainframe without rear panel main and delayed sweep and gate outputs, Less, $50.
011: aluminized P11 phosphor in lieu of P31 phosphor, no charge. Beamfider does not intensity display on Option 011 oscilloscopes.

182A SPECIFICATIONS

CATHODE-RAY TUBE AND CONTROLS
TYPE: post accelerator, 19 kV accelerating potential; aluminized P31 phosphor (other phosphors available, see Options).
GRATICULE: 8 x 10 div internal graticule. 0.2 div sub-divisions on major axes. 1 div = 1.29 cm. Front panel recessed screwdriver adjustment aligns trace with graticule. External lights provide graticule illumination.
BEAM FINDER: returns trace to CRT screen regardless of setting of horizontal, vertical, or intensity controls.
INTENSITY MODULATION: approx. ±2 V, 20 ns pulse width (≤10 MHz CW) will blank trace of normal intensity. Input R, approx. 5 k ohms. Maximum Input voltage, ±20 V (dc + peak ac).

CALIBRATOR
TYPE: approx 1 kHz square wave, <3 μs rise time.
VOLTAGE: two outputs, 250 mV p-p and 10 V p-p; accuracy, ±1%.

HORIZONTAL AMPLIFIER
EXTERNAL INPUT
Bandwidth: dc-coupled, dc to 5 MHz; ac-coupled, 5 Hz to 5 MHz.
Deflection Factor: 1 V/div. X1; 0.1 V/div. X10; accuracy, ±5%.
Vernier provides continuous adjustment between ranges.
Dynamic range: ±20 V.
Maximum input: ±300 V (dc + peak ac).
Input RG: 1 megohm shunted by approx. 30 pF.
INTERNAL SWEEP
Sweep Magnifier: X10; accuracy, ±5% (with 3% accuracy time base).

OUTPUTS
Four emitter follower outputs on rear for main and delayed gates, main and delayed sweeps or vertical and horizontal outputs when used with sampling plug-ins; maximum current available, ±3 mA; outputs will drive impedance ≥1000 ohms without distortion.

GENERAL
WEIGHT: (without plug-ins) net, 26½ lb (12.02 kg); shipping, 38½ lb (17.46 kg).
POWER: 115 or 230 V ±10%, 48 to 440 Hz, <110 watts with plug-ins at normal line. Max. mainframe power, 200 VA.

ENVIRONMENT: Mainframe operates within specifications over the following ranges.
Temperature: 0°C to +55°C.
Humidity: up to 95% relative humidity at 40°C.
Altitude: up to 15,000 ft.
Vibration: vibrated in three planes for 15 minutes each with 0.010 inch excursion, 10 to 55 Hz.

DIMENSIONS: refer to outline drawing.

ACCESSORIES FURNISHED: metallic mesh contrast filter; power cord.
PRICE (mainframe less plug-ins):
Model 182A Oscilloscope Mainframe $950.
Model 182A Option 010 Oscilloscope Mainframe $900.

OPTIONS
002: aluminized P2 phosphor in lieu of P31, no charge.
007: aluminized P7 phosphor in lieu of P31, no charge.
010: mainframe without rear panel main and delayed sweep and gate outputs, Less, $50.
011: aluminized P11 phosphor in lieu of P31, no charge. Beamfider does not intensity display on Option 011 oscilloscopes.
Model 1801A is a dual channel vertical amplifier plug-in for 180 system mainframes. Operating characteristics are: 5 mV/div to 10 V/div deflection factors; dc to 50 MHz bandwidth constant on all ranges; selectable display polarity; and selectable input coupling. The two channels can be operated singly, algebraically added, or in dual trace modes with alternate or chopped switching and selectable trigger source.

For added measurement versatility, Option 001 provides a X5 multiplier for 1 mV/div deflection factors. Option 001 also provides a Channel B output, which can be cascaded into Channel A for 500 μV/div deflection factor.

MODES OF OPERATION

Channel A: channel B; channels A and B displayed alternately on successive sweeps (ALT); channels A and B displayed by switching between channels at approx 400 kHz rate (CHOP), with blanking during switching channel A plus channel B (algebraic addition).

EACH CHANNEL (2)

BANDWIDTH (measured with or without a Model 10004B probe, 3 dB down from 8 div reference signal from 25 cm/s source. Lower limit is approx 0.8 Hz with 10004B probe when ac-coupled.)

DC-Coupled: dc to 50 MHz.

AC-Coupled: approx 8 Hz to 50 MHz.

RISE TIME: <7 ns (measured with or without 10004B probe 10% to 90% of 8 div input step from 25 cm/s source).

DEFLECTION FACTOR: 5 mV/div to 20 V/div (12 positions) in 1,2,5 sequence.

Attenuator Accuracy: ±3%.

 vernier: provides continuous adjustment between deflection factor settings and extends maximum deflection factor to at least 50 V/div.

POLARITY: + up or - up, selectable.

SIGNAL DELAY: input signals are delayed sufficiently to view leading edge of input pulse without advanced external trigger.

INPUT RC: 1 megohm shunted by approx 25 pF; constant on all ranges.

INPUT COUPLING: selectable, AC, DC, or Ground. Ground position disconnects signal input and grounds amplifier input.

MAXIMUM INPUT

DC-Coupled: ±350 V (dc + peak ac) and ±150 V (dc + peak ac) on 5 mV/div range at 10 kHz or less.

AC-Coupled: ±600 V dc.

A + B OPERATION

Amplifier: bandwidth and deflection factors are unchanged; either channel may be inverted for ±A ±B operation.

Differential Input (A-B) Common Mode: for frequencies from dc to 1 MHz, CMRR is at least 40 dB at 5 mV/div and at least 20 dB on other ranges for common mode signals of 24 div or less.

TRIGGERING

Source: A, B, A + B modes, on the signal displayed.

Chop Mode: on channel A or channel B signal.

Alternate Mode: on channel A signal, channel B signal, or successively (comp) from the displayed signal on each channel.

Frequency: dc to 50 MHz on signals causing 0.5 div or more vertical deflection in all display modes except chop; dc to 100 kHz in chop mode.

GENERAL

WEIGHT: net, 4 lb (1.8 kg); shipping, 7 lb (3.2 kg).

ENVIRONMENT: same as Model 180A/AR mainframes.

ACCESSORIES FURNISHED: two 10004B, 10:1 divider probes, approx 3½ ft.

PRICE: Model 1801A Dual Channel Vertical Amplifier.........$680.

Model 1801A Option 003 Dual Channel Vertical Amplifier.........$600.

OPTIONS (order by Option number)

003: Model 1801A without probes..............Less $80.

090: 6 ft 10006B probes substituted for 10004B, 10:1 atten, no charge.

091: 10 ft 10006B probes substituted for 10004B, 10:1 atten, no charge.

1801A OPT. 001 SPECIFICATIONS

MODES OF OPERATION

Channel A; channel B; channels A and B displayed on alternate sweeps (ALT); channels A and B displayed by switching between channels at approx 400 kHz rate (CHOP), with blanking during switching channel A plus channel B (algebraic addition).

EACH CHANNEL (2)

BANDWIDTH (measured with or without a Model 10004B probe, 3 dB down from 8 div reference signal from 25 cm/s source. Lower limit is approx 0.8 Hz with 10004B probe when ac-coupled.)

DC-Coupled: dc to 50 MHz; in X5 mode, dc to 20 MHz.

AC-Coupled: approx 8 Hz to 50 MHz; in X5 mode, 8 Hz to 20 MHz.

RISE TIME: <7 ns (measured with or without 10004B probe 10% to 90% of 8 div input step from 25 cm/s source.)

DEFLECTION FACTOR: 5 mV/div to 20 V/div (12 positions) in 1,2,5 sequence.

Attenuator Accuracy: ±3%.

 Vernier: provides continuous adjustment between deflection factor settings and extends maximum deflection factor to at least 50 V/div.

POLARITY: + up or - up, selectable.

SIGNAL DELAY: input signals are delayed sufficiently to view leading edge of input pulse without advanced external trigger.

INPUT RC: 1 megohm shunted by approx 25 pF; constant on all ranges.

INPUT COUPLING: selectable, AC, DC, or Ground. Ground position disconnects signal input and grounds amplifier input.

MAXIMUM INPUT

DC-Coupled: ±350 V (dc + peak ac) and ±150 V (dc + peak ac) on 5 mV/div range at 10 kHz or less.

AC-Coupled: ±600 V dc.

A + B OPERATION

Amplifier: bandwidth and deflection factors are unchanged; either channel may be inverted for ±A ±B operation.

Differential Input (A-B) Common Mode: for frequencies from dc to 1 MHz, CMRR is at least 40 dB at 5 mV/div and at least 20 dB on other ranges for common mode signals of 24 div or less (X1).

TRIGGERING

Source: A, B, A + B modes on the signal displayed.

Chop Mode: on channel A or channel B signal.

Alternate Mode: on channel A signal, channel B signal, or successively (comp) from the displayed signal on each channel.

Frequency: dc to 50 MHz on signals causing 0.5 div or more vertical deflection in all display modes except chop; dc to 100 kHz in chop mode.

(Specifications continued on following page.)
DUAL CHANNEL VERTICAL PLUG-INS

50 MHz MODEL 1801A/1801A OPTION 001 (CONTINUED)

CHANNEL B VERTICAL SIGNAL OUTPUT (X1)

RISE TIME
Vertical Signal Out: 9 ns (dc to 40 MHz).
Cascaded B into A: 12 ns (dc to 30 MHz).
Amplitude: 50 mV/div into 50 ohms, usable amplitude up to 800 mV
pp. Open circuit, approx 80 mV/div with usable amplitude of
>1 V.
DC Level: 0 V ±10 mV at center screen.
Source Output R: approx 50 ohms.

GENERAL
WEIGHT: net, 4 lb (1.8 kg); shipping, 7 lb (3.2 kg).
ENVIRONMENT: same as Model 181A/AR mainframe.
ACCESSORIES FURNISHED: two 10004B, 10:1 divider probes, approx
31/4 ft.
PRICE: Model 1801A Opt 001 Dual Channel Vertical Amplifier $330.
Model 1801A Opt's 001, 003 Dual Channel Vertical Amplifier $750.
OTHER OPTIONS (order by Option number)
003: Model 1801A Opt 001 without probes Less 380.
090: 6 ft 10006B probes substituted for 10004B, 10:1 attenu, no charge.
091: 10 ft 10005B probes substituted for 10004B, 10:1 attenu, no charge.

100 MHz MODEL 1802A

Model 1802A is a dual channel vertical amplifier plug-in for 180 system mainframes. Operating characteristics are: 10 mV/div to 1 V/div which may be cascaded for 1 mV/div; dc to 100 MHz bandwidth; and selectable display polarity. The two channels can be operated singly, algebraically added, or in two dual trace modes with alternate or chopped switching and selectable trigger source. A selection of optional active and passive probes provides general purpose probing with minimum circuit loading, and precise transmission line measurements can be made with the high quality 50 ohm plug-in input.

SIGNAL DELAY: input signals are delayed sufficiently to view leading edge of input pulse without advance external trigger.
DYNAMIC RANGE: on screen display of 6 divisions for signals to 100
MHz, increasing to 8 divisions at 50 MHz.
POSITIONING RANGE: ±4 divisions.
DRIFT: <±1 div over environmental temperature range (except for
cascaded operation).
INPUT R: 50 ohms ±3 ohms. (10 megohms, 10 pF with Opt 091.)
MAXIMUM INPUT: 0.72 watts (6 Vrms). (100 V with Opt 091.)
VSWR: <1.35:1 at 100 MHz on 0.01 V/div, <1.1:1 at 100 MHz on all
other deflection factors.
REFLECTION COEFFICIENT: <15% at 100 MHz on 0.01 V/div; <5%
at 100 MHz on all other deflection factors.
PROBE POWER: provides power to operate two active probes.
A + B OPERATION
AMPLIFIER: bandwidth and deflection factors are unchanged; either
channel may be inverted for ±A ±B operation.
DIFFERENTIAL INPUT (A-B): Common mode rejection ratio: >40 dB to
1 MHz, >20 dB to 100 MHz, maximum common mode signal, equivalent
to 6 divisions of deflection.
TRIGGERING
SOURCE: selectable from channel A, channel B, or composite signal in
any display mode.
FREQUENCY: dc to 120 MHz on 1 div p-p signals for Models 1820B or
1822A time base plug-ins; or dc to 75 MHz on 1 div p-p signals for
an 1821A time base plug-ins.
VERTICAL SIGNAL OUTPUT
AMPLITUDE: 100 mV/div of displayed signal into 50 ohm load, adjus-
table with front panel control; usable amplitude, 600 mV pk-pk.
BANDWIDTH: dc to >100 MHz.
RISE TIME: <3.5 ns.

1802A SPECIFICATIONS

MODES OF OPERATION
Channel A alone; channel B alone, channels A and B displayed on
alternate (ALT) sweeps; channels A and B displayed by switching
between channels at approx 400 kHz rate (CHOP), with blanking
during switching; channel A plus channel B (algebraic addition).
Vertical output allows cascading of channels.

EACH CHANNEL (2)
BANDWIDTH: dc to >100 MHz with channels A and B cascaded, dc
to >75 MHz. (3 db down from 6-div reference signal from a 50
ohm source.)
RISE TIME: <3.5 ns; with channels A and B cascaded, <4.5 ns. (10%
to 90% of 6-div input step from a 50 ohm source.)
PULSE RESPONSE: 6 div reference at 25°C overshoot, <3%; pertur-
bations, <3%; tilt, <2%. With channels cascaded, overshoot,<5%; perturbations, <5%; tilt, <3%.
DEFLECTION FACTOR
Ranges: from 0.01 V/div to 1 V/div (7 calibrated positions) in 1, 2,
5 sequence. Channels A and B may be cascaded using vertical output
to obtain 1, 2, or 5 mV/div.
Attenuator Accuracy: ±3%.
Variation: provides continuous adjustment between all deflection factor
ranges; extends maximum deflection factor to at least 2.5 V/div.
POLARITY: ±UP or -UP, selectable; OFF position disconnects signal
input from amplifier, terminates input signal in 50 ohms, and
grounds amplifier input for reference.
DUAL CHANNEL VERTICAL PLUG-INS

500 kHz, 100 μV/div MODEL 1806A

Model 1806A is a dual channel, differential input amplifier for low level measurements in 180 system mainframes. Operating characteristics are: dc to 500 kHz bandwidth, 100 μV/div to 20 V/div deflection factor, 100 dB CMRR from dc to 10 kHz with a ±10 V common mode signal on the 100 μV/div range, and less than 20 μV of noise, measured tangentially at full bandwidth.

NOISE: <20 μV, measured tangentially at full bandwidth.
INPUT: differential or single-ended on all ranges, selectable.
COMMON MODE
Frequency: dc to 10 kHz on all ranges.
Rejection Ratio: ≥100 dB (100,000 to 1) with de-coupled input on 100 μV/div range; decreasing 20 dB per decade of deflection factor to ≥40 dB on the 200 mV/div range; CMRR is ≥30 dB on the 500 mV/div to 20 V/div ranges.
Maximum Signal: ±10 V (dc + peak ac) on 100 μV/div to 200 mV/div ranges; ±400 V (dc + peak ac) on all other ranges.
INPUT COUPLING: selectable AC, DC, or OFF for both + and — inputs. OFF position disconnects signal input and grounds amplifier input for reference.
INPUT RC: 1 megohm shunted by approx. 45 pF, constant on all ranges.
MAXIMUM INPUT: ±400 V (dc + peak ac).
INPUT ISOLATION: ≥80 dB between channels at 500 kHz with shielded connectors.
TRIGGERING
SOURCE: on channel A signal for A, Chop, or Alternate displays; on channel B signal for B, Chop, or Alternate; on composite A and B for alternate.
FREQUENCY: dc to >500 kHz on signals causing 0.5 div or more vertical deflection in all display modes except Chop; dc to 100 kHz in Chop.

GENERAL
WEIGHT: net: 3½ lb (1.6 kg); shipping, 6½ lb (3.0 kg).
ENVIRONMENT: same as Model 181A/AR mainframe.
POWER: supplied by 180 system mainframe.
PRICE: Model 1806A Dual Differential Vertical Amplifier $675.
ACCESSORIES FURNISHED: two BNC-to-dual banana plug binding post adapters. HP part No. 1250-1264.
RECOMMENDED PROBES (Not supplied with Model 1806A.)
1000A/ 5 and 10 ft, 10k divider probes Price: $35.
1000A/ 5 and 10 ft, 50k divider probes Price: $40.
1005A/ 4 ft, 10k divider probes Price: $55.
10057A/ 1/2 ft, 1k probe Price: $22.
10006A/ 6 ft, 1k probe Price: $92.
100126/ 6 ft, 10k divider probe Price: $40.

1806A SPECIFICATIONS

MODES OF OPERATION
Channel A alone; channel B alone; channels A and B displayed alternately on successive sweeps (ALT); channels A and B displayed by switching between channels at approx. 100 kHz rate (CHOP), with blanking during switching.

Each Channel
BANDWIDTH: (cutoff down at 500 kHz).
DC-Coupled: dc to 500 kHz.
AC-Coupled: approx. 2 Hz to 500 kHz.
Bandwidth Limit Switch: allows upper bandwidth to be reduced to approx. 50 kHz.
DEFLECTION FACTOR
Ranges: from 100 μV/div to 20 V/div (17 positions) in 1, 2, 5 sequence.
Attenuator Accuracy: ±3% with vernier in calibrated position.
Vernier: continuously variable between ranges; extends maximum deflection factor to at least 50 V/div.

FOUR CHANNEL VERTICAL PLUG-IN

50 MHz MODEL 1804A

Model 1804A is a four channel vertical amplifier plug-in for 180 system mainframes. Operating characteristics are: 20 mV/div to 10 V/div deflection factors; dc to 50 MHz bandwidth; and selectable input coupling. The four channels may be operated singly or in any combination of traces in alternate or chopped modes with selectable trigger source.

1804A SPECIFICATIONS

MODES OF OPERATION
Channel A, B, C, or D or any combination displayed alternately on successive sweeps (ALT); channels A, B, C, or D or any combination displayed by switching between channels at approx. 1 MHz rate (CHOP), with blanking during switching.

Each Channel (4)
BANDWIDTH: (Measured with or without 10004B probe) 3 dB down from 8 div reference signal from a 25 ohm source. Lower limit is approx. 1 Hz with probe when ac-coupled.
DC-Coupled: dc to 50 MHz.
AC-Coupled: 10 Hz to 50 MHz.

RISETIME: <7 ns. (Measured with or without 10004B probe; 10% to 90% of 1 div input step from a 25 ohm source.)
DEFLECTION FACTOR
Ranges: from 0.02 V/div to 10 V/div (9 calibrated positions) in 1, 2, 5 sequence.
Attenuator Accuracy: ±3%.
Vernier: provides continuous adjustment between all deflection factor ranges; extends maximum deflection factor to at least 25 V/div.
Signal Delay: input signals are delayed sufficiently to view leading edge of input pulse without advanced external triggered.
INPUT RC: 1 megohm shunted by approximately 25 pF; constant on all ranges. (Specifications continued on following page.)
FOUR CHANNEL VERTICAL PLUG-IN
50 MHz MODEL 1804A (CONTINUED)

MAXIMUM INPUT
DC-Coupled: ±350 V (dc + peak ac); ±150 V (dc + peak ac) on 20 mV/div at 10 kHz or less.
AC-Coupled: ±400 Vdc.

TRACE IDENTIFICATION: pushbutton control displaces respective trace approx. 0.5 div.

TRIGGERING
SOURCE: selectable on signal from any channel in either chop or alternate mode, or successively from the displayed signal on each channel in alternate mode.

FREQUENCY: dc to 50 MHz on signals causing 0.5 div or more vertical deflection in all display modes except Chop; dc to 200 kHz in Chop mode.

GENERAL
WEIGHT: net, 5 lb (2.3 kg); shipping, 8 lb (3.6 kg).
ENVIRONMENT: same as Model 181A/AR mainframes.
POWER: supplied by 180 System mainframe.
PRICE: Model 1804A Four Channel Vertical Amplifier $1050.
OPTIONS (order by option number)
090: four 100048 10:1 Voltage Divider Probes approx 3½ ft long, add $160.
091: four 100068 10:1 Voltage Divider Probes approx 6 ft long, add $160.
092: four 100058 10:1 Voltage Divider Probes approx 10 ft long, add $160.

DIFFERENTIAL/DC OFFSET VERTICAL PLUG-IN
40 MHz MODEL 1803A

Model 1803A is a differential/dc offset amplifier plug-in for 180 system mainframes. Operating characteristics are: deflection factors of 1 mV/div to 2 V/div from dc to 30 MHz and from 5 mV/div to 20 V/div to 40 MHz; CMRR of 86 dB (20,000:1) on the 1 mV/div range with a 10 volt common mode signal; and calibrated offset voltage that provides differential comparison of pulse amplitude measurements with 0.5% accuracy.

RISETIME: <10 ns for deflection factors of 0.005 V/div to 20 V/div; <12 ns on 0.001 V/div and 0.002 V/div (Measured with or without 100048 probe; 10% to 90% of 8 div input step from 25 ohm source.)

DEFCCTOR FACTOR
Ranges: from 0.001 V/div to 20 V/div (14 calibrated positions) in 1, 2, 5 sequence.
Attenuator Accuracy: ±3%.
Verrier: provides continuous adjustment between all deflection factor ranges; extends maximum deflection factor to at least 50 V/div.

INPUT COUPLING: front panel selection of AC, DC, Ground or Vo for both + and − inputs. Ground disconnects signal input and grounds amplifier input for reference.
INPUT RC: 1 meghm shunted by approx 27 pF; constant on all ranges.

MAXIMUM INPUT

<table>
<thead>
<tr>
<th>Vo Range</th>
<th>Deflection Factor</th>
<th>Maximum Input (DC + Peak AC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 6 V</td>
<td>0.001 V/div to 0.02 V/div</td>
<td>± 15 V</td>
</tr>
<tr>
<td>0 to 6 V</td>
<td>0.05 V/div to 0.2 V/div</td>
<td>± 150 V</td>
</tr>
<tr>
<td>0 to 6 V</td>
<td>0.5 V/div to 20 V/div</td>
<td>± 600 V</td>
</tr>
<tr>
<td>0 to 60 V</td>
<td>0.01 V/div to 0.2 V/div</td>
<td>± 150 V</td>
</tr>
<tr>
<td>0 to 60 V</td>
<td>0.5 V/div to 20 V/div</td>
<td>± 600 V</td>
</tr>
<tr>
<td>0 to 600 V</td>
<td>0.1 V/div to 20 V/div</td>
<td>± 600 V</td>
</tr>
</tbody>
</table>

OVERLOAD RECOVERY
6 V Overload: within ±10 mV of final signal value in 0.3 µs or less, within ±5 mV in 1 µs or less, and within 1 mV in 1 ms or less.
60 V Overload: within ±100 mV of final signal value in 0.3 µs or less, within ±50 mV in 1 µs or less, and within ±10 mV in 1 ms or less.
600 V Overload: within ±1 V of final signal value in 0.3 µs or less, within ±0.5 V in 1 µs or less, and within ±100 mV in 1 ms or less.

1803A SPECIFICATIONS

VERTICAL DEFLECTION
BANDWIDTH: dc to 40 MHz (3 dB down) for deflection factors of 3.005 V/div to 20 V/div; dc to 30 MHz (3 dB down) on 0.001 V/div and 0.002 V/div. Lower 3 dB limit is approx 2 Hz with input ac coupled. (Measured with or without 100048 probe; 8 div reference signal from a 25 ohm source. Lower limit is approx 0.2 Hz with probe.)

(1803A Specifications continued on page 12.)
Differential/DC Offset Vertical Plug-In
40 MHz Model 1803A (continued)

**Common Mode Rejection Ratio:** measured at a deflection factor of 0.001 V/div. (CMRR decreases with increasing deflection factor.)

<table>
<thead>
<tr>
<th>Frequency Range</th>
<th>CMRR</th>
<th>Common Mode</th>
<th>Deflection Factor</th>
<th>Comparison Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC to &lt;100 kHz</td>
<td>≥20,000:1 (≥26 dB)</td>
<td>10 V</td>
<td>0.001 V/div to 0.02 V/div</td>
<td>±(0.15%+0.1 V/div)</td>
</tr>
<tr>
<td>100 kHz to &lt;1 MHz</td>
<td>≥10,000:1 (≥80 dB)</td>
<td>10 V</td>
<td>0.05 V/div to 0.2 V/div</td>
<td>±(0.75%+0.1 V/div)</td>
</tr>
<tr>
<td>1 MHz to &lt;10 MHz</td>
<td>≥5,000:1*</td>
<td>10 V</td>
<td>0.5 V/div to 2 V/div</td>
<td>±1%</td>
</tr>
<tr>
<td>10 MHz to 60 MHz</td>
<td>Freq. in MHz</td>
<td>1 V</td>
<td>5 V/div to 20 V/div</td>
<td>±3%</td>
</tr>
<tr>
<td>20 MHz</td>
<td>≥50:1 (≥34 dB)</td>
<td>10 V*</td>
<td>0 to ±10 V</td>
<td>±5%</td>
</tr>
</tbody>
</table>

*Divide CMRR and Voltage by Frequency in MHz.
**AC-coupled (all others dc-coupled).

**V₀ Output:** calibrated dc offset voltage available at front panel connector, continuously variable from 0 to ±6 V, 0 to ±6.0 V, or 0 to ±6 V. Accuracy of the ±6 V range is ±0.15% of reading ±8 mV when driving a resistance of 10 megohms or higher.

**Triggering**
DC to 40 MHz on signals causing 0.5 div or more vertical deflection.

**General**
Weight: net, 5 lb (2.3 kg); shipping, 8 lb (3.6 kg).
Environment: same as Model 181A/AR mainframes.
Power: supplied by 180 system mainframe.
Price: Model 1803A Differential DC Offset Amplifier $950.

Delayed Sweep Time Bases
100 MHz Triggering Model 1822A

Model 1822A is a time base and delay generator plug-in for 180 system mainframes and is designed for use with all vertical amplifier plug-ins up to 100 MHz. Operating characteristics are calibrated sweeps from 1 s/div to 50 ns/div (5 ns/div when using mainframe magnifier); triggering to 150 MHz; trigger hold off control that allows stable triggering on complex waveforms; and main, delayed, and mixed sweeps.

**1822A Specifications**

**Main Time Base**

**Sweep**
Ranges: 0.05 μs/div to 1 s/div (23 positions) in 1, 2, 5 sequence. ±3% accuracy with Vernier in calibrated position.
Vernier: continuously variable between all ranges; extends slowest sweep to at least 2.5 s/div. Uncalibrated light indicates when vernier is not in cal position.
Magnifier: (on mainframe) expands fastest sweep to 5 ns/div.

**Sweep Mode**
Normal: sweep is triggered by an internal, external, or power line signal.
Automatic: bright baseline displayed in absence of input signal. Triggering same as normal except low frequency limit is 40 Hz.

**Delayed Time Base**
Delayed time base sweeps after a time delay set by main time base and delay controls.

**Triggering**
Times to 40 MHz on signals causing 0.5 div or more vertical deflection.

**Internal**
Refer to vertical amplifier plug-in specifications.

**External**
From dc to 150 MHz on signals 250 mV pk-pk or more, increasing to 150 MHz on signals 350 mV pk-pk or more.
Line: power line frequency signal.
Level and Slope
Internal: at any point on the vertical waveform displayed.
External: continuously variable from +3 V to −3 V on either slope of the sync signal; from +30 V to −30 V in +10 setting.
Coupling: front panel selection of AC, DC, ACf, or ACS.
AC: attenuates signals below approx 20 Hz.
ACF (ac-fast): attenuates signals below approx 15 kHz.
ACS (ac-slow): attenuates signals above approx 30 kHz.
Variable Hold Off:
time between sweep triggers continuously variable, exceeding one full sweep at 50 ms/div and faster.
Trace Intensification:
used when setting up delayed or mixed time base. Intensifies that part of main time base to be expanded to full screen on delayed time base. Moving delayed sweep switch from off position activates intensified mode. Front panel adjust sets relative intensity of brightened segment.

**Specifications continued on following page.
Delayed Sweep Time Bases

100 MHz Triggering Model 1822A (Continued)

External: from dc to 100 MHz on signals 250 mV pk-pk or more, increasing to 150 MHz on 350 mV pk-pk or more.
Level and Slope: internal, at any point on the vertical waveform displayed. External, continuously variable from +3 V to -3 V on either slope of the sync signal; from +30 V to -30 V in ±10 setting.
Coupling: front panel selection of AC, DC, ACF, or ACS.
AC: attenuates signals below approx 20 Hz.
ACF (ac-fast): attenuates signals below approx 15 kHz.
ACS (ac-slow): attenuates signals above approx 30 kHz.
DELAY (before start of Delayed sweep)
Time: continuously variable from 0.05 μs to 10 s.
Accuracy: ±1%. Linearity: ±0.2%.
Trigger Output: at end of delay time approx 1 V with <50 ns rise-time from 1000 ohm source resistance.

Mixed Time Base
Dual time base in which Main time base drives first portion of sweep and Delayed time base completes sweep at up to 1000 times faster. Also operates in single sweep mode.

General
Weight: net, 4 lb (1.8 kg); shipping, 7 lb (3.1 kg).
Environment: same as Model 180A/AR mainframe.
Power: supplied by 180 System mainframe.
Price: Model 1822A Time Base and Delay Generator...........$900.

50 MHz Triggering Model 1821A

Model 1821A is a time base and delay generator plug-in for 180 system mainframes and is designed for use with 50 MHz and lower bandwidth vertical amplifier plug-ins. Operating characteristics are: calibrated sweeps from 1 s/div to 100 ns/div (10 ns/div when using mainframe magnifier); triggering to 100 MHz; and main, delayed, and mixed sweep modes.

1821A Specifications

Main Time Base

Sweep
Ranges: from 0.1 μs/div to 1 s/div (22 positions) in 1, 2, 5 sequence, ±3% accuracy with vernier in calibrated position.
Vernier: continuously variable between all ranges; extends slowest sweep to at least 2.5 s/div.
Magnifier: (on mainframe) expands fastest sweep to 10 ns/div.

Sweep Mode
Normal: sweep is triggered by an internal, external, or power line signal.
Automatic: bright baseline displayed in absence of input signal; triggering same as normal except low frequency limit is 40 Hz for internal or external modes.

Triggering
Internal: refer to vertical amplifier plug-in specifications.
External: from dc to 50 MHz on signals 0.5 V pk-pk or more, increasing to 100 MHz on signals 1 V pk-pk or more.
Line: power line frequency signal.

Level and Slope
Internal: at any point on the vertical waveform displayed.
External: continuously variable from +3 V to -3 V on either slope of the sync signal; from +30 V to -30 V in ±10 setting.

Delay Time Base
Dual time base sweeps after a time delay set by Main time base and Delay controls.

General
Price: Model 1821A Time Base and Delay Generator...........$700.
Model 1820B is a time base plug-in for 180 system mainframes and is designed for use with all vertical amplifier plug-ins up to 100 MHz. Operating characteristics are: calibrated sweeps from 2 s/div to 50 ns/div (5 ns/div when using mainframe magnifier); triggering to 150 MHz; trigger hold-off control that allows stable triggering on complex waveforms; and three sweep modes. Automatic triggering provides a baseline in the absence of an input signal and syncs on the input waveform when a vertical signal is applied.

Triggering flexibility is increased with the selection of input coupling. ACF (as-fast) attenuates trigger signals below 15 kHz, which eliminates hum; ACS (ac-slow) attenuates trigger signals above 30 kHz that could cause triggering problems in low frequency applications.

### 1820B SPECIFICATIONS

#### TIME BASE

**Sweep**
- **Ranges:** 0.05 µs/div to 2 s/div (24 positions) in 1, 2, 5 sequence; ±3% accuracy with vernier in calibrated position.

#### GENERAL

**Weight:** net, 3 lb (1.4 kg); shipping, 6 lb (2.7 kg).
**Environment:** same as Model 180A/AR mainframes.
**Power:** supplied by 180 System mainframe.
**Price:** Model 1820B Time Base $450.

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Models 1815A and 1815B provide calibrated 35 ps risetime time domain reflectometry and 12.4 GHz (28 ps risetime) sampling capabilities in the versatile 180 oscilloscope system.

The Models 1815A/B TDR/Sampler plug-ins, double-sized plug-ins for the 180 system, can be combined with appropriate remote sampler head and tunnel diode mount to obtain a calibrated TDR system that allows analysis of coaxial microwave components and identification of discontinuities on the order of 0.25 inch apart. A direct readout in feet along the line is obtained from the Model 1815A or in meters from Model 1815B. Either Model 1106A (20 ps) or Model 1108A (60 ps) tunnel diode mount is compatible for TDR with the plug-in samplers.

These same plug-ins and sampler heads used for TDR measurements also serve as either a 4GHz or 12.4 GHz sampling system with a direct readout in time. For sampling use, there is direct triggering to 500 MHz and to 18 GHz with Model 1104A/1106A trigger countdown.

Sampling heads, Model 1816A (90 ps risetime) and Model 1817A (28 ps risetime), are detachable, remote, single channel, feedthrough samplers for convenient use in 50-ohm transmission systems. The plug-in and sampler heads provide the circuits for operating the tunnel diode pulse generators.
1815A/B SPECIFICATIONS

Unless indicated otherwise, TDR and sampling performance specifications are the same. Where applicable, TDR specification is given first, followed by Sampler specification in parentheses.

Model 1815A is calibrated in feet.
Model 1815B is calibrated in meters.

VERTICAL

SCALE: reflection coefficient \( p \) (volts) from 0.005/div to 0.5/div in 7 calibrated ranges: 1, 2, 5 sequence.
ACCURACY: ±3%; TDR only, ±5% on 0.001/div and 0.005/div in signal average mode.
VERNIER: provides continuous adjustment between ranges, extends scale to >0.002/div.
SIGNAL AVERAGE: reduces noise and jitter approx 2:1.

HORIZONTAL

SCALE: Provides up to a 10,000 foot or meter display window with round-trip time or distance (time) in four calibrated decade ranges of 1/div, 10/div, 100/div, and 1000/div. Centric expander control provides direct read-out in 28 calibrated steps in 1, 2, 5 sequence from 0.01 ns/div to 1000 ns/div or from 0.01 foot or meter/div to 1000 foot or meters/div (0.01 ns/div to 1000 ns/div).
ACCURACY: ±2%; distance, TDR only, ±3% ± variations in propagation velocity.
MARKER POSITION: indicator, calibrated in divisions, provides direct read-out of round-trip time or distance (time), number of divisions × decade range in units/div.
MARKER ZERO: permits instant location of marker reference.
DIELECTRIC, TDR ONLY: calibrated for air, \( \varepsilon = 1 \), and for polyethylene, \( \varepsilon = 2.25 \). Also provides variable settings for dielectric constants \( \varepsilon = 1 \) to \( \varepsilon = 6 \) approx 4.
TRIGGERING, SAMPLING ONLY
Pulse: <0.2 mV for pulses 5 ns or wider for jitter <20 ps.
CW: signals from 500 kHz to 500 MHz require at least 80 mV for jitter <2% of signal period plus 10 μs, usable to 1 GHz. CW triggering may be extended to 18 GHz with HP Models 1104A/1106A trigger countdown.

RECORDER OUTPUTS
Approx 100 mV/div; vertical and horizontal outputs at BNC connectors on rear panel of mainframe.

DISPLAY MODES
Repetitive scan, normal or detail; single scan; manual scan, record.

GENERAL

ENVIRONMENT: same as Model 181A/AR mainframe.
WEIGHT: net, 5 lbs (2.3 kg); shipping, 10 lbs (4.5 kg).
PRICE
Model 1815A TDR/Sampler (calibrated in feet) $1250.
Model 1815B TDR/Sampler (calibrated in meters) $1250.

MODELS 1817A and 1816A
28ps and 90ps SAMPLERS SPECIFICATIONS

Unless indicated otherwise, Model 1817A and Model 1816A specifications are the same. Where applicable, Model 1817A specification used with Model 1106A tunnel diode mount is given first, followed by Model 1816A specification (in parentheses) used with Model 1108A tunnel diode mount.

TDR SYSTEM

SYSTEM RISETIME: ≈35 ps (110 ps) incident as measured with Model 1106A (Model 1106A).
OVERSHOOT: ≈±5%.
INTERNAL REFLECTIONS: <80% with 45 ps (145 ps) TDR; use reflected pulse from shorted output.
JITTER: <15 ps; with signal averaging, typically 5 ps.
INTERNAL PICKUP: \( p \leq 0.01 \).
NOISE: measured tangentially as a percentage of the incident pulse when terminated in 50 ohms and operated in signal averaging mode. <1% (0.3%) on 0.005/div to 0.02/div; <3% (1%) on 0.05/div to 0.5/div.
LOW FREQUENCY DISTORTION: ≤±3%.
MAXIMUM SAFE INPUT: 1 volt.

SAMPLER SYSTEM

RISETIME: <28 ps (60 ps).
INPUT: 50 ohm feedthrough.
DYNAMIC RANGE: 1 V p-p.
MAXIMUM SAFE INPUT: 3 volts (5 volts).
LOW FREQUENCY DISTORTION: ≤±3%.
NOISE Normal: <0.2 mV (3 mV) tangential noise on 0.01 V/div to 0.5 V/div.
Noise decreases automatically on 0.005 V/div.
Signal average: reduces noise and jitter approx 2:1.

TUNNEL DIODE MOUNT: direct connection for either Model 1106A or Model 1108A tunnel diode mount for TDR system.

ACCESSORIES SUPPLIED

CABLE, PLUG-IN TO SAMPLER: connects sampler (1816A or 1817A) to plug-in (1815A or B); HP Part No. 5060-0334; replacement price, $75.
CABLE, TUNNEL DIODE TO SAMPLER: connects tunnel diode (1106A or 1108A) to sampler, HP Part No. 01817-61603; replacement price, $18.

GENERAL

PRICE
Model 1817A 28 ps Rise Time Sampling Head $1500.
Model 1816A 90 ps Rise Time Sampling Head $1500.

MODELS 1106A and 1108A
20ps and 60ps TUNNEL DIODE MOUNTS SPECIFICATIONS

Tunnel diode mount connects directly to sampler and is required for a TDR system.

AMPLITUDE (both): >200 mV into 50 ohms.
RISETIME: Model 1106A, approx 20 ps; Model 1108A, <60 ps.
OUTPUT IMPEDANCE: 50 ohms ±2%.
SOURCE REFLECTION: Model 1106A, <10% with 45 ps TDR; Model 1108A, <10% with 145 ps TDR.
WEIGHT (both): net, 1 lb (0.5 kg); shipping, 3 lbs (1.4 kg).
Model 1108A, $175.
SAMPLING

DUAL CHANNEL 1 GHz MODEL 1810A

Model 1810A Sampling Plug-in is a 1 GHz, dual-channel, double-sized plug-in for 180 System Oscilloscope mainframes. The simplified, easy-to-use controls allow fast accurate measurements with deflection factors from 2 mV/div to 200 mV/div, frequency response from dc to 1 GHz, and 18 sweep times from 50 μs/div to 0.1 ns/div (with sweep expansion).

This sampling plug-in provides nanosecond rise-time measurements of repetitive signals with minimum familiarization time. New circuit stability allowed removal of the special controls, such as smoothing and response, normally found on sampling scopes. Conventional, single knob trigger stability makes sampling triggering adjustments as easy as real time.

This plug-in is also designed for easy calibration and servicing. New circuits reduced the number of internal adjustments to 15, all non-interacting. Hand wiring is to a minimum with individual circuit cards contacting directly to a mother board which reduces the possibility of error during servicing.

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1810A SPECIFICATIONS

MODES OF OPERATION
Channel A; channel B; channels A and B displayed on alternate samples (ALT); channel A plus channel B (algebraic addition); and channel A versus channel B.

VERTICAL CHANNELS
BANDWIDTH: dc to 1 GHz.
RISE TIME: <300 ps.
PULSE RESPONSE: <3% (overshoot and perturbations).
DEFLECTION FACTOR
Ranges: 2 mV/div to 200 mV/div (7 calibrated positions) in 1, 2, 5 sequence.
Accuracy: ±3%.
Verfield: provides continuous adjustment between deflection factor ranges; extends minimum deflection factor to <1 mV/div.
Polarity: + UP or - UP
DYNAMIC RANGE: >1.6 V.
POSITIONING RANGE: >±1 V on all deflection factors.
INPUT Rs: 50 ohms, ±2%.
MAXIMUM INPUT: ±5 V (dc + peak ac).
VSFR: <1.1:1 to 300 MHz, increasing to <1.5:1 at 1 GHz.
REFLECTION COEFFICIENT: <6%, measured with HP Model 1415A TDR.
NOISE
Normal: <2 mV, observed from center 80% of dots.
Filtered: <1 mV.
ISOLATION BETWEEN CHANNELS: >40 dB with 350 ps rise time input.
TIME DIFFERENCE BETWEEN CHANNELS: <100 ps.
A + B OPERATION: bandwidth and deflection factors are unchanged; either channel may be inverted for ±A±B operation.
VERTICAL OUTPUTS: an uncalibrated, 1 V vertical output signal from each channel is provided at the rear panel of 180 system mainframes.

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TIME BASE RANGES
Normal: 10 ns/div to 50 μs/div (12 calibrated positions) in a 1, 2, 5, sequence. ±3% accuracy with vernier in calibrated position.
Expanded: direct reading expansion up to X100 in seven calibrated steps on all normal time scales, extends the range to 100 ps/div. Accuracy is ±4% (10 ps/div, ±10% using the mainframe magnifier).
VERNIER: continuously variable between ranges; increases fastest sweep to <40 ps/div.
TRIGGERING MODE
NORMAL: trigger level control can be adjusted to trigger on a wide variety of signals.
AUTOMATIC: triggers automatically on most signals with a minimum of adjustment of the level control. A baseline is displayed in the absence of an input signal.
Internal
SOURCE: selectable, channel A triggers channel A or alternate, channel B triggers channel B, alternate, A + B, or A vs B.
SINE WAVE: 30 mV pp for signals from 1 kHz to 200 MHz; 100 mV pp for signals from 200 MHz to 1 GHz for jitter of <30 ps plus 1% of 1 period. Useful triggering can be obtained with 5 mV signals.
PULSE: 30 mV peak, 3 ns wide pulses for <30 ps jitter. Useful triggering can be obtained with 5 mV signals.
External
SINE WAVE: 30 mV pp for signals from 1 kHz to 1 GHz for jitter of <30 ps plus 1% of 1 period. Useful triggering can be obtained with 5 mV signals.
PULSE: 30 mV peak, 3 ns wide pulses for <30 ps jitter. Useful triggering can be obtained with 5 mV signals.
Either Internal or External
AUTO: 50 mV pp for CW signals from 10 kHz to 200 MHz for <30 ps jitter plus 2% of 1 period (may be used to 1 GHz with increased jitter). Pulse triggering requires 50 mV peak, 3 ns wide pulses for <30 ps jitter.
LEVEL and SLOPE: continuously variable from ±800 mV to ±800 mV on either slope of sync signal.
COUPLING: ac coupling attenuates signals below approx 1 kHz.
Variable Holdoff: variable over at least a 3:1 range in all sweep modes.
MARKER POSITION: intensified marker segment indicates point about which the sweep is to be expanded (automatically dimmed with increasing persistence in 181A and 181AR mainframes).
SCAN
Internal: dot density, continuously variable from <100 to >1000 dots/full screen or from approx 500 to >2000 dots in filtered mode.
Manual: scan is positioned manually by front panel controls.
HORIZONTAL OUTPUT: an uncalibrated approx 0.75 V amplitude signal is provided at the rear panel of a 180 or 181 mainframe.

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GENERAL
PROBE POWER: supplies power to operate two HP active probes.
WEIGHT: net, 7 lb (3.2 kg); shipping, 12 lb (5.4 kg).
ENVIRONMENT: same as Model 181A/AR mainframes.
PRICE: Model 1810A 1 GHz Sampling $1650.