hp 140A/141A PLUG-IN OSCILLOSCOPE

- 20 MHz wideband
- 150 ps TDR
- 50 μV/cm sensitivity with no dc drift
- 12.4 GHz sampling
- Swept frequency
- Variable persistence and storage

HEWLETT PACKARD
An extra measure of performance
With hp’s 140A, you can use a full spectrum of advanced plug-ins for better performance in any direction.

Solve more measurement problems in less time, with greater accuracy, and at a lower overall cost with the hp 140A Oscilloscope System. Turn the page and see.
With hp’s 140A you can use a full spectrum of advanced plug-ins for BETTER PERFORMANCE IN ANY DIRECTION

12.4 GHz Sampling with Delayed Sweep

Exceedingly fast hp switching diodes have opened a true breakthrough in sampling scope capabilities. For the first time, you can see through X band, observe CW signals to 12.4 GHz and beyond, and see fast pulses with a 28 ps rise time capability. You can also use TDR measurements to resolve discontinuities down to less than 1 cm in the design of cables, coaxial components, connectors and strip lines. In addition, you can utilize delayed sweep through the full bandwidth to get displays of pulse segments that leave conventional sampling scopes blurred. You also get less than 20 ps jitter to ensure steady, clear displays.

Two vertical amplifiers are available. Model 1411A provides dc to 12.4 GHz at 1 mV/cm, dual-channel performance with remote samplers featuring feed-through inputs for minimum signal disturbance. The other sampling vertical amplifier, Model 1410A, gives performance to 1 GHz, with both high-Z probes and 50Ω inputs—and internal triggering. Model 1425A Sampling Time Base plug-in provides delayed sweep, automatic triggering, and a movable intensified dot that makes it easy to set up the point of magnification.

50 µV/cm Zero Drift

The versatile hp 140A Scope System gives you five high-sensitivity plug-ins specifically designed for measurement of low-level signals. For example, the 1406A vertical plug-in offers high 50 µV/cm sensitivity with no dc drift—plus precision calibrated dc offset for extreme magnification. With the hp calibrated offset feature, the 1406A gives you the advantages of a dc and ac voltmeter—four-digit readout, auto decimal placement, better than 0.5% measurement accuracy. As a dc voltmeter, the 1406A offers you the additional advantages of no drift in the measurement instrument, and the ability to observe and measure any ac riding on the dc voltage. With these capabilities you can make measurements never before possible. For example, you can simultaneously display a 10 V dc signal at 50 µV/cm (giving a magnification of 200,000), measure dc level accurately to four digits, see short term dc drift with microvolt resolution, and view and measure all ac ripple—an impossible measurement with a meter. The hp 1406A plug-in also operates as a dc-coupled, no drift differential amplifier with 80 dB common mode rejection.

Simplify Design of Microwave & Pulse Circuits with 150 ps TDR

You can use a 1415A Time Domain Reflectometer plug-in to quickly determine the magnitude and nature of each resistive or reactive discontinuity in strip lines or coaxial components such as attenuators, cables, connectors and delay lines. This 150 ps system enables you to resolve continuations an inch apart. The 1415A is a completely self-contained system consisting of a fast-rise pulse generator, single channel sampler, and time base. No additional vertical or horizontal amplifiers are required, thus eliminating introduction of additional chances of error. The vertical channel is calibrated in reflection coefficient for direct readout, with a maximum sensitivity of 0.05 p/cm for measurement of extremely small discontinuities. Full 10 cm X 10 cm display area gives maximum resolution. Distances can be read directly on the horizontal axis. The compact control panel contains only those controls necessary for TDR measurements, thus making the 1415A much simpler to operate than comparable systems costing twice as much.

Accessories for direct readout in special applications: Rise Time Converters which eliminate reflections beyond the bandwidth of interest, 75Ω adapters, and a Susceptance Standard which gives direct readings of reactive discontinuities.

Get 20 MHz Bandwidth and Delayed Sweep Readability

If you need wideband performance, for example, you can use the dual-trace 1402A vertical amplifier and get dc to 20 MHz at 5 mV/cm, algebraic addition, built-in delay line for viewing the leading edge of fast-rise pulses, full 6 cm deflection and a wide dynamic range. An internal sync amplifier triggers on Channel A dual-trace mode of operation—gives stable traces and accurate time measurements without external triggering.

Easy readability of complex waveforms and accurate time interval measurements, Model 1421A Time Base & Delay Generator provides extreme magnification—calibrated time delays from 10 seconds to 0.5usec, calibrated sweep speeds from 1 sec/cm to 20 m/sec. The 1421A also offers the additional advantage of exclusive hp mixed sweep. This feature combines display of the first portion of a trace at normal sweep speeds, and simultaneously expands the trailing portion of the trace at faster delayed sweep speeds to allow step-by-step magnified examination.

Exclusive Variable Persistence and Storage

The hp 140A Scope System gives you the extraordinary versatility you need to get step-ahead measurements over the entire oscilloscope spectrum—now and in the years ahead. With 17 high-performance vertical and horizontal plug-ins to choose from, you can build in any measurement direction: wideband, sampling, high-sensitivity or measurements such as time domain reflectometry and swept frequency...all with optional variable persistence and storage if you like.

Count these exclusive capabilities: hp’s 140A is the ONLY oscilloscope system that gives you sampling bandwidth to 12.4 GHz...sweeping delayed sweep time base...50 µV/cm sensitivity with no dc drift...versatile single- or double-size plug-in capability...plus plug-ins for direct readout TDR and swept frequency. In addition, it is the only oscilloscope system to offer either standard CRT persistence in the 140A mainframe—or optional variable persistence and storage in the 141A mainframe. Select from these unique measurement capabilities, or pick the work-horse 20 MHz, 5 mV/cm dual-trace plug-in.

HEWLETT PACKARD
An ever higher measure of performance
Choose From Two hp High-Performance Mainframes:

140A WITH STANDARD CRT OR 141A WITH EXCLUSIVE VARIABLE PERSISTENCE & STORAGE

Both 140A & 141A mainframes enable you to:

- Get clearly superior performance throughout the oscilloscope measurement spectrum from dc to 12.4 GHz.
- Use all 17 hp high-performance 1400 Series plug-ins.
- Push a button and immediately locate a trace via convenient beam finder.
- See brilliant, sharp, steady displays with advanced 7.3 kV CRT.
- Get an accurate reading from any angle with no parallax, internal-graticule CRT.

In addition to these advantages, the 141A mainframe also enables you to:

- Match the persistence of your screen to any signal for steady traces without annoying flicker.
- Store waveforms for side-by-side comparison.
- The advanced hp 140A and 141A mainframes give you a choice between conventional (fixed) CRT persistence—and variable persistence & storage. As a result, the 140A/141A system gives you not only an unimpeded plug-in capability, but also, the CRT variability you need to meet the requirements of any measurement problem today—six months from now—or any future time. These hp 140A and 141A mainframes are specifically designed to give you both high-frequency and high-sensitivity performance. Both consist of the essential functional blocks for low and high-frequency applications—plug-in capability, included in a plug-in compatible CRT, associated circuitry, power supplies, and the dc supplies required to power the hp 1400 Series plug-ins which contain CRT drive circuitry.

Exclusive 141A: Variable Persistence and Storage Make It... THE SCOPE WITH AN ADJUSTABLE MEMORY

The 141A mainframe gives you all the advantages of the 140A mainframe—plus the exclusive benefits of the hp variable persistence and storage.

When the 141A has a 7.3 kV, post-accelerator CRT—which you control—then by means of a knob, you can adjust the 141A's memory time (trace persistence) from 0.02 seconds to a minute...to hours...to days. This exclusive hp variable persistence allows you to adjust the CRT persistence to match the changing characteristics of your signal—whether the signal is changing slowly or rapidly—whether necessary number of traces can be held for trend comparisons, or for flicker-free displays. With a bi-stable storage tube, all information is stored, often creat-

Exclusive hp variable persistence enables you to match the persistence of your CRT to any signal—whether changing or stationary—whether necessary number of traces can be held for trend comparisons, or for flicker-free displays. With a bi-stable storage tube, all information is stored, often creat-

ing jumbled displays—or you have flickering "full" erase and no retained information.

The hp mesh storage tube offers many advantages. With the 141A CRT, the stored trace has the same high contrast as a conventional CRT. Intermediate trace values stand out clearly, you can easily distinguish between four or five separate trace intensities—as opposed to the limiting black-and-white-only displays of ordinary bi-stable storage. Intensity of the 141A CRT can be varied by a front panel control, or modulated externally for XY-Z presentations. Maximum viewing intensity in store-view mode is 200 foot lamberts—25 times brighter than bi-stable tubes. With the hp mesh storage CRT, the

See signal trends while making circuit adjustments by simply making persistence long enough so that several traces appear on screen simultaneously.

trace brightness and writing speed are maintained even when the trace bulb of the high-stability CRT is changed. By increasing the intensity of the 141A's pen, the image pen of your CRT is capable of showing greater power than ever before. This feature provides a graphic display of your critical operating parameters at a glance. (a) pen tip voltage, (b) amplification of a safety device, or (c) temperature signals above some predetermined limit. As much as a full minute of information can be stored in this manner for days.

The advanced hp 141A scope for variable persistence, conventional persistence, and storage—is like having three scopes in one. Also, you have the advantage of choosing from any of the hp high-performance 1400 Series plug-ins.
hp's 1400 Series plug-ins cover the measurement spectrum from dc to 12.4 GHz in any direction.
Model 140A Specifications

Plug-ins: Accepts Model 1400-series plug-ins; upper compartment for horizontal axis; lower compartment for vertical axis; center 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 modifications); etched safety glass face plate reduces glare.
- Graticule: 10 cm x 10 cm parallax-free internal grid; ruled in cm squares; major horizontal and vertical axes, and second and tenth horizontal graticule lines; major horizontal and vertical lines, 1 cm subdivisions.
- Intensity modulation: Ac coupled; 20 volt pulse will blank trace of normal intensity; input terminals on rear panel.
- Writing CRT warranted for one year.
- Writing CRT: HP Model 197A Camera with f/1.9 lens (3000 mm speed film).
- P31 Phosphor: 300 cm/sec.
- P11 Phosphor: 430 cm/sec.
- Calibrator: Type: Frequency-rectangular signal, approximately 0.5 sec rise time.
- Voltage: Two outputs: 1 volt and 10 volts peak-to-peak, ±1% from 15°C to 35°C, ±3% from 0°C to 5°C.
- Beam finder: Preserving beam finder control brings trace on CRT screen regardless of settings of horizontal, vertical or intensity controls.
- Power requirements: 115 or 230 volts ±10%, 50 to 60 Hz, normally less than 280 watts (varies with plug-in units used).

Model 140A Specifications

Plug-ins: same as Model 140A.

Cathode ray tube:
- Type: Post-accelerator storage tube, 7300 volt accelerating potential; aluminized P31 phosphor, etched safety glass face plate reduces glare.
- Graticule: 10 x 10 divisions (approximately 9.4 x 9.4 cm) parallax-free internal grid; 5 subdivisions per major horizontal and vertical axes, and on second and tenth horizontal graticule lines.
- Internally modulated: ac coupled; 20 volt pulse will blank trace of normal intensity; input terminals on rear panel.
- Warranty: CRT specifications (warranty time, writing rate, brightness, storage time) warranted for one year.
- Persistence: Normal: normal persistence of P31 phosphor (approximately 0.1 second).
- Variable:
  - Normal writing rate mode: continuously variable from less than 0.2 second to more than one minute (typically two to three minutes).
  - Max. writing rate mode: typically variable from 0.2 second to 15 seconds.
  - Max. writing rate mode: typically variable from 0.2 second to 15 seconds.
- Erase: manual; erases takes approximately 100 msec; scope ready to receive signal after erase (see options for remote erase).

Writing rate (divergence operation): (using HP Model 197A Camera with f/1.9 lens and Poroid/3 3000 speed film): 100 cm/sec.

Writing rate:
- Normal: greater than 20 cm/sec.
- Max.: greater than 1 cm/sec.

Storage time: Normal Writing Rate Mode Max. Writing Rate Mode

<table>
<thead>
<tr>
<th>Mode</th>
<th>STORE Mode (dim display)</th>
<th>VIEW Mode (bright display)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>longer than 1 hour</td>
<td>longer than 1 minute</td>
</tr>
<tr>
<td>typically</td>
<td></td>
<td>(typically 2 or 3 minutes)</td>
</tr>
<tr>
<td>Writing rate</td>
<td>1 minute</td>
<td>1 minute</td>
</tr>
<tr>
<td>Brightness</td>
<td>greater than 100 foot-lamberts</td>
<td>typically 5 foot-lamberts</td>
</tr>
</tbody>
</table>

Calibrator:
- Beam finder: same as Model 140A
- Power requirements: same as Model 140A
- Dimensions:
  - Weight: net 40 lbs (18 kg); shipping, 50 lbs (23 kg).
  - Price: HP Model 140A (without plug-in), $1395.00.
  - Power: (specified by option number), 09: Remote erase.
  - BNC input on rear panel; shorting to ground for at least 50 msec erases screen; input:
  - Special order: chassis slides and adapter kit; fixed slides, order HP Part No. 1490-0719, $40.00; slide adapter kit for mounting slides on scope, order HP Part No. 1490-0721, $20.

Model 1402A Dual Trace Amplifier

The 1402A Dual Trace Amplifier provides greater than 20 MHz bandwidth plus 5 mV/cm sensitivity on each channel for accurate analysis of high frequency low level signals. Rise times 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 following the other 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, switching to Channel A and Channel B into the chopped dual trace mode assures triggering on the displayed waveform rather than the trigger. 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.

Specifications

Mode of operation: (Channel A alone, Channel B alone, Channel A and Channel B displayed on alternate sweeps, Channel A and Channel B displayed by switching at approx. 100 Hz, with trace blanking during switching; Channel A and Channel B added algebraically, polarity of Channel A may be inverted to obtain differential operation.

Bandwidth: (6 cm reference signal) ac coupled, dc to 20 MHz; ac coupled, 2 Hz to 20 MHz.

Rise time: less than 20 nsec with 6 cm step input.

Deflection factor (sensitivity): each channel; 5 mV/cm to 10 V/cm, 11 ranges in a 1, 2, 5, 10 sequence; accuracy ±3%; vernier provides continuous adjustment between 5 mV/cm and dc to 20 MHz.

Signal delay: signal is delayed so that leading edge of tristate signals is visible at start of sweep.

Common mode rejection: in B & A mode at 40 dB on 5, 10, and 20 mV/cm ranges, at least 30 dB on 50 mV/cm to 10 V/cm ranges, common mode signal not greater than 150 mV (equivalent to 150 volts on 1 V/cm range) or a frequency of 500 Hz.

Input RC: 1 megohm shunted by 43 pf.

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

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

Price: HP Model 1402A $575.
**WIDE BAND AMPLIFIER**

**1405A DUAL TRACE AMPLIFIER**

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

**Description**

The 1405A Dual Trace Amplifier provides 5 MHz bandwidth at 5 mV/cm 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 -60 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 cm 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 cm segment of the 50 cm trace can be positionally calibrated 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/cm 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.

**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 added by switching at approx. 100 kHz, with trace blanking during switching, (5) Channel A and Channel B added by switching at approx. 100 kHz, with trace blanking during switching.
- **Input sensitivity:** (50 mV/cm to 20 V/cm) (the lower limit is extended to approx. 0.2 Hz with a X10 probe).
- **Deflection factor:** (sensitivity): each channel: 50mV/cm to 10 V/cm, 11 ranges in a 1, 2, 5 sequence, accuracy ±3%.
- **Input noise:** (B-9): peak shunted by 43 pF. (Input noise: 50 mV to 20 V/cm, the lower limit is extended to approx. 0.2 Hz with a X10 probe).
- **Weight:** net, 6 lbs (2.7 kg), shipping, 7 lbs (3.2 kg).
- **Price:** HP Model 1405A, $325.
- **Special order:** double-size, single-channel, X-Y only version of Model 1400A: order K5-10400A; price, $375.

**PREFERENCE AC & DC AMPLIFIERS**

**1406A**

- 50 V/cm
- dc to 400 kHz
- dc stabilized (no drift)
- Calibrated offset control for accurate ac & dc measurements

**Description**

In addition to 50 V/cm sensitivity, no drift ac stabilization, and wide dynamic range, the 1406A offers a calibrated dc offset control 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 (1.5%) dc level into the other side. The top of the waveforms 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 in the dc amplifier.

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

**Specifications**

- **Sensitivity:** 50 mV/cm to 20 V/cm in 1, 2, 5 sequence.
- **Offset range:** ±0.1 V, ±0.5 V, ±1 V, ±5 V, ±10 V.
- **Common mode rejection:** ±3%.
- **Amplifier output:** Approx. 1 V/cm, dc coupled, single ended, dc level approx. 0 with input output impedance less than 100 ohms, dynamic range ±5 V.
- **Bandwidth:**
  - Upper limit: ±20 V/cm to 100 V/cm/400 kHz (0.9 V vs rise time)
  - Lower limit: ±50 mV/cm to 200 kHz
- **Input limitations:**
  - Maximum input overload: ±50 mV/cm to 20 V/cm (60 dB).
  - Maximum output overload: ±50 mV/cm to 20 V/cm (60 dB).

- **Drift:**
  - Temperature drift: Less than 0.2 cm or less than ±20 mV per 200 hrs, whichever is greater.
  - Temperature changes: Less than ±0.2 cm or less than ±50 mV, whichever is greater over a temperature range of 0°C to 55°C.
  - Drift correction occurs at 3 Hz for 50 ms/cm sweeps and faster; and 0.1 Hz for 0.1 cm/s sweeps and slower.

- **Ranges:**
  - Range to range shift: DC stabilization maintains a fixed baseline reference within ±1 cm on CRT over entire range of sensitivity after a 3-minute warmup.

- **Positioning:**
  - Baseline can be positioned ±10 cm by control.

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

- **Specifications:**
  - ±0.1 V, ±1 V, ±10 V, ±100 V, ±1000 V. Up to ±10 V offset can be used on all sensitivity ranges; an equivalent ±100 V range can be used from 0.5 mV/cm through 20 V/cm, and an equivalent ±1000 V range from 5 mV/cm through 20 V/cm.

- **Accuracy:** ±0.15% of indicated value plus ±0.05% of full scale offset range, on ±0.1 V, ±1 V, ±5 V, ±10 V ranges, ±0.4% of indicated value plus ±0.05% of full scale offset range, on ±100 V and ±1000 V ranges.

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

- **Common mode rejection:** ±3%.

- **Common mode rejection:** ±3%.

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

- **Max input:**
  - V, range: 10 V (DC + peak AC), 0.5 V/cm to 20 mV/cm, 150 V, 60 V/cm to 2 cm, 600 V, 5 cm to 20 V/cm.
  - V range: 100 V (DC + peak AC)
  - V range: 50 V (DC + peak AC)

- **Price:** HP Model 1406A, $375.

- **X-Y operation:** Two 1406A's 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, 1400's be-line serial 441-02136 and 1421A's be-line serial 456-0065 must be modified. (Order kits 01420-66502 for the 1422A, 01421-66501 for the 1421A.)

- **Weight:** Net, 5 lbs (2.3 kg), shipping, 7 lbs (3.2 kg).
- **Price:** $890.
### HIGH SENSITIVITY AMPLIFIERS

<table>
<thead>
<tr>
<th>Model</th>
<th>Bandwidth</th>
<th>Upper Limit</th>
<th>100 uv/cm</th>
<th>dc to 400 kHz</th>
<th>Selectable bandwidth</th>
<th>Differential on all ranges</th>
<th>Low drift</th>
</tr>
</thead>
<tbody>
<tr>
<td>1400A</td>
<td>1 mV/cm</td>
<td>500 kHz</td>
<td>True</td>
<td>True</td>
<td>True</td>
<td>True</td>
<td>True</td>
</tr>
<tr>
<td>1401A</td>
<td>1 mV/cm</td>
<td>450 kHz</td>
<td>True</td>
<td>True</td>
<td>True</td>
<td>True</td>
<td>True</td>
</tr>
</tbody>
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### HIGH SENSITIVITY AMPLIFIERS

<table>
<thead>
<tr>
<th>Model</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>1403A</td>
<td>Bandwidth: 106 dB common mode rejection, Guarded input</td>
</tr>
<tr>
<td>1407A</td>
<td>Bandwidth: 50 uv/cm, No drift, 80 dB common mode rejection</td>
</tr>
</tbody>
</table>

### Specifications

<table>
<thead>
<tr>
<th>Model</th>
<th>1400A</th>
<th>1401A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bandwidth</td>
<td>400.0 (0.9 sec rise time), 40 or 0 kHz</td>
<td>400.0 (0.9 sec rise time), 40 or 0 kHz</td>
</tr>
<tr>
<td>Input and Amplifier coupling set to:</td>
<td>dc to 400 kHz</td>
<td>dc to 400 kHz</td>
</tr>
<tr>
<td>Deflection factor (sensitivity):</td>
<td>100 mV/v to 20 V/cm, 17 ranges</td>
<td>100 mV/v to 20 V/cm, 17 ranges</td>
</tr>
<tr>
<td>Common mode rejection:</td>
<td>differential input may be selected on all ranges: CMRR at 40 dB on 0.1 mV/cm to 0.2 V/cm ranges, signal not to exceed 1 V pk-pk, at least 0 dB on 0.5 V/cm to 20 V/cm ranges, signal not to exceed 4 V pk-pk at least 30 dB on 0.5 V/cm to 20 V/cm ranges, signal not to exceed 10 V pk-pk on 0.5 V/cm to 20 V/cm ranges, signal not to exceed 4 V pk-pk on 0.2 V/cm to 20 V/cm ranges, signal not to exceed 20 V pk-pk on 0.5 V/cm to 20 V/cm ranges</td>
<td>differential input may be selected on all ranges: CMRR at 40 dB on 0.1 mV/cm to 0.2 V/cm ranges, signal not to exceed 1 V pk-pk, at least 0 dB on 0.5 V/cm to 20 V/cm ranges, signal not to exceed 4 V pk-pk at least 30 dB on 0.5 V/cm to 20 V/cm ranges, signal not to exceed 10 V pk-pk on 0.5 V/cm to 20 V/cm ranges, signal not to exceed 4 V pk-pk on 0.2 V/cm to 20 V/cm ranges, signal not to exceed 20 V pk-pk on 0.5 V/cm to 20 V/cm ranges</td>
</tr>
<tr>
<td>DC offset:</td>
<td>uncalibrated dc offset is provided in both single-ended and differential operation; the maximum amount of offset obtainable, referenced to the input, varies with deflection factor approx. as follows: 0.1 V at 50 mV/cm, increasing to 0.5 V at 10 V/cm, 5 V at 100 mV/cm, 50 V at 1 V/cm, 500 V at 10 V/cm, 1000 V at 20 V/cm, 0 V at 200 V/cm, 100 V pk-pk at 5 V/cm to 20 V/cm ranges, 1000 V pk-pk at 200 V/cm ranges</td>
<td>uncalibrated dc offset is provided in both single-ended and differential operation; the maximum amount of offset obtainable, referenced to the input, varies with deflection factor approx. as follows: 0.1 V at 50 mV/cm, increasing to 0.5 V at 10 V/cm, 5 V at 100 mV/cm, 50 V at 1 V/cm, 500 V at 10 V/cm, 1000 V at 20 V/cm, 0 V at 200 V/cm, 100 V pk-pk at 5 V/cm to 20 V/cm ranges, 1000 V pk-pk at 200 V/cm ranges</td>
</tr>
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### Typical CMR

<table>
<thead>
<tr>
<th>Model</th>
<th>Typical CMR with unbalanced source impedance when using Guard Drive Ext on most sensitive ranges:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1403A</td>
<td>Unbalance 60 Hz 120 Hz 1 kHz 10 kHz</td>
</tr>
<tr>
<td>1407A</td>
<td>Common mode rejection (dB)</td>
</tr>
<tr>
<td>0.01</td>
<td>0.2</td>
</tr>
<tr>
<td>0.1</td>
<td>1.2</td>
</tr>
<tr>
<td>5.10</td>
<td>5.60</td>
</tr>
<tr>
<td>50.10</td>
<td>46</td>
</tr>
</tbody>
</table>

### Accessories

- 6-ft double-shielded extension cable
- A- and B-channel binding post adapter

### Price

<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>1400A</td>
<td>$250</td>
</tr>
<tr>
<td>1401A</td>
<td>$245</td>
</tr>
<tr>
<td>1403A</td>
<td>$475</td>
</tr>
<tr>
<td>1407A</td>
<td>$625</td>
</tr>
</tbody>
</table>

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*Images and diagrams are not provided in this text.*


**TIME BASES**

- **10 MHz triggering**
- **Sweeps to 50 ns/cm**
- **Automatic triggering**

- **500 kHz triggering**
- **Sweeps to 200 ns/cm**
- **Automatic triggering**

**Specifications**

**Range:**
- 1 sec/cm to 5 sec/cm, 21 ranges in a 1, 2, 5 sequence; accuracy ±3%; vernier provides continuous adjustment between steps and extends the 5 sec/cm step to at least 12.5 sec/cm.
- Magnifier: X1, overall accuracy ±5%; expands 1 sec/cm speed to 300 nsec/cm.

**Automatic triggering:** (baseline displayed in the absence of input signal)
- Internal: 40 Hz to 500 kHz for signals causing 0.5 cm or more vertical deflection; also from line signal.
- External: 40 Hz to 500 kHz for signals at 0.5 V pk-pk.

**Trigger signal:** 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 cm or more vertical deflection.
- External: for signals at least 0.5 V pk-pk; dc coupled, 1 Hz to 10 MHz; ac coupled, 10 Hz to 500 kHz; max. input, 600 V pk (dc + ac).

**Trigger point and slope:** selectable in both directions 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.

**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/cm to 5 V/cm.

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

**Weight:** 5 lbs (2.3 kg); shipping 7 lbs (3.2 kg).

**描述**

The 1424A Time Base and Delay Generator provides a sweep speed to 10 nsec/cm with stable triggering to 20 MHz and beyond.

The delayed sweep feature of the 1424A 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 1424A provides the deflection signal to the CRT. The 1424A has provision to trigger the delay 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 rise time accuracy of amplitude can be accurately measured without jitter.

The four basic sweep modes of the 1424A are shown above:

(A) **Normal Sweep**; (B) **Integrated 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 delayed portion of (B) expanded to full screen; and (D) **Mixed Sweeps**, beam deflection initiated 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 sec/cm to 1 sec/cm, 21 ranges in a 1, 2, 5 sequence; accuracy ±3%; vernier provides continuous adjustment between steps and extends 1 sec/cm step to at least 25.5 sec/cm.

**Triggering:** (when used with Model 1424A):
- **Amplitude selection**:
  - Internal: approx. 10 Hz to 15 MHz for signals causing 0.5 cm or more vertical deflection.
  - External: for signals at least 0.5 V pk-pk; dc coupled, 1 Hz to 20 MHz; approx. ±7 V to 20 MHz, max. input, 600 V pk (dc + ac).

**Delay (before start of delayed sweep)**
- **Accuracy:** 1%, linearity ±0.2%; 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 nsec rise time, from 1 kohms output impedance.

**Amplitude selection:**
- **Input:** approx. 10 Hz to 15 MHz for signals causing 0.5 cm or more vertical deflection.

**Trigger point and slope:** selectable in both directions 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.

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

**Horizontal input:**
- Bandwidth: dc coupled, 10 Hz to 500 kHz; max. input, 500 V pk-pk; ac coupled, 10 Hz to 500 kHz; max. input, 600 V pk (dc + ac).

**Trigger point and slope:** selectable in both directions 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.

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

**Horizontal input:**
- Bandwidth: dc coupled, 10 Hz to 500 kHz; max. input, 500 V pk-pk; ac coupled, 10 Hz to 500 kHz; max. input, 600 V pk (dc + ac).

**Triggering:** (when used with Model 1424A):
- **Amplitude selection**:
  - Internal: approx. 10 Hz to 15 MHz for signals causing 0.5 cm or more vertical deflection.
  - External: for signals at least 0.5 V pk-pk; dc coupled, 1 Hz to 20 MHz; approx. ±7 V to 20 MHz, max. input, 600 V pk (dc + ac).

**Delay (after start of delayed sweep)**
- **Accuracy:** 1%, linearity ±0.2%; 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 nsec rise time, from 1 kohms output impedance.

**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 cm or more vertical deflection.

**External:** delayed sweep triggered by external signal after end of delay period; for signals at least 0.5 V pk-pk; dc coupled, 1 Hz to 20 MHz; approx. ±7 V to 20 MHz, max. input, 600 V pk (dc + ac).

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

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

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

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

**Weight:** 5 lbs (2.3 kg); shipping 7 lbs (3.2 kg).

**Price:** HP Model 1424A, $325.

**Description**

The 1424A Time Base and Delay Generator provides sweep speed to 10 nsec/cm with stable triggering to 20 MHz and beyond.

The delayed sweep feature of the 1424A 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 1424A provides the deflection signal to the CRT. The 1424A has provision to trigger the delay 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 rise time accuracy of amplitude can be accurately measured without jitter.

The four basic sweep modes of the 1424A are shown above:

(A) **Normal Sweep**; (B) **Integrated 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 delayed portion of (B) expanded to full screen; and (D) **Mixed Sweeps**, beam deflection initiated by delaying sweep and then by the faster delayed sweep.
1 GHz SAMPLING AMPLIFIER

Description

The Dual Channel 1410 A Sampling Vertical Amplifier provides 1 mV/cm sensitivity at 1 GHz, and combines in a single unit the convenience of high-impedance probes for circuit measurement PLUS 50-ohm inputs with delay lines for internal triggering—both with the full 1 GHz bandwidth. Both give less than 100 ps time difference between channels for accurate phase measurements in the A vs B mode, and for precise dual trace time comparisons.

Optimum compromise among rise time, overshoot, and noise can be achieved and quickly made with the front-panel rise time 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.

Specifications

<table>
<thead>
<tr>
<th>Mode of Operation:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Channel A only</td>
</tr>
<tr>
<td>2. Channel B only</td>
</tr>
<tr>
<td>3. Channel A and Channel B</td>
</tr>
<tr>
<td>4. Channel A and Channel B added algebraically</td>
</tr>
<tr>
<td>5. Channel A vs. Channel B</td>
</tr>
</tbody>
</table>

| Polarity: Either channel may be displayed either positive or negative up in any mode. |
| Rise Time: Less than 350 ps. |
| Bandwidth: DC to 1 GHz. |
| Overshoot: Less than 5%. |
| Sensitivity: Calibrated ranges from 1 mV/cm to 200 mV/cm in 1, 2 & 5 stages. Vernier control provides continuous adjustment between ranges and increases maximum sensitivity to greater than 0.4 mV/cm. |
| Attenuator Accuracy: ±3%. |
| Isolation Between Channels: Greater than 40,000 to 1 GHz. |

Input Impedance: Probes, 10 Ohms shunted by 2 pF nominal. GR Type 874 inputs 50 ohms ±5%, with 57 ns inter-channel delay and good pulse propagation speed. Reflexion from input connector is approx. 10%, using a 50 Ω TDR system.

Noise: 30 nV (1 mV/cm range), 60 nV (10 mV/cm range), 100 nV (200 mV/cm range), 200 nV (5 V/cm range), 500 nV (10 V/cm range). Noise decreases continuously smoothed ranges 2 and 1 mV/cm ranges. Improved design of smoothing switch reduces noise and jitter approximately 40%. Vernier control provides continuous adjustment between the normal and smoothed modes.

Dynamic Range: ±2 volts.

Drift: Less than 3 mV/hr after warmup.

Maximum Safe Input:

Probes: ±50 volts.
50Ω inputs: ±5 volts.
Triggering: Internal or external when using 50Ω inputs. Internal triggering selectable from Channel A or B. External triggering necessary when using probes.

Time Difference Between Channels (for probes or 50Ω inputs):

Less than 100 ps.

Recorder Outputs: Front panel outputs provide 0.1 V/cm from a 500Ω source. DC level adjustable from approximately 0.05 V/cm to 0.2 V/cm. DC level adjustable from approx. −1.9 V to +3.5 V.

Accessories Provided:

1021A 2 10.1 Divider
1021A 2 Isolator
1021A 2 0.001 μF Blocking Capacitor
1021A 3 GR Adapter
1021A 2 Micrometer Adapter
1021A 1 50Ω T Connector
1013-42102 1 Ground Clip
5620-0457 6 Probe Tips

Weight: Net, 10 lbs (4.5 kg). Shipping, 15 lbs (6.8 kg).
Price: $1600.

1 GHz ACCESSORIES

1410A ACCESSORIES (Separately Available)

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, $30.00.

10216A Isolator. Increases convenience and accuracy when probing by reducing base line shift and transient response changes caused by changes in the circuit source impedance. 1410A rise time is increased to approximately 8 ns and 0.001 μF capacitance is increased by less than 3 pF. Price, $25.00.

10217A Blocking Capacitor. This blocking capacitor (0.001 μF) permits measurements of signals that are ±300 volts from ground (±500 V when used with 1021A 10:1 Divider). The blocking capacitor contributes only 1% wav in a 1 μsec pulse with peak-to-peak waveform, alone, and 0.1% lag 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, $20.00.

10218A 50-Ohm T Connector. Permits monitoring of signals in 20-ohm transmission lines with the 1410A without terminating the line or disturbing the signal. Mixes both 50 and 500 ohm signals with up to 10% error, and is greater than 20% of the input step height. Price, $40.00.

Additional Accessories (Not Supplied with 1410A)

10203A 100:1 Divider. This 100:1 divider may be used to reduce signal levels as high as 200 V to the ±2 V dynamic range of the 1410A. The 10203A offers less than 1 pF shunt capacitance and 10 megohm shunt resist ance to the circuit under test. The (K01-10203A Divider Adapter must be used to adopt the 10203 A to the 1410A probe). Price, $20.00.

K01-10203A Divider Adapter. Applies the 100:1 Divider to the 1410A probe. Price, $30.00.

1102B Accessory Kit

The Model 1102B Accessory Kit permits convenient circuit probing and reduced circuit loading with oscilloscopes that have 50-ohm input impedances. It thus allows probing with the 1410A where the 50Ω inputs are used in order to get internal triggering. The kit is also ideal for the 1432A where a high input impedance is needed to prevent loading of the test circuit.

Specifications

10201A to D Resistorless Divider Probes and 10212A Cable. The dividers should always be terminated with 50 Ω resistance to provide the correct voltage division. They should not be attached directly to the 1410A probe.

10206A Blocking Capacitor. This blocking capacitor (0.001 μF) permits measurements of signals that are ±600 volts from ground. No more than 2.5 pF shunt capacitance is added to the input by the blocking capacitor. Price, as sold separately, $35.00.

10205A Blocking Capacitor. This blocking capacitor (0.1 μF) may be used to observe relatively long pulses or signals ±200 volts from ground. Signals which have rise times greater than 1 μsec may be displayed without distortion. No input capacitance is added to the input. Price, as sold separately, $279.00.

The kit also includes a 40 ft coaxial cable, coaxial. Type N to BNC Female; 1 oz GR Type 874. Type N Female to GR Adapter included in kit. Weight 30 lbs. (13.6 kg). Price, as sold separately, $180.00.

10204A Accessory Kit, Model 1102B. Price, $160.00.
12.4 GHz SAMPLING AMPLIFIER

Description

The 1411A Sampling Vertical Amplifier is a basic vertical plug-in that accepts a series of wide band samplers. All three samplers have 1 mV/cm 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. Rise time is set with a front panel knob, allowing convenient adjustment of rise time 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 C and Channel D.
  4. Channel A and Channel B added cabled.
  5. Channel A and Channel B.
- Polarity: Either channel may be displayed either positive or negative up in any mode.
- Sensitivity: Calibrated ranges from 1 mV/cm to 200 mV/cm in a 1, 2, 5 sequence. Vertical control provides continuous adjustment between ranges and increases maximum sensitivity to greater than 0.4 mV/cm.
- Attenuator Accuracy: ±3%.
- Isolation Between Channels: Greater than 40 dB over bandwidth of sampler.
- Recorder Outputs: Front panel outputs provide 0.1 V/cm from a 500 V source. Gain adjustable from approx. 0.05 V/cm to 0.2 V/cm. DC level adjustable from approx. -1.5 V to +5 V.
- Weight: Net, 10 lbs (4.5 kg). Shipping, 15 lbs (6.8 kg).
- Price: $700.

1432A 90 psec SAMPLER

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

Specifications

(When used with 1411A)

- Rise Time: Less than 90 ps.
- Bandwidth: DC to 4 GHz.
- Overload: Less than ±5%.
- Noise: Less than 3 mV from 5 mV/cm to 200 mV/cm (otherwise same as 1430A).
- Dynamic Range: ±1.0 volt.
- Low Frequency Distortion: Less than ±3%.
- Maximum Safe Input: ±5 volts.
- Input Characteristics: Mechanical: GF type 874 connectors used on input and output.
- Electrical: 50-ohm feedthrough, dc coupled. Reflection from sampler is approx. 1%, using a 90-ohm 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 Length: 5 ft. (for longer cable, see special order below).
- Weight: Net, 4 lbs (1.8 kg). Shipping, 9 lbs (4.1 kg).
- Accessories Provided: Two Amplifier APC-7 to female Type N adapters (HP 10524A). Two 50-ohm loads (HP 305A).
- Price: $300.

Special Order: 10-ft. connecting cable (5 ft. is standard), order C01-1432A. Price, $303.50.

12.4 GHz SAMPLERS

1430A 28 psec SAMPLER 1431A 12.4 GHz SAMPLER

Description

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

Specifications

(When used with 1411A)

- Rise Time: Approx. 28 ps. (Less than 35 ps observed with 1105A/1106A pulse generator and 905A 50-ohm load).
- Bandwidth: DC to approx. 12.4 GHz.
- Overload: Less than ±3%.
- Noise: (3 X RMS, or observed signal excluding 10% of random data) Less than 8 mV, 5 mV/cm to 200 mV/cm, 0.5 V/cm. Noise decreases on automatically smoothed ranges 2, 5, and 1 mV/cm. Smoothed position of smoothing switch reduces noise and jitter (approximately 1.5 V/cm). Vertical control provides continuous adjustment between the normal and smoothed modes.
- Dynamic Range: ±1 volt.
- Low Frequency Distortion: Less than ±3%.
- Maximum Safe Input: ±3 volts.
- Input Characteristic:
  - Mechanical: Amplifier APC-7 precision 7 mm connectors on input and output.
  - Electrical: 50-ohm feedthrough, dc coupled. Reflection from sampler is approx. 1%, using a 40 ps TDR system. Pulses emitted from sampler input are approximately 10 mV in amplitude and 5 ns in duration.
  - Time Difference Between Channels: Less than 10 ps.
  - Connecting Cable Length: 5 ft. (for longer cable see special order below).
  - Accessories Provided: Two Amplifier APC-7 to female Type N adapters (HP 10224A). Two 50-ohm loads (HP 905A).
  - Price: $300.00.

Special Order: 10-ft. connecting cable (5 ft. is standard), order C01-1430A. Price, $303.50.

1431A

Description

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

Specifications

(When used with 1411A)

- Rise Time: Approx. 28 ps.
- VSWR: DC to 12.4 GHz: 1.41
- 8 to 10 GHz: 1.61
- 10 to 12.4 GHz: 2.01
- Noise: Less than 7 mV from 5 mV/cm to 200 mV/cm (otherwise same as 1430A).
- Dynamic Range: ±1 volt.
- Low Frequency Distortion: Less than ±3%.
- Maximum Safe Input: ±3 volts.
- Input Characteristics:
  - Mechanical: Amplifier APC-7 precision 7 mm connectors 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° at 5 GHz, typically less than 2° at 1 GHz.
**12.4 GHz SAMPLING APPLICATIONS**

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

**Description**

If design of GHz coaxial components is important to you then HP's new sampling system used as a Time Domain Reflectometer is your answer. For the first time 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 because of this new advance in sampling techniques. HP Models 1424A or 1425A Time Base, 1411A

![Response of sampler to incident step in TDR System](image1)

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

![Typical TDR resolution of discontinuities in a cable-connector-adapter-cable combination](image2)

Fig. 2. Typical TDR resolution of discontinuities in a cable-connector-adapter-cable combination. a) large cable connected to connector; b) connector to adapter; c) 50 ohm load in adapter; d) adapter to connector; e) connector to small cable. Horizontal: 50 psec/cm; Vertical: reflection coefficient = 0.04/cm.

![Reflections were caused by three sections of 75 ohm center conductors inserted into a 50 ohm air line](image3)

Fig. 3. Reflections were caused by three sections of 75 ohm center conductors inserted into a 50 ohm air line. They are ½", 1/16" and 1/16" in length spaced by 1/8". The ½" section has reached maximum deflection (flattened slightly) and even the 1/16" 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, for the first time 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 TWI 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 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 the HP 140A Main Frame or, if you prefer, the HP 141A Variable Persistence and Storage Main Frame.

![Oscillogram shows 18 GHz sine wave](image4)

Figure 1. Oscillogram shows 18 GHz sine wave. Note that jitter even at this frequency is less than 10 psec. Signal was obtained using 1431A 12.4 GHz Sampler and 1104A/1106A Trigger Countdown.

![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 50 GHz and typically less than 2° at 18 GHz](image5)

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 50 GHz and typically less than 2° at 18 GHz.

![Display 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](image6)

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.

![This is a typical hookup of HP's new Sampling systems for measuring or monitoring microwave signals](image7)

Figure 4. This is a typical hookup of HP's new Sampling systems for measuring or monitoring microwave signals.
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 calibrated sweeps as fast as 10 psec/cm, low jitter, triggering to 5GHz, and direct readout of sweeps, even when expanded. Accurate time interval measurements can be made with the calibrated marker position control which positions the intensified marker to the point on the trace about which expansion is desired. A baseline in the absence of an input signal is provided with automatic tracking 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. The external scan input makes the 1424A adaptable to automatic systems, and allows the use of a strip chart recorder rather than a more expensive X-Y recorder.

Specifications

**Sweep Range:** 24 ranges, 10 ps/cm to 500 ns/cm in a 1, 2, 5 sequence. Sweeps from 1 ns/cm to 500 ns/cm may be expanded up to 100 times and read out directly. Sweeps from 10 ns/cm to 500 ns/cm are obtained by expansion and also read out directly. Accuracy ±3%, except for slight non-linearity at start of normal (unexpanded) sweep. Vernier provides continuous adjustment between ranges to increase maximum sweep speed to faster than 5 ps/cm.

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

**Maximum Delay:** Less than 500 ps.

**Triggering:** Less than 1 GHz

**Internal (with 1410A):**

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

Pulses: At least 40 mV amplitude required of pulses 2 ns or wider for jitter less than 20 ps.

Sine Waves: Signals from 200 Hz to 300 MHz require 25 pF amplitude for jitter less than 10 ps after 10 µsec input signal period. (Usable to 1 GHz with increased jitter.)

Level Selected: None.

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 pF for jitter less than 10 ps after 10 µsec input signal period. (Usable to 1 GHz with increased jitter.)

Level Selected: None.

**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.

**Scope:** Positive or negative.

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

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

External Trigger Input: 500 µA ac or dc coupled; signal input in sensitive and ≤ 5 mV in normal. Maximum Safe Input: Sensitive, 5 V rms or peak transient. Normal, 5 V rms (50 Ω).

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

**Triggering:** Greater than 1 GHz.

Jitter less than 20 ps for 25 MHz input, 500 MHz 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 range approx. 60 seconds for one scan.

External: 0 to ±15 V required for scan; input impedance 10 kΩ.

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

**Pulse Output:**

Amplitude: Greater than 1.5 V into 50Ω.

Rise Time: Approx. 1 µsec.

Overshoot: Less than 5%.

Width: Approximately 1 µsec.

Relative Jitter: Less than 10 ps.

Peak to Peak: One pulse per sample.

Weight: Net, 8 lbs (3.6 kg), Shipping, 9 lbs (4.1 kg).

Price: $1,000.

The 1425A's delayed sweep feature allows detailed examination (magnification as great as 100,000:1) 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 using the Automatic triggering mode. This same automatic triggering mode provides a base line 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.

Specifications

**Main Sweep:**

Range: 1 nsec/cm to 10 nsec/cm, 13 ranges in a 1, 2, 5 sequence; accuracy ±3%, except for slight non-linearity at start of unexpanded sweep; vernier provides continuous adjustment between steps and extends maximum magnification speed to at least 4 ps/sec/cm.

Magnitude: X1 to X100 in 7 calibrated steps; increase 2 nsec/cm sweep step to 10 nsec/cm; push button returns magnifier to X1.

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

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

Triggering: For both Main and Delaying Sweep.

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

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

Sine Waves: Signals from 200 Hz to 300 MHz require 50 mV amplitude for jitter less than 10 ps after 10 µsec input signal period (usable to 1 GHz with increased jitter).

Level Selected: None.

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

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

Sine Waves: Signals from 200 Hz to 300 MHz require 50 mV amplitude for jitter less than 10 ps after 10 µsec input signal period (usable to 1 GHz with increased jitter).

Level Selected: None.

**External:**

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

Sine Waves: Signals from 200 Hz to 300 MHz require 50 mV amplitude for jitter less than 1.5% of input signal period +10 ps.

**Delay Time:** Continuity variable from 50 nsec to 10 seconds.

**Accuracy:** ±3%; linearity 0.5%; jitter time less than 0.1% part in 20,000 or 20 ps, whichever is greater.

**Sweep Mode:** Main, delay and main delayed sweep; Scanning: Same as 1424A except no external scan input.

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

**Weight:** Net, 7 lbs (3.2 kg), Shipping, 11 lbs (5 kg).

Price: $1,000.
SAMPLING ACCESSORIES

110A/1106A
20 psec Pulse Generator

110A/1106A
18 GHz Trigger Countdown

Specifications

Output:
Rise Time: Approximately 20 ps. Less than 35 ps observed with HP Model 1411A/1430A 28 psec Sam- pler and HP Model 10, 50 psec terminating.
Overload: Less than ±5% as observed on 1411A/ 1430A with 500A.
Drop: Less than 3% in first 100 ns.
Width: Approximately 3 µs.
Amplitude: Greater than -200 mV into 50Ω.
Output Characteristics (1106A):
Mechanical: Amphenol APC-7 connector.
Electrical: DC resistance—50Ω ± 2%. Source reflec- tion—less than 10%, using a 40 pF TDR system.
DC offset voltage—approximately 0.1 V.
Triggering:
Amplitude: At least ±0.5V peak required.
Rise Time: Less than 20 ns required. Jitter less than 15 ns when triggered by a 1 ns rise time sync pulse from 1125A or 1425A Sampling Time Base.
Width: Greater than 2 ns.
Maximum Safe Input Voltage: 500V.
Input Impedance: 500 ohms, ac coupled through 20 pF.
Repetition Rate: 0 to 100 Hz; free runs at 100 Hz.

Model 213B
Pulse Generator

Model 1103A
Trigger Countdown

Permits stable triggering, 500 MHz to 10 GHz, by dividing down input trigger pulse to 30 MHz. 16 mV rms input produces less than 30 psec jitter at 5 GHz. Sensitivity decreases 5 GHz to 250 MHz at 10 GHz. Price: $75.

50-OHM LOADS

The hp 908A and 909A are 50-ohm terminating co-axial loads with frequency range of 4 GHz and dc-18 GHz respectively. The 908A has a Type N male connector and the 909A has an APC-7 with Type N option. Price: 908A, $35; 909A, $75.

Model 10200B Sync Probe

The 10200B, for use with Model 1424A and 1425A Sampling Time Bases, increases trigger input impedance to more than 750,000 ohms, as coupled. It reduces sensi- tivity by about 4 dB at 10 MHz and higher, and by about 20-35 dB at frequencies approaching 100 MHz. Price: $50.

COAXIAL ATTENUATORS

8492A Fixed Coaxial Attenuator
Nominal attenuation: 3, 6, 10, 15, 30, 60, 90 dB. Price: $125.
8491A Fixed Coaxial Attenuator
Nominal attenuation: 3, 6, 10, 15, 30, 60, 90 dB. Price: $50.

AIRE LINE EXTENSIONS

Price: 11566A 20 cm air line extensions...

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 trans- forms the Model 1404A/1414A into an X-Y oscilloscope which speeds and simplifies microwave swept-frequency measurements. Insertion loss vs. frequency measure- ments 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. Read- outs directly in dB, provided by the Model 1416A's logarithmic amplifier. The Attenuation-DB control al- lows a calibrated dB offset to be applied to an offset 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 mini- mizes drift, and a front-panel switchable 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, a 0 dB reference 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 1404A/ 1414A/1416A combination and appropriate auxiliary equipment. Sweep oscillators and associated instru- ments 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. Sweep-frequency techniques are also useful for over-all system analysis.

Sweep-frequency techniques are not only helpful in 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 V/cm to 10 mm/cm, 8 ranges in a 1, 2, 5, 10, 20 sequence, accuracy ±3%.
Logarithmic: 0.5 V/cm to 10 mm/cm (referenced to input), in 5 ranges, accuracy (after 30 min. warmup), ±0.07 dB/8 mm/cm to ±25 dB/8 mm/cm. Noise: typical observed values on CRT:

Mode
Noise at low bandwidth
Noise at high bandwidth
Linear: Noise at 100 kHz
40 V pk-pk
200 V pk-pk
Logarithmic:
Input signal level
0 dB
20 dB
40 dB
60 dB
80 dB
90 dB
0.05 dB
0.3 dB
0.6 dB
1.2 dB
2.0 dB
3.5 dB
4.8 dB
8492A Fixed Coaxial Attenuator
Nominal attenuation: 3, 6, 10, 15, 30, 60, 90 dB. Price: $125.
8491A Fixed Coaxial Attenuator
Nominal attenuation: 3, 6, 10, 15, 30, 60, 90 dB. Price: $50.

AIR LINE EXTENSIONS

Price: 11566A 10 cm / 11567A 20 cm air line extensions.

Linear: less than 120 mV; Model 1416A deflection fac- tor set to 0.05 mV/cm and input shortened.
Logarithmic: less than 50 mV/cm; Model 1416A de- flection factor set to 5 mV/cm and input signal of
-50 V / -130 dB
Internal calibrator: four positions: 0, 10, 20, and 30 dB below approximately 50 mV, accuracy ±0.01 dB/10 dB. Sweep and Blanking: supplied by Model 690-Series Sweep Oscillator.

Recorder outputs:
Vertical: gain adjustable from 0 to approximately 200 mV/cm; direct coupling to recorder. Horizontal: gain adjustable from 0 to approximately 100 mV/cm; dc level adjustable over approximately ±1 V.

Inputs:
Vertical: input impedance, 75 ohms; dynamic range: logarithmic, -50 dB to -100 mV linear 0 to -100 mV; BNC connector receives output from Models 423A or 423A Crystal Detectors, or Models 7860 or 78960 Rectangular Detectors (all Option D). Horizontal: ramp required: amplitude between 7.5 and 30 volts; some part of the ramp must be at 0 V or blanking. 0 to 5 V gate supplied by Model 690-Series Sweep Oscillator; early models require slight modi- fications.

Power: supplied by oscilloscope. Weight: net 7 lbs (3.2 kg); shipping 14 lbs (6.3 kg). Price: HP Model 1416A, $675.
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/140A or 141A Oscilloscope represents a completely integrated broadband system for testing cables, transmission lines, striplines, 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.

The 1415A is a completely self-contained system consisting of a fast rise pulse generator, single channel sampler, and time base. No additional vertical or horizontal amplifiers are required, eliminating introduction of additional chances of error. The compact control panel contains only those controls necessary for TDR measurements—making the 1415A much simpler to operate than comparable systems costing twice as much.

Specifications

- System (in reflectometer configuration):
  - Rise Time: Less than 150 psec.
  - Overshoot: 5% or less (down to 15%)
  - Internal Reflections: Less than 10%.
- Reflectometer Sensitivity: Reflectance coefficients as small as 0.001 can be observed.
  - Ref. Rate: 150 kc nominal.
  - Signal Channel:
    - Rise Time: Approximately 110 psec.
    - Reflection Coefficient: 0.005/cm in 1, 2, 5 sequence.
    - Input: 50 ohms, feed-through type.
    - Noise and Internal Pickup/Peak: 0.1% of step (terminated in 50 ohms).
    - Dynamic Range: 0.05 volt.
    - External Signal Level: Up to 1 V p-p may be safely applied to the SIGNAL INPUT connector.
    - Attenuator Accuracy: ±3%.
  - Step Generator:
    - Amplitude: Approximately 0.25 V into 50 ohms (0.5 V into open circuit).
    - Rise Time: Approximately 50 psec.
    - Output Impedance: 50 ohms ±1 ohm.
    - Dropout: Less than 1%.
- Distance/Time Scale:
  - Distance Scale (cm Line/cm Display) Accuracy: ±5%.
  - Polyethylene Line (x = 2.25): cm/cm to 2000 cm/cm.
  - Air Line (x = 1): 300 cm/cm to 3000 cm/cm.
  - Time Scale: 20 to 20000 psec/cm, ±5% accuracy.
  - Magnification: 1:1 at x=200 in 1, 2, 5 sequence.
  - Accuracy of the basic sweep is maintained at all magnification settings with the exception of the first 0.1 cm of the top of the step.
  - Delay Control: 0 to 10 cm of unswept magnification, calibrated.
  - Jitter: Less than 20 psec.
- Power Supply:
  - 115/220 V, 50/60 Hz, 1.5 A.
- Accessories:
  - FR-2 (120 volt)
  - FR-1 (110 volt)

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

TDR ACCESSORIES

RISE TIME CONVERTERS

Model 10452A through 10456A Rise Time Converters slow down the step from the 1415A in order to eliminate reflections caused by frequencies beyond the bandwidth of interest.

Specifications

- Rise Times: (10-90% points as measured in 150 ps rise time system)
  - 10452A: 0.5 nsec.
  - 10453A: 1 nsec.
  - 10454A: 2 nsec.
  - 10455A: 5 nsec.
  - 10456A: 10 nsec.
- Rise Time Accuracy: Better than ±5%.
- Overshoot: Less than ±3%.
- Output Impedance (46): 50 ohms (accuracy determined by output impedance of generator).
- Output Mismatch: Less than ±5% reflection to output rise time.
- Allowable Input Voltage: Up to 50 volts, open circuit (from a 50 ohm source).
- Connectors: GR Type 874.
- Price: $75 each.

75-Ohm ADAPTERS

874A/B Susceptance Standard

874A, GR Type 874, 874B, 874C

K60-1415A HUM FILTER

Model 10452A through 10456A Rise Time Converters slow down the step from the 1415A in order to eliminate reflections caused by frequencies beyond the bandwidth of interest.

Specifications

- Rise Time: 0.5 nsec.
- Output Impedance: 50 ohms ±1 ohm.
- Capacitance: Range: 0 to 1 pf.
- Inductance: Range: 0 to 2 nH.
- Accuracy: Capacitance: ±0.005 pf or ±5%, whichever is greater, from 0 to 0.5 pf, inductance: ±0.013 kHz or ±2%, whichever is greater, from 0 to 1.3 kHz.
- Line Length: 17.4 cm.
- Connectors: 874A, GR Type 874, 874B, 874C.
- Power: 874A, 275; 874B, 874C.

874A, GR Type 874, 874B, 874C.

K60-1415A HUM FILTER

Power line interference can be reduced with the K60-1415A 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 SIGNAL 6 dB
  - 1 watt.
- Introduced Reflection: Less than 5%.
- Dropout (Dropout): Less than 3%.
- Power: 115-230 volts AC
  - 50-60 Hz
  - 1 watt.
- Price: $175.00.

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

Model 10457A: Converts 50 ohm GR to 75 ohm Type N. Price: $35.

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

The 874A is a TDR comparison standard for simple, rapid, direct-reading evaluation of reactive discontinuities.

Specifications

- Characteristic Impedance: 50 ohms ±1 ohm.
- Inductance Range: 0 to 1 pf.
- Accuracy: Capacitance: ±0.005 pf or ±5%, whichever is greater, from 0 to 0.5 pf, inductance: ±0.013 kHz or ±2%, whichever is greater, from 0 to 1.3 kHz.
- Line Length: 17.4 cm.
- Connectors: 874A, GR Type 874, 874B, 874C.
CAMERA—PROBES—TESTMOBILES

Voltage Divider Probes

The high impedance input of these probes reduces loading of oscilloscopes on the circuit under test. 600 to 20k volts, and the probes provide attenuation for large signals. The probes may be quickly and accurately compensated for optimum step response.

<table>
<thead>
<tr>
<th>Probe Name</th>
<th>Range</th>
<th>Impedance</th>
<th>Attenuation</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>TSP-410A</td>
<td>0-100V</td>
<td>2000 kΩ</td>
<td>100x</td>
<td>$30</td>
</tr>
<tr>
<td>TSP-412A</td>
<td>0-500V</td>
<td>1000 kΩ</td>
<td>100x</td>
<td>$50</td>
</tr>
<tr>
<td>TSP-414A</td>
<td>0-1000V</td>
<td>500 kΩ</td>
<td>100x</td>
<td>$80</td>
</tr>
</tbody>
</table>

400kΩ, 100kΩ, 50kΩ, 10kΩ, 1kΩ

* These probes have black identification bands; the others have red bands.

Straight-Through Probe

The 10025A is a thin, flexible probe with push-button pincher jaws to provide a straight-through connection to hard-to-get-at points. Price: $15.

10035A Probe Tip Kit, $5

Provides maximum versatility when used with the voltage divider probe. The kit contains a pincher jaw, banana tip, pin tip, hook tip, and spring tip.

Adapters

<table>
<thead>
<tr>
<th>Adapter Type</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>10110A BNC to Banana Post Adapter</td>
<td>$5</td>
</tr>
<tr>
<td>10111A Shielded Banana Plug to BNC Adapter</td>
<td>$7</td>
</tr>
</tbody>
</table>

Current Probe And Amplifier

1110A Probe and 1111A Amplifier permit direct measurement of current from 50 Hz to 20 MHz. Sensitivity is 1 mg/cm to 5 a/cm. 1110A (usable separately, 1700 Hz to 40 MHz) $100, 1111A, $160.

Viewing Hoods

10175B, $15

Polarized Hood increases contrast and reduces glare for viewing dim traces under all ambient light conditions. Hood with removable vinyl face mask ideal for viewing fast transients (non-polarized).

Camera

Model 197A Camera provides an accurate, convenient way of recording scope traces. The 197A has a black light for illuminating internal parts, providing easy-to-read, three-shade photographs. 197A, $540; 197A, Option 01 (without black light) $490.

1117B Testmobile

1119A Testmobile

UNITED STATES HP FIELD OFFICES

ALABAMA
F.D. Bowers, 4407 9th Avenue, Mobile, Alabama 36607
Tel: (205) 432-5201
SN 110570-1503

ARKANSAS
F. D. Bowers, 4407 9th Avenue, Mobile, Alabama 36607
Tel: (205) 432-5201
SN 110570-1503

CALIFORNIA
10110A BNC to Banana Post Adapter, $5
10111A Shielded Banana Plug to BNC Adapter, $7

CONNECTicut
10110A BNC to Banana Post Adapter, $5
10111A Shielded Banana Plug to BNC Adapter, $7

Delware
10110A BNC to Banana Post Adapter, $5
10111A Shielded Banana Plug to BNC Adapter, $7

FloRIDA
10110A BNC to Banana Post Adapter, $5
10111A Shielded Banana Plug to BNC Adapter, $7

GeORGiA
10110A BNC to Banana Post Adapter, $5
10111A Shielded Banana Plug to BNC Adapter, $7

illinois
10110A BNC to Banana Post Adapter, $5
10111A Shielded Banana Plug to BNC Adapter, $7

inDIana
10110A BNC to Banana Post Adapter, $5
10111A Shielded Banana Plug to BNC Adapter, $7

Louisiana
10110A BNC to Banana Post Adapter, $5
10111A Shielded Banana Plug to BNC Adapter, $7

MainE
10110A BNC to Banana Post Adapter, $5
10111A Shielded Banana Plug to BNC Adapter, $7

MICHIGAN
10110A BNC to Banana Post Adapter, $5
10111A Shielded Banana Plug to BNC Adapter, $7

MINNESOTA
10110A BNC to Banana Post Adapter, $5
10111A Shielded Banana Plug to BNC Adapter, $7

Missouri
10110A BNC to Banana Post Adapter, $5
10111A Shielded Banana Plug to BNC Adapter, $7

new Jersey
10110A BNC to Banana Post Adapter, $5
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new Mexico
10110A BNC to Banana Post Adapter, $5
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new York
10110A BNC to Banana Post Adapter, $5
10111A Shielded Banana Plug to BNC Adapter, $7

north Carolina
10110A BNC to Banana Post Adapter, $5
10111A Shielded Banana Plug to BNC Adapter, $7

Ohio
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Pennsylvania
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Texas
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Utah
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Virginia
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Washington
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10111A Shielded Banana Plug to BNC Adapter, $7

Wisconsin
10110A BNC to Banana Post Adapter, $5
10111A Shielded Banana Plug to BNC Adapter, $7

For areas not listed, contact: Head Field Engineer, P.O. Box 932, Palo Alto, California 94302
Tel: (415) 496-2303

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hp 140A/141A PLUG-IN OSCILLOSCOPE

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hp 140A/141A PLUG-IN OSCILLOSCOPE

- 20 MHz wideband
- 150 ps TDR
- 50 μV/cm sensitivity with no dc drift
- 12.4 GHz sampling
- Swept frequency
- Variable persistence and storage

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THE SCOPE THAT GIVES BETTER PERFORMANCE IN ANY DIRECTION

hp 140A/141A PLUG-IN OSCILLOSCOPE

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