OSCILLOSCOPES

Digitizing Oscilloscopes (cont'd)

HP 54121T, 54122T, 54123T, 54124T

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

NEW

DESIGNED FOR HP-IB SYSTEMS

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, HP 54123T, and 54124T 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 gives you a new confidence in state-of-the-art measurements.

Key Contributions

- dc – 50 GHz bandwidth (HP 54124T) – 7 ps rise time
- dc – 34 GHz bandwidth (HP 54123T) – 10.3 ps rise time
- dc – 20 GHz bandwidth (HP 54121T) – 17.5 ps rise time
- dc – 12.4 GHz bandwidth (HP 54122T) – 28.2 ps rise time
- 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, HP 54123T, and HP 54124T)
- 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 typically 35 ps rise time and typically 1% flatness (HP 54121T, HP 54123T, and HP 54124T)
- Reflection (TDR)/transmission (TDT) normalization[1] (HP 54121T, HP 54123T, and HP 54124T)
- 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

Ringing and waveform distortion can be eliminated by using time-domain reflectometry on the HP 54121T, the HP 54123T, and the HP 54124T to locate and remove discontinuities in transmission line systems.

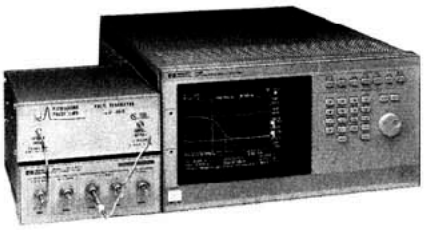
[1] Normalization uses the Bracewell transform, which is under license from Stanford University.

HP 54120-Series Specifications

Vertical (channels)[1]

	HP 54121T	HP 54122T	HP 54123T	HP 54124T
dc-coupled Bandwidth (−3 dB)[2]				
High bandwidth				
Chan 1	18.0 GHz	12.4 GHz	20.0 GHz	20.0 GHz
Chan 2	20.0 GHz	12.4 GHz	34.0 GHz	34.0 GHz
Chan 3,4	20.0 GHz	12.4 GHz	34.0 GHz	50.0 GHz
Low bandwidth				
Chan 1	12.4 GHz	10.0 GHz	12.4 GHz	12.4 GHz
Chan 2	12.4 GHz	10.0 GHz	18.0 GHz	18.0 GHz
Chan 3,4	12.4 GHz	10.0 0Hz	18.0 GHz	26.5 GHz
Transistion time (10% to 90%) (calculated from T, = .35/BW)				
High bandwidth				
Chan 1	19.4 ps	28.2 ps	17.5 ps	17.5 ps
Chan 2	17.5 ps	28.2 ps	10.3 ps	10.3 ps
Chan 3,4	17.5 ps	28.2 ps	10.3 ps	7.0 ps
Low bandwidth				
Chan 1	28.2 ps	35.0 ps	28.2 ps	28.2 ps
Chan 2	28.2 ps	35.0 ps	19.4 ps	19.4 ps
Chan 3,4	28.2 ps	35.0 ps	19.4 ps	13.2 ps
Noise (rms)				
High bandwidth	≤2 mV	≤2 mV (1:1 attenuation)	≤2 mV	≤2 mV
Low bandwidth	≤1 mV	≤1 mV (1:1 attenuation)	≤1 mV	≤1 mV
Scale factor (full-scale is 8 divisions)				
Minimum	1 mV/div	1 mV/div	1 mV/div	1 mV/div
Maximum	80 mV/div	2.4 V/div	80 mV/div	80 mV/div
Attenuation factors	N/A	X1, X3, X10, X30	N/A	N/A
Programmable dc offset[3]	± 500 mV	± 500 mV × atten. factor	± 500 mV	± 500 mV
dc accuracy				
Single Voltage Marker[4]	Average mode: ± **0.4% of full-scale** or marker reading (whichever is greater) ± 2 mV × attenuation factor[5]			
	High bandwidth persistence mode: ± **0.4% of full-scale** or marker reading (whichever is greater) ± 2 mV × attenuation factor[6] ± 3.0% of[6] (reading - channel offset)[7]		Low bandwidth persistence mode: ± **0.4% of full-scale** or marker reading (whichever is greater) ± 2 mV × attenuation factor[5] ± 1.5% of[6] (reading - channel offset)[7]	
Inputs				
Number	4	4	4	4
Dynamic range	± 320 mV relative to channel offset	± 320 mV × attenuation factor	± 320 mV relative to channel offset	± 320 mV relative to channel offset
Maximum safe input voltage	± 2 V dc + peak ac (+ 16 dBm)	± 5 V dc + peak ac (+24 dBm)	± 2 V dc + peak ac (+ 16 dBm)	± 2 V dc + peak ac (+ 16 dBm)
Nominal impedance	50 Ω	50 Ω	50 Ω	50 Ω
Percent reflection	≤5% for 30 ps rise time	≤5% for 30 ps rise time	≤5% for 30 ps rise time	≤5% for 30/20 ps rise time
Connectors	3.5 mm (m)	3.5 mm (m)	3.5 mm (m)	3.5 mm/2.4 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.[5]
[4] When driven from a 0 Ω source.
[5] The attenuation factor of the HP 54121T, 54123T, and 54124T is 1.
[6] For the HP 54123T and 54124T, the 3% changes to 5% and the 1.5% changes to 2%.
[7] Performing a vertical software calibration immediately before making a measurement eliminates the final term in the persistence mode dc accuracy specification.



Picosecond Pulse Labs 4015B

15-ps, −9 V External TDR or TDT Source

The PicoSecond Pulse Labs model 4015B pulse generator extends the TDR/TDT performance of the HP 54120-Series oscilloscopes. The pulse generator produces a 15-ps fall time with an amplitude of −9 V, which can be triggered by any HP 54120-Series TDR step generator. Contact Dr. Jim Andrews at PSPL, P.O. Box 44, Boulder, CO 80306, (303)443-1249.

TDR System (HP 54121T, HP 54123T, and HP 54124T only)

	Combined oscilloscope and TDR performance	Normalized characteristics[1]
Rise time[2,3]	≤45 ps	Adjustable: allowable values based on time base setting Minimum: 10 ps or 0.08 × time/div, whichever is greater Maximum: 5 × time/div
Flatness[2]	≤ + 1% after 1 ns from edge; ≤ + 5%, −3% to 1 ns from edge	≤ 0.1%
Levels		
low	0 V ± 2 mV	0 V ± 2 mV
high	+ 200 mV ± 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 rise time of the generator is less than 35 ps, as calculated by (Tr system)^2 = (Tr generator)^2 + (Tr scope)^2

Horizontal (time base)

Scale factor (full-scale is 10 divisions)	10 ps/division to 1 s/division
Delay (time offset relative to trigger)	16 ns to 10 s or 1000 screen diameters, whichever is smaller
Time interval accuracy	≤10 ps ± 0.1% of reading (Dual marker measurement)
Time Interval Resolution	0.25 ps[1] or 0.02 division, whichever is larger

[1] 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 (Trigger and time base combined) (one standard deviation)	≤ 2.5 ps + 5E-5 × delay setting (Tested using 2 GHz synthesized source at 200 mV peak-to-peak with High-Frequency Sensitivity ON and High-Frequency Reject OFF.)
Trigger input	
Maximum safe input voltage	± 2 V dc + ac peak (+16 dBm)
Nominal impedance	50 Ω
Percent reflection	≤10% for 100 ps rise time
Connector	3.5 mm (m)