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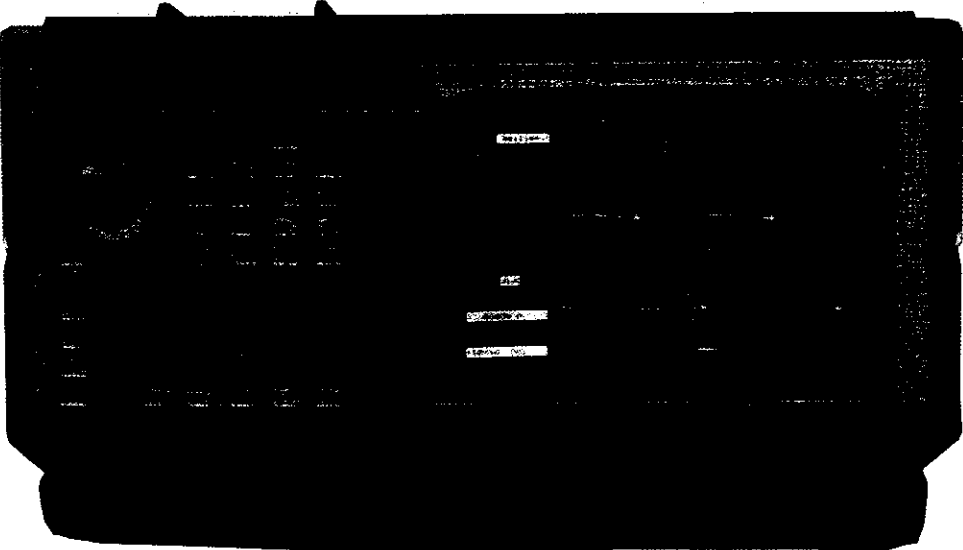
# OSCILLOSCOPES

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HP 54501A, 54502A, 54503A, 54504A, 54510A

- Choice of 100 MHz, 250 MHz, 400 MHz, 500 MHz bandwidth
- Single-shot and repetitive signal performance
- Up to 4 channels
- Fully programmable
- Automatic pulse parameter measurements

- Dual-time-base windowing (except HP 54510A)
- Pan and zoom (HP 54510A)
- Automatic limit testing
- Three-year warranty
- Affordable



HP 54501A, 54502A, 54503A, 54504A, 54510A

## The HP 54500 Family of Digitizing Oscilloscopes

### A Family of Affordable Digitizing Oscilloscopes

There are 5 models in the HP 54500 family of digitizing oscilloscopes. For repetitive signals, the HP 54501A and 54503A offer 100 MHz and 500 MHz, respectively, and 4-channel, general-purpose performance. When single-shot capability is important, the HP 54502A and 54504A provide, respectively, 100 MHz and 50 MHz single-shot, and they both provide 400 MHz repetitive signal bandwidths. Using custom ADC design and other custom-integrated circuits, the HP 54510A boosts single-shot performance to 250 MHz as the first 1 gigasample-per-second portable oscilloscope. All these instruments deliver surprising performance at an affordable price.

### The Digitizing Advantage

The HP 54500 family of oscilloscopes has features and functions that were previously available only on considerably higher-priced instruments. Like the HP 54100 series digitizing oscilloscopes, these instruments include all the digitizing advantages, such as autoscale, pushbutton hard-copy output, automatic measurements, nonvolatile setup and waveform memories, and full HP-IB programmability.

### Affordable Automation

The HP 54500 family's fully programmable setup and data acquisition capabilities can be used with your HP Vectra PC, IBM PC, or other compatible personal computer. The built-in HP-IB interface, the simplified, self-documenting programming language, and the high data throughput rate provide a modestly priced yet powerful automated test system.

### Easy to Use

All members of the HP 54500 family have a simplified user interface that makes them easy to operate. Adjustments are made with a single front-panel knob or numeric keypad. Automatic measurements, hard-copy output, and instrument setup are performed with simple keystrokes. Operation is intuitive and straightforward.

### Lightweight and Portable

Members of the HP 54500 family weigh only 22 pounds and are easily transported. Their small size allows them to fit easily in the trunk of a car, making them ideal for field applications. An optional soft carrying case is also available, as well as a sturdy transit case for safe shipment. See page 163 for accessories.

### Dual-time-base Windowing

Dual-time-base windowing lets you zoom in on fine details of the waveform you are measuring. Similar to the dual-delayed sweep feature found on some analog oscilloscopes, dual-time-base windowing gives you a time-expanded view of a smaller portion of the waveform, defined by you with the instrument's easy-to-use cursors.

### Measurement Limit Test

Using measurement limit test, the HP 54500 family can automatically characterize a circuit or device over temperature or time without human supervision. Specify upper and lower limits for any measurement. If a measurement exceeds predefined limits, the violating waveform, measurements, and other display data can be automatically stored or transferred to an external printer or controller. These instruments can automatically calculate maximum, minimum, average, and most recent values for all measurements, making device or circuit characterization even more accurate.

### Advanced Logic and TV Triggering

Hewlett-Packard's advanced logic triggering is a standard feature in the HP 54500 family. Use it to trigger on a wide variety of user-specified conditions. Trigger on edge, pattern, state, or trigger-after-delay to capture such elusive events as timing violations or transient bus phenomena. Select line and field for a variety of video waveforms. The 54500 family makes it easy to focus on the video information you need to capture.

# OSCILLOSCOPES

## Digitizing Oscilloscopes

### HP 54510A

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<b>Horizontal (time)</b>	1 ns/div to 5 s/div
<b>Time base range</b>	20 ps
<b>Maximum time base resolution</b>	( $0.005\% \times \text{delta } t + 2(10^9) \times \text{delay setting} + 100 \text{ ps}$ )
<b>Delta-t-accuracy</b>	( $0.005\% \times \text{delta } t + 2(10^9) \times \text{delay setting} + 150 \text{ ps}$ )
<b>Real time</b>	(single acquisition)
<b>Delay range</b>	10,000 × (s/div)
<b>Delay range</b>	(post-trigger)
<b>Delay range</b>	(pre-trigger)
<b>Available Delay</b>	-160 × (s/div)
<b>Time/div Setting</b>	1 ns to 50 ns/div
<b>Time/div Setting</b>	1 ns to 50 ns/div

<b>Triggering</b>	
<b>Trigger sensitivity</b>	Internal dc to 50 MHz 0.5 div
<b>Trigger sensitivity</b>	External 50 MHz to 250 MHz 1.0 div
<b>Trigger level range</b>	Internal dc to 250 MHz 100 mv p-p into 50 Ω
<b>Trigger level range</b>	External dc to 250 MHz 1.75 ns
<b>Trigger level range</b>	External dc to 250 MHz 2.8 ns
<b>Waveform record length</b>	8001 points (real time)
<b>Waveform record length</b>	501 points (repetitive)
<b>Maximum sample rate</b>	1 GSa/s (2 ch. simultaneous)
<b>Vertical resolution</b>	10 bits via HP-IB w/averaging ( $\pm 0.1\%$ )
<b>Vertical resolution</b>	8 bits over eight divisions ( $\pm 0.4\%$ )
<b>Vertical gain range</b>	$\pm 1.25\%$ of full scale
<b>Vertical sensitivity</b>	1 mV/div to 5 V/div
<b>Number of channels</b>	2 (simultaneous)
<b>Rise time</b>	1.4 ns
<b>Bandwidth limits</b>	Switchable ac-coupled lower - 3 dB frequency: 450 Hz LF reject lower - 3 dB frequency: 90 Hz Bandwidth limit - 3 dB frequency: 30 MHz
<b>Bandwidth</b>	dc to 250 MHz (-3 dB) (300-MHz repetitive mode typical)
<b>Vertical (voltage)</b>	

### HP 54510A Specifications and Characteristics

The HP 54510A is a 1 gigasample/second, 2-channel, portable digitizing oscilloscope with a memory depth of 8 k samples per channel. The HP 54510A retains all of the key features and user friendliness of other 54500 Series oscilloscopes. The HP 54510A adds waveform calculus, memory bar for pan and zoom, faster update rate, and faster throughput over HP-IB. The HP 54510A is an affordable high-performance oscilloscope for applications such as advanced hardware design and troubleshooting, high-energy research, and manufacturing test/AITE.

<b>Vertical (voltage)</b>	dc to 250 MHz (-3 dB) (300-MHz repetitive mode typical)
<b>Bandwidth</b>	dc to 250 MHz (-3 dB) (300-MHz repetitive mode typical)
<b>Switchable bandwidth limits</b>	ac-coupled lower - 3 dB frequency: 450 Hz LF reject lower - 3 dB frequency: 90 Hz Bandwidth limit - 3 dB frequency: 30 MHz
<b>Rise time</b>	1.4 ns
<b>Number of channels</b>	2 (simultaneous)
<b>Vertical sensitivity</b>	1 mV/div to 5 V/div
<b>Vertical gain range</b>	$\pm 1.25\%$ of full scale
<b>Vertical accuracy</b>	8 bits over eight divisions ( $\pm 0.4\%$ )
<b>Vertical resolution</b>	10 bits via HP-IB w/averaging ( $\pm 0.1\%$ )
<b>Maximum sample rate</b>	1 GSa/s (2 ch. simultaneous)
<b>Waveform record length</b>	8001 points (real time)
<b>Waveform record length</b>	501 points (repetitive)
<b>Input R (selectable)</b>	1 MΩ $\pm 1\%$ or 50 Ω $\pm 1\%$
<b>Input C</b>	7 pF nominal
<b>Input coupling</b>	ac, dc
<b>Maximum input voltage</b>	1 MΩ $\pm 250 \text{ V [dc + peak ac (< 10 kHz)]}$ 50 Ω: 5 V rms
<b>Offset range</b>	<b>Vertical Sensitivity</b> Available Offset 1 mV to 50 mV/div $\pm 2 \text{ V}$ > 50 mV to 250 mV/div $\pm 10 \text{ V}$ > 250 mV to 1.25 V/div $\pm 50 \text{ V}$ > 1.25 V to 5 V/div $\pm 250 \text{ V}$
<b>Offset accuracy</b>	$\pm 1.0\%$ of ch offset + 2% of full scale
<b>Dynamic range</b>	$\pm 1.5 \times$ full scale from center of screen
<b>Channel-to-channel isolation</b>	40 dB: dc to 50 MHz 30 dB: 50 MHz to 250 MHz
<b>Voltage measurement</b>	<b>Dual cursor accuracy</b> $\pm 1.25\%$ of full scale + 0.032 $\times$ V/div <b>Single cursor accuracy</b> $\pm 1.25\%$ of full scale + offset accuracy + $0.016 \times$ V/div

**Ordering Information**  
The HP 54510A Digitizing Oscilloscope comes with two HP 10430A 10:1 10 MΩ probes, a front-panel manual, a programming manual, a power cord, and a 3-year warranty.

**HP 54510A 1 GSa/s Digitizing Oscilloscope**  
Opt 908 Rackmount Kit (5061-6175) + \$250  
Opt 910 Additional front panel, programming and service manuals + \$75  
Opt 090 Delete probes - \$200

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Opt 910 Additional front panel, programming and service manuals + \$75  
Opt 090 Delete probes - \$200

Upper bandwidth reduces by 2.5 MHz for each degree above 35°C.  
Rise times are calculated from  $t_r = \frac{\text{bandwidth}}{0.35}$   
\* Accuracies decrease 0.08% of full scale per degree C from firmware calibration temperature and are valid for a temperature range  $\pm 10^\circ \text{C}$  from firmware calibration temperature. These accuracies apply to both repetitive and real time (single acquisition modes).  
\* Expansion is used below 7 mV/div range, so resolution and accuracies are correspondingly reduced. Below 7 mV/div, full scale is defined as 56 mV.  
\* Available over HP-IB waveform record length is:  
Repetitive: 500 points  
Real time: 8,000 points  
\* Specification applies at the maximum sampling rate. At lower sampling rates specification should read  $\pm (0.005\% \times \text{delta } t + 2(10^9) \times \text{delay setting} + 0.15 \times \text{sample interval})$ . For bandwidth limited signals  $t_r = 1.4 \times \text{sample interval}$ . Sample interval is defined as 1/sample rate. Specification also applies to those automatic measurements computing time intervals on similar slope edges (such as pos-pos, neg-neg).

# OSCILLOSCOPES

## Digitizing Oscilloscopes

### HP 54502A

HP 54502A 400 MHz, 400 MSA/s Digitizing Oscilloscope

The HP 54502A is a 400 MHz, 400 MSA/s sample rate, 2-channel digitizing oscilloscope designed for both repetitive and single-shot signals. In repetitive mode, the HP 54502A has a 400 MHz bandwidth. In real-time mode, its 400 MSA/s sample rate provides a single-shot bandwidth of 100 MHz. Like other members of the HP 54500 family, the HP 54502A has all the digitizing advantages of oscilloscopes that are much higher in price. Its high repetitive/single-shot bandwidth, ease of use, HP-IB programmability, and HP 54500 family general-purpose features make it a powerful tool for both manual and automated test applications.

### HP 54502A Specifications and Characteristics

<b>Bandwidth</b>	dc to 100 MHz
<b>Switchable bandwidth limits</b>	ac-coupled lower - 3 dB freq.: 10 Hz LF reject lower - 3 dB freq.: 450 Hz Bandwidth limit: dc to 30 MHz
<b>Rise time</b>	3.5 ns
<b>Number of channels</b>	2 (simultaneous)
<b>Vertical sensitivity range</b>	2 mV/div to 5 V/div
<b>Vertical gain accuracy (dc)</b>	± 2.0% of full scale
<b>Vertical resolution</b>	± 1.6% of full scale (6 bit A/D) ± 0.4% of full scale (8 bits with ≥ 8 averages)
<b>Maximum sample rate</b>	400 MSA/s
<b>Waveform record length</b>	Normal: 501 points Extended: 2001 points
<b>Input R</b>	1 MΩ ± 1% or 50 Ω ± 1%
<b>Input C</b>	7 pF nominal (selectable)
<b>Input coupling</b>	ac, dc
<b>Maximum input voltage</b>	1 MΩ: ± 250 V [dc + peak ac (< 10 kHz)] 50 Ω: 5 V rms
<b>Offset range</b>	Available offset: 2 mV to 50 mV/div ± 10 V ± 50 V ± 250 V Vertical sensitivity: 2 mV to 50 mV/div > 50 mV to 250 mV/div > 250 mV to 1.25 V/div > 1.25 V to 5V/div
<b>Offset accuracy</b>	± 1.5 × full scale from center of screen
<b>Dynamic range</b>	40 dB: dc to 50 MHz 30 dB: 50 to 400 MHz 40 dB: dc to 50 MHz (with channels at equal sensitivity)
<b>Channel-to-channel isolation</b>	± (2.0% of full scale + 0.032 × V/div) ± (2.0% of full scale + offset accuracy + 0.016 × V/div)
<b>Voltage measurement accuracy (dc)</b>	± (2.0% of full scale + 0.032 × V/div) ± (2.0% of full scale + offset accuracy + 0.016 × V/div)
<b>Single cursor</b>	1 ns/div to 5 s/div
<b>Time base range</b>	50 ps (maximum)
<b>Maximum time base resolution</b>	± (2% × screen diameter diameter + 0.01% × delta t + 500 ps)
<b>Delta-t accuracy</b>	Time/div setting: 50 ns to 5 s/div 100 ns to 20 m/s/div 1 ns to 50 μs/div
<b>Delay range</b>	Available delay: 40 × (s/div) settings: 1 μs to 5 s/div 1 ns to 500 ns/div Line trigger Low-frequency reject (-3dB 50 KHz)

<b>Delay range</b>	Available delay: 40 × (s/div) settings: 1 μs to 5 s/div 1 ns to 500 ns/div Line trigger Low-frequency reject (-3dB 50 KHz)
<b>Trigger level</b>	Internal: ± 1.5 × full scale from center of screen External: ± 2V
<b>Trigger pulse width (minimum)</b>	Internal: 7.0 ns External: 2.8 ns
<b>Trigger pulse width (maximum)</b>	Internal: 1.75 ns External: 2.8 ns
<b>Trigger sensitivity</b>	Internal: 0.5 div External: 1.25 div N/A 100 mV peak-to-peak dc to 250 MHz into 50 Ω
<b>Internal trigger coupling</b>	Low-frequency reject (-3dB 50 KHz)
<b>Power requirements</b>	Voltage: 115/230 Vac, -25% to +15% 48 to 66 Hz, Power 350 VA maximum Weight: Net: approximately 10 kg (22 lb), Shipping: approximately 20 kg (44 lb) Size: 194.3 mm H × 422.3 mm W × 355.6 mm D (7.65 in × 16.62 in × 14 in); does not include front panel protrusions. Specifications valid for temperature range ± 10° C from software calibration temperature with 8 or more averages selected. Upper bandwidth reduces by 2.5 MHz for each °C above +35° C. Rise times are calculated from: $t_r = \frac{0.35}{\text{bandwidth}}$ Vertical gain accuracy decreases 0.08% per °C from software calibration temperature. Expansion is used below 7 mV/div full scale is defined as 56 mV. Correspondingly reduced. Below 7 mV/div full scale is defined as 56 mV. On time/div settings 1 ns/div and slower, bandwidth in repetitive mode is 100 MHz. Available over HP-IB waveform record length is: Real-time normal: 500 points, extended: 2000 points. Repetitive 10 ns to 5 s/div: 1024 pts. 2 ns/div: 400 pts. 1 ns/div: 200 pts. 5 ns/div: 1000 pts.
<b>Test Option</b>	Make telecom mask template measurements to ANSI, CCITT, and ISDN standards without using Mylar overlays. HP 54502A Option 00 automates many of the mask measurements that are time-consuming with analog oscilloscopes. Pass-fail accuracy and repeatability are improved through the use of automatic measurements, eliminating human error.
<b>HP 54502A Option 001 Features</b>	• 16 standard telecom signal mask templates stored in ROM • Positive and negative templates • Automatic triggering on positive "isolated ones" in live traffic for many standard telecom signals • Automatic best-fit of test signals to positive mask templates • Automatic pass-fail comparison of mask templates with corresponding input signals • Automatic storage, printing or plotting of failed signals • User-defined pass-fail tolerance • Memory protection for user mask templates, waveforms and front panel setups For more information on this option and a technical data sheet contact your local HP sales office (see page 684). For the HP 54502A Option 001, the term "isolated ones" is defined as a pulse sequence of at least two zeroes, followed by one, followed by at least two zeroes.
<b>Ordering Information</b>	The HP 54502A digitizing oscilloscope comes complete with 1 HP 10430A 10:1 MΩ probes, a front panel manual, a program manual, a service manual, a power cord, and a three-year warranty.
<b>HP 54502A Digitizing Oscilloscope</b>	Qty 1
<b>Opt 001 Telecommunications Mask Template Test Option</b>	Qty ≥ 2 (each)
<b>Opt 908 Rack Mount Kit (5061-6175)</b>	
<b>Opt 910 Additional Front-Panel Programming, and Service Manual</b>	
<b>Opt 090 Delete Probes</b>	



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