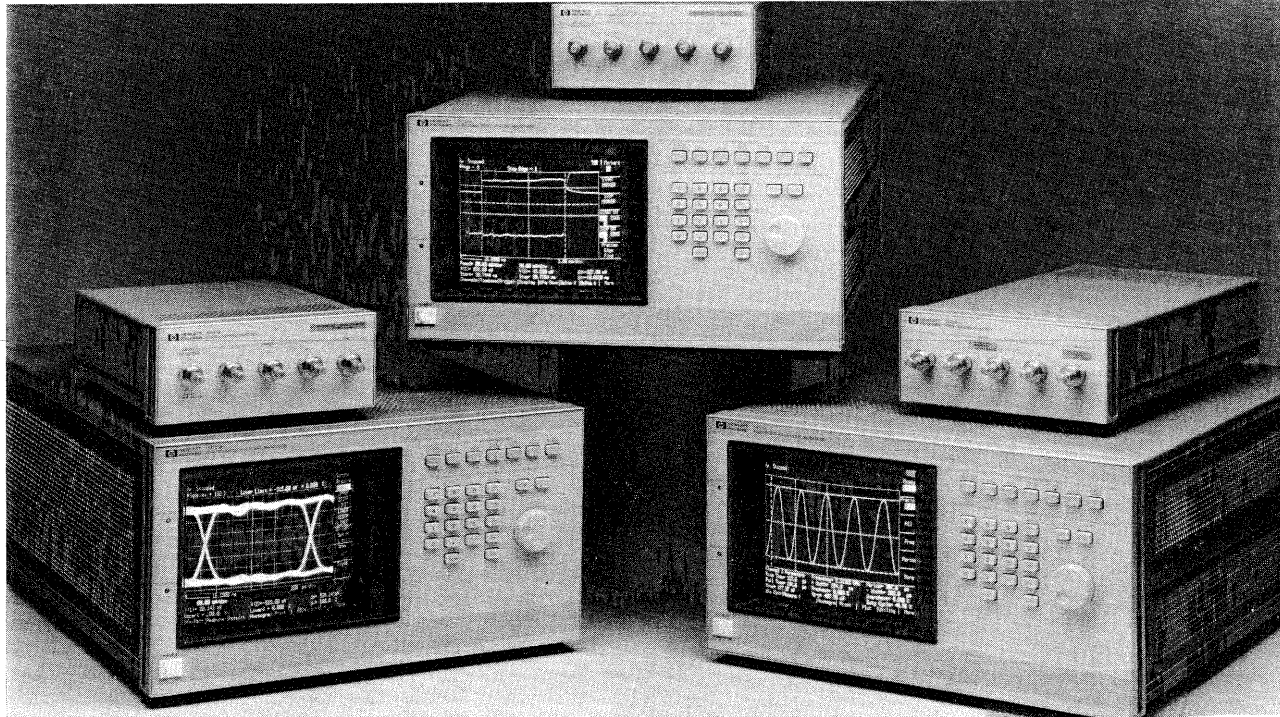


# OSCILLOSCOPES & WAVEFORM ANALYZERS

## Digitizing Oscilloscopes (cont'd)

HP 54121T, 54122T, 54123T

- 12.4 GHz, 20 GHz, 34 GHz bandwidth
- 0.25 ps timing resolution
- Built-in histograms
- 2.5 GHz edge trigger
- Time domain reflectometry
- HP PaintJet printer output



The HP 54120-series of high bandwidth digitizing oscilloscopes featuring digital feedback sampling for repeatable, accurate, and operator-independent measurement results.

### HP 54120-series High Bandwidth Digitizing Oscilloscopes

The HP 54120-series of digitizing oscilloscopes combines high bandwidth, a time domain reflectometer (HP 54121T and HP 54123T only), four input channels, and superb stability in an easy-to-use, fully programmable oscilloscope that needs no manual loop gain adjustment. Whether your application involves high-speed device and circuit characterization, high-speed telecom analysis, or microwave design, the HP 54120-series of digitizing oscilloscopes give you a new confidence in state-of-the-art measurements.

#### Key Contributions

- dc - 12.4 GHz bandwidth (HP 54122T) - 28.2 ps risetime
- dc - 20 GHz bandwidth (HP 54121T) - 17.5 ps risetime
- dc - 34 GHz bandwidth (HP 54123T) - 10.3 ps risetime
- 10 ps time interval accuracy
- 0.25 ps time interval resolution
- 10 ps/div to 1 s/div
- 0.4 % vertical accuracy
- 32 microvolt resolution
- 1 mV/div to 80 mV/div (HP 54121T and HP 54123T)
- 1 mV/div to 2.4 V/div (HP 54122T)
- Automatic pulse parameter measurements
- Fully HP-IB programmable
- Pushbutton hardcopy documentation

- Four input channels
- Step generator with 35 ps risetime and 1% flatness (HP 5412 and HP 54123T)
- Reflection (TDR)/transmission (TDT) normalization<sup>1</sup> (HP 54121T and HP 54123T)
- Time and voltage histograms

#### Picosecond measurements

The 0.25 ps time interval resolution and typically 1 ps time interval accuracy of the HP 54120 family reduce the oscilloscope's contribution to errors in digital pulse parameter measurements in semiconductors and computers.

#### Quantify Noise and Jitter

Time and voltage histograms, which quantify noise and jitter measurements, characterize the eye patterns in telecommunications applications. Eye height and width, location of one and zero, are easily found with histograms. With no loop gain control, you can obtain repeatable results that do not vary between operators or between oscilloscopes over the entire input dynamic range.

#### Eliminate Reflections with TDR

Ringings and waveform distortion can be eliminated by using time domain reflectometry on the HP 54121T and the HP 54123T to locate and remove discontinuities in transmission line systems.

NOTE 1: Normalization uses the Bracewell transform, which is under license from Stanford University.

**HP 54120-Series Specifications Channels**

(Vertical) <sup>1</sup>	HP 54121T	HP 54122T	HP 54123T
<b>Bandwidth</b> (-3 dB) <b>High Bandwidth<sup>2</sup></b>	dc to 20 GHz chs 2,3,4 (ch 1 is -3.5 dB @ 20 GHz) dc to 18 GHz, ch 1	dc to 12.4 GHz	dc to 34 GHz chs 2,3,4 dc to 20 GHz, ch 1
<b>Low Bandwidth</b>	dc to 12.4 GHz	dc to 10 GHz	dc to 18 GHz, chs 2,3,4 dc to 12.4 GHz, ch 1
<b>Transition Time</b> (10% to 90%) (calculated from Tr=.35/BW)			
<b>High bandwidth</b>	<17.5 ps, Chs 2,3,4 <19.4 ps, Ch 1	<28.2 ps	<10.3 ps Chs 2,3,4 <17.5 ps, Ch 1
<b>Low bandwidth</b>	<28.2 ps	<35.0 ps	<19.4 ps, Chs 2,3,4 <28.2 ps, Ch 1
<b>Noise (rms)</b> <b>High bandwidth</b>	<2 mV	<2 mV (1:1 attenuation)	<2 mV
<b>Low bandwidth</b>	<1 mV	<1 mV (1:1 attenuation)	<1 mV
<b>Scale factor</b> (full-scale is 8 divisions)			
<b>Minimum</b>	1 mV/div	1 mV/div	1 mV/div
<b>Maximum</b>	80 mV/div	2.4 V/div	80 mV/div
<b>Atten. factors</b>	N/A	X1, X3, X10, X30	N/A
<b>Programmable dc Offset<sup>3</sup></b>	± 500 mV	± 500 mV x atten. factor	± 500 mV
<b>dc Accuracy</b> <b>Single Voltage Marker<sup>4</sup></b>	Average mode : ± 0.4% of full-scale or marker reading (whichever is greater) ± 2 mV x attenuation factor <sup>5</sup>  High bandwidth Persistence mode : ± 0.4% of full-scale or marker reading (whichever is greater) ± 2 mV x attenuation factor <sup>5</sup> ± 3.0% of <sup>6</sup> (reading - channel offset)  Low bandwidth Persistence mode : ± 0.4% of full-scale or marker reading (whichever is greater) ± 2 mV x attenuation factor <sup>5</sup> ± 1.5% of <sup>6</sup> (reading - channel offset)		
<b>Inputs</b>			
<b>Number</b>	Four	Four	Four
<b>Dynamic range</b>	± 320 mV relative to channel offset	± 320 mV x attenuation factor	± 320 mV relative to channel offset
<b>Maximum safe input voltage</b>	± 2 V dc +peak ac (+16 dBm)	± 5 V dc +peak ac (+24 dBm)	± 2 V dc +peak ac (+16 dBm)
<b>Nominal impedance</b>	50 Ω	50 Ω	50 Ω
<b>Percent reflection</b>	<5% for 30 ps risetime	<5% for 30 ps risetime	<5% for 30 ps risetime
<b>Connectors</b>	3.5 mm (m)	3.5 mm (m)	3.5 mm (m)

**TDR System (HP 54121T and HP 54123T only)**

<b>Risetime<sup>2,3</sup></b>	Combined Oscilloscope and TDR Performance	Normalized Characteristics <sup>1</sup>
	<45 ps	Adjustable: allowable values based on time-base setting Minimum: 10 ps or 0.08 X time/div, whichever is greater Maximum: 5 X time/div
<b>Flatness<sup>2</sup></b>	<+ 1% after 1 ns from edge; <+ 5%, - 3% to 1 ns from edge	< 0.1%
	<b>Levels: Low</b> 0 V ± 2 mV <b>High</b> + 200 mV ± 2 mV	0 V ± 2 mV + 200 mV ± 2 mV

1. Normalized information is a characteristic, not a specification. The information is presented here for comparison purposes only. Normalization characteristics are achieved only with the use of the normalization calibrations and firmware routines.
2. Measured in the low bandwidth and average display modes.
3. The risetime of the generator is less than 35 ps, as calculated by (Tr system)<sup>2</sup> = (Tr generator)<sup>2</sup> + (Tr scope)<sup>2</sup>

**Time base (Horizontal)**  
**Scale factor (full-scale is 10 divisions)**

<b>Minimum</b>	10 ps/division
<b>Maximum</b>	1 s/division

**Delay (time offset relative to trigger)**

<b>Minimum</b>	16 ns
<b>Maximum</b>	1000 screen diameters or 10 seconds, whichever is smaller.

**Time Interval Accuracy**  
(Dual marker measurement) < 10 ps ± 0.1% of reading

**Time Interval Resolution**  
0.25 ps<sup>1</sup> or .02 division, whichever is larger

At 10 ps/division, data points are plotted at 0.2 ps intervals to match the display pixel resolution.

**Trigger-External Input Only**

**Sensitivity**  
dc - 100 MHz 40 mV peak-to-peak  
100 MHz to 2.5 GHz Increasing linearly from 40 mV at 100 MHz to 200 mV at 2.5 GHz.

**Pulse width** < 200 ps, > 200 mV

**High frequency reject** Trigger bandwidth reduced to approximately 100 MHz.

**Trigger level range** ± 1 V

**Jitter** < 2.5 ps + 5E-5 X delay setting  
(Trigger and time base combined one standard deviation)

(Tested using 2 GHz synthesized source at 200 mV peak-to-peak with High Frequency Sensitivity ON and High Frequency Reject OFF.)

**Trigger Input**

<b>Maximum Safe Input Voltage</b>	± 2 V dc ac peak (+16 dBm)
<b>Nominal Impedance</b>	50 Ω
<b>Percent Reflection</b>	<10% for 100 ps risetime
<b>Connector</b>	3.5 mm (m)

1. When operated within ± 5 C (± 9 F) of the temperature of the last front panel calibration.
2. The input samplers are biased differently for increased bandwidth in the high bandwidth mode.
3. An effective offset of ± 820 mV x attenuation factor can be achieved by using the ± 500 x attenuation factor mV of channel offset and adding ± 320 mV x attenuation factor of offset with the waveform math offset scaling function.<sup>5</sup>
4. When driven from a 0 Ω source.
5. The attenuation factor of the HP 54121T and the HP 54123T is 1.
6. For the HP 54123T, the 3% changes to 5% and the 1.5% changes to 2%.

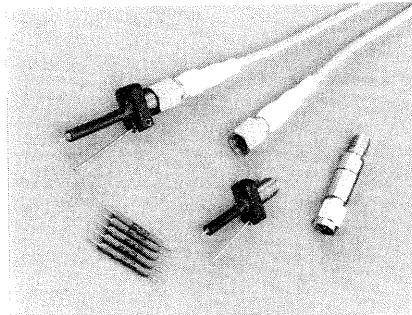
# OSCILLOSCOPES & WAVEFORM ANALYZERS

Accessories For The HP 54120 Series Digitizing Oscilloscopes

HP 54006A, 54007A, 54008A, 54118A, 10086A



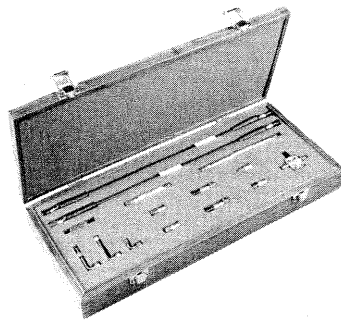
HP 54118A



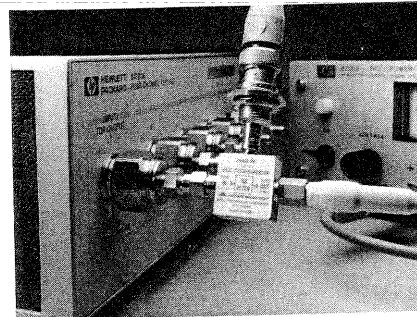
HP 54006A



HP 54008A



HP 54007A



HP 10086A

Hewlett-Packard has a large number of accessories for use with wideband digital sampling oscilloscopes that will help you build a multi-gigahertz system that is tailored to your unique needs.

### The HP 54118A, 500 MHz to 18 GHz Trigger Simple/Stable Triggering at Microwave Frequencies

For applications requiring more than 2.5 GHz trigger bandwidth, use the HP 54118A 18 GHz Trigger. The HP 54118A gives your HP 54120-series oscilloscope true event triggering from 500 MHz to 18 GHz with less than 1.7 ps of rms jitter at 18 GHz. This powerful and versatile accessory extends the oscilloscope's measurement capabilities to applications in lightwave communications, pulsed RF, gigabit logic, pseudo random bit stream eye patterns, and other microwave signals.

True event triggering is not possible with countdown synchronizers, but with the event triggering capability of the HP 54118A, you are no longer restricted to the limitations of countdown synchronizers. An HP microwave thinfilm IC locks onto your input signal and holds it, even if the signal has frequency drift or large deviations in FM modulation.

Independent control of arming and triggering levels let you make measurements that simply were not possible before, such as triggering on a carrier of a radar pulse or CW signals with large noise components. And the trigger's variable holdoff feature makes it a snap to trigger on the carrier of a burst RF signal.

### The HP 54006A 6 GHz Probe High Frequency Hand-held Probing

Probing multi-GHz systems with the HP 54006A, 10:1, 500  $\Omega$  and 20:1, 1 k $\Omega$  resistive divider probes lets you access circuit nodes that do not have a 50  $\Omega$  connector. These probes let you see the signal at specific points, such as the input to a gate. You can also use them to probe circuits that are not nominally 50  $\Omega$ .

### The HP 54008A 22 ns Delay Line

#### Viewing the Trigger Signal

The HP 54008A delay line provides 22 ns of delay with a usable frequency response of 20 GHz. By adding this accessory to your HP 54120 oscilloscope system, you will be able to view the trigger event. The HP 54008A has enough delay to view the trigger event with the HP 54118A Trigger installed in the trigger path also.

### The HP 54007A Accessory Kit

#### Low-loss Measurements For the HP 54120 Oscilloscope Systems

The HP 54007A Accessory Kit provides an assortment of parts with 3.5 mm connectors for low-loss measurements. This kit is highly recommended for low-loss reflection and transmission measurements. It also includes semi-rigid coax, formed for use with the HP 11667B power splitter.

#### Contents of HP 54007A Accessory Kit:

17-inch cable, APC 3.5 (f-f)	17-inch cable, APC 3.5 (m-f)
Coaxial short, APC 3.5 (f)	Coaxial short, APC 3.5 mm (m)
50 $\Omega$ termination, APC 3.5 (m)	50 $\Omega$ termination, APC 3.5 (f)
7.5 cm airline, APC 3.5 (m-f)	Power splitter, APC 3.5 mm (f)
6 cm. semi-rigid "L", SMA (m-m)	3 cm. semi-rigid "L", SMA (m-m)
6 dB attenuator, APC 3.5 (m-f)	40 dB attenuator, APC 3.5 (m-f)
Adapter, APC 3.5 mm (m-m)	

### HP 10086A ECL Terminator

#### Safe, Reliable Termination For Measuring ECL Devices

Create a simple high-performance 10 GHz interface between an ECL-compatible output and a 50  $\Omega$  instrument input. The ECL terminator provides bias and termination for your device under test, while presenting an undistorted and level-shifted signal to your measurement equipment. It also provides proper termination to ECL output devices, thereby reducing the risk of destroying sensitive output devices.

**HP 54120B includes:**

- Color mainframe
- Interface cable
- Service manual for the HP 54120B
- Power cord

**HP 54121A includes:**

- Operating and programming manuals for the HP 54121T
- Service manual for the HP 54121A
- Four vertical channels, switchable step generator, and a trigger input
- Five adapters, APC-3.5 (f-f) (HP P/N 5061-5311)
- Five coaxial shorts, SMA (m) (HP P/N 0960-0055)
- One anti-static mat with wrist strap (HP 9300-1484)
- RF accessories (HP P/N 54121-68701):
  - Five 20 dB attenuators, APC-3.5 (f-m) (HP 33340C opt 020)
  - Three 50  $\Omega$  cables, SMA (m-m) (HP P/N 8120-4948)
  - Two SMA (m) to BNC (f) adapters (HP P/N 1250-1200)
  - One 50  $\Omega$  termination, SMA (m) (HP P/N 1250-2153)
  - One 50  $\Omega$  termination, SMA (f) (HP P/N 1250-2151)
  - One coaxial short, SMA (f) (HP P/N 1250-2152)

**HP 54121T Documentation**

- HP 54121T Front Panel Reference Manual (HP P/N 54121-90903)
- HP 54121T Programming Manual (HP P/N 54121-90904)
- HP 54120 Family Getting Started Guide (HP P/N 5952-4239)
- HP 54120B Mainframe Service Manual (HP P/N 54120-90907)
- HP 54121A Service Manual (HP P/N 54121-90902)

**HP 54122A includes:**

- Operating and programming manuals for the HP 54122T
- Service manual for the HP 54122A
- Four vertical channels, internal attenuators, and a trigger input.
- Five adapters, APC-3.5 (f-f) (HP P/N 5061-5311)
- Five coaxial shorts, SMA (m) (HP P/N 0960-0055)
- One anti-static mat with wrist strap (HP 9300-1484)
- RF accessories (HP P/N 54122-68701):
  - One 20 dB attenuator, APC 3.5 (f-m) (HP P/N 33340C opt. 020)
  - Three 50  $\Omega$  cables, SMA (m-m) (HP P/N 8120-4948)
  - Five SMA (m) to BNC (f) adapters (HP P/N 1250-1200)

**HP 54122T Documentation**

- HP 54122T Front Panel Reference Manual (HP P/N 54122-90903)
- HP 54122T Programming Manual (HP P/N 54122-90904)
- HP 54120 Family Getting Started Guide (HP P/N 5952-4239)
- HP 54120B Mainframe Service Manual (HP P/N 54120-90907)
- HP 54122A Service Manual (HP P/N 54122-90901)

**HP 54123A includes:**

- Operating and programming manuals for the HP 54123T
- Service manual for the HP 54123A
- Four vertical channels, switchable step generator, and a trigger input.
- Five adapters, APC-3.5 (f-f) (HP P/N 5061-5311)
- Five coaxial shorts, SMA (m) (HP P/N 0960-0055)
- One anti-static mat with wrist strap (HP 9300-1484)
- RF accessories (HP P/N 54123-68701):
  - Five 20 dB attenuators, APC-3.5 (f-m) (HP 33340C opt 020)
  - Three 50  $\Omega$  cables, SMA (m-m) (HP P/N 8120-4948)
  - Two SMA (m) to BNC (f) adapters (HP P/N 1250-1200)
  - One 50  $\Omega$  termination, SMA (m) (HP P/N 1250-2153)
  - One 50  $\Omega$  termination, SMA (f) (HP P/N 1250-2151)
  - One coaxial short, SMA (f) (HP P/N 1250-2152)

**HP 54123T Documentation**

- HP 54123T Front Panel Reference Manual (HP P/N 54123-90902)
- HP 54123T Programming Manual (HP P/N 54123-90903)
- HP 54120 Family Getting Started Guide (HP P/N 5952-4239)
- HP 54120B Mainframe Service Manual (HP P/N 54120-90907)
- HP 54123A Service Manual (HP P/N 54123-90901)

**Ordering information****HP 54120B Digitizing Oscilloscope Mainframe**

- **Opt 908** Rackmount Kit (HP P/N 5061-9679)
- **Opt 910** One additional set of manuals
- **Opt W30** Extended Repair Service. See page 725
- **Opt W32** Calibration Service. See page 725.

**HP 54121T 20 GHz Digitizing Oscilloscope**

The HP 54121T 20 GHz Digitizing Oscilloscope consists of model numbers, the HP 54120B Digitizing Oscilloscope Mainframe and the HP 54121A Four Channel Test Set. The HP 54121T is recommended ordering configuration.

**HP 54121T 20 GHz Digitizing Oscilloscope**

- **Opt 090** Deletes RF accessories
- **Opt 908** Rackmount Kits (HP P/N 5061-9672)
- **Opt 910** One additional set of manuals
- **Opt W30** Extended Repair Service. See page 725.

**HP 54121A Four Channel Test Set**

- **Opt 090** Deletes RF accessories
- **Opt 908** Rackmount Kit (HP P/N 5061-9672)
- **Opt 910** One additional set of manuals
- **Opt W30** Extended Repair Service. See page 725.

**HP 54122T 12.4 GHz Digitizing Oscilloscope**

The HP 54122T 12.4 GHz Digitizing Oscilloscope consists of two model numbers, the HP 54120B Digitizing Oscilloscope Mainframe and the HP 54122A Four Channel Test Set. The HP 54122T is the recommended ordering configuration.

**HP 54122T 12.4 GHz Digitizing Oscilloscope**

- **Opt 090** Deletes RF accessories
- **Opt 908** Rackmount kits (1 ea HP P/N 5061-9672)
- **Opt 910** One additional set of manuals
- **Opt W30** Extended Repair Service. See page 725.

**HP 54122A Four Channel Test Set**

- **Opt 090** Deletes RF Accessories
- **Opt 908** Rackmount Kit (HP P/N 5061-9672)
- **Opt 910** One additional set of manuals
- **Opt W30** Extended Repair Service. See page 725.
- **Opt W32** Calibration Service. See page 725.

**HP 54123T 34 GHz Digitizing Oscilloscope**

The HP 54123T 34 GHz Digitizing Oscilloscope consists of two model numbers, the HP 54120B Digitizing Oscilloscope Mainframe and the HP 54123A Four Channel Test Set. The HP 54123T is the recommended ordering configuration.

**HP 54123T 34 GHz Digitizing Oscilloscope**

- **Opt 090** Deletes RF accessories
- **Opt 908** Rackmount kits (1 ea HP P/N 5061-9672)
- **Opt 910** One additional operating and programming manual
- **Opt W30** Extended Repair Service. See page 725.

**HP 54123A Four Channel Test Set**

- **Opt 090** Deletes RF Accessories
- **Opt 908** Rackmount Kit (HP P/N 5061-9672)
- **Opt 910** One additional set of manuals
- **Opt W30** Extended Repair Service. See page 725.

**Accessories****HP 54006A 6 GHz resistive divider probe kit****HP 54007A Accessory kit****HP 54008A 22 ns Delay line****HP 54118A 18 GHz Trigger**

- **Opt 090** Deletes RF accessories
- **Opt 908** Rackmount kit (HP 5061-9672)
- **Opt 910** One additional Manual
- **Opt W30** Extended Repair Service. See page 725.

**HP 10086A ECL Terminator**

For additional information concerning any high bandwidth oscilloscope or high bandwidth oscilloscope accessory see HP publication number 5952-7084.