

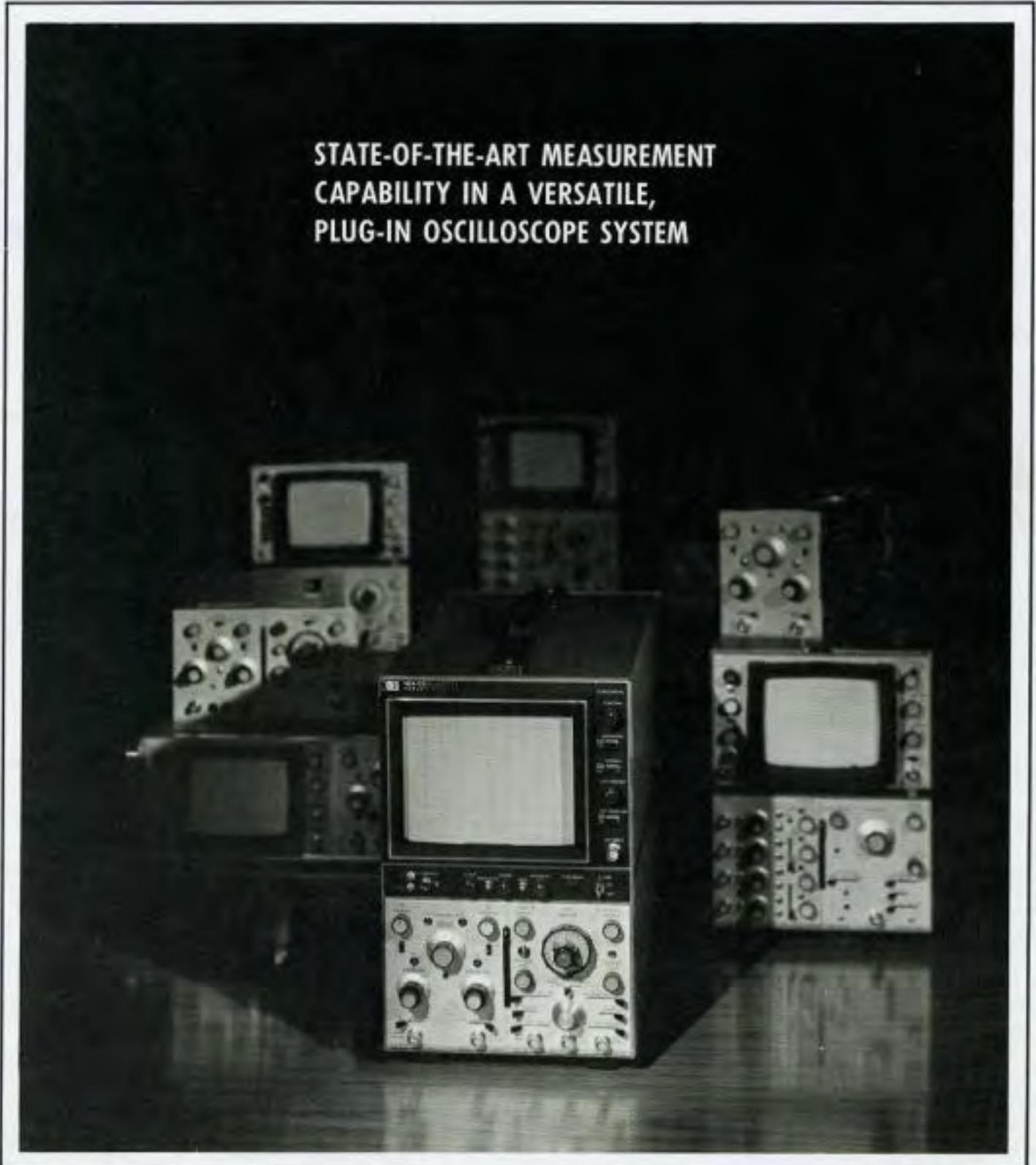
HEWLETT  PACKARD
OSCILLOSCOPE SYSTEMS

HIGH FREQUENCY PLUG-IN OSCILLOSCOPES

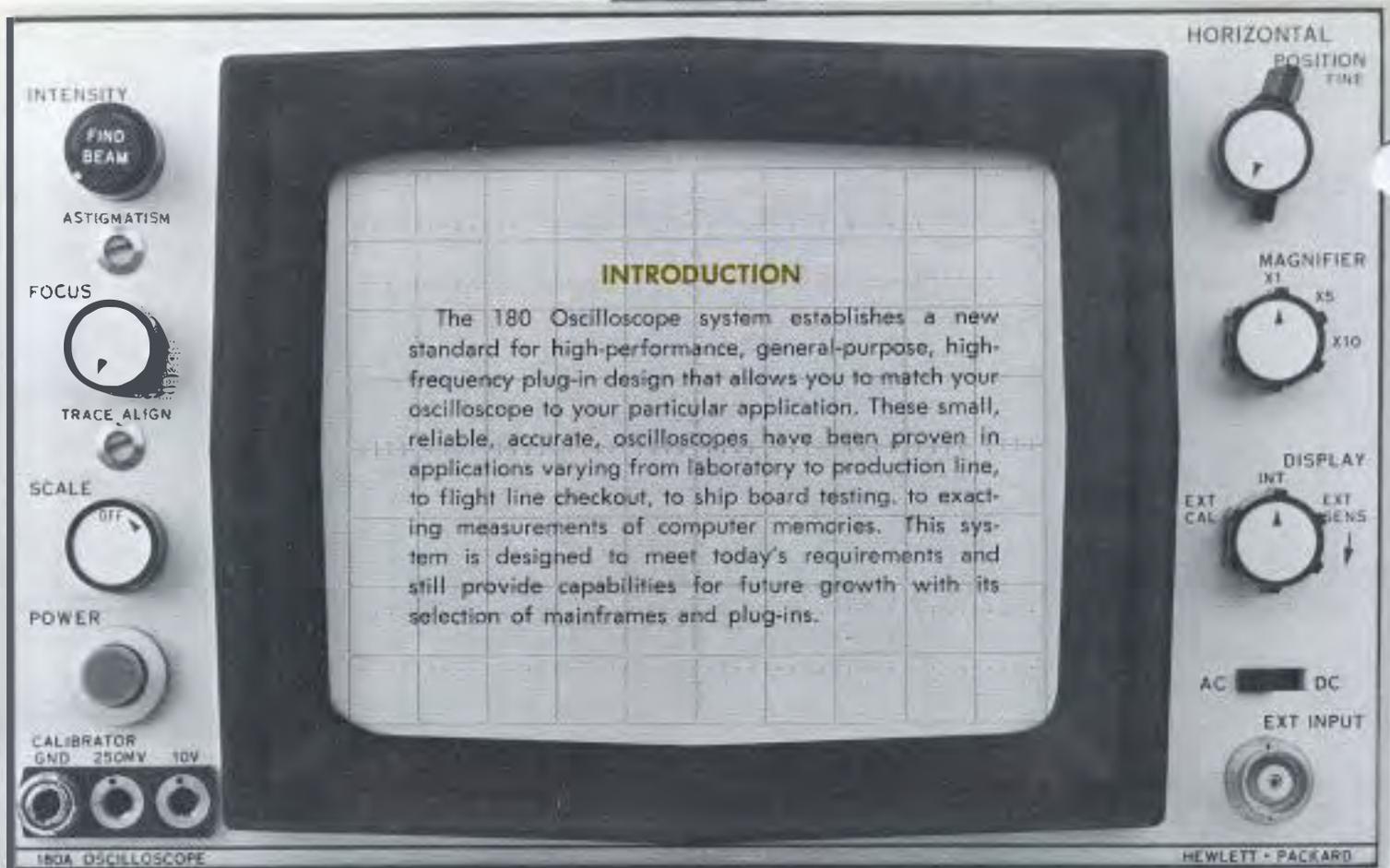
THE
180
SYSTEM

TECHNICAL DATA 15 OCT 71

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



For more information, call your local HP Sales Office or East (201) 265-5000 . Midwest (312) 677-0400 . South (404) 436-6181
West (213) 877-1282. Or, write: Hewlett-Packard, 1501 Page Mill Road, Palo Alto, California 94304. In Europe, 1217 Meyrin-Geneva



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 500 μ V/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.

180 SYSTEM SELECTION/COMPATABILITY CHARTS

MAINFRAMES			
Model No.	DESCRIPTION	PRICE	REFERENCE
180A	Cabinet style for up to 100 MHz real time plug-ins	\$895	Page 6
180AR	5¼-inch high rack/bench style version of 180A	\$995.	Page 6
181A	Cabinet style, variable persistence and storage CRT, 100 MHz	\$1950.	Page 5
181AR	5¼-inch high rack/bench style version of 181A	\$2025.	Page 5
182A	Large screen, 100 MHz, cabinet style	\$950.	Page 6
183A	Cabinet style, >500 MHz bandwidth, 4 cm/ns writing speed	\$1850.	See 183A/B data sheet
183B	5¼-inch high rack/bench style, version of 183A	\$1925.	See 183A/B data sheet
183C	Cabinet style, >500 MHz bandwidth, selectable scan, 4 or 8 cm/ns writing speed	\$2500.	See 183C/D data sheet
183D	5¼-inch high rack/bench style, version of 183C	\$2600.	See 183C/D data sheet

VERTICAL PLUG-INS								
MODEL NO.	1801A	1802A	1803A	1804A	1806A	1830A	1831A/B	1810A
Bandwidth (MHz)	50	100 (75 cas- caded)	40 (30)	50	0.5	250	>600	1 GHz
Min. deflection factor/div	5 mV (500µV Opt 001 cas- caded)	10 mV (1 mV cascaded)	5 mV (1 mV)	20 mV	100µV	10 mV	≈6 V	2 mV
Channels	2 (1 cas- caded Opt 001)	2 (1 cas- caded)	1 (diff)	4	2	2	1831A, 1 (diff) 1831B, 1 single ended	2
Differential input	Yes	Yes	Yes (with dc offset)	No	Yes	Yes	1831A	Yes
Price	\$680. Opt 001 \$830.	\$1200.	\$950.	\$1050.	\$675.	\$900.	1831A, \$375. 1831B, \$425.	\$1650.
Reference	Page 8	Page 9	Page 11	Page 10	Page 10	See 183A/B data sheet	See 183C/D data sheet	Page 16

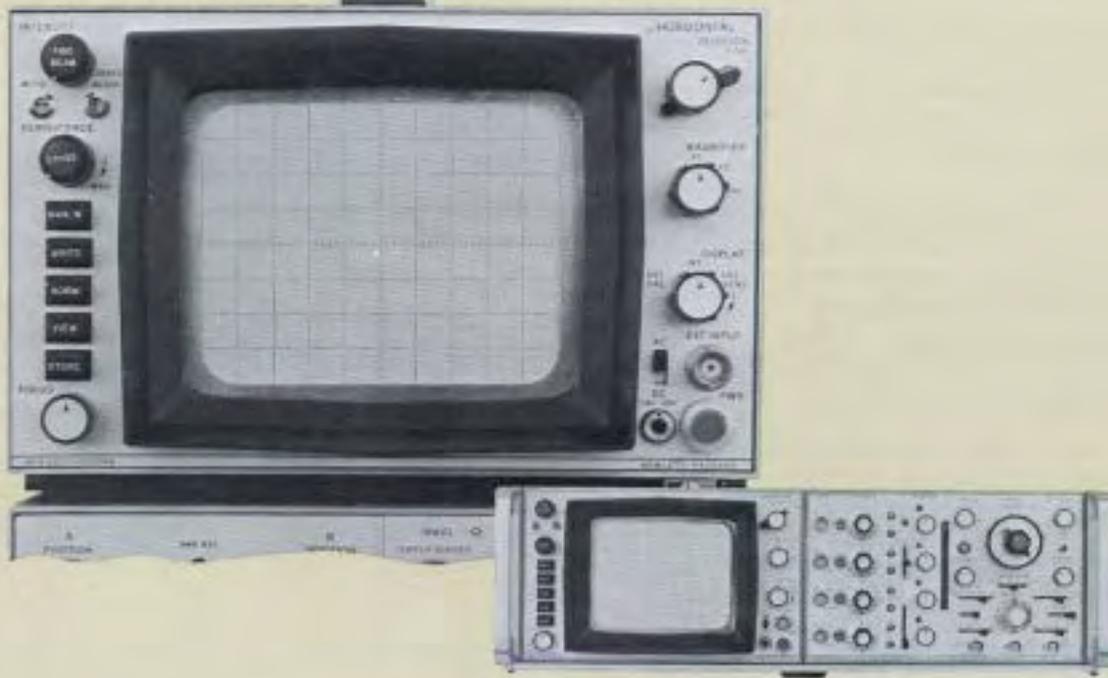
TIME BASE PLUG-INS							TDR/SAMPLER
MODEL NO.	1820B	1821A	1822A	1840A	1841A	1810A	1815A/B
Ext trig	150 MHz	100 MHz	150 MHz	>500 MHz	>500 MHz	>1 GHz	35 ps calibrated rise time TDR, 12.4 GHz sampling.
Int trig	120 MHz	75 MHz	120 MHz	250 MHz	250 MHz	1 GHz	
Sweep speeds/div	5 ns - 2s	10ns - 1s	5 ns - 1s	1 ns - 0.1s	1 ns - 0.1s	100 ps (expanded)- 50µs	Requires sampling head and tunnel diode
Delayed and mixed sweep	No	Yes	Yes	No	delayed	No	
Price	\$450.	\$700.	\$900.	\$650.	\$1150.	\$1650.	\$2250-3300 (depending on sampling head)
Reference	Page 14	Page 13	Page 12	See 183A/B data sheet	See 1841A data sheet	Page 16	Page 14

Plug-in and Mainframe Compatibility Chart																				
	VERTICAL PLUG-INS								MAINFRAME				VERTICAL PLUG-INS							
	1801A	1802A	1803A	1804A	1806A	1810A	1831A/B		180A/AR	181A/AR	182A	183A/B 183C/D	1801A	1802A	1803A	1804A	1806A	1830A	1831A/B	
MAINFRAME								TIME BASE PLUG-INS												
180A/AR	X	X	X	X	X			1820B	X	X	X	X	X	X	X	X	X			
								1821A	X	X	X	X	X	X	X	X	X			
181A/AR	X	X	X	X	X			1822A	X	X	X		X	X	X	X	X			
								1840A				X	X	X	X	X	X	X	X	
182A	X	X	X	X	X			1841A				X	X	X	X	X	X	X	X	
								1815A/B	X	X	X	X	35 ps Rise Time TDR/12.4 GHz Single Channel Sampling							
183A/B/C/D	X	X	X	X	X	X	X	1810A	X	X	X	X	1 GHz, Dual Channel Sampling							

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 ns pulse width (≤ 10 MHz CW) blanks trace of normal intensity. Input R, 5100 ohms.

PERSISTENCE

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

Variable: from < 0.2 S to > 1 min.

STORAGE WRITING SPEED

Write Mode: > 20 div/ms.

Max. Write Mode: > 1000 div/ms.

BRIGHTNESS: > 200 foot Lamberts.

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.

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.

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, $\pm 5\%$ (with 3% accuracy time base).

GENERAL**CALIBRATOR**

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

Amplitude: 10Vp-p; accuracy, $\pm 1\%$.

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 (Rock): 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, to 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 $\pm 10\%$, 48 to 440 Hz, < 115 watts at normal line with plug-ins. Max. mainframe power, 225 VA.

DIMENSIONS: see 180A/AR outline drawings, page 7.

ACCESSORIES FURNISHED: 7 1/2 ft. power cord, Model 10178A mesh contrast filter; rack mounting hardware and two probe holders (HP P/N 5050-0464) 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)

H49: Model 181A or 181AR with remote programming capability for Write, Max. Write, Normal, Store, View, and Erase functions. Programming accomplished through contact closure, DTL, or TTL logic sources. Price: Model 181A Option H49, \$2450. Model 181AR Option H49, \$2525.

180 SYSTEM MAINFRAMES

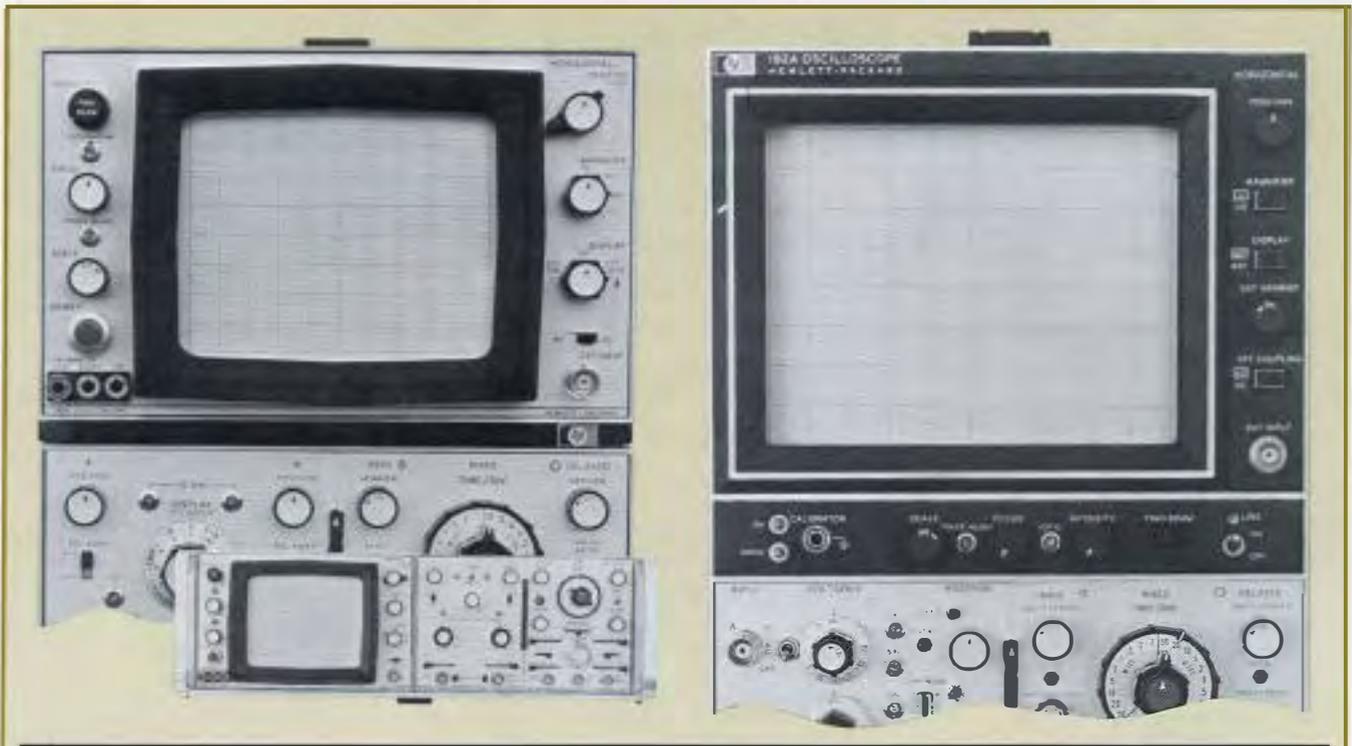
CONVENTIONAL and LARGE SCREEN MODELS 180A/AR and 182A

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 dis-

plays, 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 +2V, ≥ 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; oc-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: ± 20 V.

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

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

INTERNAL SWEEP

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

GENERAL

CALIBRATOR

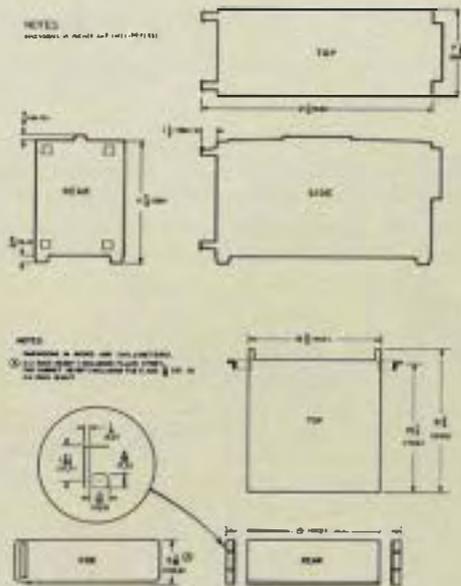
Type: approx 1 kHz square wave, 3 μ s rise time.

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

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.)

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 $+65^{\circ}\text{C}$; 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 $\pm 10\%$, 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; rock mounting hardware and 2 probe holders (HP P/N 5050-0464) are also supplied with the 180 AR rock 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.
Beamfinder does not intensify 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, ≥ 50 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, $< 3 \mu\text{s}$ rise time.

VOLTAGE: two outputs, 250 mV p-p and 10 V p-p; accuracy, $\pm 1\%$.

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, $\pm 5\%$.

Vernier provides continuous adjustment between ranges.

Dynamic range: ± 20 V.

Maximum input: ± 300 V (dc + peak ac).

Input RC: 1 megohm shunted by approx 30 pF.

INTERNAL SWEEP

Sweep Magnifier: X10; accuracy, $\pm 5\%$ (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 $\pm 10\%$, 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.

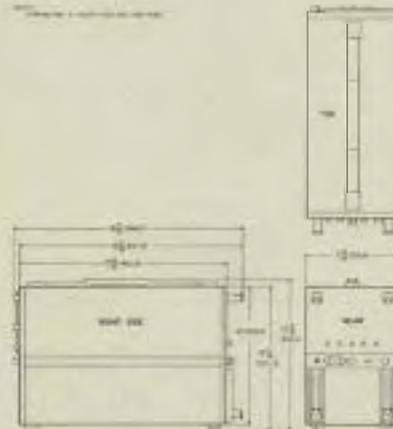
Temperature: 0°C to $+55^{\circ}\text{C}$.

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. Beamfinder does not intensify display on Option 011 oscilloscopes.

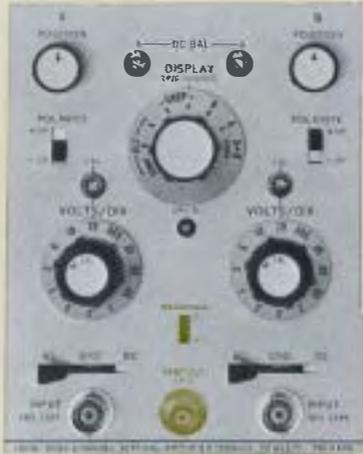
DUAL CHANNEL VERTICAL PLUG-INS

50 MHz MODEL 1801A/1801A OPTION 001

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 μ V/div deflection factor.



1801A OPT. 001 INDICATED IN COLOR

1801A SPECIFICATIONS

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 ohm 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 ohm source.).

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

Attenuator Accuracy: $\pm 3\%$.

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 $\pm A \pm B$ 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: some os Model 180A/AR mainframes.

ACCESSORIES FURNISHED: two 10004B, 10:1 divider probes, approx 3 1/2 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 10005B 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 a 25 ohm 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: (Measured with or without 10004B probe 10% to 90% of 8 div input step from 25 ohm source.) <7 ns; in X5 mode, <18 ns.

DEFLECTION FACTOR: 5 mV/div to 20 V/div (12 positions) in 1,2,5 sequence. X5 mode increases deflection factor to 1 mV/div. With channel B output cascaded with channel A (X1 mode), 500 μ V/div.

Attenuator Accuracy: $\pm 3\%$.

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 $\pm A \pm B$ 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 (X1) 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 8 into A: 12 ns (dc to 30 MHz).

Amplitude: 50 mV/div into 50 ohms, usable amplitude up to 800 mV p-p. Open circuit, approx 80 mV/div with usable amplitude of >1 V.

DC Level: 0 V \pm 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: some as Model 181A/AR mainframe.

ACCESSORIES FURNISHED: two 10004B, 10:1 divider probes, approx 3 1/2 ft.

PRICE: Model 1801A Opt 001 Dual Channel Vertical Amplifier \$830.

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 \$80.

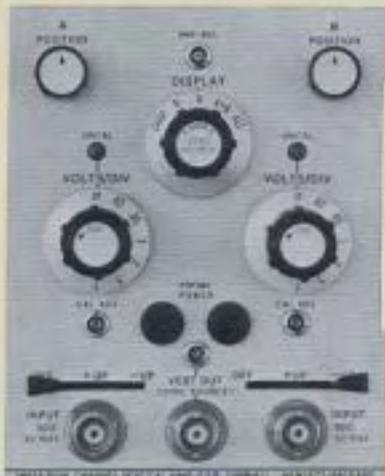
090: 6 ft 10006B probes substituted for 10004B, 10:1 atten, no charge.

091: 10 ft 10005B probes substituted for 10004B, 10:1 atten, 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.



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 8-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%; perturbations, <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: \pm 3%.

Vernier: 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.

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: \pm 4 divisions.

DRIFT: < \pm 1 div over environmental temperature range (except for cascaded operation).

INPUT R: 50 ohms \pm 2 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 \pm A \pm 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 on 1821A time base plug-ins.

VERTICAL SIGNAL OUTPUT

AMPLITUDE: 100 mV/div of displayed signal into 50 ohm load, adjustable with front panel control; useable amplitude, 600 mV pk-pk.

BANDWIDTH: dc to >100 MHz.

RISE TIME: <3.5 ns.

GENERAL

WEIGHT: net, 5 lb (2,3 kg); shipping, 8 lb (3,6 kg).

PROBE POWER: provides power to operate two active probes.

ENVIRONMENT: some as Model 181A/AR mainframes.

POWER: supplied by 180 System mainframe.

ACCESSORIES FURNISHED: calibrator adapter (HP Part No. 01802-63201).

PRICE: Model 1802A Dual Channel Vertical Amplifier \$1200.

OPTIONS (order by option number)

090: two Model 10020A resistive divider probe sets; add \$200.

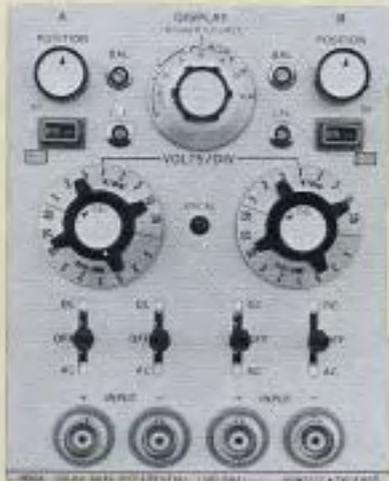
091: two Model 1124A active probes; add \$250.

DUAL CHANNEL VERTICAL PLUG-INS

500 kHz, 100 $\mu\text{V}/\text{div}$ 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 $\mu\text{V}/\text{div}$ to 20 V/div deflection

factors, 100 dB CMRR from dc to 10 kHz with a $\pm 10\text{ V}$ common mode signal on the 100 $\mu\text{V}/\text{div}$ range, and less than 20 μV of noise, measured tangentially at full bandwidth.



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 ($<3\text{dB}$ 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 $\mu\text{V}/\text{div}$ to 20 V/div (17 positions) in 1, 2, 5 sequence.

Attenuator Accuracy: $\pm 3\%$ with vernier in calibrated position.

Vernier: continuously variable between ranges; extends maximum deflection factor to at least 50 V/div.

NOISE: $<20\ \mu\text{V}$, 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: $\geq 100\ \text{dB}$ (100,000 to 1) with dc-coupled input on 100 $\mu\text{V}/\text{div}$ range, decreasing 20 dB per decade of deflection factor to $\geq 40\ \text{dB}$ on the 200 mV/div range; CMRR is $\geq 30\ \text{dB}$ on the 500 mV/div to 20 V/div ranges.

Maximum Signal: $\pm 10\ \text{V}$ (dc + peak ac) on 100 $\mu\text{V}/\text{div}$ to 200 mV/div ranges; $\pm 400\ \text{V}$ (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: $\pm 400\ \text{V}$ (dc + peak ac).

INPUT ISOLATION: $\geq 80\ \text{dB}$ 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 $>500\ \text{kHz}$ 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, 3 $\frac{1}{2}$ lb (1.6 kg); shipping, 6 $\frac{1}{2}$ 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.)

10001A/B: 5 and 10 ft, 10:1 divider probes. Price, \$35.

10002A/B: 5 and 10 ft, 50:1 divider probes. Price, \$40.

10003A: 4 ft, 10:1 divider probe. Price \$35.

10007A: 3 $\frac{1}{2}$ ft, 1:1 probe. Price \$22.

10008A: 6 ft, 1:1 probe. Price \$22.

10012B: 6 ft, 10:1 divider probe. Price \$40.

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: $<7\ \text{ns}$. (Measured with or without 10004B probe: 10% to 90% of 8 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.

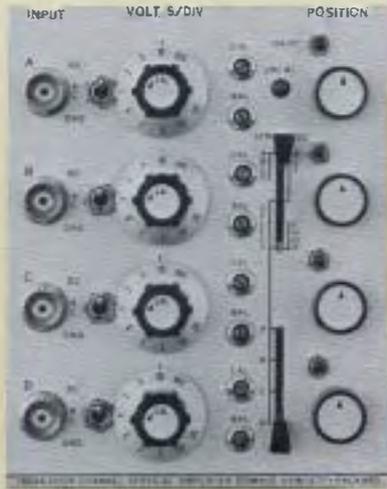
Attenuator Accuracy: $\pm 3\%$.

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 10004B 10:1 Voltage Divider Probes approx 3 1/2 ft long, add \$160.

091: four 10006B 10:1 Voltage Divider Probes approx 6 ft long, add \$160.

092: four 10005B 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.



1803A SPECIFICATIONS

VERTICAL DEFLECTION

BANDWIDTH: dc to 40 MHz (3 dB down) for deflection factors of 0.005 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 uncoupled. (Measured with or without 10004B probe; 8 div reference signal from a 25 ohm source. Lower limit is approx 0.2 Hz with probe.)

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 10004B probe; 10% to 90% of 8 div input step from 25 ohm source.)

DEFLECTOR FACTOR

Ranges: from 0.001 V/div to 20 V/div (14 calibrated positions) in 1, 2, 5 sequence.

Attenuator Accuracy: $\pm 3\%$.

Vernier: 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 V_0 for both + and - inputs. Ground disconnects signal input and grounds amplifier input for reference.

INPUT RC: 1 megohm shunted by approx 27 pF; constant on all ranges.

MAXIMUM INPUT

V_0 Range	Deflection Factor	Maximum Input (DC + Peak AC)
0 to 6 V	0.001 V/div to 0.02 V/div	± 15 V
0 to 6 V	0.05 V/div to 0.2 V/div	± 150 V
0 to 6 V	0.5 V/div to 20 V/div	± 600 V
0 to 60 V	0.01 V/div to 0.2 V/div	± 150 V
0 to 60 V	0.5 V/div to 20 V/div	± 600 V
0 to 600 V	0.1 V/div to 20 V/div	± 600 V

OVERLOAD RECOVERY

6 V Overload: within ± 10 mV of final signal value in 0.3 μ s or less, within ± 5 mV in 1 μ s or less, and within 1 mV in 1 ms or less.

60 V Overload: within ± 100 mV of final signal value in 0.3 μ s or less, within ± 50 mV in 1 μ s or less, and within ± 10 mV in 1 ms or less.

600 V Overload: within ± 1 V of final signal value in 0.3 μ s or less, within ± 0.5 V in 1 μ s or less, and within ± 100 mV in 1 ms or less.

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.)

Frequency Range	CMRR	Common Mode Input Sinewave (Max pk-pk)
DC to <100 kHz	$\geq 20,000:1$ (≥ 86 dB)	10 V
100 kHz to <1 MHz	$\geq 10,000:1$ (≥ 80 dB)	10 V
1 MHz to <10 MHz	$\geq 5,000:1^*$	10 V*
	Freq. in MHz	Freq. in MHz
20 MHz	$\geq 50:1$ (≥ 34 dB)	1 V
60 Hz	$\geq 2,000:1$ (≥ 66 dB)**	10 V

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

V_o OUTPUT: calibrated dc offset voltage available at front panel connector, continuously variable from 0 to ± 0.006 V, 0 to ± 0.06 V, 0 to ± 0.6 V, or 0 to ± 6 V. Accuracy of the ± 6 V range is $\pm 0.15\%$ of reading ± 8 mV when driving a resistance of 10 megohms or higher.

DC OFFSET

V _o Range	Deflection Factor	Comparison Accuracy
0 to ± 6 V	0.001 V/div to 0.02 V/div	$\pm(0.15\% + 8$ mV)
	0.05 V/div to 0.2 V/div	$\pm(0.75\% + 8$ mV)
	0.5 V/div to 2 V/div	$\pm 1\%$
0 to ± 60 V	5 V/div to 20 V/div	$\pm 3\%$
	0.01 V/div to 0.2 V/div	$\pm(0.4\% + 80$ mV)
	0.5 V/div to 2 V/div	$\pm(0.75\% + 80$ mV)
0 to ± 600 V	5 V/div to 20 V/div	$\pm 3\%$
	0.1 V/div to 2 V/div	$\pm(0.65\% + 0.8$ V)
	5 V/div to 20 V/div	$\pm 3\%$

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.

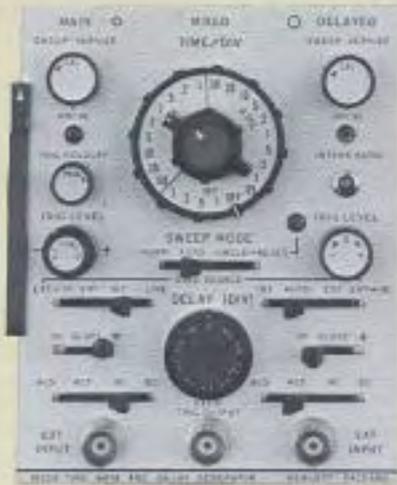
PRICE: Model 1803A Differential DC Offset Amplifier \$950.

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 μ s/div to 1 s/div (23 positions) in 1, 2, 5 sequence. $\pm 3\%$ 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.

Single: sweep occurs once with some triggering as Normal; reset spring-return switch with indicator light.

TRIGGERING

Internal: refer to vertical amplifier plug-in specifications.

External: from dc to 100 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 $\div 10$ setting.

Coupling: front panel selection of AC, DC, ACF, or ACS.

AC: attenuates signals below approx 20 Hz.

AFC (oc-fast): attenuates signals below approx 15 kHz.

ACS (oc-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.

DELAYED TIME BASE

Delayed time base sweeps after a time delay set by Main time base and Delay controls.

SWEEP

Ranges: 0.05 μ s/div to 50 ms/div (19 positions) in 1, 2, 5 sequence. $\pm 3\%$ accuracy with Vernier in Calibrated position.

Vernier: continuously variable between all ranges; extends slowest sweep to at least 125 ms/div. Uncalibrated light indicates when vernier is not in CAL position.

TRIGGERING: applies to intensified Main, Delayed and Mixed time base triggering.

Internal: refer to vertical amplifier plug-in specifications.

Automatic: delayed sweep is automatically triggered at end of set time delay. (Specifications continued on following page.)

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 $\div 10$ setting.

Coupling: front panel selection of AC, DC, ACF, or ACS.

AC: attenuates signals below approx 20 Hz.

AFC (oc-fast): attenuates signals below approx 15 kHz.

ACS (oc-slow): attenuates signals above approx 30 kHz.

DELAY (before start of Delayed sweep)

Time: continuously variable from 0.05 μ s to 10 s.

Accuracy: $\pm 1\%$. Linearity, $\pm 0.2\%$. Time jitter is $< 0.005\%$ (1 part in 20,000) of maximum delay of each step.

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 (3.2 kg).

ENVIRONMENT: same as Model 180A/AR mainframes.

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: cali-

brated 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 μ s/div to 1 s/div (22 positions) in 1, 2, 5 sequence. $\pm 3\%$ 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.

Single: sweep occurs once with some triggering as normal; reset push-button with indicator light.

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 $\div 10$ setting.

Coupling: front panel selection of AC, DC, ACF, or ACS.

AC: attenuates signals below approx 20 Hz.

AFC (oc-fast): attenuates signals below approx 15 kHz.

ACS (oc-slow): attenuates signals above approx 30 kHz.

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. Rotating Delayed time base sweep switch from Off position activates intensified mode. Front panel screwdriver adjust sets relative intensity of brightened segment.

DELAYED TIME BASE

Delayed time base sweeps after a time delay set by Main time base and Delay controls.

SWEEP

Ranges: from 0.1 μ s/div to 50 ms/div (18 positions) in 1, 2, 5 sequence. $\pm 3\%$ accuracy with Vernier in calibrated position.

Vernier: continuously variable between all ranges; extends slowest sweep to at least 125 ms/div.

TRIGGERING: applies to intensified Main, Delayed, and Mixed time base triggering.

Internal: refer to vertical amplifier plug-in specifications.

Automatic: delayed sweep is automatically triggered at end of set time delay.

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.

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 $\div 10$ setting.

Coupling: front panel selection of AC, DC, ACF, or ACS.

AC: attenuates signals below approx 20 Hz.

AFC (oc-fast): attenuates signals below approx 15 kHz.

ACS (oc-slow): attenuates signals above approx 30 kHz.

DELAY (before start of Delayed sweep)

Time: continuously variable from 0.1 μ s to 10 s.

Accuracy: $\pm 1\%$. Linearity, $\pm 0.2\%$. Time jitter is $< 0.005\%$ (1 part in 20,000) of maximum delay of each step.

Trigger Output: (at end of Delay time) approx 1.5 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 mainframes.

POWER: supplied by 180 System mainframe.

PRICE: Model 1821A Time Base and Delay Generator \$700.

SINGLE TIME BASE

100 MHz TRIGGERING MODEL 1820B

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 μ s/div to 2 s/div (24 positions) in 1, 2, 5 sequence. $\pm 3\%$ accuracy with vernier in calibrated position.

Vernier: continuously variable between ranges; extends slowest sweep to at least 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.

Single: sweep occurs once with same triggering as Normal; reset push-button with armed indicator light.

TRIGGERING

Internal: refer to vertical amplifier plug-in specifications.

External: dc to 100 MHz on signals 250 mV p-p or more, increasing to 150 MHz on signals of 350 mV p-p 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.

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.

SAMPLING/TDR

35 ps RISE TIME TDR MODELS 1815A/B

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.

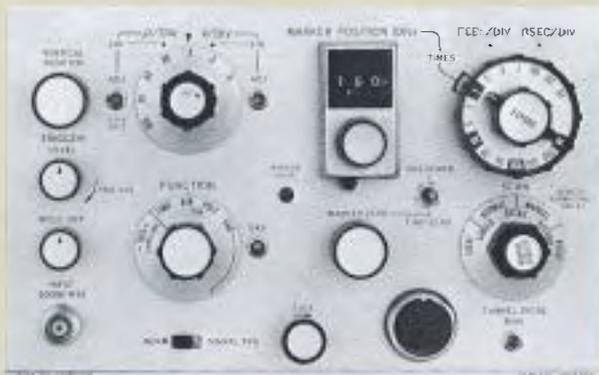
The Models 1815A/B TDR/Sampler plug-ins, double-sized plug-ins for the 180 system, can be combined with appropriate remote sampler head and tunnel diode mount to obtain a calibrated TDR system that allows analysis of coaxial microwave components and identification of discontinuities on the order of 0.25 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 count-down.

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.

35 ps RISE TIME TDR MODELS 1815A/B (CONTINUED)



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 ρ (volts) from 0.005/div to 0.5/div in 7 calibrated ranges; 1, 2, 5 sequence.

ACCURACY: $\pm 3\%$; TDR only, $\pm 5\%$ on 0.01/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. Concentric expand 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 feet or meters/div (0.01 ns/div to 1000 ns/div) propagation velocity.

ACCURACY: time, $\pm 3\%$; distance, TDR only, $\pm 3\% \pm$ variations in propagation velocity.

MARKER POSITION: indicator, calibrated in divisions; provides direct read-out of round-trip time or distance (time), number of divisions \times decade range in units/div.

MARKER ZERO: ten-turn control provides variable reference for marker position dial; allows direct read-out of round-trip time or distance (time) between two or more displayed events.

ZERO FINDER: permits instant location of marker reference.

DIELECTRIC, TDR ONLY: calibrated for air, $\epsilon = 1$, and for polyethylene, $\epsilon = 2.25$. Also provides variable settings for dielectric constants $\epsilon = 1$ to $\epsilon =$ approx 4.

TRIGGERING, SAMPLING ONLY

Pulses: <50 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 ps; 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 mainframes.

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 RISE TIME: <35 ps (110 ps) incident as measured with Model 1106A (Model 1108A).

OVERSHOOT: $<\pm 5\%$.

INTERNAL REFLECTIONS: $<10\%$ with 45 ps (145 ps) TDR; use reflected pulse from shorted output.

JITTER: <15 ps; with signal averaging, typically 5 ps.

INTERNAL PICKUP: $\rho \leq 0.01$.

NOISE: measured tangentially as a percentage of the incident pulse when terminated in 50 ohms and operated in signal averaging mode. $<1\%$ (0.5%) on 0.005/div to 0.02/div; $<3\%$ (1%) on 0.05/div to 0.5/div.

LOW FREQUENCY DISTORTION: $\leq \pm 3\%$.

MAXIMUM SAFE INPUT: 1 volt.

SAMPLER SYSTEM

RISE TIME: <28 ps (90 ps).

INPUT: 50 ohm feedthrough.

DYNAMIC RANGE: 1 V p-p

MAXIMUM SAFE INPUT: 3 volts (5 volts).

LOW FREQUENCY DISTORTION: $\leq \pm 3\%$.

NOISE

Normal: <8 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. 5060-0441; 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 \$850.

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.

RISE TIME: Model 1106A, approx 20 ps; Model 1108A, <60 ps.

OUTPUT IMPEDANCE: 50 ohms $\pm 2\%$.

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).

PRICE: Model 1106A, \$550. Model 1108A, \$175.

SAMPLING

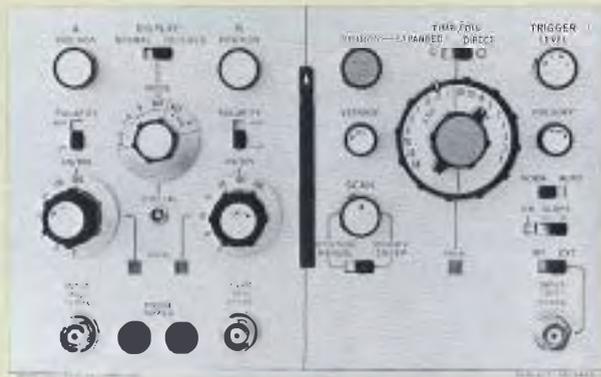
DUAL CHANNEL 1 GHz MODEL 1810A

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 μ s/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.



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: <350 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: $\pm 3\%$.

Vernier: provides continuous adjustment between all 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 R: 50 ohms, $\pm 2\%$.

MAXIMUM INPUT: ± 5 V (dc + peak ac).

VSWR: <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 $\pm A \pm B$ operation.

VERTICAL OUTPUTS: an uncalibrated, 1 V vertical output signal from each channel is provided at the rear panel of 180 system mainframes.

TIME BASE RANGES

Normal: 10 ns/div to 50 μ s/div (12 calibrated positions) in a 1, 2, 5 sequence. $\pm 3\%$ accuracy with vernier in calibrated position.

Expanded: direct reading expansion up to X100 in seven calibrated steps on oil normal time scales, extends the range to 100 ps/div. Accuracy is $\pm 4\%$ (10 ps/div, $\pm 10\%$ 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 p-p for signals from 1 kHz to 200 MHz, 100 mV p-p 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 p-p 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 p-p 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 control.

HORIZONTAL OUTPUT: an uncalibrated approx 0.75 V amplitude signal is provided at the rear panel of a 180 or 181 mainframe.

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.