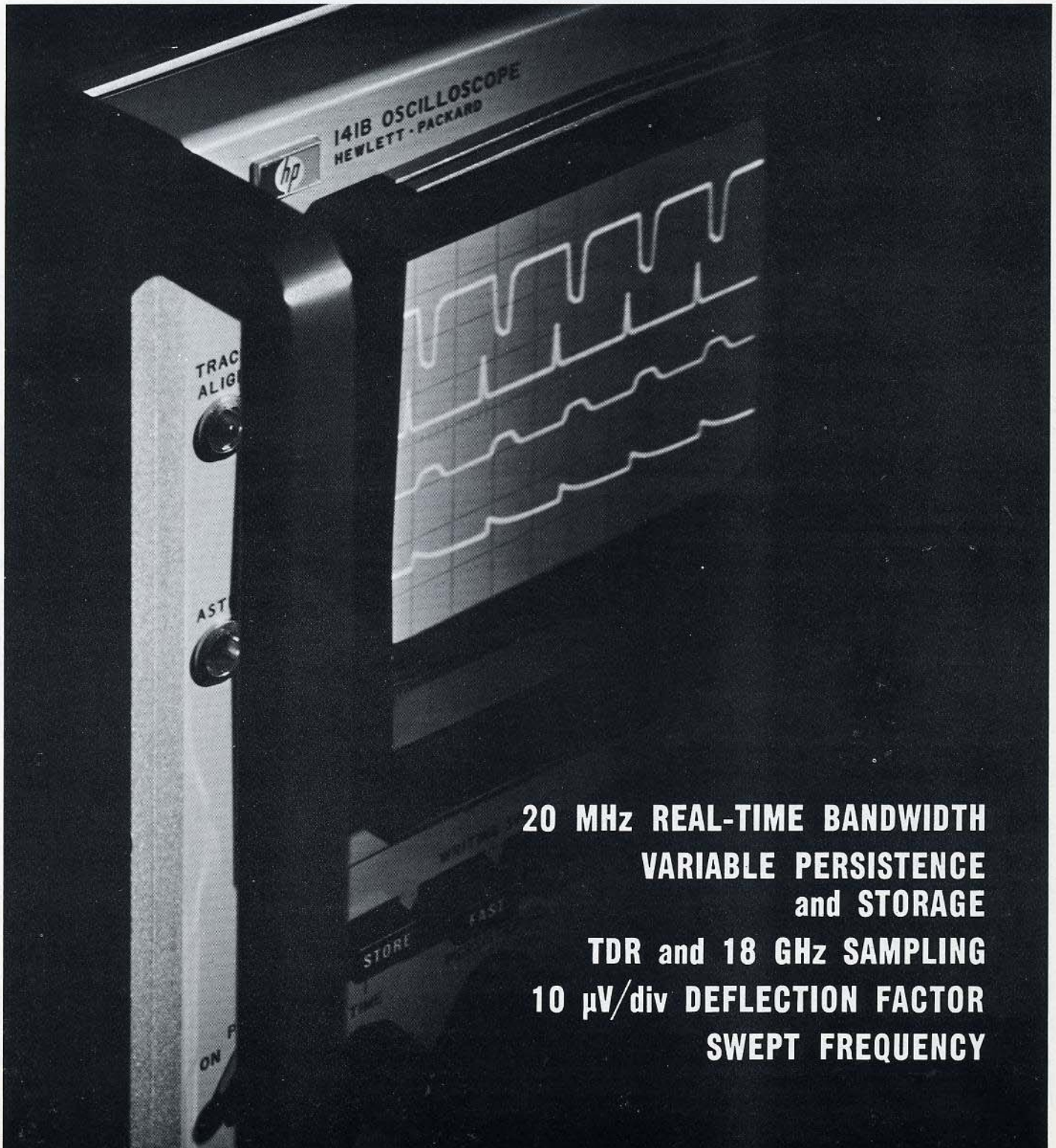


HEWLETT  PACKARD  
OSCILLOSCOPE SYSTEMS

# GENERAL PURPOSE PLUG-IN OSCILLOSCOPES

the  
140  
SYSTEM

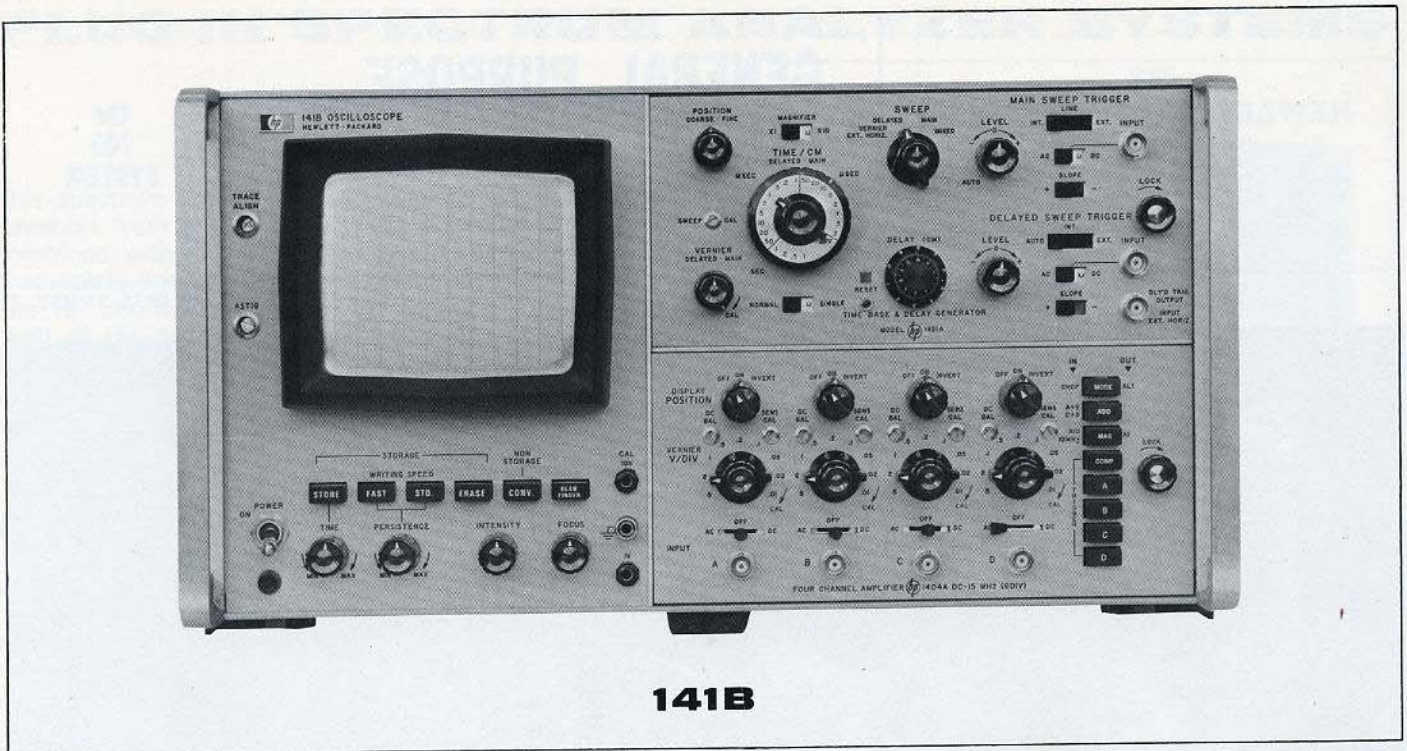
TECHNICAL DATA, 15 MAR. 71



**20 MHz REAL-TIME BANDWIDTH**  
**VARIABLE PERSISTENCE**  
**and STORAGE**  
**TDR and 18 GHz SAMPLING**  
**10  $\mu$ V/div DEFLECTION FACTOR**  
**SWEPT FREQUENCY**

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





The HP 140 Oscilloscope System provides the versatility you need for measurements over the entire oscilloscope spectrum. With 22 high-performance plug-ins to choose from, you can head in any measurement direction: wideband, sampling, high sensitivity, or time domain reflectometry and swept frequency.

Count these capabilities: the 140-Oscilloscope system gives you sampling bandwidth to 18 GHz; sampling delayed sweep time base;  $10 \mu\text{V}/\text{div}$  deflection factor; single, dual, and four channel vertical plug-ins; delayed and mixed sweeps; versatile single—or double-size plug-in capability; plus plug-ins for direct readout TDR, swept frequency, and spectrum analysis. In addition, it is the only plug-in system to offer standard CRT persistence in the 140 mainframes; optional variable persistence and storage in the 141 mainframes; or large screen display in the 143 mainframe.

The HP 140-system mainframes are designed to give you high-frequency and high-sensitivity performance. The mainframe contains a post-accelerator CRT with associated control circuits and power supplies and the power supplies for the plug-ins.

Since the plug-ins contain all CRT deflection circuits, you can use any plug-in in any mainframe without modifying the mainframe and you get exclusive capabilities in mixing plug-ins. You can not only select the amplifier you need for the vertical axis, but also, you select the time base generator for the horizontal axis.

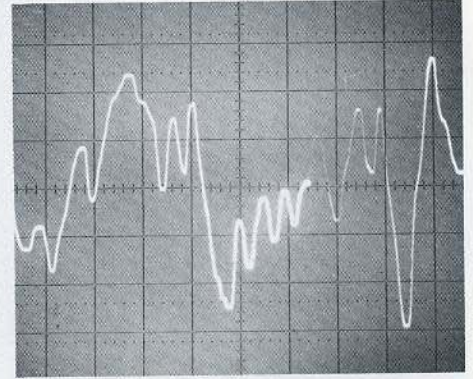
Further, since the 140-system CRT's have identical horizontal and vertical deflection factors, you can use two vertical amplifiers for an X-Y display; or one single-channel amplifier and one dual-channel amplifier to plot two variables against a third; or two dual-channel amplifiers for a pair of simultaneous X-Y displays.

All 140-system mainframes have a convenient beam-finder which returns a trace to the screen for fast trouble-free set-up.

The 141 mainframes give you all the advantages of the 140 mainframes plus the exclusive benefits of an HP mesh CRT with variable persistence and storage.

This exclusive HP variable persistence allows you to adjust CRT persistence to match the changing characteristics of a signal. Any necessary number of traces can be held for trend comparisons or for flicker-free low-frequency displays.

*Exclusive hp variable persistence enables you to match the persistence of your CRT screen to any signal—eliminating annoying flicker on slow signals such as swept frequency and sampling waveforms, transducer signals and low-frequency displays.*



With the HP mesh storage tube, a stored trace has the same high contrast as a conventional CRT and intermediate trace values are easily distinguished between four or five different trace intensities. Trace intensity can be controlled from the front panel or externally modulated for X-Y-Z presentations. Plus, with the storage mesh CRT, trace brightness and writing speed are maintained over the life of the tube, which is warranted for one year.

Another 140-System feature is the large screen, 8 x 10 inch viewing area, 143A mainframe, which is useful when the display is to be viewed from a distance or by several people at one time. The Model 143A provides high resolution displays throughout the oscilloscope spectrum with the same accuracy and linearity associated with conventional 5-inch displays. With the large screen display you clearly get superior performance from dc to 18 GHz and the versatility of using all 1400-series plug-ins pulse spectrum analysis.



# CONVENTIONAL MAINFRAMES



## Description

Model 140A and 140B mainframes contain the basic functional circuits for both low and high frequency applications, as well as those for sampling. Each contains a post-accelerator CRT with its associated power supplies and control circuits, and the dc sup-

plies required to power the Model 1400-series plug-ins. The plug-ins contain all of the circuits necessary to produce beam deflection, and operate directly into the CRT.

## Specifications, 140A 140B

**Plug-ins:** Model 1400-series and Model 8550-series plug-ins; upper compartment for horizontal axis and lower compartment for vertical axis; removable divider shield may be removed to accommodate a single dual-axis Model 1400-series unit.

### Cathode-ray tube

**Type:** post-accelerator, 7300-volt accelerating potential; aluminized P31 phosphor (other phosphors available, see options); etched safety glass face plate reduces glare.

**140A Graticule:** 10 div x 10 div parallax-free internal graticule marked in 1 cm squares; major horizontal and vertical axes, and second and tenth horizontal graticule lines have 2 mm subdivisions.

**140B Graticule:** 8 div x 10 div parallax-free internal graticule marked in 1 cm squares; subdivisions of 2 mm on major horizontal and vertical axes, and 10·90% lines for 6 and 8 div display.

**Intensity modulation:** ac-coupled, +20 volt pulse blanks trace of normal intensity; rear panel input terminals.

**Warranty:** CRT warranted for one year.

**Writing speed:** (using HP Model 197A Camera with f/1.9 lens and Polaroid® 3000 speed film).

P31 Phosphor: 250 cm/μs.

P11 Phosphor: 430 cm/μs.

### Calibrator

**Type:** line-frequency rectangular signal, approximately 0.5μs risetime.

**Voltage:** two outputs: 1 volt and 10 volts peak-to-peak, ±1% from 15° C to 35° C, ±3% from 0° C to 55° C.

**Beam finder:** returns trace to CRT screen regardless of settings of horizontal, vertical, or intensity controls.

**Power requirements:** 115 or 230 volts ±10%, 48 to 66 Hz, normally less than 285 watts (varies with plug-in units used).

**Dimensions:** 16¾" wide, 9" high, 18⅜" deep over-all (425,4 x 229 x 466,7 mm); hardware furnished for conversion to 19" x 8¾" x 16⅜" (483 x 222 x 416 mm) behind panel rack mount.

**Weight:** net, 37 lbs (16,8 kg); shipping, 45 lbs (20,4 kg).

**Options** (specify by option number).

002: P2 phosphor, no charge.

007: P7 phosphor, no charge.

011: P11 phosphor CRT. Beam finder intensification function is deleted due to burn sensitivity of P11 phosphor, no charge.

631: Non-internal graticule CRT with P31 phosphor, add \$10.

**Price:** HP Model 140A (without plug-ins), \$795.

HP Model 140B (without plug-ins), \$695.

**Accessories:** refer to page 29.



# VARIABLE PERSISTENCE MAINFRAMES



## Specifications, 141A/141B

**Plug-ins:** Model 1400-series plug-ins; upper compartment for horizontal and lower compartment for vertical; divider shield may be removed for double size plug-ins.

### Cathode-ray tube

**Type:** post-accelerator storage tube, 9000-volt (7300 volts in 141A) accelerating potential; aluminized P-31 phosphor; etched safety glass face plate reduces glare.

**141A Graticule:** 10 x 10 divisions (approximately 9.4 x 9.4 cm) parallax-free internal graticule; 5 subdivisions per major division on major horizontal and vertical axes, and on second and tenth horizontal graticule lines.

**141B Graticule:** 8 x 10 divisions (approximately 7.5 x 9.4 cm) parallax-free internal graticule including 10% to 90% lines for 6 and 8 division reference; 5 subdivisions per major division on major horizontal and vertical axes.

**Intensity modulation:** ac-coupled, +20 volt pulse blanks trace of normal intensity; input terminals on rear panel.

**Warranty:** CRT specifications (persistence, writing rate, brightness, storage time) warranted for one year.

### Persistence

**Conventional:** natural persistence of P31 phosphor (approximately 40 microseconds).

### Variable:

**Standard writing speed mode:** continuously variable from less than 0.2 second to more than one minute (typically to two or three minutes).

**Fast writing speed mode:** typically variable from 0.2 seconds to 15 seconds.

**Erase:** manual or optional remote (see options); erasure takes approximately 350 ms; scope ready to record immediately after erasure.

**Writing speed photographic (conventional operation):** (using HP Model 197A camera with f/1.9 lens and ASA 3000 speed film): 100 cm/ $\mu$ s.

### Writing speed (storage):

**Standard Mode:** 20 cm/ms.

**Fast mode:** 1 cm/ $\mu$ s.

**141A Storage time:** from Normal Writing Rate mode to

Store, traces may be stored for more than 1 hour. To View mode, traces may be viewed at normal intensity for more than 1 minute. From Max. Writing Speed mode to Store, traces may be stored at reduced intensity for more than 15 minutes. To View mode, traces may be stored at normal intensity for more than 15 seconds.

**141B Storage time:** standard writing speed; more than 2 hours at reduced brightness, typically 4 hours. Traces may be viewed at maximum brightness for more than one minute.

**Fast writing speed:** traces may be stored at reduced brightness for more than 15 min. (typically 30 min.) or stored at maximum brightness for more than 15 seconds.

**Brightness:** 100 foot-lamberts in standard mode.

### Calibrator

**Type:** line-frequency rectangular signal, approximately 0.5  $\mu$ s risetime.

**Voltage:** two outputs; 1 volt and 10 volts peak-to-peak,  $\pm 1\%$  from 15° C to 35° C,  $\pm 3\%$  from 0° C to 55° C.

**Beam finder:** returns trace to CRT screen regardless of settings of horizontal or vertical controls.

**Power requirements:** 115 or 230 volts  $\pm 10\%$ , 48 to 66 Hz, normally less than 285 watts (varies with plug-in units used).

**Dimensions:** 16 $\frac{3}{4}$ " wide, 9" high, 18 $\frac{3}{8}$ " deep over-all (425 x 229 x 467 mm); hardware furnished for quick conversion to 19" x 8 $\frac{3}{4}$ " x 16 $\frac{3}{8}$ " (483 x 222 x 416 mm) behind panel rack mount.

**Weight:** net, 40 lb (18 kg); shipping, 51 lb (23 kg).

### Options (specify by option number).

**009:** Remote erase. BNC input on rear panel; shorting to ground for at least 50 ms erases screen, with scope ready to use 350 ms after ground is removed; input draws 20 mA from ground through a 600-ohm impedance to a -12 volt supply, add \$25.

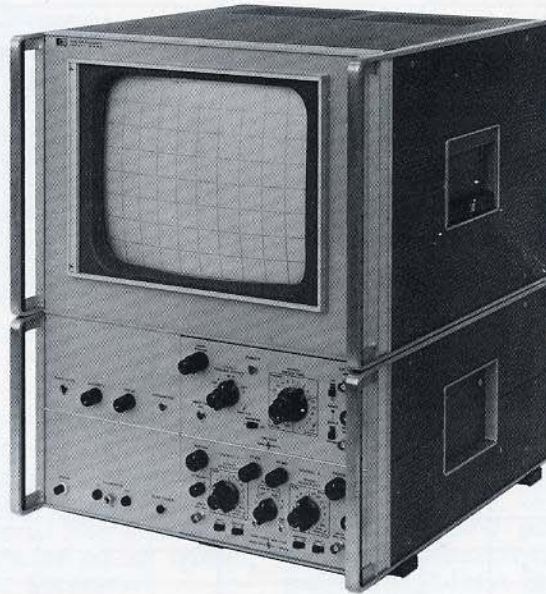
**Price:** HP Model 141A, \$1600.

HP Model 141B, \$1500.

**Accessories:** refer to page 29.



# LARGE SCREEN MAINFRAME



## Description

The HP Model 143A Oscilloscope mainframe provides the extreme versatility of a dual-axis plug-in oscilloscope, and in addition has a very large 8-inch by 10-inch viewing area. The large display is useful wherever the readout is to be viewed from a distance or by several people at one time.

The Model 143A provides higher resolution displays throughout the oscilloscope measuring spectrum with the same accuracy and linearity normally associated

with a conventional 5" display.

This large-screen oscilloscope is specifically designed to give you both high-frequency and high-sensitivity performance. It consists of the essential functional blocks for low and high frequency applications-plus sampling. Included are an advanced-design post accelerator CRT, associated control circuits, and the power supplies for the HP 1400-series plug-ins.

## Specifications

**Plug-ins:** accepts standard Model 1400-series plug-ins; upper compartment for horizontal axis and lower compartment for vertical axis (all plug-in specifications are same except bandwidth is 15 MHz with Model 1402A); center shield may be removed to accommodate a single dual axis Model 1400-series unit. Plug-in panel nomenclature of centimeter/divisions translates directly to inch divisions on the Model 143A display. For example, 5 V/cm deflection factor is displayed as 5 V/inch on the Model 143A.

### Cathode-ray tube

**Type:** post-accelerator, 20 kV accelerating potential; aluminized P31 phosphor (other phosphor available on order).

**Graticule:** 8-inch by 10-inch parallax-free internal graticule marked in one inch squares; major vertical and horizontal axes have 0.2-inch subdivisions (other graticules available on order).

**Intensity modulation:** ac-coupled (down 3 dB at 4 kHz), +20 volt pulse blanks trace of normal intensity; rear panel input.

**Warranty:** CRT warranted for one year.

### Calibrator

**Type:** line-frequency rectangular signal, approximately 0.5  $\mu$ s risetime.

**Voltage:** two outputs; 1 volt and 10 volts peak-to-peak  $\pm 1\%$  from 15°C to 35°C,  $\pm 3\%$  from 0° to +55°C.

**Beam finder:** returns trace to CRT screen regardless of vertical, horizontal, or intensity control settings.

**Power requirements:** 115 or 230 volts  $\pm 10\%$ , 48 to 66 Hz, normally less than 235 watts (varies with plug-in units used).

**Weight:** without plug-ins, net 62 lbs (28,1 kg); shipping 81 lbs (36,7 kg).

**Dimensions:** 16 $\frac{3}{4}$ " wide, 21" high, 18 $\frac{3}{8}$ " deep over-all (426 x 533 x 467 mm); hardware furnished for quick conversion to 19" x 20 $\frac{3}{4}$ " x 16 $\frac{3}{8}$ " (483 x 527 x 416 mm) behind panel rack mount.

**Accessories furnished:** rack mounting hardware for conversion to a standard EIA rack configuration.

**Options (specify by option number).**

001: smoke gray CRT filter improves trace contrast, add \$15.

002: P2 phosphor CRT, no charge.

004: P4 phosphor CRT, no charge.

007: P7 phosphor CRT, no charge.

011: P11 phosphor CRT, note beam finder intensification function is deleted due to burn sensitivity of P11 phosphor, no charge.

631: non-internal graticule with P31 phosphor, add \$10.

**Price:** HP Model 143A, \$1500.

### Accessories available:

Anti-reflection filter; nylon mesh attached to contrast filter to reduce reflections. Model 10181A, amber for P7 phosphor; Model 10182A, green for standard phosphors. Price: Model 10181A, \$35; Model 10182A, \$35.



# 1400-SERIES PLUG-IN SELECTION CHART

VERTICAL PLUG-IN	REALTIME								SAMPLING					DOUBLE SIZE	
	1400B	1401A	1402A	1403A	1404A	1405A	1406A	1408A	1410A	1411A/1430A	1411A/1430B	1411A/1431A	1411A/1432A	1415A	1416A
Capabilities	1400B	1401A	1402A	1403A	1404A	1405A	1406A	1408A	1410A	1411A/1430A	1411A/1430B	1411A/1431A	1411A/1432A		
Bandwidth	500kHz	450kHz	20MHz	400kHz	15MHz	5MHz	400kHz	500kHz	1 GHz	12.4 GHz	18 GHz	12.4 GHz	4 GHz		
Deflection Factor/div	100 $\mu$ V	1mV	5mV	10 $\mu$ V	10mV	5mV	50 $\mu$ V	100 $\mu$ V	1 mV	1 mV	1 mV	1 mV	1 mV		
Channels	1	2	2	1	4	2	1	2	2	2	2	2	2		
X-Y	x	x	x	x	x	x	x	x	x	x	x	x	x		
Delayed Sweep	1421A for Realtime								1425A for Sampling						
No Drift							x								
Max. CMRR in dB	100	40	40	106	40	40	60	100							
Algebraic Add.		x	x		x	x		x	x	x	x	x			
TDR														x	
Wide Band TDR										x	x				
Swept Freq.												x			x
RECOMMENDED TIME BASES															
1420A	x	x		x		x	x	x							
1421A	x	x	x	x	x	x	x	x							
1422A	x	x		x			x	x							
1423A	x	x	x	x	x	x	x	x							
1424A									x	x	x	x	x		
1425A									x	x	x	x	x		
SPECTRUM ANALYZER SYSTEM PLUG-INS															
8553B/8552B	1 kHz to 110 MHz Spectrum analysis														
8554L/8552B	500 kHz to 1250 MHz Spectrum analysis														
8555A/8552B	10 MHz to 40 GHz Spectrum analysis														



## 1400B

- 100  $\mu$ V/div
  - dc to 500 kHz
  - Differential on all ranges
  - 100 dB CMRR
- Price: \$275. Page 12



## 1402A

- 5 mV/div
  - dc to 20 MHz-dual trace
  - Signal delay for fast rise viewing
- Price: \$575. Page 8



## 1404A

- 10 mV/div to 15 MHz
  - 1 mV/div to 10 MHz
  - Signal delay for fast rise viewing
  - Selectable triggering
- Price: \$975. Page 10



## 1406A

- 50  $\mu$ V/div-dc to 400 kHz
  - No drift
  - Calibrated offset for accurate ac and dc measurements
- Price: \$950. Page 11



## 1401A

- 1 mV/div-dual trace
  - dc to 450 kHz
  - Convenient dual trace triggering
- Price: \$450. Page 12



## 1403A

- 10  $\mu$ V/div
  - 0.1 Hz to 400 kHz
  - 106 dB CMRR
- Price: \$575. Page 14



## 1405A

- 5 mV/div-dual trace
  - dc to 5 MHz
  - Algebraic addition
- Price: \$350. Page 9



## 1408A

- 100  $\mu$ V/div-dual channel
  - dc to 500 kHz
  - 100 dB CMRR
  - Alternate or chopped sweeps
- Price: \$575. Page 13



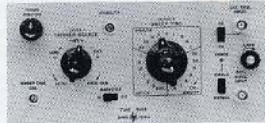
# 1400-SERIES PLUG-IN SELECTION CHART



## 1410A

- 1 mV/div at 1 GHz—dual trace
- Internal triggering
- High impedance probes and 50Ω inputs

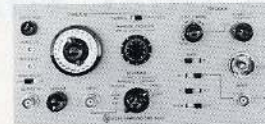
Price: \$1700. Page 19



## 1420A

- 10 MHz triggering
- Sweeps to 50 ns/div
- Auto triggering

Price: \$375. Page 15



## 1424A

- Triggering to 5 GHz
- Sweeps to 10 ps/div
- Direct readout on all sweeps

Price: \$1400. Page 24



## 1425A

- Delayed sweep
- Sweeps to 10 ps/div
- Triggering to 1 GHz

Price: \$1900. Page 25



## 1411A

- 1 mV/div—dual trace
- Bandwidths to 12.4 GHz
- Remote samplers

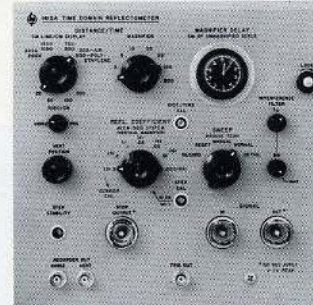
Price: \$700. Page 21



## 1421A

- 20 MHz triggering
- Delayed sweep
- Sweeps to 20 ns/div

Price: \$675. Page 16



## 1415A

- Complete TDR system for testing cables, connectors, striplines
- Determines location, meaning, and nature of each discontinuity
- Resolves discontinuities—an inch apart
- Easy to operate

Price: \$1200. Page 28



## 1430A

- 28 ps risetime—

Price: \$3000. Page 22

## 1430B

- 20 ps risetime

Price: \$3500. Page 23

## 1431A

- 12.4 GHz bandwidth

Price: \$3000. Page 22



## 1422A

- 500 kHz triggering
- Sweeps to 200 ns/div
- Auto triggering

Price: \$250. Page 15



## 1416A

- Speeds and simplifies swept frequency measurements
- High resolution direct readout in dB
- Low drift
- X-Y recorder outputs

Price: \$900. Page 27



## 1432A

- 90 ps risetime

Price: \$1000. Page 21



## 1423A

- 20 MHz triggering
- Sweeps to 20 ns/div
- Trigger hold-off

Price: \$490. Page 15

## Spectrum Analyzer Plug-Ins

### Tuning Sections



## 8555A

- 10 MHz - 40 GHz RF Section



## 8554L

- 500 kHz - 1.25 GHz RF Section



## 8553B

- 1 kHz - 110 MHz RF Section

### IF Sections



## 8552A

- Standard IF Section



## 8552B

- High Resolution IF Section

- Complete Spectrum Analyzer System presents amplitude versus frequency over a 7 dB display range.

- Absolute signal amplitude measurement in dBm or Voltage

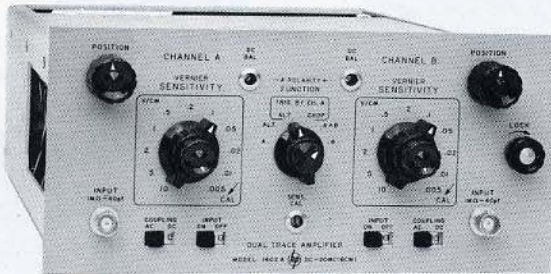
Price: 8552A, \$2150  
8552B, \$2850  
8553B, \$2200  
8554L, \$3500  
8555A, \$5975

Page 32



# WIDE BAND AMPLIFIER

## 1402A DUAL TRACE AMPLIFIER



- 5 mV/div
- dc to 20 MHz
- Algebraic addition of channels
- Signal delay for fast-rise viewing
- Convenient dual trace triggering

### Description

The 1402A Dual Trace Amplifier provides greater than 20 MHz bandwidth plus 5 mV/div sensitivity on each channel for accurate analysis of high frequency low level signals. Risetimes of signals can be easily measured because the 1402A has a built-in delay line in the vertical amplifier following the trigger take-off.

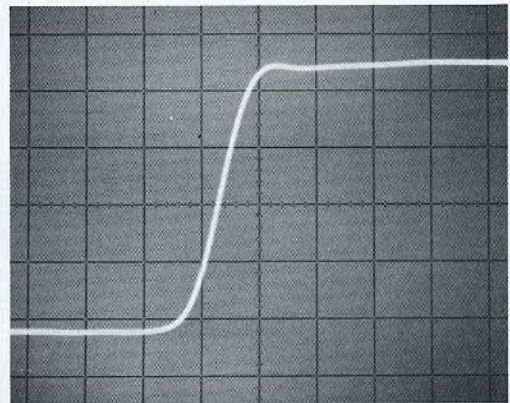
Two signals can be displayed with the 1402A in each of two modes. Slow signals can be viewed in the chopped mode, since the input to the CRT is switched between Channel A and Channel B at a high rate during each sweep. Fast signals can be viewed in the alternate mode since the input to the CRT is switched at the end of each sweep, with Channel A displayed during one sweep and Channel B on the following sweep.

Accurate time difference measurements are possible because the sync amplifier in the 1402A can be switched to Channel A alone. This feature is useful when dual traces are displayed on alternate sweeps; switching the sync to Channel A preserves the time relationship between the two signals, because the sweep always triggers on the same point on Channel A. Also, syncing to Channel A when in the chopped dual trace mode assures triggering on the displayed waveform rather than the chopper. Two unrelated signals can be displayed by triggering on the composite waveform. This feature avoids resorting to external triggering for either of these dual trace presentations.

Single-channel displays are also possible for either

input A or B. The two channels may also be displayed algebraically added, and a polarity reversal switch on Channel A allows the differential signal, B—A, to be displayed.

Although maximum bandwidth is obtained from the 1402A with 6 div or less deflection, larger amplitude signals can be displayed without distortion and with only a small sacrifice in bandwidth. For example, the bandwidth when using a full 10-div deflection is greater than 15 MHz.



Above photo demonstrates bandwidth and excellent transient response of 1402A Dual Trace Amplifier. Sweep time is 20 ns/div; sensitivity is 5mV/div.

### Specifications

**Mode of operation:** (1) Channel A alone, (2) Channel B alone, (3) Channel A and Channel B displayed on alternate sweeps, (4) Channel A and Channel B displayed by switching at approx 100 kHz, with trace blanking during switching, (5) Channel A and Channel B added algebraically, polarity of Channel A may be inverted to obtain differential operation.

**Bandwidth:** (6 div reference signal) dc coupled, dc to 20 MHz; ac coupled, 2 Hz to 20 MHz. (15 MHz in a Model 143A Mainframe).

**Risetime:** less than 20 ns with 6 div step input.

**Deflection factor (sensitivity):** each channel; 5 mV/div to 10 V/div, 11 ranges in a 1, 2, 5 sequence; accuracy  $\pm 3\%$ ; vernier provides continuous adjustment be-

tween steps and extends 10 V/div step to at least 25 V/div.

**Signal delay:** signal is delayed so that leading edge of fast-rise signals is visible at start of sweep.

**Common mode rejection:** (in B-A mode) at least 40 dB on 5, 10, and 20 mV/div ranges, at least 30 dB on 50 mV/div to 10 V/div ranges; common mode signal not to exceed 150 div (e.g., 150 volts on 1 V/div range) or a frequency of 500 kHz.

**Input RC:** 1 megohm shunted by 43 pF.

**Maximum input:** 600 volts peak (dc + ac).

**Weight:** net, 7 lb (3.2 kg); shipping, 13 lb (5.9 kg).

**Price:** HP Model 1402A, \$575.

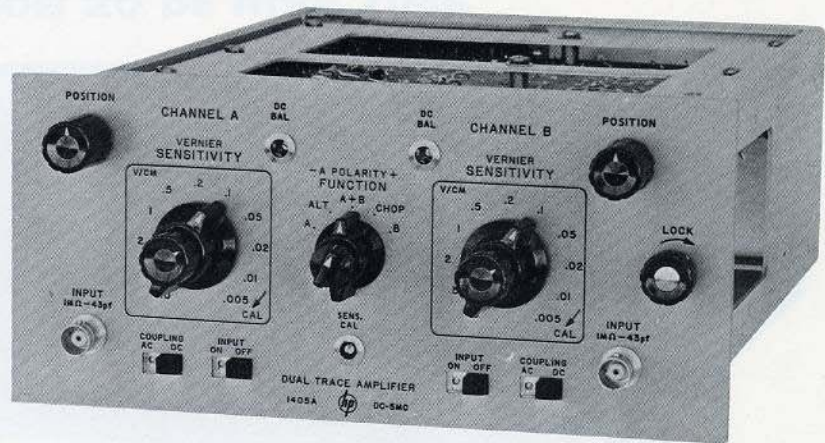
Option 090: two 10012A probes, add \$80.



# WIDE BAND AMPLIFIER

## 1405A DUAL TRACE AMPLIFIER

- 5 mV/div
- dc to 5 MHz
- Algebraic addition
- Full 10 div deflection
- Wide dynamic range



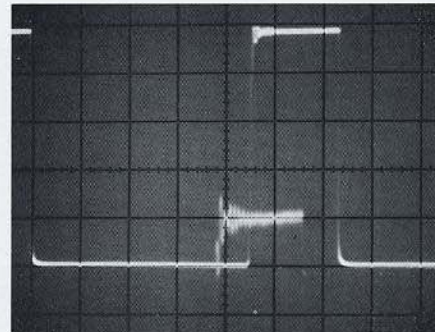
### Description

The 1405A Dual Trace Amplifier provides 5 MHz bandwidth at 5 mV/div sensitivity. Dual trace presentations can be displayed on alternate sweeps or by chopping between the two input signals on the same sweep at a 100 kHz rate. In addition to single-trace presentations of Channel A or B, the two channels may be algebraically added or, by a reversal of the Channel A polarity switch, the differential signal may be viewed. The full 5 MHz frequency response is achieved in every operating mode, and when operating in any sensitivity position.

In all operating modes each channel has independent positioning and sensitivity controls, permitting the comparison of signals with widely differing amplitudes. When used as a differential amplifier, a common-mode rejection of better than 40 dB in the higher sensitivity positions permits the display of low-level signals while attenuating undesirable components such as hum.

The wide dynamic range of the 1405A permits a 50 div peak-to-peak signal to be displayed without significant distortion. Using A + B mode and a variable dc voltage source such as the 723A power supply applied to the second channel, any 10-div segment of the 50-div trace can be positioned on screen and analyzed. The 1405A is an ideal tool for video waveforms when

used with the 1421A Time Base and Delay Generator, since any single line of a television frame may be isolated and displayed. The 5 mV/div sensitivity permits the display of signals in low-level stages, or permits the use of attenuator probes to prevent circuit loading. For X-Y measurements, such as phase shift or Lissajous patterns, the 1405A may be used with any other 1400 series plug-in (including another 1405A) for either vertical or horizontal deflection.



Double exposure showing 5-div pulse on upper waveform, and the same pulse expanded, 10 X to view small perturbation on the top.

### Specifications

**Mode of operation:** (1) Channel A alone, (2) Channel B alone, (3) Channel A and Channel B displayed in alternate sweeps, (4) Channel A and Channel B displayed by switching at approx 100 kHz, with trace blanking during switching, (5) Channel A and Channel B added algebraically, polarity of Channel A may be inverted to obtain differential operation.

**Bandwidth:** dc coupled, dc to 5 MHz (70 ns risetime); ac coupled, 2 Hz to 5 MHz (the lower limit is extended to approx 0.2 Hz with a X10 probe).

**Deflection factor (sensitivity):** each channel; 5mV/div to 10 V/div, 11 ranges in a 1, 2, 5 sequence; accuracy  $\pm 3\%$ ; vernier provides continuous adjustment between

steps and extends 10 V/div step to at least 25 V/div.  
**Common mode rejection:** at least 40 dB on 5, 10, and 20 mV/div ranges, at least 30 dB on 50 mV/div to 10 V/div ranges; common mode signal not to exceed 50 div (e.g., 0.5 volt on 10 mV/div range) or a frequency of 50 kHz.

**Input RC:** 1 megohm shunted by 43 pF.

**Maximum input:** 600 volts peak (dc + ac).

**Weight:** net, 4 lb (1.8 kg); shipping, 10 lb (4.5 kg).

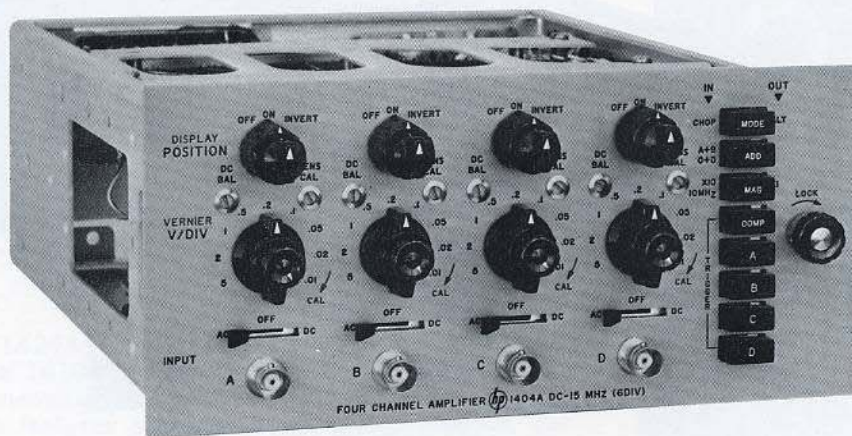
**Price:** HP Model 1405A, \$350.

**Special order:** double-size, single-channel, X-Y only version of Model 1405A; order 1405A OPT H20; price, \$475.



# WIDE BAND AMPLIFIER

## 1404A FOUR TRACE AMPLIFIER



- 10 mV/div to 15 MHz
- 1 mV/div to 10 MHz
- Selectable triggering

### Description

When you need to display four channels of information, the HP Model 1404A Four Channel Vertical Amplifier plug-in provides twice the measurement capability of a two-channel scope. As a part of the 140 series scope system, the 1404A gives you 15 MHz, 10 mV/div deflection factor or 1 mV/div to 10 MHz with a X10 magnifier, in your lab or production area.

This amplifier allows you to measure relationships or make timing comparisons of two to four inputs. It is ideal for designing logic circuits, or for checking time relationships of digital logic pulse trains.

Channels A + B and channels C + D may be displayed, algebraically added, and a polarity reversal switch position on each channel allows the differential of either pair of inputs to be displayed.

The 1404A amplifier offers a choice of selectable or composite triggering. When Channel A, B, C, or D trigger pushbutton is pressed, you trigger on the selected channel and see the time relationship with each of the other channels. Composite triggering, which triggers each sweep individually, is also provided.

The 1404A is fully compatible with any of the 140-Series mainframes. When used in a 140A or B Oscilloscope, the 1404A adds the versatility of four channel displays. In a 141A or B Oscilloscope, you can display four traces simultaneously, vary the persistence to view four simultaneous slow sweeps without flicker, or store them. When used in a 143A Oscilloscope four well-defined traces can be clearly observed, from a distance, on the large 8 x 10 inch CRT.

### Specifications

**Modes of operations:** Any channel or combination of channels may be displayed. The display may be selected to be on alternate sweeps or switched between four channels at approximately 200 kHz rate with blanking during switching. Algebraic addition is provided for Channels A + B and Channels C + D in alternate or chopped modes. An invert switch on each channel allows signal summing or difference with either polarity result displayed.

#### Each Channel

**Bandwidth:** (Referenced to a 6 division 50 kHz signal) dc-coupled; X1 mag 0 to 15 MHz, X10 mag 0 to 10 MHz, ac-coupled; X1 mag 2 Hz to 15 MHz, X10 mag 2 Hz to 10 MHz.

**Risetime:** Referenced to a 6 division high step input, less than 25 ns in X1 mag and less than 40 ns in X10 mag.

**Deflection Factor:** 0.01 V/div to 5 V/div; 9 ranges in a 1, 2, 5, 10 sequence; attenuator accuracy  $\pm 3\%$ ; vernier provides continuous adjustment between ranges and extends maximum deflection factor to approximately 12.5 V/div, X10 mag changes deflection factor to 1 mV/div to 0.5 V/div.

**Input RC:** 1 megohm shunted by approximately 30 pF.

**Maximum Input:** 600 volts (dc + peak ac).

**Triggering:** In alternate mode, by any one of the four channels (A, B, C, or D) or by the composite signal (COMP). Any channel turned off is skipped by composite triggering. In alternate mode X1 mag, 1/2 division of deflection will trigger to 1 MHz increasing to 1 div at 15 MHz (2 div for COMP). In X10 mag, 1 div to 10 MHz. Triggering frequency is limited to 200 kHz in chopped mode.

**Signal Delay:** Signal is delayed 250 ns so that leading edge of fast risetime signals are visible at start of sweep.

**Common Mode Rejection Ratio:** (in A + B or C + D) at least 40 dB on 0.01 to 0.05 V/div ranges, at least 30 dB on 0.1 to 5 V/div ranges; common mode signal not to exceed either 100 divisions or 500 kHz.

**Weight:** net 6 lbs (2.7 kg); shipping 8 lbs (3.6 kg).

**Power:** Supplied by mainframe.

**Price:** Model 1404A, \$975.

**Options:** (specify by option number).

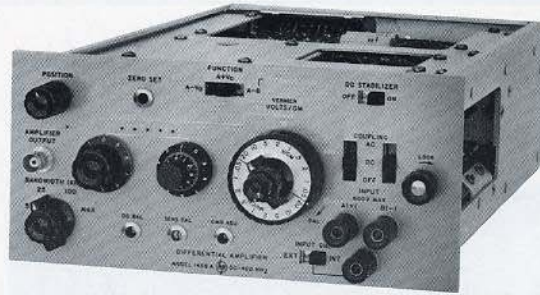
090: four 10012A high impedance probes, add \$160.



# PRECISION AC & DC AMPLIFIER

## 1406A

- 50  $\mu\text{V}/\text{div}$
- dc to 400 kHz
- dc stabilized (no drift)
- Calibrated offset for accurate ac & dc measurements



## Description

In addition to 50  $\mu\text{V}/\text{div}$  sensitivity, no drift dc stabilization, and wide dynamic range, the 1406A offers a calibrated dc offset for better than 0.5% accurate ac and dc voltage measurements.

Accurate measurements are accomplished by inserting the test signal into one side of a high common mode rejection differential amplifier and a very accurate (.15%) dc level into the other side. The top of the waveform is then positioned to center screen with the offset controls and the offset reading noted. This is then repeated for the bottom of the waveform. The difference between the two offset readings is the ac amplitude.

The same technique is used when measuring a dc level except only one reading is required; zero volts is already established because the stabilizer eliminates drift.

The range switching is interlocked with the sensitivity switching so that the direct reading offset does not change when changing the sensitivity. There are ten offset ranges providing  $\pm 1\text{V}$  to  $\pm 1000\text{V}$  in decade steps.

The 1406A can also be used as a differential amplifier. The high common mode rejection and no drift features provide for accurate differential measurements. An external ground is also provided to eliminate ground loops.

The adjustable bandwidth control of the 1406A allows the user to reduce bandwidth from the maximum of 400kHz down to 100, 25, 5kHz, eliminating noise present in the unused part of the bandwidth. The front panel amplifier output permits driving external equipment such as X-Y recorders or tape recorders.

## Specifications

**Sensitivity:** 50  $\mu\text{V}/\text{div}$  to 20 V/div in a 1, 2, 5 sequence. Vernier provides continuous adjustment between ranges and extends minimum sensitivity to at least 50 V/div. Attenuator accuracy is  $\pm 3\%$ .

**Amplifier output:** Approx 1V/div, dc coupled, single ended, DC level approx 0 volts, output impedance less than 100 ohms, dynamic range  $\pm 5\text{V}$ .

### Bandwidth

#### Upper limit:

20 V/div to 100  $\mu\text{V}/\text{div}$ —400 kHz (0.9  $\mu\text{s}$  risetime); or 50  $\mu\text{V}/\text{div}$ —300 kHz

Upper limits of MAX, 100, 25, and 5 kHz selectable with front panel switch on all sensitivities.

**Lower limit:** DC with input DC coupled, 2 Hz with input AC coupled.

### Drift:

**Long-term drift:** less than  $\pm 0.2$  div or less than  $\pm 20$   $\mu\text{V}$  per 200 hrs, whichever is greater.

**Temperature drift:** Less than  $\pm 0.2$  div or less than  $\pm 50$   $\mu\text{V}$ , whichever is greater over a temperature range of 0°C to 55°C.

Drift correction occurs at 3 Hz for 50 ms/div sweeps and faster, and 1.5 Hz on 0.1 s/div sweeps and slower.

**Range to range shift:** dc stabilization maintains a fixed baseline reference within  $\pm 1$  div on CRT over entire range of sensitivity after a 3-minute warmup.

**Positioning:** Baseline can be positioned  $\pm 10$  div by continuous position.

**DC offset:** Offset is applied to the B (-) input.

**Readout:** 4-digit resolution, with lighted decimal indicators.

**Ranges:**  $\pm 0.1\text{V}$ ,  $\pm 1\text{V}$ ,  $\pm 10\text{V}$ ,  $\pm 100\text{V}$ ,  $\pm 1000\text{V}$ . Up to  $\pm 10\text{V}$  offset can be used on all sensitivity ranges; an equivalent  $\pm 100\text{V}$  range can be used from 0.5 mV/div through 20 V/div, and an equivalent  $\pm 1000\text{V}$  range from 5mV/div through 20 V/div.

**Accuracy:**  $\pm 0.15\%$  of indicated value plus 0.05% of full scale offset range, on  $\pm 0.1\text{V}$ ,  $\pm 1\text{V}$ , and  $\pm 10\text{V}$  ranges.  $\pm 0.4\%$  of indicated value plus 0.05% of full scale offset range, on  $\pm 100\text{V}$  and  $\pm 1000\text{V}$  ranges.

**Differential input:** May be selected on all sensitivity ranges. Single-ended operation is used when employing offset.

**Common mode rejection:** [ $\pm 5\text{V}$  (dc + pk ac) or  $\pm 10\text{V}$  dc, dc coupled, 50  $\mu\text{V}/\text{div}$  to 20 mV/div] dc to 60 Hz, 80 dB; 60 Hz to 10 kHz, 60 dB.

### Maximum input without overload

50  $\mu\text{V}/\text{div}$  to 20 mV/div— $\pm 10\text{V}$  pk-pk

50 mV/div to 2 V/div— $\pm 100\text{V}$  pk-pk

5 V/div to 20 V/div— $\pm 600\text{V}$  pk-pk

**Dynamic range:** Dynamic signals of at least  $\pm 50$  div of deflection can be displayed without distortion.

**Input impedance:** 1 megohm shunted by 100 pF, constant on all attenuator ranges.

### Max input:

**V<sub>1</sub> range:** .1-10

15 V (dc + peak ac), .05 mV/div to 20 mV/div; 150 V, 50 mV/div to .2 V/div; 600 V, .5 V/div to 20 V/div.

**V<sub>2</sub> range:** 100

150 V (dc + peak ac)

**V<sub>3</sub> range:** 1000

600 V (dc + peak ac)

**X-Y operation:** Two 1406A's or 1406A and a 1407A can be used to give stabilized X-Y presentation.

**Time base compatibility:** The 1406A and 1407A can be used directly with the 1422A and 1423A; 1420's below serial 441-01326 and 1421A's below serial 545-00651 must be modified. (Order kits 01420-69502 for the 1420A, 01421-69501 for the 1421A.)

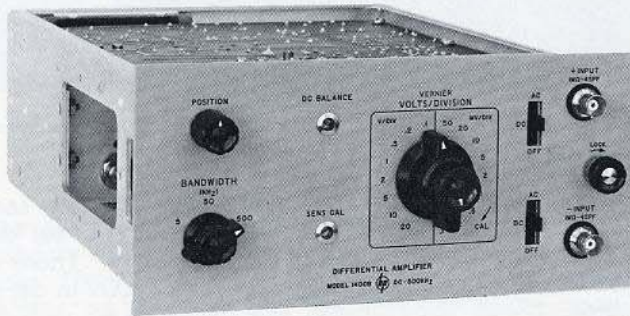
**Weight:** Net, 6 lb (2.7 kg); shipping, 12 lb (5.4 kg).

**Price:** \$950.



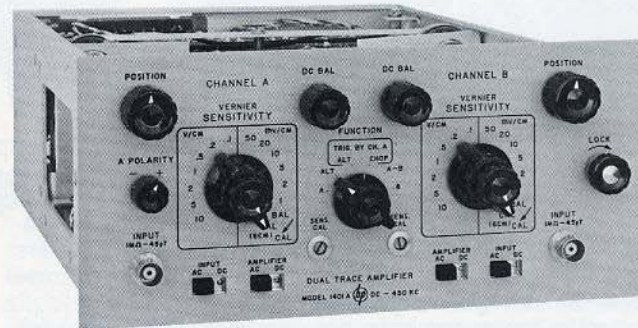
# HIGH SENSITIVITY AMPLIFIERS

1400B



- 100  $\mu\text{V}/\text{div}$
- dc to 500 kHz
- Selectable bandwidth
- Low drift
- Differential on all ranges

1401A



- 1 mV/div
- dc to 450 kHz
- Convenient dual trace triggering
- Low drift
- Two independent X-Y displays using two plug-ins

1400B

## Specifications

1401A

### Deflection factor

**Ranges:** from 0.1 mV/div to 20 V/div (17 positions) in 1, 2, 5 sequence.  $\pm 3\%$  accuracy with vernier in calibrated position.

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

### Bandwidth

DC to 500 kHz with a maximum risetime of 0.7  $\mu\text{s}$ . 2 Hz to 500 kHz when ac-coupled. Front panel control reduces upper frequency limit to 50 kHz  $\pm 20\%$  and 5 kHz  $\pm 20\%$ .

**Noise:** tangential noise is  $< 25 \mu\text{V}$  at full bandwidth (which is approximately 50  $\mu\text{V}$  pk-pk).

### Input

Differential or single-ended on all ranges, selectable by front panel control.

### Common mode characteristics (dc-coupled)

**Frequency:** DC to 10 kHz on all ranges.

**Rejection ratio:** 100 dB (100,000 to 1) on 0.1 mV/div range, decreasing by less than 20 dB per decade of deflection factor to at least 40 dB on the 0.2 V/div range; CMRR is at least 30 dB on the 0.5 V/div to 20 V/div ranges.

**Signal maximum:**  $\pm 10$  V (dc + peak ac) on 0.1 mV/div to 0.2 V/div ranges;  $\pm 400$  V (dc + peak ac) on all other ranges.

### Input coupling

Front panel selection of DC, AC, or OFF for both + and - inputs.

### Input RC

1 megohm shunted by approximately 45 pF; constant on all ranges.

### Maximum input

$\pm 400$  volts (dc + peak ac).

**Weight:** net 4 lbs (1.8 kg); shipping 10 lbs (4.5 kg).

**Price:** HP Model 1400B, \$275.

**Bandwidth:** Input and Amplifier coupling set to dc, dc to 450 kHz (0.8  $\mu\text{s}$  risetime); Input set to dc and Amplifier set to ac, dc to 450 kHz for deflection factors from 50 mV/div to 10 V/div; from 1 mV/div to 20 V/div, lower cutoff depends on the deflection factor; approximately 0.5 Hz (to 450 kHz) at 20 mV/div and 10 Hz (to 450 kHz) at 1 mV/div; Input set to ac and Amplifier set to dc, 2 Hz to 450 kHz.

**Deflection factor (sensitivity):** each channel; 1 mV/div to 10 V/div, 14 ranges in a 1, 2, 5 sequence; accuracy  $\pm 3\%$ ; vernier provides continuous adjustment between steps and extends 10 V/div step to at least 25 V/div.

**Phase shift:** when used with another Model 1401A, less than 2° relative phase shift up to 50 kHz with X and Y deflection factors the same, and verniers in Cal.

**Common mode rejection ratio:** both inputs may be switched to one channel to give differential input; cmrr at least 40 dB on 1 mV/div to 0.1 V/div ranges, signal not to exceed 4 V pk-pk; at least 30 dB on 0.2 V/div to 10 V/div ranges, signal not to exceed 40 V pk-pk on 0.2, 0.5, and 1 V/div ranges or 400 V pk-pk on 2, 5, and 10 V/div ranges; measured with 1 kHz sine wave.

**Input RC:** 1 megohm shunted by 45 pF.

**Maximum input:** 60 volts peak (dc + ac).

**Internal calibrator:** line frequency square wave, 6 div pk-pk; displayed when vernier is set to Cal; accuracy  $\pm 3\%$ .

**Mode of operation:** (1) Channel A alone, (2) Channel B alone, (3) Channel A and Channel B displayed on alternate sweeps, (4) Channel A and Channel B displayed by switching at approx 100 kHz, with trace blanking during switching, (5) Channel A minus Channel B.

**Display polarity:** + up or - up, selectable.

**Weight:** net, 5 lb (2.3 kg); shipping, 11 lb (5.3 kg).

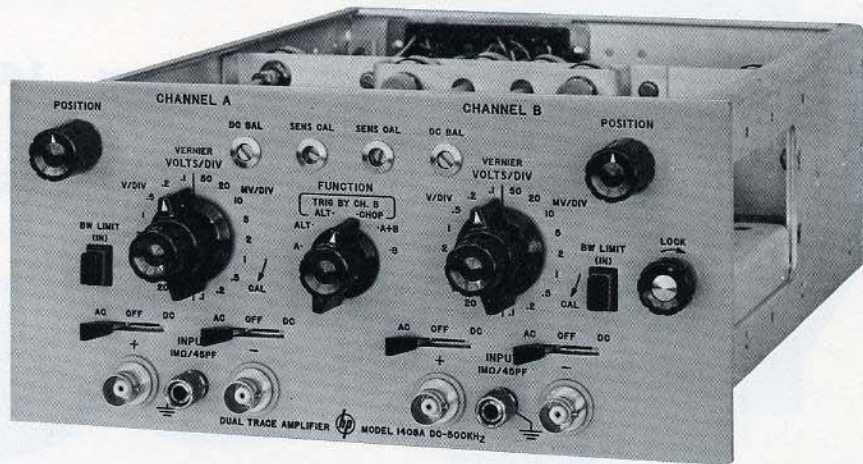
**Price:** HP Model 1401A, \$450.



# HIGH SENSITIVITY AMPLIFIER

## HIGH SENSITIVITY AMPLIFIER MODEL 1408A

- 100  $\mu\text{V}/\text{div}$  dual-channel
- dc to 500 kHz
- 100 dB CMRR
- Alternate or chopped sweeps



### MEASURE MICROVOLT SIGNALS

#### Description

Model 1408A Dual Trace Amplifier provides 500 kHz bandwidth at 100  $\mu\text{V}/\text{div}$  sensitivity. Dual trace presentations can be displayed on alternate sweeps or by chopping between the two input signals, during the same sweep, at a 100 kHz rate. In addition to single-trace presentations of Channel A or B, the channels may be algebraically added or, by reversing the polarity of the input signal, the differential signal may be viewed. Two 2-position bandwidth limit switches (50 and 500 kHz) improve resolution of low level signals by eliminating noise from the unused portion of the bandwidth.

Solid-state circuits throughout the instrument provide stable operation and less frequent calibration. The 100  $\mu\text{V}/\text{div}$  vertical amplifier exhibits very low

drift (typically less than 50  $\mu\text{V}$  per hour) and tangential noise of less than 25  $\mu\text{V}$ .

Model 1408A has a common mode rejection ratio of 100,000 to 1 (100 db) in the most sensitive deflection factor of 100  $\mu\text{V}/\text{div}$ , over a dc to 10 kHz frequency range. This high CMRR is made even more useful by the  $\pm 10$  volts common mode signal specification in the more sensitive deflection factor settings, a combination not previously available in low frequency plug-in oscilloscopes. High CMRR eliminates concern about inaccuracies caused by induced voltage in differential signal leads. For example, a common mode signal of 10 volts would be reduced to only 100 microvolts. And, no time-consuming front panel adjustments are required.

#### Specifications

##### Deflection Factor

**Ranges:** From 100  $\mu\text{V}/\text{div}$  to 20 V/div (17 positions) in 1, 2, 5 sequence.  $\pm 3\%$  accuracy.

**Vernier:** Continuously adjustable between all ranges; extends maximum deflection factor to at least 50 V/div.

##### Bandwidth

DC to 500 kHz with a maximum risetime of 0.7  $\mu\text{s}$ . 2 Hz to 500 kHz when ac-coupled. Front panel control reduces upper frequency limit to 50 kHz  $\pm 20\%$ .

**Noise:** tangential noise is  $< 25 \mu\text{V}$  at full bandwidth (which is approximately 50  $\mu\text{V}$  pk-pk).

##### Input

Differential or single-ended on all ranges, selectable by front panel control.

##### Common mode characteristics (dc coupled)

**Frequency:** DC to 10 kHz on all ranges.

**Rejection ratio:** 100 dB (100,000 to 1) on 0.1 mV/div range, decreasing by less than 20 dB per decade of deflection factor to at least 40 dB on the 0.2 V/div range; CMRR is at least 30 dB on the 0.5 V/div to 20 V/div ranges.

**Signal maximum:**  $\pm 10$  V (dc + peak ac) on 0.1 mV/div to 0.2 V/div range;  $\pm 400$  V (dc + peak ac) on all other ranges.

##### Input coupling

Front panel selection of AC, OFF, or DC for both + and - inputs.

##### Input RC

1 megohm shunted by approximately 45 pF; constant on all ranges.

##### Maximum input

$\pm 400$  volts (dc + peak ac).

**Modes of operation:** (1) Channel A alone, (2) Channel B alone, (3) Channels A and B displayed on alternate sweeps with composite triggering, (4) Channels A and B displayed on alternate sweeps with Channel B triggering, (5) Channels A and B displayed by switching between channels at approximately 100 kHz with trace blanking during switching and trigger signal from Channel B, (6) Channel A plus Channel B.

**Display Polarity:** + up or - up, selectable.

**Weight:** net 4 $\frac{1}{2}$  lb (2 kg); shipping 10 $\frac{1}{2}$  lb (4.8 kg).

**Price:** HP Model 1408A, \$575.



# HIGH SENSITIVITY AMPLIFIERS



## 1403A

- 10  $\mu\text{V}/\text{div}$
- 106 dB common mode rejection
- Guarded input

## Description

Model 1403A combines 10  $\mu\text{V}/\text{div}$  deflection factor with a guarded input for 106 dB common mode rejection ratio, which allows accurate measurements of low-level differential signals. The guard achieves the high common mode rejection ratio by protecting both the differential input amplifier and the two leads to the test point with a floating shield. The shield may be driven either internally by the common mode signal obtained from the amplifier for full 106 dB rejection, or

externally from the signal source for high common mode rejection even with unbalanced source impedances.

Bandwidth may be reduced from either the high or low end with front panel switches. This allows you to reduce the effective noise, since the bandwidth need only be as wide as is necessary for a given measurement and provides improved resolution of low level signals.

## Specifications

**Input modes:** (1) input A single-ended, (2) input B single-ended and inverted, (3) A-B differential, (4) Off disconnects inputs and grounds input amplifier, (5) CMRR and (6) Cal for calibrating the instrument; A and B inputs, guard, and chassis ground are brought out through a special guarded connector; guard is normally driven by internal common mode signal amplifier; with unbalanced source impedances, the guard may be driven externally, preserving high CMRR.

**Bandwidth:** 0.1 Hz to 400 kHz (0.9  $\mu\text{s}$  risetime) (to 200 kHz at 10  $\mu\text{V}/\text{div}$  and to 300 kHz at 20  $\mu\text{V}/\text{div}$ ) upper and lower limits may be independently selected; lower: 0.1, 1, 10, and 100 Hz; upper: max (greater than 400 kHz), 100, 10, 1, and 0.1 kHz.

**Deflection factor (sensitivity):** 0.01 mV/div to 100 mV/div, 13 ranges in a 1, 2, 5 sequence; accuracy  $\pm 3\%$ ; vernier provides continuous adjustment between steps and extends 100 mV/div step to at least 125 mV/div.

**Phase shift:** when used with another Model 1403A, less than 2° relative phase shift up to 50 kHz with X and Y deflection factors the same, and verniers in Cal.

**Common mode rejection ratio:** differential input may be selected on all ranges; with a balance input impedance and the Guard Drive in Ext, CMRR may be adjusted to the values below for up to 5 V pk-pk, 45 Hz to 3 kHz (for Int. CMRR is 6 dB less than shown below).

Deflection factor (mV/div)	Common mode rejection ratio (dB)
0.01 to 0.2	106
0.5, 1, 2	86
5, 10, 20	66
50, 100	46

**Typical CMRR with an unbalanced source impedance when using Guard Drive Ext on most sensitive ranges:**

Unbalance	60 Hz	120 Hz	1 kHz	10 kHz
100 ohms	100 dB	100 dB	100 dB	90 dB
1 k ohms	100 dB	100 dB	90 dB	70 dB
10 k ohms	80 dB	80 dB	70 dB	50 dB

**Input RC:** 10 megohms shunted by approx 60 pF.

**Maximum input:** 600 volts peak (dc + ac) on A and B inputs, 10 volts on Guard input.

**Noise:** 20  $\mu\text{V}$  pk-pk at 100 kHz, noise is reduced as bandwidth is reduced.

**Internal calibrator:** line frequency square wave, 100 mV pk-pk; displayed when input selector is set to Cal; accuracy  $\pm 3\%$ .

**Weight:** net, 5 lb (2.3 kg); shipping 11 lb (5.2 kg).

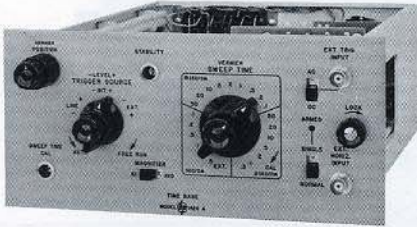
**Accessories furnished:** 6-ft double-shielded extension cable, and a 4-terminal binding post adapter.

**Price:** HP Model 1403A, \$575.



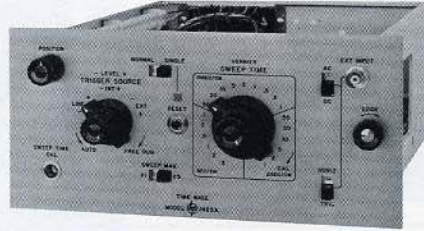
# TIME BASES

## 1420A



- 5 MHz triggering
- Sweeps to 50 ns/div
- Automatic triggering

## 1422A



- 500 kHz triggering
- Sweeps to 200 ns/div
- Automatic triggering

## 1423A



- 20 MHz triggering
- Sweeps to 20 ns/div
- Trigger hold-off

### Specifications

**Range:** 0.5  $\mu$ s/div to 5 s/div, 22 ranges in a 1, 2, 5 sequence; accuracy  $\pm 3\%$ ; vernier provides continuous adjustment between steps and extends the 5 s/div step to at least 12.5 s/div.

**Magnifier:** X10, over-all accuracy  $\pm 5\%$ ; expands 0.5  $\mu$ s/div speed to 50 ns/div.

**Automatic triggering:** (baseline displayed in the absence of an input signal).

**Internal:** 40 Hz to 500 kHz for signals causing 0.5 div or more vertical deflection; also from line signal.

**External:** 40 Hz to 500 kHz for signals at least 0.5 V pk-pk.

**Trigger slope:** positive or negative slope of external sync signal or internal vertical deflection signal.

#### Amplitude selection triggering

**Internal:** 10 Hz to 10 MHz for signals causing 0.5 div or more vertical deflection.

**External:** for signals at least 0.5 V pk-pk; dc coupled, dc to 10 MHz; ac coupled, 10 Hz to 10 MHz; max input, 600 V pk (dc + ac).

**Trigger point and slope:** from any point on the vertical waveform presented on CRT; or continuously variable from  $-7$  to  $+7$  volts on external sync signal; positive or negative slope.

**Single sweep:** front panel switch permits single sweep operation.

#### Horizontal Input

**Bandwidth:** dc to better than 1.5 MHz (typically).

**Deflection factor (sensitivity):** vernier permits continuous adjustment from approx 50 mV/div to 5 V/div.

**Input RC:** 1 megohm shunted by approx 50 pF.

**Weight:** net 5 lb (2,3 kg); shipping 10 lb (4,5 kg).

**Price:** HP Model 1420A, \$375.

**Range:** 1  $\mu$ s/div to 5 s/div, 21 ranges in a 1, 2, 5 sequence; accuracy  $\pm 3\%$ ; vernier provides continuous adjustment between steps and extends the 5 s/div step to a least 12.5 s/div.

**Magnifier:** X5, over-all accuracy  $\pm 5\%$ ; expands 1  $\mu$ s/div speed to 200 ns/div.

**Automatic triggering:** (baseline displayed in the absence of an input signal).

**Internal:** 50 Hz to 500 kHz for signals causing 0.5 div or more vertical deflection; also from line signal.

**External:** 50 Hz to 500 kHz for signals at least 0.5 V pk-pk.

**Trigger slope:** positive or negative slope of external sync signal or internal vertical deflection signal.

#### Amplitude selection triggering

**Internal:** dc or 10 Hz to 500 kHz (depending on vertical system) for signals causing 0.5 div or more vertical deflection.

**External:** for signals at least 0.5 V pk-pk; dc coupled, dc to 500 kHz; ac coupled, 10 Hz to 500 kHz max input, 600 V pk (dc + ac).

**Trigger point and slope:** from any point on the vertical waveform presented on CRT; or continuously variable from  $-10$  to  $+10$  volts on external sync signal; positive or negative slope.

**Single sweep:** front panel switch permits single sweep operation.

#### Horizontal input

**Bandwidth:** dc coupled, dc to 400 kHz; ac coupled, 20 Hz to 400 kHz.

**Deflection factor (sensitivity):** vernier permits continuous adjustment from approx 0.8 V/div to 2.5 V/div.

**Input RC:** 1 megohm shunted by approx 150 pF.

**Weight:** net 5 lb (2,3 kg); shipping 9 lb (4,1 kg).

**Price:** HP Model 1422A, \$250.

**Range:** 0.2  $\mu$ s/div to 5 s/div, 23 ranges in a 1, 2, 5 sequence; accuracy  $\pm 3\%$ ; vernier provides continuous adjustment between steps and extends the 5 s/div step to at least 12.5 s/div.

**Magnifier:** X10, over-all accuracy  $\pm 5\%$ ; expands 0.2  $\mu$ s/div speed to 20 ns/div.

**Automatic triggering:** (baseline displayed in the absence of an input signal) same as normal, except lower limit is 40 Hz for both ac and dc coupling.

#### Normal triggering

**Internal:** dc coupled: dc with Models 1406A/1407A) to 15 MHz for signals causing 0.5 div or more vertical deflection, to 20 MHz for 1 div signals; ac coupled: 10 Hz to 15 MHz for 0.5 div signals, to 20 MHz for 1 div signals; ACF; approx 2 kHz to 15 MHz for 0.5 div signals, to 20 MHz for 1 div signals.

**External:** for signals at least 0.5 V pk-pk; dc coupled, dc to 20 MHz; ac coupled, 10 Hz to 20 MHz; ACF, approx 2 kHz to 20 MHz; max input, 600 V pk (dc + ac).

**Line:** triggering from line frequency also selectable.

**Trigger point and slope:** selectable in both normal and automatic; from any point on the vertical waveform presented on CRT, or continuously variable from  $-5$  to  $+5$  volts on external sync signal; positive or negative slope.

**Trigger hold-off:** time continuously variable exceeding one full sweep at 50 ms/div and faster, prevents multiple triggering on signals that have desired triggering level and slope appearing more than once per cycle.

**Trigger input RC:** dc and ac, approx 1 megohm shunted by 50 pF; ACF, approx 120 k ohms shunted by 50 pF.

**Single sweep:** front panel switch permits single sweep operation.

#### Horizontal input

**Bandwidth:** dc to 500 kHz.

**Deflection factor (sensitivity):** vernier and X 10 magnifier permit continuous adjustment from approx 300 mV/div to 30 V/div.

**Input RC:** 1 megohm shunted by approx 50 pF.

**Weight:** net 5 lb (2,3 kg); shipping 11 lb (5 kg).

**Price:** HP Model 1423A, \$490.



# TIME BASES



## 1421A TIME BASE AND DELAY GENERATOR

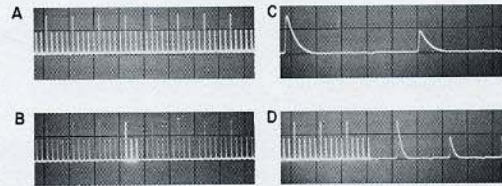
- Stable triggering to 20 MHz
- Single sweep in any mode
- Automatic triggering, easy to use
- Sweeps to 20 nsec/cm

### Description

The 1421A Time Base and Delay Generator provides sweep speeds to 20 ns/div with stable triggering to 20 MHz and beyond.

The delayed sweep feature of the 1421A permits detailed examination of any portion of a complex signal or pulse train by generating an accurately controlled delay time, at the end of which, a second sweep in the 1421A provides the deflection signal to the CRT. The 1421A has provision to trigger the deflection sweep at the end of the delay interval either automatically, on the vertical deflection signal (internal) or on an external signal. In the Automatic mode, the delayed sweep is immediately triggered at the end of the delay interval, thereby permitting accurate measurements of the time jitter in the input waveform. In the internal and external modes, the delayed sweep is armed at the end

of the delay interval and the signal triggers the delayed sweep. Thus the risetime and amplitude can be accurately measured without jitter.



The four basic sweep modes of the 1421A are shown above. (A) Normal Sweep; (B) Intensified Sweep, the deflection developed by the delaying sweep and the trace brightened during the time that the delayed sweep is running; (C) Delayed Sweep, the brightened portion of (B) expanded to full screen; and (D) Mixed Sweep, beam deflected initially by delaying sweep and then by the faster delayed sweep.

### Specifications

**Main sweep:** for displaying signals vs time where sweep delay is not required; employs the main time base only.

**Range:** 0.2  $\mu$ s/div to 1 s/div, 21 ranges in a 1, 2, 5 sequence; accuracy  $\pm 3\%$ ; vernier provides continuous adjustment between steps and extends 1 s/div step to at least 2.5 s/div.

**Triggering:** (when used with Model 1402A).

#### Amplitude selection

**Internal:** approx 10 Hz to 15 MHz for signals causing 0.5 div or more vertical deflection, to 20 MHz for 1 div signals; also from line signal.

**External:** for signals at least 0.5 V pk-pk; dc coupled, dc to 20 MHz; ac coupled, approx 5 Hz to 20 MHz.

**Trigger point and slope:** controls allow selection of level and positive or negative slope; trigger level of external sync signal is continuously variable from  $-5$  to  $+5$  volts.

**Automatic:** baseline displayed in the absence of an input signal; internally down to 40 Hz on most rectangular waveforms causing 1 div or more vertical deflection, also on line signal; externally down to 40 Hz on most rectangular waveforms at least 1 V pk-pk; trigger slope, positive or negative.

**Trace intensification:** used for setting up Delayed or Mixed Sweep modes by increasing brightness of portion of Main Sweep which will be expanded to full screen in Delayed Sweep, or magnified portion of display in Mixed Sweep; rotating Delayed Sweep time switch out of Off position activates intensified mode.

**Delayed sweep:** delayed time base sweeps after a time delay set by Main Sweep and Delay Controls.

**Range:** 0.2  $\mu$ s/div to 50 ms/div, 17 ranges in a 1, 2, 5 sequence; accuracy  $\pm 3\%$ ; vernier provides continuous adjustment between steps and extends 50 ms/div step to at least 125 ms/div.

**Delay (before start of delayed sweep)**

**Time:** continuously variable from 0.5  $\mu$ s to 10 s.

**Accuracy:**  $\pm 1\%$ ; linearity,  $\pm 2\%$ ; time jitter less than 0.005% of max. delay of each range (1 part in 20,000).

**Trigger output:** (at end of delay time) approx  $+4$  V with less than 150 ns risetime, from 1 k ohms output impedance.

**Triggering:** (applies to intensified Main, Delayed, and Mixed Sweep modes).

**Automatic:** delayed sweep starts precisely at end of delay period.

**Internal:** delayed sweep triggered by vertical waveform presented on CRT after end of delay period; approx 10 Hz to 15 MHz for signals causing 0.5 div or more vertical deflection, or to 20 MHz for 1 div signals.

**External:** delayed sweep triggered by external signal after end of delay period; for signals at least 0.5 V pk-pk; dc to 20 MHz; ac coupled, approx 5 Hz to 20 MHz.

**Trigger point and slope:** (internal and external) Same as Main Sweep.

**Mixed sweep:** dual sweep-speed display in which main sweep drives first portion of display, and delayed sweep completes the display at sweep speeds up to 100 times faster; changeover point determined by delay setting.

**Triggering:** same as for Delayed Sweep.

**Magnifier:** X 10, any display; over-all accuracy  $\pm 5\%$ ; expands 0.2  $\mu$ s/div speed to 20 ns/div.

**Single sweep:** any display can be operated in single sweep.

#### Horizontal input

**Bandwidth:** dc to typically better than 500 kHz.

**Deflection factor (sensitivity):** vernier and X 10 magnifier permits continuous adjustment from approx 0.3 V/div to 30 V/div.

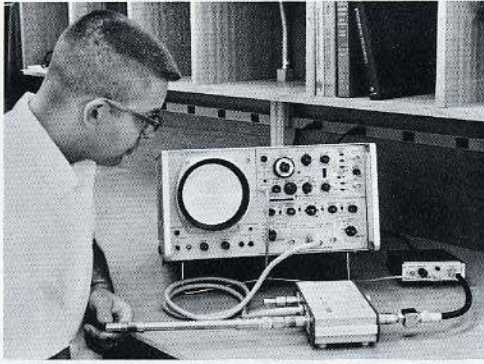
**Input RC:** 1 megohm shunted by less than 20 pF.

**Weight:** net, 6 lb (2.7 kg); shipping, 11 lb (5 kg).

**Price:** HP Model 1421A, \$675.



# 12.4 GHz SAMPLING APPLICATIONS



- 40 ps TDR
- Discontinuity Resolution to less than 1 cm
- Remote Sampling Heads
- Reflection coefficient sensitivity to .002/div

## Description

If design of GHz coaxial components is important to you then HP's sampling system used as a Time Domain Reflectometer is your answer. You can see discontinuities causing undesired reflections at very high frequencies. Connectors, attenuators, delay lines, distributed deflection plates, switches, and strip lines are just a few of the many devices that can be designed or checked quickly using sampling techniques.

HP Models 1424A or 1425A Time Base, 1411A Vertical Amplifier, 1430A 28 ps Sampler, and the

1105/1106A Fast Rise Pulser make up the system. 20 ps pulses (with less than 5% overshoot) driven through the 28 ps sampler into the system under test form a TDR system with a risetime of less than 40 ps which is about the time it takes light to travel  $\frac{1}{2}$ " in air.

Contact your HP Field Engineer soon for a demo on your own application. It may be the solution to one or more of your unanswered design problems.

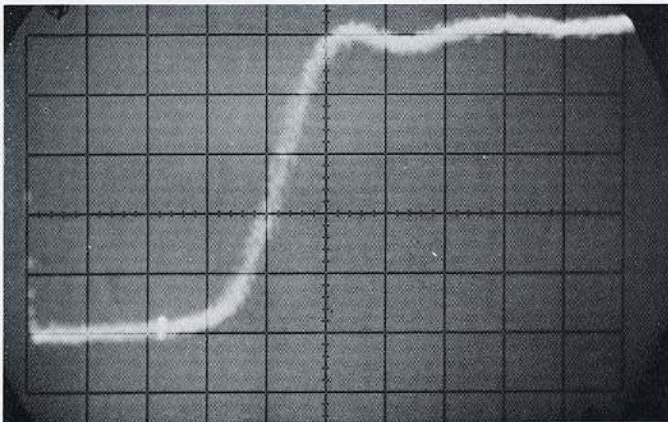


Fig. 1. Response of sampler to incident step in TDR System of Fig. 3. Typical risetime is less than 35 ps. Vertical: reflection coefficient = 0.2/div; Horizontal: 20ps/div.

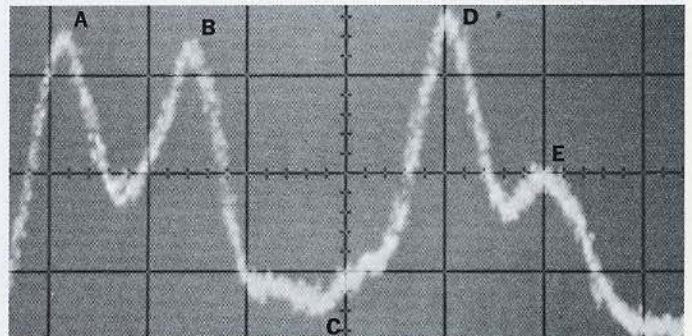
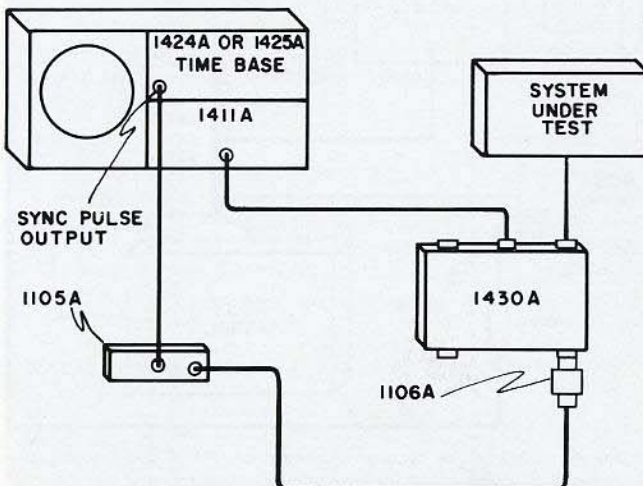


Fig. 2. Typical TDR resolution of discontinuities in a cable-connector-adapter-connector-cable combination. a) large cable connected to connector; b) connector to adapter; c) 50 $\Omega$  bead in adapter; d) adapter to connector; and e) connector to small cable. Horizontal: 50 ps/div; Vertical: reflection coefficient = .004/div.

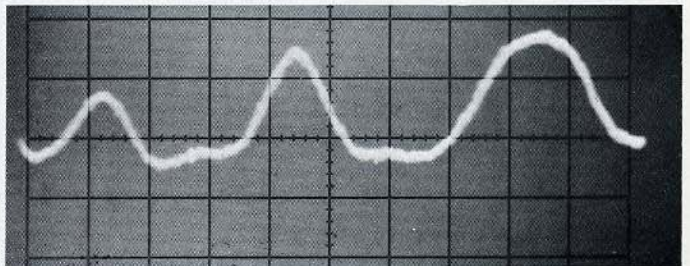
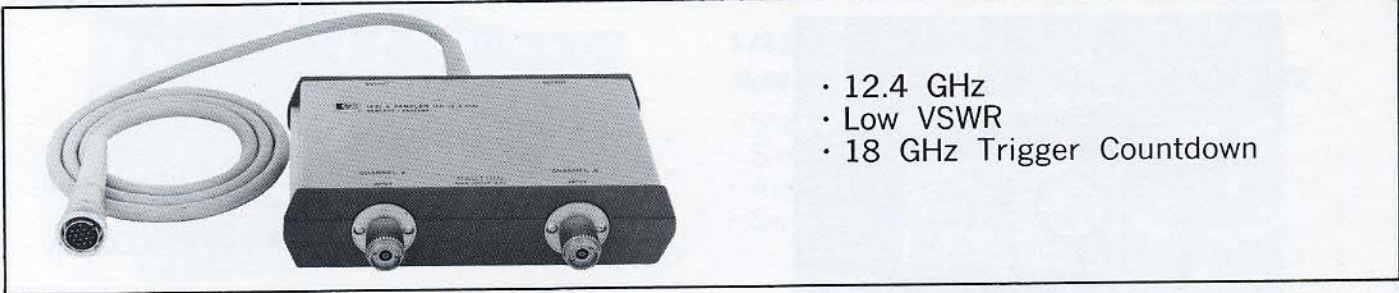


Fig. 3. Reflections were caused by three sections of 75 $\Omega$  center conductors inserted into a 50 $\Omega$  air line. They are  $\frac{1}{8}$ ",  $\frac{1}{4}$ " and  $\frac{1}{2}$ " in length spaced by  $\frac{5}{8}$ ". The  $\frac{1}{2}$ " section has reached maximum deflection (flattened slightly) and even the  $\frac{1}{4}$ " section is very near the same magnitude.



# 12.4 GHz SAMPLING APPLICATIONS



- 12.4 GHz
- Low VSWR
- 18 GHz Trigger Countdown

## Description

Whether your application is in the design or monitoring of microwave systems, you can make accurate oscilloscope measurements through X-band.

Observe outputs from your signal source for amplitude, distortion and jitter. Check gain, distortion, frequency and phase shift of TWT and other high frequency amplifiers. All types of modulated signals can be looked at for modulation index, distortion, and

phase shift. Low frequency distortion can be detected by making X-Y recordings using the recorder outputs of the Vertical Amplifier.

All this and more is made possible using the HP 1431A 12.4 GHz Sampler with the HP 1411A Vertical Amplifier, the HP 1424A or 1425A Time Base, and the HP 1104A/1106A Trigger Countdown. Select a HP 140 Mainframe a HP 141 Variable Persistence and Storage Mainframe, or the HP 143A Mainframe.

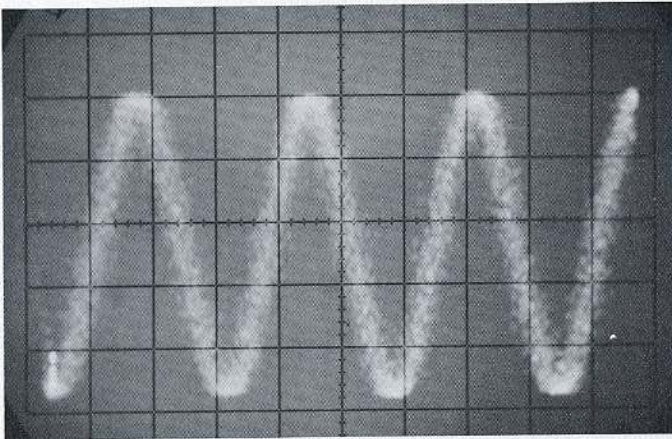


Figure 1. Oscillogram shows 18 GHz sine wave. Note that jitter even at this frequency is less than 10 ps. Signal was obtained using 1431A 12.4 GHz Sampler and 1104A/1105A Trigger Countdown.

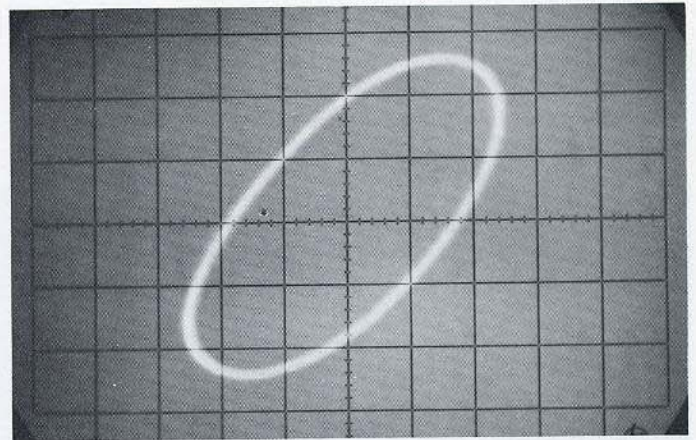


Figure 3. Accurate phase measurements can be made with the HP Model 1431A 12.4 GHz Sampler which has less than 10° phase difference between channels at 5GHz and typically less than 2° at 1GHz.

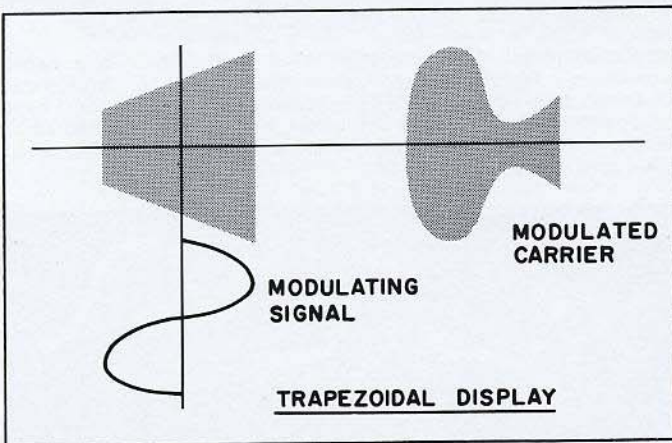


Figure 2. Displays like this one represent a technique of measuring characteristics of a modulator without the need for triggering. Basically, the idea is to feed the modulated carrier into the vertical channel and the modulating signal into the horizontal channel. Set MODE to A Vs B and free run the sweep.

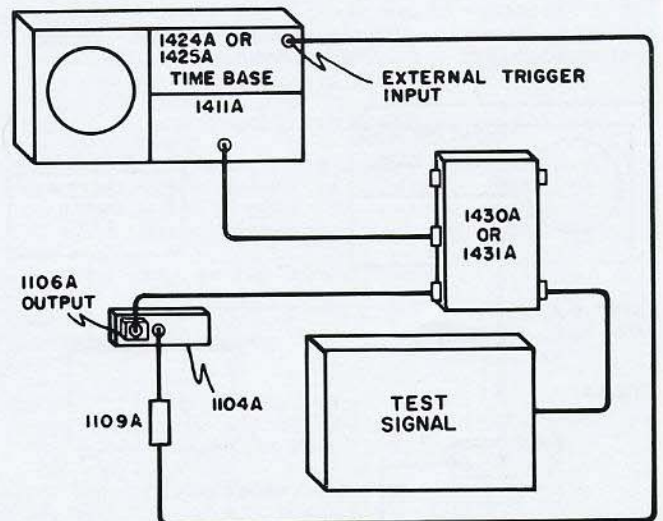


Figure 4. This is a typical hookup of HP's new Sampling systems for measuring or monitoring microwave signals.



# 1 GHz SAMPLING AMPLIFIER

## 1410A

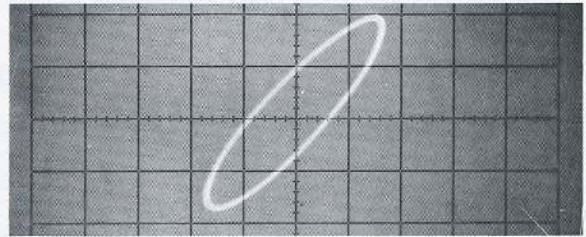
- Internal triggering
- High impedance probes and 50 $\Omega$  inputs
- 1 mV/div at 1 GHz



## Description

The versatile 1410A Sampling Vertical Amplifier provides 1 mV/div sensitivity at 1GHz. Optimum compromise among risetime, overshoot, and noise can be easily and quickly made with the front-panel risetime and smoothing controls.

Front-panel recorder outputs with both d-c level and amplitude adjustments simplify your X-Y or strip chart recorder setup and enable permanent recording of CRT traces.



The A vs. B mode of the 1410A permits X-Y measurements to 1 GHz and above.

## Specifications

### Mode of Operation

1. Channel A only.
2. Channel B only.
3. Channel A and Channel B.
4. Channel A and Channel B added algebraically.
5. Channel A vs. Channel B.

**Polarity:** Either channel may be displayed either positive or negative up in any mode.

**Risetime:** Less than 350 ps.

**Bandwidth:** DC to 1 GHz.

**Overshoot:** Less than 5%.

**Sensitivity:** Calibrated ranges from 1 mV/div to 200 mV/div in a 1, 2, 5 sequence. Vernier control provides continuous adjustment between ranges and increases maximum sensitivity to greater than 0.4 mV/div.

**Attenuator Accuracy:**  $\pm 3\%$ .

**Isolation Between Channels:** Greater than 40 dB to 1 GHz.

### Input Impedance

Probes: 100K ohms shunted by 2 pF nominal.

GR Type 874 Inputs: 50 ohms  $\pm 2\%$  with 57 ns internal delay lines for viewing leading edge of fast rise signals. Reflection from input connector is approx 10%, using a 150 ps TDR system.

**Noise:** (With sampling efficiency set to 100%, record amplitude set for 100 mV/div, input terminated in 50 $\Omega$ , and sweep set to 10  $\mu$ s/div). Less than 8 mV from Y record output as measured on a true RMS meter, from 5 mV/div to 200 mV/div. (Corresponds to approximately 1 mV observed noise on CRT excluding 10% of random dots). Noise decreases on automatically smoothed ranges 2 and 1 mV/div. Smoothed position of smoothing switch reduces noise and jitter

approximately 4:1. Vernier control provides continuous adjustment between the normal and smoothed modes.

**Dynamic Range:** 2Vp-p.

**Drift:** Less than 3 mV/hr after warmup.

**Maximum Safe Input:**

Probes:  $\pm 50$  volts.

50 $\Omega$  Inputs:  $\pm 5$  volts.

**Triggering:** Internal or external when using 50 $\Omega$  inputs.

Internal triggering selectable from Channel A or B.

External triggering necessary when using probes.

**Time Difference Between Channels (for probes or 50 $\Omega$  Inputs):**

Less than 100 ps.

**Recorder Outputs:** Front panel outputs provide 0.1 V/div from a 500 $\Omega$  source. Gain adjustable from approximately 0.05 V/div to 0.2 V/div. DC level adjustable from approx -1.5 V to +0.5 V.

### Accessories Provided:

Model	Quantity	Description
10214A	2	10:1 Divider
10216A	2	Isolator
10217A	2	0.001 $\mu$ F Blocking Capacitor
10218A	2	BNC Adapter
10219A	1	GR Adapter
10220A	2	Microdot Adapter
10221A	1	50 $\Omega$ T-Connector
10213-62102	6	Ground Clip
5020-0457	6	Probe Tip
—	1	Accessory Box

**Weight:** Net, 12 lb (5,4 kg). Shipping, 19 lb (8,6 kg).

**Price:** \$1700.



# 1 GHz ACCESSORIES

## 1410A ACCESSORIES (Separately Available)



10214A

**10214A 10:1 Divider.** Permits accurate measurement of signals as large as 20 volts peak-to-peak and increases the impedance of the probe to 1 megohm shunted by 2.5 pF. Price, \$30.



10216A

**10216A Isolator.** Increases convenience and accuracy when probing by reducing baseline shift and transient response changes caused by changes in the circuit source impedance. 1410A risetime is increased to approximately 0.6 ns and probe input capacitance is increased by less than 3 pF. Price, \$25.



10217A

**10217A Blocking Capacitor.** This blocking capacitor (0.001  $\mu$ F) permits measurements of signals that are  $\pm 50$  volts from ground (to  $\pm 200$  V when used with 10214A 10:1 Divider). The blocking capacitor contributes only 1% sag to a 1  $\mu$ s pulse when used with the probe alone, and 0.1% sag when used with the 10:1 divider. No more than 2.5 pF shunt capacitance is added to the input by the blocking capacitor. Price, \$20.



10218A

**10218A BNC Adaptor.** Converts probe tip into a male BNC connector. Price, \$7.



10219A

**10219A GR Adapter.** Converts probe tip into a GR Type 874 connector. Price, \$15.



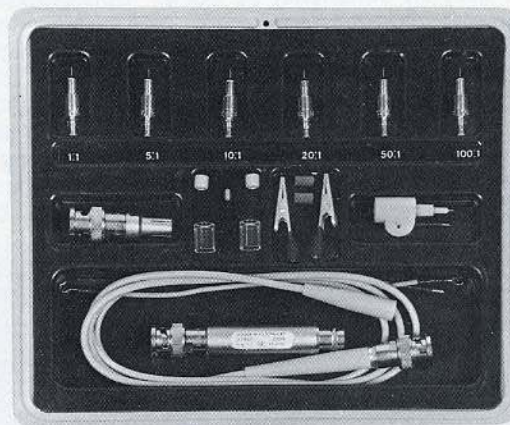
10220A

**10220A Microdot Screw-on Adapter.** Allows easy connection to coaxial connectors, and also provides a solid ground reference. Price: 10220A, \$4.



10221A

**10221A 50-Ohm T Connector.** Permits monitoring of signals in 50-ohm transmission lines with the 1410A without terminating the line or disturbing the signal. Mismatch is low; the reflection from a step input is no greater than 20% of the input step height. Price, \$50.



10020A Miniature Resistive Dividers

Division Ratio	Input R* (ohms)	Division Accuracy	Max. V† (rms)	Input C (pF)
1:1	50		6	
5:1	250	$\pm 3\%$	9	0.7
10:1	500	$\pm 3\%$	12	0.7
20:1	1000	$\pm 3\%$	15	0.7
50:1	2500	$\pm 3\%$	25	0.7
100:1	5000	$\pm 3\%$	35	0.7

\* When terminated in 50 ohms.

† Limited by power dissipation of resistive element.

### Accessories furnished

Included are: HP Model 10218A BNC Adapter Tip; 4-ft cable, a 6-32 adapter tip, ground leads, and Model 10240B Blocking Capacitor.

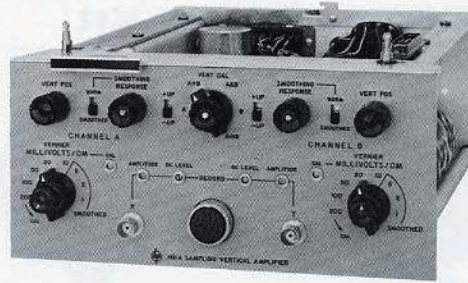
**Weight:** net, 1 lb (0.5 kg); shipping 3 lb (1.4 kg).  
**Price:** Model 10020A, \$100.



# 12.4 GHz SAMPLING AMPLIFIER

## 1411A

- Bandwidths to 12.4 GHz
- 1 mV/div
- Remote samplers
- Feed-through inputs



## Description

The 1411A Sampling Vertical Amplifier is a basic vertical plug-in that accepts a series of wideband samplers. All three samplers have 1 mV/div sensitivity. Feed-through inputs are also featured, for monitoring signals without terminating them and for precise Time Domain Reflectometry measurements.

The remote samplers, connected to the oscilloscope

by a five-foot cable, can be placed right at the signal source, eliminating lossy lines.

Risetime is set with a front panel knob, allowing convenient adjustment of risetime and bandwidth to the ultimate when needed, at the sacrifice of increased noise. Front panel recorder outputs and an X-Y mode for wideband phase measurements add to the 1411A's measurement capability.

## Specifications

(When used with 1430A, 1431A, or 1432A)

### Mode of Operation:

1. Channel A only.
2. Channel B only.
3. Channel A and Channel B.
4. Channel A and Channel B added algebraically.
5. Channel A vs. Channel B.

**Polarity:** Either channel may be displayed either positive or negative up in any mode.

**Sensitivity:** Calibrated ranges from 1 mV/div to 200 mV/div in a 1, 2, 5 sequence. Vernier control provides

continuous adjustment between ranges and increases maximum sensitivity to greater than 0.4 mV/div.

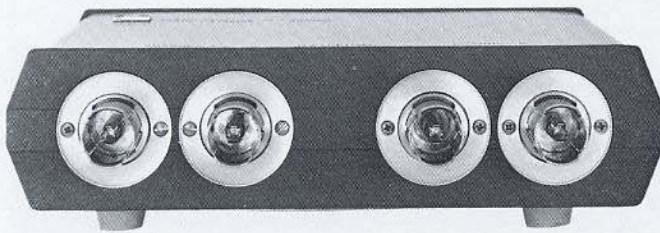
**Attenuator Accuracy:**  $\pm 3\%$ .

**Isolation Between Channels:** Greater than 40 dB over bandwidth of sampler.

**Recorder Outputs:** Front panel outputs provide 0.1 V/div from a 500 $\Omega$  source. Gain adjustable from approx 0.05 V/div to 0.2 V/div. DC level adjustable from approx -1.5 V to +0.5 V.

**Weight:** Net, 5 lb (2,3 kg). Shipping, 12 lb (5,4 kg).  
**Price:** \$700.

## 1432A 90 ps SAMPLER



The 1432A is a lower-priced version of the 1430A and 1431A. Its 90 ps risetime (DC to 4 GHz bandwidth), 1 mV/div sensitivity, and feed through inputs permit many accurate measurements involving CW, fast pulses, and TDR.

## Specifications

(When used with 1411A)

**Risetime:** Less than 90 ps.

**Bandwidth:** DC to 4 GHz.

**Overshoot:** Less than  $\pm 5\%$ .

**Noise:** Same as 1430A, except less than 10 mV from Y record output, corresponding to approximately 3 mV observed noise.

**Dynamic Range:**  $\pm 1$  V<sub>p-p</sub>.

**Low Frequency Distortion:** Less than  $\pm 3\%$ .

**Maximum Safe Input:**  $\pm 5$  volts.

### Input Characteristics:

**Mechanical:** GR type 874 connectors used on input and output.

**Electrical:** 50 ohm feedthrough, dc coupled. Reflection from sampler is approx 15% using a 90 ps TDR system. Pulses emitted from sampler input are approximately 50 mV in amplitude and 10 ns wide.

**Time Difference Between Channels:** Less than 25 ps.

**Connecting Cable Lengths:** 5 ft (for longer cable, see special order below).

**Weight:** Net, 4 lb (1,8 kg). Shipping, 9 lb (4,1 kg).

**Accessories Provided:** Two GR Model 874-W50 50 ohm loads.

**Price:** \$1000.

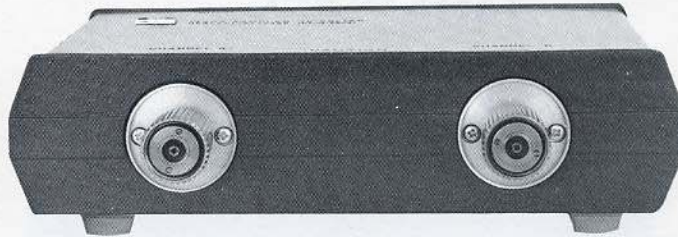
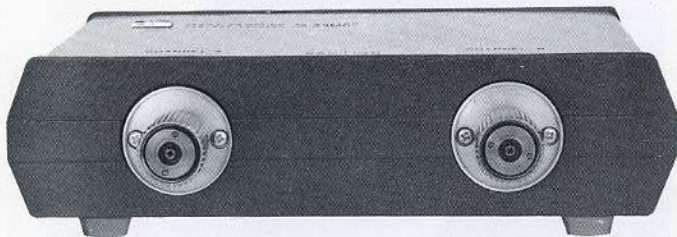
**Special Order:** 10-ft connecting cable (5-ft is standard), order 1432A Opt. C01. Price, \$1035.



# 12.4 GHz SAMPLERS

## 1430A 28 ps SAMPLER

## 1431A 12.4 GHz SAMPLER



### Description

The 1430A provides 28 ps risetime with minimal overshoot for accurate measurements on fast-rise pulses. Used with the 1105A/1106A 20 ps pulse generator, its response and feed-through inputs make it ideal for TDR measurements.

The 1431A allows viewing of CW signals from dc to beyond 12.4 GHz at 1 mV/div sensitivity. It differs slightly from the 1430A, having a very flat bandwidth and low VSWR at the sacrifice of increased overshoot.

### Specifications

#### 1430A

(When used with 1411A)

**Risetime:** Approx 28 ps. (Less than 35 ps observed with 1105A/1106A pulser and 909A 50-ohm load.)

**Bandwidth:** DC to approx 12.4 GHz.

**Overshoot:** Less than  $\pm 5\%$ .

**Noise:** (Same conditions at 1410A noise spec.). Less than 30 mV from Y record output as measured on a true RMS meter, from 10 mV/div to 200 mV/div. (Corresponds to approximately 8 mV observed noise on CRT excluding 10% of random dots). Noise decreases on automatically smoothed ranges 5, 2, and 1 mV/div. Smoothed position of smoothing switch reduces noise and jitter approximately 4:1. Vernier control provides continuous adjustment between the normal and smoothed modes.

**Dynamic Range:**  $\pm 1$  V.

**Low Frequency Distortion:** Less than  $\pm 3\%$ .

**Maximum Safe Input:**  $\pm 3$  volts.

#### Input Characteristics:

**Mechanical:** Amphenol APC-7 precision 7 mm connectors on input and output.

**Electrical:** 50 ohm feedthrough, dc coupled. Reflection from sampler is approx 10%, using a 40 ps TDR system. Pulses emitted from sampler input are approximately 10 mV in amplitude and 5 ns in duration. VSWR  $< 3:1$  at 12.4 GHz.

**Time Difference Between Channels:** Less than 5 ps.

**Connecting Cable Length:** 5 ft.

**Weight:** Net, 4 lb (1.8 kg). Shipping 9 lb (4.1 kg).

**Accessories Provided:** Two Amphenol APC-7 to female Type N adapters (HP 11524A). Two 50-ohm loads (HP 909A).

**Price:** \$3000.

**Special Order:** 10-ft connecting cable, order 1430A Opt C01. Price, \$3035.

#### 1431A

(When used with 1411A)

**Bandwidth:** DC to greater than 12.4 GHz (less than 3 dB down from a 10 div dc reference).

**Risetime:** Approx 28 ps.

**VSWR:** DC to 8 GHz 1.4:1  
8 to 10 GHz 1.6:1  
10 to 12.4 GHz 2.0:1

**Noise:** Same as 1430A.

**Dynamic Range:**  $\pm 1$  V.

**Low Frequency Distortion:** Less than  $\pm 3\%$ .

**Maximum Safe Input:**  $\pm 3$  volts.

#### Input Characteristics

**Mechanical:** Amphenol APC-7 precision 7 mm connector used on input and output.

**Electrical:** 50-ohm feedthrough, dc coupled. Reflection from sampler is approx 5%, using a 40 ps TDR system. Pulses emitted from sampler input are approximately 10 mV in amplitude and 5 ns in duration.

**Phase Shift Between Channels:** Less than  $10^\circ$  at 5 GHz, typically less than  $2^\circ$  at 1 GHz.

**Connecting Cable Lengths:** 5 ft.

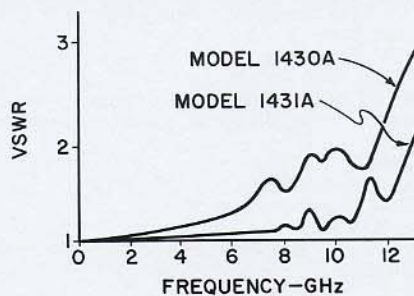
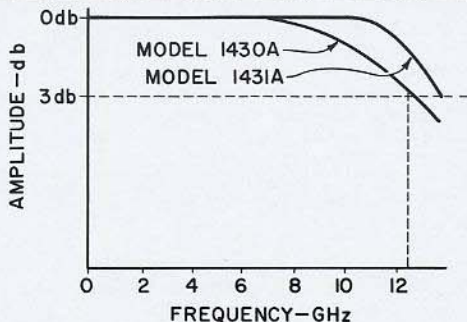
**Weight:** Net, 4 lb (1.8 kg). Shipping 9 lb (4.1 kg).

**Accessories Provided:** Two Amphenol APC-7 to female Type N adapters (HP 11524A). Two 50-ohm loads (HP 909A).

**Price:** \$3000.

**Special Order:** 10-ft connecting cable (5-ft is standard), order 1430A Opt. C01 or 1431A Opt. C01. Price, \$3035.

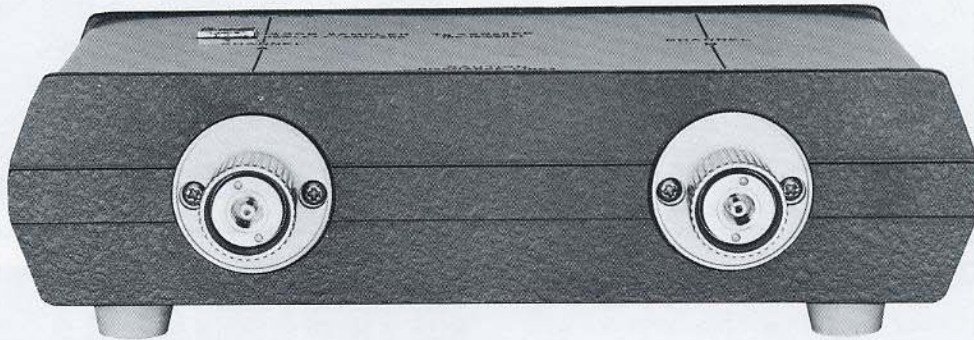
**Recommended Accessory:** HP Model 1109A High Pass Filter.





# 18 GHz SAMPLER

## 1430B 20 ps RISE TIME



### Description

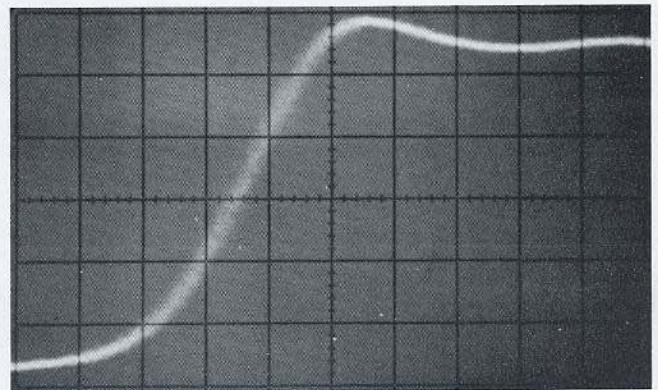
Model 1430B sampler provides 20 ps rise time with low overshoot for accurate measurements of fast rise pulses. Whether your application is design or monitoring microwave systems, this sampling head provides accurate oscilloscope measurements to 18 GHz.

The feedthrough measurement technique allows accurate measurements with the system load connected. This allows a minimum amount of signal to be removed from a system for a more accurate display of the transmitted information. If desired, terminated measurements can be made with the specified terminations that are supplied as standard accessories. Also, the industry standard 7 mm precision connectors increase the measurement accuracy by reducing reflections.

A remote sampling head also reduces error by reducing signal loss inherent in long high frequency connecting lines. This allows lower frequency sampled signals to be accurately monitored at the oscilloscope with minimum line losses.

By coupling this 18 GHz sampling head with a 1411A sampling vertical amplifier plug-in, a 1424A or 1425A sampling time base plug-in, and the 1104A/1106A trigger countdown in a 140 system mainframe, you

have an accurate display of your system output. With this measurement tool you can: observe signal source outputs for distortion and jitter; check gain, distortion, frequency, and phase shift of traveling wave tubes and other high frequency amplifiers; and modulated signals can be monitored for modulation index, distortion, and phase shift.



### Specifications

(When used with 1411A)

**Rise Time:** Approx 20 ps. (<28 ps observed with 1105A/1106A pulse generator and 909A 50 ohm load.)

**Bandwidth:** DC to >18 GHz.

**Overshoot:** <7.5%.

**Noise:** 10 mV unsmoothed; 2.5 mV smoothed. Both measured tangentially.

**Dynamic Range:**  $\pm 1$  volt.

**Low Frequency Distortion:**  $< \pm 5\%$ .

**Maximum Safe Input:**  $\pm 3$  volts.

**Input Characteristics**

**Mechanical:** Precision Amphenol APC-7, 7 mm connectors on input and output.

**Electrical:** 50 ohm feedthrough, dc-coupled. Reflection from sampler is approx 10%, using a 40 ps TDR system. Pulses emitted from sampler input are approx 10 mV amplitude and 5 ns duration.

**Time Difference Between Channels:** <5 ps.

**Connecting Cable Lengths:** 5 ft. (for longer cable, see options).

**Weight:** Net, 4 lb (1.8 kg). Shipping, 9 lb (4.1 kg).

**Accessories Provided:** two Amphenol APC-7 to female Type N adapters (HP Model 11524A). Two 50 ohm loads (HP Model 909A).

**Price:** Model 1430B, \$3500.

**Options** (order by Option number)

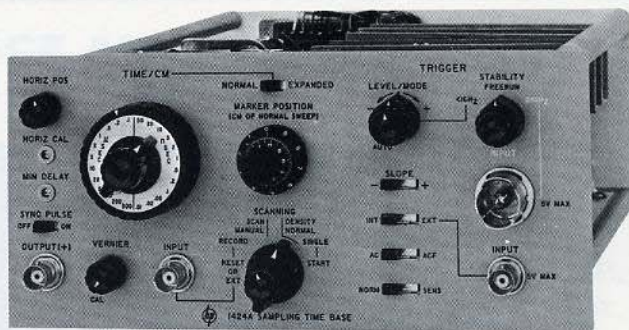
**CO1:** 10-ft. connecting cable (5-ft is standard). Add \$35.



# SAMPLING TIME BASES

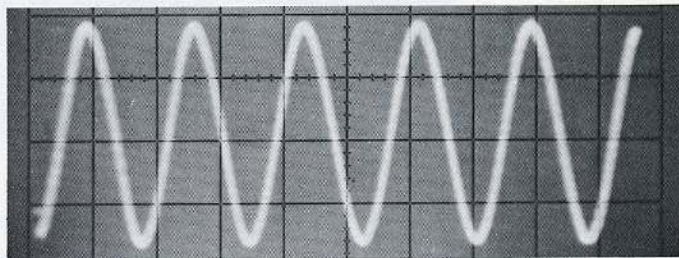
## 1424A

- Direct readout of all sweeps
- Calibrated sweeps to 10 ps/div
- Triggering to 5 GHz



## Description

The 1424A is an easy-to-operate time base for use with the 1410A and 1411A plug-ins. Convenient and more meaningful measurements are made possible through features such as: direct sweep readout, calibrated marker position control which positions an intensified marker and automatic triggering which locks in on a wide range of signals. A single scan feature helps provide clearer photos and stored traces of drifting or changing signals.



Solid triggering to 5 GHz without external count down box.

## Specifications

**Sweep Range:** 24 ranges, 10 ps/div to 500  $\mu$ s/div in a 1, 2, 5 sequence. Sweeps from 1 ns/div to 500  $\mu$ s/div may be expanded up to 100 times and read out directly. Sweeps from 10 ps/div to 500 ps/div are obtained by expansion and also read out directly. Accuracy  $\pm 3\%$  except for time represented by approximately first  $\frac{1}{4}$  div of unexpanded sweep. Vernier provides continuous adjustment between ranges and increases maximum sweep speed to faster than 4 ps/div.

**Marker Position:** Intensified marker indicates point about which sweep is expanded; 10-turn, calibrated control. Accuracy,  $\pm 1.5$ mm.

**Minimum Delay:** Less than 55 ns.

**Triggering:** (Less than 1 GHz)

**Internal (with 1410A)**

**Automatic:** Baseline displayed in the absence of an input signal.

**Pulses:** At least 50 mV amplitude required of pulses 2 ns or wider for jitter less than 30 ps.

**Sine Waves:** Signals from 200 Hz to 150 MHz require 25 mV amplitude for jitter less than 10% of input signal period. (Usable to 1 GHz with increased jitter.)

**Level Select**

**Pulses:** At least 50 mV amplitude required for pulses 2 ns or wider for jitter less than 20 ps.

**Sine Waves:** Signals require from 200 Hz to 150 MHz 25 mV amplitude (increasing to 400 mV at 1 GHz) for jitter less than 1.5% of input signal period + 10 ps.

**External**

**Automatic:** Baseline displayed in the absence of an input signal.

**Pulses:** At least 100 mV amplitude required of fast rise pulses 2 ns or wider for jitter less than 20 ps.

**Sine Waves:** Signals from 200 Hz to 500 MHz require 50 mV for jitter less than 10% of input signal period. (Usable to 1 GHz with increased jitter.)

**Level Select**

**Pulses:** At least 50 mV amplitude required of fast

rise pulses 2 ns or wider for jitter less than 20 ps.

**Sine Waves:** Signals from 200 Hz to 1 GHz require 50 mV for jitter less than 1.5% of input signal period + 10 ps. Jitter is less than 50 ps for signals of 10 mV at 1 GHz.

**Slope:** Positive or negative.

**Sensitivity:** Jitter specifications above given for sensitive mode; normal mode reduces sensitivity by approximately 10:1.

**Dynamic Range:** 100 mV in sensitive; 1.0 V in normal (external).

**External Trigger Input:** 50 $\Omega$ , ac or ac fast; signal output, <10 mV in sensitive and <5 mV in normal.

**Maximum Safe Input:** Sensitive, 5 V rms or peak transient. Normal, 5 V rms (50 V peak transient). Internal, 5 V rms or peak transient.

**Jitter:** Less than 10 ps on 1 ns/div range, and less than 20 ps (or 0.005% of unexpanded sweep speed, whichever is larger) at 2 ns/div and slower, with signals having risetimes of 1 ns or faster.

**Triggering (Greater than 1 GHz)**

Jitter less than 30 ps for 25 mV input, 1 GHz to 4 GHz, and 50 mV input, 4 to 5 GHz.

**Scanning**

**Internal:** X axis driven from internal source. Scan density continuously variable.

**Manual:** X axis driven by manual scan control knob.

**Record:** X axis driven by internal slow ramp; approximately 60 seconds for one scan.

**External:** 0 to +15 V required for scan; input impedance, 10k $\Omega$ .

**Single Scan:** One scan per actuation; scan density continuously variable.

**Sync Pulse Output**

**Amplitude:** Greater than 1.5 V into 50 $\Omega$ .

**Risetime:** Approx 1 ns.

**Overshoot:** Less than 5%.

**Width:** Approximately 1  $\mu$ s.

**Relative Jitter:** Less than 10 ps.

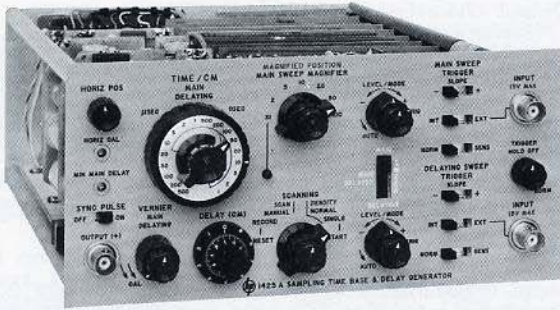
**Repetition Rate:** One pulse per sample.

**Weight:** Net, 5 lb (2,3 kg). Shipping, 11 lb (5 kg).

**Price:** \$1400.



# SAMPLING TIME BASES



## 1425A

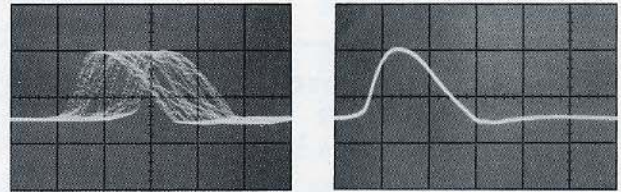
- Delayed sweep
- Calibrated sweeps to 10 ps/div
- Triggering to 1 GHz

## Description

The 1425A's delayed sweep feature allows detailed examination (magnification as great as 10,000:1) of any portion of complex signals and pulse trains for the first time in the GHz region. And accurate time jitter measurements in the input waveform can be measured when in the Automatic triggering mode. This same automatic triggering mode provides a baseline in the absence of an input signal aiding in getting a trace displayed sooner.

When you want to set up a magnified trace, an intensified marker dot locates the expansion point for

you. You also get push button return to X1 magnification for fast reference or relocation of the expansion point.



Jitter on delayed pulse in left photo eliminated at right by retriggering the delayed sweep. Sweep speed, 1 ns/div; delay, 5  $\mu$ s.

## Specifications

### Main Sweep

**Range:** 1 ns/div to 10  $\mu$ s/div, 13 ranges in a 1, 2, 5 sequence; accuracy  $\pm 3\%$ , except for time represented by approximately first  $\frac{1}{4}$  div of unexpanded sweep. Vernier provides continuous adjustment between steps and extends maximum magnified speed to at least 4 ps/div.

**Magnifier:** X1 to X100 in 7 calibrated steps; increase 1 ns/div sweep step to 10 ps/div; pushbutton returns magnifier to X1.

**Marker Position:** Intensified marker indicates point about which sweep is expanded; 10-turn control.

**Minimum Delay:** Main Sweep, less than 55 ns; Main Delayed Sweep, less than 105 ns.

### Triggering (for both Main and Delaying Sweep)

#### Internal

**Automatic:** Baseline displayed in the absence of an input signal.

**Pulses:** At least 75 mV amplitude required of pulses 2 ns or wider for jitter less than 30 ps.

**Sine Waves:** Signals from 200 Hz to 150 MHz require 50 mV amplitude for jitter less than 10% of input signal period (usable to 1 GHz with increased jitter).

#### Level Select

**Pulses:** At least 100 mV amplitude required of fast rise pulses 2 ns or wider for jitter less than 20 ps.

**Sine Waves:** Signals from 200 Hz to 150 MHz require 50 mV amplitude (increasing to 400 mV at 1 GHz) for jitter less than 1.5% of input signal period  $\pm 10$  ps.

#### External

**Automatic:** Baseline displayed in the absence of an input signal.

**Pulses:** At least 100 mV amplitude required of fast rise pulses 2 ns or wider for jitter less than 20 ps.

**Sine Waves:** Signals from 200 Hz to 500 MHz require 50 mV amplitude for jitter less than 10% of input signal period (usable to 1 GHz with increased jitter).

### Level Select

**Pulses:** At least 50 mV amplitude required for fast rise pulses 2 ns or wider for jitter less than 20 ps.

**Sine Waves:** Signals from 200 Hz to 1 GHz require 50 mV for jitter less than 1.5% of input signal period  $\pm 10$  ps; jitter is less than 50 ps for signals of 10 mV amplitude at 1 GHz.

**Trigger Input:** 50-ohms, ac-coupled (2.2  $\mu$ F); signal output, less than 10 mV in sensitive, and less than 5 mV in normal.

**Slope:** Positive or negative.

**Sensitivity:** Jitter specifications given above are for sensitive mode; normal mode reduces sensitivity by approx 10:1.

**Dynamic Range:** 100 mV in sensitive, 1.0 V in normal (external).

**Maximum Input:** Sensitive, 5 V rms or peak transient; normal 5 V rms (50 V pk transient); internal, 5 V rms or peak transient.

**Jitter:** Less than 10 ps on 1 ns/div range and less than 20 ps (or 0.005% of unexpanded sweep, whichever is larger) at 2 ns/div and slower, with large amplitude signals having risetimes of 1 ns or faster.

### Delaying Sweep

**Range:** 10 ns/div to 500  $\mu$ s/div, 15 ranges in a 1, 2, 5 sequence; accuracy  $\pm 3\%$ , except for slight nonlinearity at start of sweep,  $\pm 5\%$  on 200  $\mu$ s/div and 500  $\mu$ s/div ranges, vernier provides continuous adjustment between steps and increases 10 ns/div step to at least 4 ns/div.

**Delay Time:** Continuously variable from 50 ns to 5 ms.

**Accuracy:**  $\pm 3\%$ ; linearity 0.5%; jitter time is less than 1 part in 20,000 or 20 ps, whichever is greater.

**Sweep Functions:** Main, delaying, and main delayed.

**Scanning:** Same as 1424A except no external scan input.

**Sync Pulse Output:** Same as 1424A. Pulse always synchronized to main sweep trigger circuit; pulse delay and rate are variable.

**Weight:** Net, 7 lb (3,2 kg). Shipping, 13 lb (5,9 kg).

**Price:** \$1900.



# SAMPLING ACCESSORIES

## 1104A/1106A/18GHz Trigger Countdown 1104A/1108A/10GHz Trigger Countdown



1106A

1108A

1104A

### Specifications 1104A/1106A/1108A

#### Input

Frequency range: (1106A) 1 GHz to 18 GHz. (1108A) 1 GHz to 10 GHz.

Sensitivity: (1106A) signals 100 mV or larger and up to 12.4 GHz, produce <20 ps of jitter (200 mV required to 18 GHz). (1108A) signals up to 50 mV or larger and up to 10 GHz, produce <20 ps of jitter.

Maximum safe input:  $\pm 1$  V.

Input impedance: (1106A) 50-ohm Amphenol APC-7 input connector. (1108A) 50-ohm GR-874 input connector. Reflection from input connector is <10% using a 40 ps TDR system.

Signal appearing at input connector: approximately 250 mV.

#### Output

Center frequency: approximately 100 MHz.

Amplitude: typically 150 mV.

#### Weight

1104A: net 2 lbs (0.9 kg); shipping 4 lbs (1.8 kg).

1106A or 1108A: net 1 lb (0.5 kg); shipping 2 lb (0.9 kg).

Price: HP Model 1104A, \$200. HP Model 1106A, \$550. HP Model 1108A, \$200.

Recommended accessory: HP Model 1109A/1129A High Pass Filter.

## 1105A/1106A/20ps Pulse Generator 1105A/1108A/60ps Pulse Generator



1106A

1108A

1105A

### Specifications 1105A/1106A/1108A

#### Output

Risetime: approx 20 ps with 1106A, (<60 ps with 1108A), <35 ps observed with HP Model 1411A/1430A 28 ps Sampler and HP Model 909A 50 ohm termination.

Overshoot:  $\pm 5\%$  as observed on 1411A/1430A with 909A.

Droop: less than 3% in first 100 ns.

Width: approximately 3  $\mu$ s.

Amplitude: greater than +200 mV into 50 ohms.

Output characteristics (1106A/1108A):

Mechanical: (1106A) Amphenol APC-7 connector. (1108A) GR-874 connector.

Electrical: dc resistance; 50 ohm  $\pm 2\%$ . Source reflection; less than 10%, using a 40 ps TDR system. DC offset voltage; approximately 0.1 V.

#### Triggering

Amplitude: at least  $\pm 0.5$  V peak required.

Risetime: less than 20 ns required. Jitter less than 15 ps when triggered by 1 ns risetime sync pulse from 1424A or 1425A Sampling Time Base.

Width: greater than 2 ns.

Maximum safe input: 10 volts.

Input impedance: 200 ohms, ac-coupled through 20 pF.

Repetition rate: 0 to 100 kHz; free runs at 100 kHz.

Accessories provided (with Model 1105A): one 6-ft. 50 ohm cable with Type N connectors, HP Model No. 10132A.

#### Weight

1106A or 1108A: net 1 lb (0.5 kg); shipping 2 lbs (0.9 kg).

1105A: net 2 lb (0.9 kg); shipping 4 lb (1.8 kg).

Price: HP Model 1105A, \$200. HP Model 1106A, \$550. HP Model 1108A, \$175.

## 1109A/1129A High-Pass Filters

The 1109A and 1129A High Pass Filters transmit only frequencies above 1 GHz. They are useful for blocking the 100 MHz "kickout" encountered when using a tunnel diode countdown to view high frequency signals on a sampling oscilloscope. The 1109A is designed for use with the Model 1104A/1106A Trigger Countdown, and the 1129A mates with the Model 1104A/1108A.

### Specifications 1109A

Lower Bandwidth Limit: 3 dB down at 3 GHz, nominal.

#### Input Characteristics

Mechanical: amphenol APC-7 precision 7 mm connector.

Electrical (with output terminated in 50 ohms)

Reflection: less than 10% using 40 ps TDR system.

VSWR: typically 1.1:1 up to 10 GHz increasing to 2:1 at 15 GHz.

DC Resistance: 50 ohms  $\pm 2\%$  shunted across line.

Weight: net, 5 oz. (0.14 kg).

Price: \$200.

### Specifications 1129A

Lower Bandwidth Limit: 3 dB down at 3 GHz, nominal.

#### Input Characteristics

Mechanical: GR-874 connector.

Electrical (with output terminated in 50 ohms)

Reflection: Less than 3% using 150 ps TDR system.

DC Resistance: 50 ohms  $\pm 2\%$  shunted across line.

Weight: net, 4 oz. (0.11 kg).

Price: \$100.

## Other Sampling Accessories

50-ohm loads: Models 908A and 909A.

50-ohm adapter: Model 11524A; has type N female and APC-7 connectors. Price, \$55.

Air line extensions: Model 11566A; 10 cm, APC-7 connector. Model 11567A; 20 cm, APC-7 connector. Price, \$100. each.



# SWEPT FREQUENCY INDICATOR



## 1416A

- Speeds and simplifies swept-frequency measurements
- High resolution readout directly in dB
- Low drift
- X-Y recorder outputs

## Description

The Model 1416A Swept Frequency Indicator transforms a Model 140 series mainframe into an X-Y oscilloscope which speeds and simplifies microwave swept-frequency measurements. Insertion loss vs. frequency measurements on attenuators, filters, ferrite isolators, and return loss measurements on all types of loads can be made with ease and accuracy.

The Model 1416A incorporates a number of features which provide convenience and accuracy not available with the usually used conventional X-Y scope. Readouts directly in dB are provided by the Model 1416A's logarithmic amplifier. The Attenuation-dB control allows a calibrated dB offset to be applied to an offscreen trace, allowing it to be centered on screen and for high resolution readings. A linear mode of operation is also provided. A chopper stabilized input amplifier minimizes drift, and a front-panel adjustable bandwidth switch allows the operator to select a bandwidth just wide enough to present the signal with a minimum

amount of noise. An internal dB calibrator, accurate to 3%, allows a quick check of amplifier accuracy. Also provided on the front panel are outputs for driving an X-Y recorder. Thus, you can now achieve speed, convenience, and accuracy with all types of swept-frequency measurements by using the Model 140 mainframe/1416A combination and appropriate auxiliary equipment. Sweep oscillators and associated instruments are available for testing both coaxial and wave-guide microwave components from 1 to 40 GHz. Such items as adapters, impedance transformers, tuners, loads, filters, detectors, couplers, and attenuators can be measured or adjusted. Swept-frequency techniques are also useful for over-all system analysis.

Swept-frequency techniques are not only helpful design aids, but can be used as maintenance tools as well. They provide fast routine maintenance checks on laboratory instruments. Hours, and sometimes days, of tedious precise measurements can often be completed within minutes.

## Specifications

**Mode of operation:** linear or logarithmic.

### Bandwidth

**Linear:** variable from approximately 1 kHz to 30 kHz in four steps.

**Logarithmic:** varies with input level.

### Deflection factor (sensitivity)

**Linear:** 50  $\mu$ V/div to 10 mV/div, 8 ranges in a 1, 2, 5 sequence; accuracy  $\pm 3\%$ .

**Logarithmic:** 0.5 dB/div to 10 dB/div (referred to rf input into crystal detector) in 5 ranges; accuracy (after 30-min. warmup),  $\pm 0.02$  dB/dB (0 to -25 dB) and  $\pm 0.03$  dB/dB (-25 to -30 dB).

**Noise:** typical observed values on crt:

Mode	Noise at low bandwidth	Noise at high bandwidth
Linear	40 $\mu$ V pk-pk	200 $\mu$ V pk-pk
Logarithmic: input signal level		
0 dB	0.05 db	0.1 dB
-10 dB	0.05 dB	0.2 dB
-20 dB	0.3 dB	0.4 dB
-25 dB	1 dB	1 dB
-30 dB	4 dB	4 dB

**Maximum measured noise at RECORDER OUTPUT**  
(measured with a True RMS Voltmeter, and recorder output deflection factor set to 200 mV/div).

**Linear:** Less than 120 mV; Model 1416A deflection factor set to 0.05 mV/div and input shortened.

**Logarithmic:** less than 50 mV/div; Model 1416A deflection factor set to 5 dB/div and input signal of -50  $\mu$ V (-30 dB).

**Internal calibrator:** four positions: 0, 10, 20, and 30 dB below approximately 50 mV; accuracy  $\pm 0.01$  dB/dB.

**Sweep and blanking:** supplied by Sweep Oscillator.

### Recorder outputs

**Vertical:** gain adjustable from 0 to approximately 200 mV/div, dc level adjustable over approximately  $\pm 1.5$  volts.

**Horizontal:** gain adjustable from 0 to approximately 100 mV/div, dc level adjustable over approximately  $\pm 1$  volt.

### Inputs

**Vertical:** Input impedance, 75 k ohms; dynamic range: logarithmic, -50  $\mu$ V to -100 mV; linear 0 to -100 mV; BNC connector receives output from Models 423A or 424A Crystal Detectors, or Models 786D or 787D Directional Detectors (all Option 002).

**Horizontal:** ramp required: amplitude between 7.5 and 20 volts; some part of ramp must be at 0 volts.

**Blanking:** 0 to -5 V gate.

**Power:** supplied by oscilloscope.

**Weight:** net 7 lb (3.2 kg); shipping 13 lb (5.9 kg).

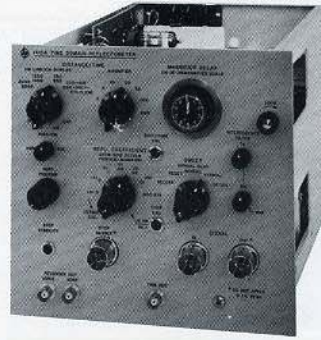
**Price:** HP Model 1416A, \$900.



# TIME DOMAIN REFLECTOMETER

## 1415A

- Complete system for testing cables, connectors, striplines
- Determines location, magnitude, and nature of each discontinuity
- Locates discontinuities within an inch
- Easy to operate

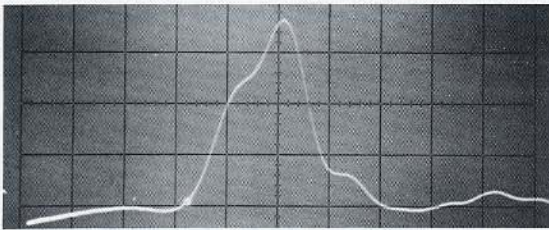


## Description

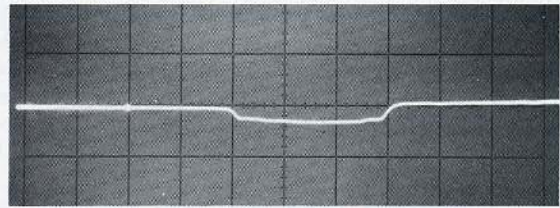
The 1415A Time Domain Reflectometer/140-series mainframe represents a completely integrated broadband system for testing cables, transmission lines, strip lines, connectors and many other types of devices used in your high frequency systems.

You can, for example, quickly determine the magnitude and nature of each resistive or reactive discontinuity in coaxial components such as attenuators,

cables, connectors and delay lines used in microwave and pulse circuit design. Or you can locate and identify cable faults such as shorts, opens, loose connectors, defective tap offs, splices and mismatches if you are using cables for signal transmission. Whatever your application the 1415A can save you time and money by minimizing guesswork and indecision.



Magnified display of a BNC connector joining two 50-ohm cables. The horizontal axis is set at 2 cm/div. Multiplying the 3.5 cm deflection by the reflection coefficient sensitivity of 0.01/cm, one can determine the connector has a  $\rho$  of 0.035.



TDR display of a section of unknown cable spliced into a length of 50-ohm cable. Noting the distance setting of 40 cm/div, and reflection coefficient sensitivity of 0.2/div, one can determine the unknown cable is 120 cm long and has a  $Z_0$  of 44 ohms.

## Specifications

### System (in reflectometer configuration)

- Risetime:** Less than 150 ps.
- Overshoot:** 5% or less overshoot and ringing (down to 1/2% in 2 ns).
- Internal Reflections:** Less than 10% (does not limit resolution).
- Reflectometer Sensitivity:** Reflection coefficients as small as 0.001 can be observed.
- Rep Rate:** 150 kHz nominal.

### Signal Channel

- Risetime:** Approximately 110 ps.
- Reflection Coefficient:** 0.5/div to 0.005 div in 1, 2, 5 sequence.
- Input:** 50 ohms, feed-through type.
- Noise and Internal Pickup, Peak:** Less than 0.2 div on
- Dynamic Range:**  $\pm 0.5$  volt.
- External Signal Level:** Up to 1 V p-p may be safely applied to the SIGNAL OUT connector.
- Attenuator Accuracy:**  $\pm 3\%$ .

### Step Generator

- Amplitude:** approximately 0.25 V into 50 ohms (0.5 V into open circuit).
- Risetime:** Approximately 50 ps.
- Output Impedance:** 50 ohms  $\pm 1$  ohm.
- Droop:** Less than 1%.

### Distance/Time Scale

- Distance Scale (cm Line/div Display) Accuracy:** 5%.
- Polyethylene Line ( $\epsilon = 2.25$ ):** 200 to 2000 cm/div.

**Air Line ( $\epsilon = 1$ ):** 300 to 3000 cm/div (0.19 mi.).

**Time Scale:** 20 to 200 ns/div,  $\pm 5\%$  accuracy.

**Magnification:** X1 to X200 in 1, 2, 5 sequence.

Accuracy of the basic sweep is maintained at all magnifier settings with the exception of time represented by the first 0.1 div of the top of the step.

**Delay Control:** 0 to 10 div of unmagnified sweep, calibrated.

**Jitter:** Less than 20 ps.

**Power:** Supplied by oscilloscope.

**Weight:** Net, 7 lb (3.2 kg). Shipping, 13 lb (5.9 kg).

**Accessories Furnished:** 2 GR elbows (HP Part No. 1250-0239). 1 GR to Type N Adapter (1250-0240), and 1 Type N to BNC Adapter (1250-0067).

**Price:** 1415A, \$1200.

**Option 014:** Long-line TDR for cables up to 1000 meters (0.62 mile). P7 phosphor recommended for mainframe, no extra charge. Specifications same as for 1415A except as follows:

**System Risetime:** Less than 200 ps.

**Rep. Rate:** 300 kHz, nominal.

**Noise and Internal Pickup:**  $< 0.25\%$  of step.

**Droop:**  $< 2\%$ .

**Time Scale:** 20 ns/div to 1  $\mu$ s/div.

**Air Line:** 300 cm/div to 150 m/div.

**Polyethylene:** 200 cm/div to 100 m/div.

**Price:** 1415A Option 014, \$1300.



# TDR ACCESSORIES

## Models 10452A-10456A Risetime Converters

Model 10452A through 10456A Risetime Converters slow down the step from the 1415A in order to eliminate reflections caused by frequencies beyond the bandwidth of interest. Risetimes: (10-90% points as measured in 150 ps risetime system.)

10452A: 0.5 ns. 10453A: 1 ns. 10454A: 2 ns.  
10455A: 5ns. 10456A: 10 ns.

### Specifications

Risetime accuracy: within  $\pm 5\%$ .

Overshoot: less than  $\pm 3\%$ .

Output impedance (dc): 50 ohms (accuracy determined by output impedance of generator).

Output mismatch: less than  $\pm 5\%$  reflection to output risetime. Allowable input voltage: up to 50 volts, open circuit (from a 50-ohm source).

Connectors: GR Type 874.

Price: \$95.

## Models 10457A-10458A 50 to 75 ohm Adapters

Adapters convert 1415A 50 ohm output to 75 ohm systems.

Model 10457A: converts 50 ohm GR to 75 ohm Type N. Price: \$45.

Model 10458A: converts 50 ohm GR to 75 ohm Type F (CATV). Price: \$25.

## Model 1107A Hum Filter

Power line interference can be reduced with the 1107A Hum-Filter when used with Time Domain Reflectometers such as the HP Model 1415A. A front panel switch allows you to select either 60 Hz or 400 Hz filtering.

### Specifications

#### Hum rejection

In a 50 ohm hum source  
50-120 Hz, 40 dB; 400 Hz, 35 dB.

Introduced reflection: less than 5% using a 150 ps TDR system.

Step distortion (droop): less than 3%.

#### Power

115-230 volts ac; 50-400 Hz; 1 watt.

Price: \$325.



10452A



10457A



10458A



1107A

## TDR Application Notes

The following application notes about TDR measurements are available, at no charge, from your local Hewlett-Packard field engineering office, or write Hewlett-Packard Co., 1501 Page Mill Road, Palo Alto, California 94304.

### AN 67

Cable Testing With Time Domain Reflectometry

A summary of cable-testing techniques using TDR. Discusses ways of simplifying cable measurements when multiple reflections or spurious signals are present. Includes a slide rule for quick measurements of distance and impedance.

### AN 75

Selected Articles On TDR Applications

Includes (1) TDR—Theory and Applications, (2) Transmission Line Pulse Reflectometry, (3) Mechanical Scaling Enhances TDR Use, (4) Some Uses of TDR in the Design of Broadband UHF Components, (5) Thermocouple Fault Location by TDR.

### AN 94

Connector Design Employing TDR Techniques

Describes techniques and results of 28 pico second risetime TDR examination of physical parts of the connector and relating this data to mechanical contact configuration and the theoretical design.



# ACCESSORIES

## Voltage Divider Probes

The high impedance input of these probes reduces loading of oscilloscopes on the circuit under test and provides attenuation of large signals. The probes may be quickly and accurately compensated for optimum step response and maintains the specified risetime and bandwidth performance of 140-system instruments.

Probe	Atten.	Resistance (meg ohms)	Capacitance	Div Accuracy	Scope Compensation Range (pF)	Peak Volts	Approx. Over-all Length	Price
10001A	10:1	10	20 pF	2%	15-55	600	5'	35.
10001B	10:1	10	20 pF	2%	15-45	600	10'	35.
10002A	50:1	9	2.5 pF	3%	15-55	1000	5'	40.
10002B	50:1	9	5 pF	3%	15-55	1000	10'	40.
10007A	1:1	—	30 pF	—	—	600	3.5'	22.
10008A	1:1	—	60 pF	—	—	600	6'	22.
10012B	10:1	10	16 pF	3%	30-55	500	6'	40.

## Straight-Through Probe

The 10025A is a thin, flexible probe with push-button operated pincer jaws that provide a connection to hard-to-get-at test points. Price, \$15.

## Probe Tip Kit

10035A Probe Tip kit, \$5.

Model 10035A probe tip kit contains a variety of useful tips for the Model 10001 and 10002 divider probes. The kit contains a pincer jaw, banana tip, pin tip, hook tip, and spring tip.

## Testmobiles

The 1117B and 1119A and B Testmobiles provide convenient portable use of oscilloscopes and other equipment. The 1117B accepts rack mount units making it a mobile test station. Model 1119A accepts standard HP modular instruments and Model 1119B has a Model 10480A drawer, for cables and accessories, in place of the lateral brace. Price: 1117B, \$225; 1119A, \$110; 1119B, \$145.

## Blank Plug-Ins

The blank plug-ins allow you to build special purpose plug-ins to extend your 140-system versatility. Full-size, 10477A, price, \$30. Double-size, 10478A, price, \$35.

## Current Probe and Amplifier

1110A Probe and 1111A Amplifier permit direct measurement of current from 50 Hz to 20 MHz. Deflection factor is 1 mA/div to 5 A/div. 1110A probe may be used separately, 1700 Hz to 40 MHz. Price 1110A, \$125; 1111A, \$200.

## Adapters

10110A BNC to Banana Post Adapter, \$7.

10111A Shielded Banana Plug to BNC Adapter, \$10.

## Operating and Transit Cases

A wide selection of operating and transit cases to fit your HP instruments is available. Contact your local Hewlett-Packard field engineer for operating and transit cases to fit these instruments.





# ACCESSORIES

## Viewing Hoods

10175A, \$15.

Polarized Hood increases contrast and reduces glare for viewing dim traces under all ambient light conditions.

10175B, \$20.

Hood with removable vinyl face mask for viewing fast transients (non-polarized).

10176A, \$10.

Flexible viewing hood for HP 5-inch rectangular CRT bezels.

## Cameras

Model 197A Camera provides an accurate, convenient method of recording scope traces. The 197A has a black light for illuminating internal graticules, providing easy-to-read photographs.

Price: 197A, \$595.

Option 001 (without black light), \$545.

Model 198A camera is an easy-to-use, low cost, battery operated camera for recording scope displays. Also, the camera can be focused without a focus plate, eliminating through-the-lens focusing.

Price: 198A, \$375.

## CRT Light Filters

**5-inch rectangular CRT oscilloscope (140B and 141B).**

Model 10178A, wire mesh contrast filter. Price, \$15.

Model 10179A, nylon mesh contrast filter. Price, \$7.

Amber plastic filter, HP Part number 5020-0530.

Price, \$2.50.

Blue plastic filter, HP Part number 5020-0554.

Price, \$2.50.

**5-inch round CRT oscilloscopes (140A and 141A).**

Model 10180A nylon mesh contrast filter, Price, \$7.

Model 120A-83A amber plastic filter. Price, \$6.50.

Model 120A-83B blue plastic filter. Price, \$6.50.

Model 120A-83G green plastic filter. Price, \$3.50.

**Large screen CRT (143A).**

Green plastic filter HP part number 01300-02701.

Price, \$4.

Amber plastic filter HP part number 01300-02702.

Price, \$4.

Gray plastic filter HP part number 01300-02703.

Price, \$4.

Anti-reflection filter: nylon mesh attached to contrast filter.

Model 10181A amber filter. Price, \$35.

Model 10182A green filter. Price, \$35.

## Slides and Slide Adapters

Both fixed and pivoted 22-inch slides are available for slide mounting the 140-series oscilloscopes. A slide adapter kit is required for either type of slide.

Slide adapter kit: HP part number 1490-0721; price, \$40.

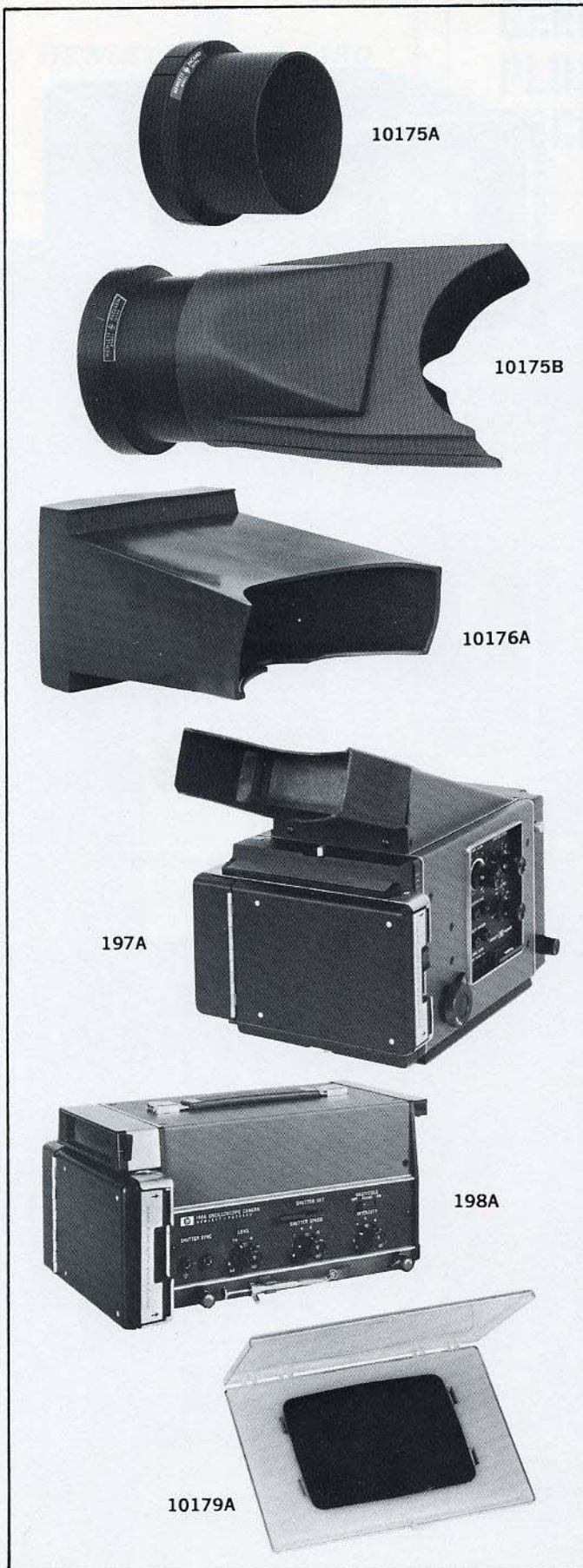
Fixed slides: HP part number 1490-0714; price, \$32.50.

Pivot slides: HP part number 1490-0718; price, \$40.

## Plug-in Extender

Plug-in extender cable allows calibration and maintenance while an instrument is operating. One cable required for each plug-in, two required for double-size plug-ins. At least one extender cable is recommended for calibrating upper compartment plug-ins in a Model 143A mainframe.

Price: Model 10406A, \$40.





# PLUG-IN SPECTRUM ANALYZER SYSTEMS

## Description

This spectrum analyzer system offers complete plug-in coverage from 1 kHz to 40 GHz. A Display Section is combined with an RF Section and IF Section to form a complete spectrum analyzer, tailored to your needs. The RF Section determines the frequency range and most of the major specifications; a choice in IF and Display Sections allows you to select the system for your application.

### MODEL 8555A/8552B/8552A

- 10 MHz to 18 GHz frequency coverage. Extends to 40 GHz with external waveguide mixer.
- Absolute amplitude calibration in dBm or  $\mu\text{V}$  from 10 MHz to 18 GHz.
- Automatic stabilization reduces residual FM to less than 100 Hz pk-pk.
- High sensitivity, measure  $-125$  dBm ( $0.12 \mu\text{V}$ ) signal on fundamental mixing.
- Selectable bandwidths allow resolution to 100 Hz.
- Full 70 dB display range.

### MODEL 8554L/8552B/8552A

- 500 kHz – 1250 MHz frequency range.
- Absolute amplitude calibration in dBm or  $\mu\text{V}$  over the entire range.
- Excellent  $\pm 1$  dB flatness over the entire frequency range.
- High sensitivity, measure  $-117$  dBm ( $0.4 \mu\text{V}$ ) signals.
- Selectable, high resolution bandwidths.
- 70 dB display range, up to 70 dB of freedom from distortion products.

### MODEL 8553B/8552B/8552A

- 1 kHz – 110 MHz frequency coverage in two ranges, 0 – 110 and 0 – 11 MHz.
- Exceptional  $\pm 0.5$  dB flatness over entire frequency range.
- Absolute amplitude calibration in dBm or  $\mu\text{V}$  over entire frequency range.
- High sensitivity, measure  $-130$  dBm ( $0.07 \mu\text{V}$ ) signals.
- Automatic phase lock reduces residual FM to less than 1 Hz pk-pk (high resolution IF).
- Selectable bandwidths allow resolution to 10 Hz.
- Full 70 dB display range, free from distortion products.



**8555A/8552B**  
with 141T Variable  
Persistence Display Section



**8554L/8552A**  
with 140T Normal  
Persistence Display Section



**8553L/8552A**  
with 143S Large  
Screen Display Section

For more information about these Spectrum Analyzers, contact your local Hewlett-Packard Field Engineer or write to Hewlett-Packard Company, Palo Alto, California 94304.