

Vertical

CHAN

Deflection factors:

Channels 1 and 4: With single screen selected, attenuation factors are adjustable from 5 mV/div to 5 V/div in a 1-2-5 sequence with the knob. Finer adjustments can be made using direct keypad entry or the knob with the FINE key selected.

Channels 2 and 3: With single-screen mode selected, attenuation factors are adjustable from 100 mV/div to 500 mV/div in a 1-2-5 sequence with the knob. Finer adjustments can be made using direct keypad entry or the knob with the FINE key selected.

Probe attenuation factors: Values from 0.9 to 1K may be entered to scale the oscilloscope for external probes or attenuators attached to the channel inputs. When probe tip calibration is performed, this value is calculated automatically.

Bandwidth limit (HF Reject): Can be selected for each individual input to provide a low-pass filter with a -3 dB point at approximately 20 MHz for both triggering and signal display.

ECL/TTL Presets: vertical deflection factor, offset, and trigger level can be preset independently on each channel for ECL and TTL levels.

Horizontal

TIME
BASE

Dual time base windowing: Allows user to zoom in on user-defined portion of the waveform using cursors that are displayed on the top half of the screen. An expanded time base is displayed on the lower half of the screen. The window time base can be set to provide as much as a 20:1 expansion ratio.

Waveform measurements are performed on the dual time base window information when windowing is turned on.

Delay between channels: difference in delay between channels can be nulled out to compensate for differences in input cables or probe length. Use the *time null cal* found in the Utility menu.

Reference location: The reference point can be located at the left edge, center, or right edge of the display. For zero delay, the reference point is the trigger point. For non-zero delay, the reference point is equal to the trigger point plus the delay time.

Trigger Modes

TRIG

Edge trigger: Positive or negative edge can be selected for trigger on any of the four channel inputs.

Pattern trigger: A pattern can be specified using all four of the inputs. Each of the inputs can be specified as a *high*, *low*, or *don't care* with respect to the level setting in the edge trigger menu. Trigger can be selected to occur on the last edge to enter the specified pattern or the first edge to exit the specified pattern.

Time-qualified pattern trigger: A trigger will occur on the first edge to exit a pattern, only if it meets the specified time criteria. The available time-qualified modes are:
 pattern present less than [time]
 pattern present greater than [time]
 range — pattern present greater than [time1] and less than [time2]

The time [time] settings are adjustable from 20 ns to 160 ms ($\pm 3\%$). The time filter recovery time is less than or equal to 12 ns. In the PATTERN PRESENT LESS THAN [TIME] mode, the pattern must be present greater than 7 ns for the trigger to respond.
Glitch Trigger: Use PATTERN PRESENT LESS THAN [TIME] with [time] selected such that it is just under the pulse width of the signal you are analyzing. The minimum capturable glitch width is 7 ns.

State trigger: A pattern is specified on any three of the four inputs, with the fourth input used as a clock. A trigger will occur on the rising or falling edge of the input specified as the clock when the pattern is present or not present. Setup time for the pattern with respect to the clock is less than or equal to 10 ns; hold time is zero.

Delayed Trigger

Event-delayed mode: The trigger can be qualified by an edge, pattern, time-qualified pattern or state. The delay can be specified as a number of occurrences of a rising or falling edge of any of the four inputs. The trigger is an occurrence of a rising or falling edge of any of the four inputs. The occurrence values can be set from 1 to 16,000,000. The maximum edge-counting rate is 100 MHz.

Time-delayed mode: The trigger can be qualified by an edge, pattern, time-qualified pattern, or state. The delay is selectable from 30 ns to 160 ms. The trigger is an occurrence of a rising or falling edge of any of the four inputs. The number of occurrences can be set from 1 to 16,000,000. The maximum edge counting rate is 100 MHz.

TV Trigger

60 Hz / 525 lines: Source may be selected to be any one of the four inputs. Trigger level is adjustable for the selected source. Polarity is selected for positive or negative synchronizing pulses. A trigger occurs on the selected line and field of a 2/1 interlaced composite video signal. Line numbering is 1 to 263 for field 1 and 1 to 262 for field 2. This TV trigger mode is compatible with broadcast standard M.

50 Hz / 625 lines: Same as 60 Hz / 525 lines, except line numbering is 1 to 313 for field 1 and 314 to 625 for field 2. This TV trigger mode is compatible with the following broadcast standards: B,C,D,G,H,I,K,K1,L and N.

User-defined mode: Source may be selected to be any one of the four inputs. Trigger level is adjustable for the selected source. The trigger is qualified with a high or low pulse that meets a selectable time range. The trigger is an occurrence of a rising or falling edge of the source after the qualifying pulse. The time settings for the qualifier are selectable from 20 ns to 160 ms. The trigger occurrence value is selectable from 1 to 16,000,000.

NOTE: All TV trigger modes require a clamped video signal for stable triggering. Use the HP 1133A TV/Video Sync Pod to provide clamped video output that can be used with the HP 54501A's TV triggering capabilities.

Holdoff: Holdoff is adjustable in 20 ns steps from 40 ns to 320 ms. A separate holdoff setting is available for each trigger mode except DELAYED TRIGGER, which is fixed to 40 ns.

Display

DISPLAY

Data display resolution: 451 points horizontally by 256 points vertically.

Number of screens: 1, 2 or 4 screens can be selected. This allows the overlapping of channels or memories for comparison, or viewing them on up to 4 data display areas.

Display modes

Minimum persistence: One waveform data value is displayed in each horizontal position of the display. The waveform is updated as new data is acquired for a particular horizontal position.

Variable persistence: the time that each data point is retained on the display can be varied from 200 ms to 10 seconds, or it can be displayed infinitely.

Averaging: the number of averages, (n) can be specified in powers of 2, up to 2048. On each acquisition, 1/n times the new data is added to (n-1)/n of the previous value at each time coordinate. Averaging operates continuously, except for the HP-IB DIGITIZE command, for which averaging terminates at a user-specified number of averages.

Envelope: Provides a display of the running maximum and minimum voltage levels at each horizontal position of a repetitive waveform.

Graticules: The user may select full grid, axes, frame, or no graticule.

Connect-the-dots: Provides a continuous display, connecting the sample points with straight lines. Connect-the dots is operative for modes in which a single valued waveform can be connected, including AVERAGE, ENVELOPE and MINIMUM PERSISTENCE modes.

Scroll mode: The 54501A automatically selects scroll mode at time-per-division settings from 200 ms/div to 5 s/div if the scope is in AUTO mode, or if the scope is in TRIGGERED mode with the delay at the left edge of the display set is greater than or equal to 0. Scroll mode updates each data point on the displayed waveform as the data is acquired.

Delta V / Delta t

 ΔV
 Δt

Markers: dual voltage markers and dual time markers are provided. Voltage markers can be independently assigned to channels, memories, or functions.

Waveform Math

WFORM
MATH

Two independent functions are provided for waveform math. The operators are +, -, \times , VS, INVERT and ONLY. The vertical channels or any of the waveform memories can be used as operands for the waveform math. Sensitivity and offset for these functions can be adjusted independently.

Waveform Save

WFORM
SAVE

Four non-volatile waveform memories and two volatile pixel memories are provided. Waveform memories store single-valued waveforms, such as an averaged waveform. If an envelope waveform is stored to a waveform memory, it will automatically be stored with the upper waveform in one waveform memory and the lower waveform in another. Pixel memories store an entire screen of waveform data. They are very useful for storing multiple, overlapping waveforms and infinite persistence waveforms.

Automatic Parametric Measurements



Automatic Pulse Parameter Measurements:

The HP 54501A performs 16 automatic pulse parameter measurements from the front panel and additional measurements via HP-IB including ALL, OVERSHOOT and PRESHOOT. The standard measurements are performed with 10%, 50% and 90% voltage thresholds, as defined by IEEE standard 194-1977, "IEEE Standard Pulse Terms and Definitions."

User-definable Measurement Thresholds:

The HP 54501A lets you set your own thresholds for automatic measurements. Both the upper and lower thresholds can be set from 0% to 100%, as long as the upper threshold value is always greater than or equal to the lower threshold. The mid threshold is always equal to the mid-value between the upper and lower threshold.

Continuous measurements:

Can be turned on or off. With continuous measurements off, the voltage and time markers are placed on the waveform to indicate where the measurement is taken.

Measurement Statistics:

The maximum, minimum, average and most recent of continuously updated measurements are calculated and displayed. Any three measurements can be selected.

Measurement Limit Test:

Maximum and minimum limits can be set for three of the automatic measurements. These continuously updated measurements are compared to the maximum and minimum limits. If the measurements are found to be outside the defined limits, the acquisition is stopped and the waveform can be stored to a memory or the screen can be sent to a printer. In addition, an HP-IB Service Request can be generated, so a controller can be flagged to request the waveform and measurement information via HP-IB.

Setup Aids



Autoscale:

Pressing the Autoscale button automatically adjusts the vertical and horizontal deflection factors as well as the trigger level for a display appropriate to the signals applied to the inputs. The Autoscale feature requires a signal with a duty cycle greater than 0.5% and a frequency greater than 50 Hz.

Save/Recall:

Four front-panel setups (1-4) may be saved in non-volatile memory.

Recall Clear:

Resets the HP 54501A to its factory default settings.

Recall 0:

If Autoscale, ECL or TTL preset, or RECALL SETUP are inadvertently selected, RECALL 0 restores the instrument to its last state prior to selection.



Show:

Displays instrument status, including volt/div, offset, and trigger condition.

Hardcopy



The CRT display, including menus and measurement results, can be transferred directly to an HP-IB graphics printer, including the HP 2225A ThinkJet® or compatible printers.

HP-IB Programmability

Full Programmability:

The HP 54501A provides full programmability. Instrument settings and operating modes, including automatic measurements, may be remotely programmed via HP-IB (IEEE-488). HP-IB programming complies with IEEE 488.2-1988 "Standard Codes, Formats, Protocols, and Common Commands."

Data Acquisition and Transfer Rate:

A 500-point data record can be acquired and transferred to a computer at a rate of approximately 10 times per second, as tested with an HP 9000, Series 200 Controller. The acquired data was type normal, completion criteria 100%, with the oscilloscope at a time/division setting of 5 μ s/div.

Data Transfer Rates:

Approx. 120 Kbytes/s.
Probe Compensation Output: An approximately 1.5 MHz signal is provided for probe compensation. A probe-to-BNC adapter is used to connect the probe to the rear panel Probe Compensation BNC output. During calibration, this output is used to provide other calibration signals, as described in the Service Manual.

DC Calibrator Output: This output is used for vertical calibration of the HP 54501A, as described in the Service Manual.

General Characteristics

Environmental Conditions

Temperature

Operating: 0° C to + 55° C

Non-operating: - 40° C to + 70° C

Humidity

Operating: up to 95% relative humidity (non-condensing) at + 40° C

Non-operating: up to 90% relative humidity at + 65° C.

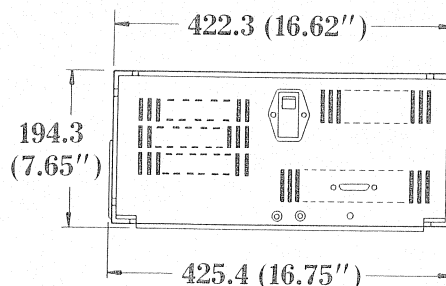
Altitude

Operating: up to 4600 meters (15 000 ft)

Non-operating: up to 15 300 meters (50 000 ft).

Dimensions

Refer to outline drawings below.



Product Support

Built-in Self-test and Calibration Routines

Internal self-test capabilities provide confidence that greater than 90% of the instrument is operating properly. Self-calibration routines, also selected through the front panel, ensure that the instrument is operating with its greatest accuracy.

Three-Year Warranty — Low Cost-of-Ownership

The HP 54501A provides a three-year warranty. HP's Blue Stripe board exchange program assures economical and timely repair of units, reducing your cost-of-ownership.

Solutions

HP's System Engineering Organization can help you configure an HP-IB system and provide software support for your application, developing solutions to meet your measurement needs. Contact your Hewlett-Packard sales and service office for more information.

Vibration:

Operating: Random vibration 5-500 Hz, 10 minutes per axis, 0.3 G(rms) Non-operating: Random vibration 5-500 Hz, 10 minutes per axis, 2.41 G(rms); Resonant search: 5 to 500 Hz swept sine, 1 Octave/minute sweep rate, (0.75g), 5 minute resonant dwell @ 4 resonances per axis.

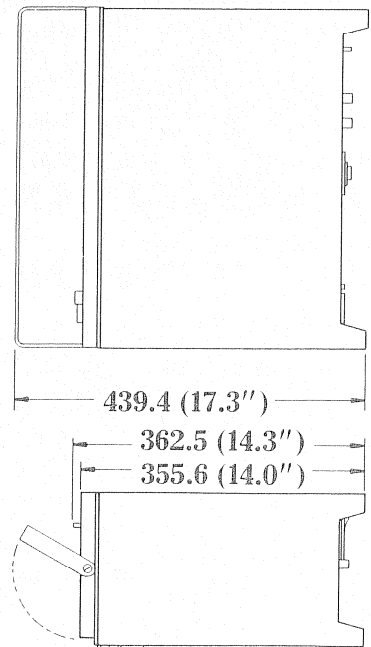
Power Requirements

Voltage: 115/230 V ac, - 25% to + 15%, 48-66 Hz. Power: 350 VA maximum.

Weight

Net: approximately 10 kg (22 lb).

Shipping: approximately 20 kg (44 lb).



Bandwidth dc-coupled Repetitive	dc to 100 MHz (-3dB)
Single Shot	dc to 1 MHz <small>(Based on 10 points per period of input signal.)</small>
ac-coupled Repetitive	10 Hz to 100MHz (-3dB)
Single Shot	10 Hz to 1 MHz <small>(Based on 10 points per period of input signal.)</small>
Risetime (calculated from: Risetime = 0.35/Bandwidth)	3.5 ns
Number Of Channels	4 (2+2) <small>Channels 2 and 3 are limited attenuator inputs, optimized for digital signals.</small>
Simultaneous Channels	2+2 <small>Channels 1 or 2 simultaneous with 3 or 4. With more than two channels, the other channels are acquired alternately in pairs.</small>
Vertical Sensitivity	Maximum 5 mV/div Minimum 5 V/div
Vertical Gain Accuracy (dc)	±1.5%
Vertical Resolution	±0.4% — 8 bit A/D <small>(Since expansion is used for 5 mV/div range, A/D resolution is 7 bits [0.8%] in that range.)</small> ±0.1% — 10 bits via HP-IB <small>(with averaging)</small>
Maximum Sample Rate	10 Msa/s
Memory Depth	501 points (display) 1024 points (via HP-IB) <small>For single-shot via HP-IB, maximum memory depth is 501 points.</small> <small>For 2ns/div time base range, memory depth is 200 points.</small> <small>For 5ns/div time base range, maximum memory depth via HP-IB is 501 points.</small>
Input RC (nominal)	1 MΩ , 16 pF
Input Coupling	ac, dc
Max Input Voltage	± 250 V DC + peak AC (<10KHz)

Offset Range	Sensitivity range	Available offset
	5 - 50 mV/div 0.1 - 1 V/div 1 - 5 V/div	±2V ±20V ±200V
Offset Accuracy	± 2% of offset + 0.2 × (V/div)	
Dynamic Range	±16 divisions from center	
<small>Operating range for dc + peak AC input.</small>		
Channel-to-channel Isolation <small>(with channels at equal sensitivity)</small>	40 db dc to 20 MHz 30 db 20 MHz to 100 MHz	
Voltage Measurement Accuracy Single Cursor	Gain Accuracy + offset accuracy + A/D resolution	
Dual Cursor <small>(single channel)</small>	Gain Accuracy + 2 × A/D resolution	
Time Base Range	Minimum 2 ns/div Maximum 5 s/div	
Time Base Accuracy	.005%	
Maximum Time Base Resolution	100 ps	
Delta t Accuracy	1 ns ±(5E-5) × Delta t ± 0.02 × (t/div) <small>Delta t accuracy for dual-cursor, single-channel measurement, or for channel-to-channel measurement after visual time null calibration has been done.</small>	
Delay Range (post-trigger)	Time Base Setting	Available Delay
	50 ms - 5 s 100 μs - 20 ms 2 ns - 50 μs	40 × (s/div) 1 s -10,000 × (s/div)
Delay Range (pre-trigger)	10 μs - 5 s 20 ns - 5 μs 2 ns - 10 ns	-40 × (s/div) -200 μs -10,000 × (s/div)
Trigger Sensitivity		
5mv/div	dc-20MHz 20MHz-100MHz	0.1 × full-scale 0.25 × full-scale
All Other	dc-20MHz 20MHz-100MHz	0.05 × full-scale 0.125 × full-scale
Trigger Pulse Width (minimum)	7 ns	
Trigger Level Range	±6 div from center	

Specifications valid for temperature range ± 10° C from calibration temperature with 8 averages selected and channel(s) in sensitivity range 1, 2 or 5

- INDICATES SPECIFIED PARAMETER
- INDICATES CHARACTERISTIC