

SECTION I

GENERAL INFORMATION

1-1. INTRODUCTION

This Service Manual contains information necessary to test, adjust, and service the Hewlett-Packard 54110D Digitizing Oscilloscope. This manual is divided into 6 sections as follows:

- I - General Information
- II - Performance Tests
- III - Adjustments
- IV - Replaceable Parts
- V - Manual Changes
- VI - Service

Information for operating, programming, and interfacing the Model 54110D is contained in the 54110D Operating and Programming Manual supplied with each instrument.

The General Information Section includes a description of the 54110D Digitizing Oscilloscope, its specifications, options, available accessories, and general installation instructions.

Also listed on the title page of this manual is a Microfiche part number. This number can be used to order 4 X 6 inch microfilm transparencies of the manual. Each microfiche contains up to 96 photo-duplicates of the manual pages. The microfiche package also includes the latest Manual Changes supplement as well as pertinent Service Notes.

1-2. SPECIFICATIONS

Table 1-1 lists the specifications for the Model 54110D. These specifications include the performance standards against which the oscilloscope is tested. Also included is Table 1-2, which lists supplemental characteristics. Supplemental characteristics are not specifications but are typical characteristics included as additional information for the user.

1-3. SAFETY CONSIDERATIONS

Safety information relevant to the service procedure being described is provided in the appropriate sections of this manual. The Model 54110D and this manual should be reviewed for safety markings and instructions before work is begun.

Table 1-1. Specifications

VERTICAL (Voltage)

Bandwidth (-3dB):¹

- with HP 54002A: dc to 1 GHz
- with HP 54001A: dc to 700 Mhz
- with HP 54003A: dc to 300 Mhz

Transition Time (10% to 90%):¹

- with HP 54002A: ≤ 350 ps
- with HP 54001A: ≤ 450 ps
- with HP 54003A: ≤ 1.2 ns

Deflection Factor (full-scale = 8 divisions):¹

- with HP 54002A: 10 mV/div to 1 V/div in 1-2-5 steps
- with HP 54001A: 100 mV/div to 10 V/div in 1-2-5 steps
- with HP 54003A: 100 mV/div to 10 V/div in 1-2-5 steps

DC Accuracy, Single Voltage Marker:¹

- with HP 54002A: $\pm 3\%$ of full-scale $\pm 2\%$ of offset²
- with HP 54001A: $\pm 6\%$ of full-scale $\pm 2\%$ of offset ± 50 mV
- with HP 54003A: $\pm 6\%$ of full-scale $\pm 2\%$ of offset ± 50 mV

DC Delta Voltage Accuracy (Two Markers On Same Channel):¹

- with HP 54002A: $\pm 1\%$ of full-scale $\pm 3\%$ of reading²
- with HP 54001A: $\pm 1\%$ of full-scale $\pm 6\%$ of reading
- with HP 54003A: $\pm 1\%$ of full-scale $\pm 6\%$ of reading

DC Offset:

RANGE: ± 1.5 x full-scale (referenced to center screen)

ADJUSTMENT RESOLUTION: adjustable in steps of 0.0025 x full-scale

Dynamic Range: deflection factor and offset should be scaled so that the unmagnified signal remains within the the full-scale display range.

Magnifier: expands displayed signal vertically from 1 to 16 times; adjustable in 0.5% steps.

Inputs: two inputs, configurable with HP 54000-series pods.

Table 1-1. Specifications (Continued)

HORIZONTAL (Time)

Deflection Factor (full-scale = 10 divisions): 100 ps/div to 1 s/div

ADJUSTMENT RESOLUTION: adjustable in 1-2-5 steps via knob and cursor keys. Adjustable to three significant figures via keypad or HP-IB command.

Delay (Time Offset):

PRE-TRIGGER RANGE: up to -200 ms or -10 divisions, whichever is greater.

POST-TRIGGER RANGE: up to +1 second or +10 divisions, whichever is greater.

ADJUSTMENT RESOLUTION: adjustable in steps of 10 ps or 10^{-6} x delay setting, whichever is greater.

Time Base Accuracy:

SINGLE-CHANNEL: $\leq (100 \text{ ps} \pm 2 \times 10^{-5} \times \text{delta T reading})$

DUAL-CHANNEL: $\leq (200 \text{ ps} \pm 2 \times 10^{-5} \times \text{delta T reading})$

TRIGGER

Trigger Source	Vertical Channel 1 or 2		
Input Pod	HP 54002A	HP 54001A	HP 54003A ³
Trigger Level Range	$\pm 2 \times \text{full-scale}$		
Trigger Level Adjustment Resolution	$0.0025 \times \text{full-scale}$		
Trigger Sensitivity DC to 100 MHz	$0.12 \times \text{full-scale}$		
Above 100 Mhz (frequency range)	$0.24 \times \text{full-scale}$ (100 MHz to 500 MHz)	$0.24 \times \text{full-scale}$ (100 Mhz to 300 Mhz)	
Pulse width > 1 ns	$0.24 \times \text{full-scale}$		

Table 1-1. Specifications (Continued)

TRIGGER (Continued)				
Trigger Source	Trigger Input 3 or 4			
Input Pod	HP 54002A	HP 54001A	HP 54003A ³	
Trigger Level Range	±2 V	±20 V		
Trigger Level Adjustment Resolution	2 mV	20 mV		
Trigger Sensitivity DC to 100 MHz	40 mV	400 mV		
Above 100 Mhz (frequency range)	80 mV (100 MHz to 500 MHz)	800 mV (100 Mhz to 500 MHz)	800 Mv (100 MHz to (300 Mhz)	
Pulse width > 1 ns	80 mV	800 mV		
<p>RMS Jitter: $\leq(50 \text{ ps} + 5 \times 10^{-7} \times \text{delay setting})$</p> <p>Trigger Source: channel 1, channel 2, trigger 3, trigger 4. Independent trigger level settings on all sources. Edge trigger on any source. Logical pattern trigger on all sources.</p> <p>Trigger 3 and 4 Input: configurable with HP 54000-series pods.</p>				
INPUTS				
	HP 54002A 50Ω Input	HP 54001A 1 GHz Miniature Active Probe	HP 54003A 1 MΩ Input, With 10:1 Probe Attached	HP 54003A 1 MΩ Input, With 10:1 Probe Removed
Maximum Input Voltage	5 V rms	20 V peak	20 V peak	2 V peak

Table 1-1. Specifications (Continued)

INPUTS (Continued)				
	HP 54002A 50 Ω Input	HP 54001A 1 GHz Miniature Active Probe	HP 54003A 1 M Ω Input, With 10:1 Probe Attached	HP 54003A 1 M Ω Input, With 10:1 Probe Removed
Coupling	dc	dc	dc	dc
Input Capacitance (Nominal)	N/A	2 pf	8 pf	10 pf
Input Resistance (Nominal)	50 Ω	10 k Ω	1 M Ω	1 M Ω
Bandwidth * (-3dB)	dc to 1 GHz	dc to 1 GHz	dc to 300 MHz	dc to 300 MHz
Transition Time * (10% to 90%)	≤ 350 ps	≤ 350 ps	≤ 1.2 ns	≤ 1.2 ns
Division Ratio *	1:1	10:1 $\pm 3\%$	10:1 $\pm 3\%$	1:1 $\pm 1\%$

CATHODE-RAY TUBE

X-RAY EMISSION: CRT emission <0.1 mR/hr; not measurable in background noise using Victoreen Model 440RF/C.

NOTES:

1. These specifications apply over ambient temperature range of +15°C to +35°C.
2. When driven from a 50 Ω source.
3. With the 10:1 divider probe supplied with the 54003A.

* Refer to VERTICAL and TRIGGER specifications for system performance specifications.

Table 1-2. Supplemental Characteristics

DIGITIZER

Resolution: 7 bits (1 part in 128). Effective resolution can be extended up to approximately 10 bits by using magnification and averaging.

Digitizing Rate: up to 40 megasamples/second.

VERTICAL

Input Protection: a relay opens when applied voltage exceeds rated input voltage for input pod in use (see Specifications).

HORIZONTAL

Delay Between Channels: difference in delay between channels can be nulled out in 10 ps steps up to 10 ns to compensate for differences in input cables or probe length.

Reference Location: the reference point can be located at the left edge, center, or right edge of the display. The reference point is that point where the time is offset from the trigger by the delay time.

TRIGGER

Input Protection: a message appears on the display when the applied voltage exceeds rated input voltage for input pod in use (see Specifications).

Holdoff

HOLDOFF-BY-EVENTS: range of events counter is from 2 to 67 million events. Maximum counting rate is 80 MHz. An event is defined as anything that satisfies the triggering conditions selected.

HOLDOFF-BY-TIME: adjustable in 10 ns steps from 70 ns to 670 ms.

Trigger Modes

EDGE TRIGGER: on any source (see Specifications, Trigger Source).

PATTERN TRIGGER: a pattern can be specified for all sources. Each source can be specified as high, low, or don't care. Trigger can occur on the last edge to enter the specified pattern or the first edge to exit the specified pattern.

Table 1-2. Supplemental Characteristics (Continued)

Trigger Modes (Continued)

TIME QUALIFIED PATTERN TRIGGER: trigger occurs on the first edge to exit the specified pattern, only if the pattern was present for less than [greater than] the specified time. Filter time is adjustable from 10 ns to 5 seconds. Filter recovery time is ≤ 8 ns. In the "Pattern present <[time]" mode, the pattern must be present ≥ 1 ns for the trigger to respond.

STATE TRIGGER: a pattern can be specified for any three sources. Trigger can be set to occur on an edge of either polarity on the source specified as the clock (not one of the pattern sources) when the pattern is present or not present. Setup time for the pattern to be present prior to the clock edge is < 4 ns; hold time is zero.

Delayed Trigger

EVENTS-DELAYED MODE: the trigger can be armed by an edge on any source, then triggered by the n th edge on any other source.

The number of events, n , can be set from 1 to $10^8 - 1$.
Maximum event counting rate is 150 MHz.

TIME-DELAYED MODE: the trigger can be armed by an edge on any source, trigger by the first edge on any other source after a specified time has elapsed. The delay time can be set from 20 ns to 5 seconds.

DISPLAY

Data Display Resolution: 501 points horizontally (full-scale) by 256 points vertically.

Data Display Formats

SPLIT SCREEN: each channel display is four divisions high.

FULL SCREEN: the two channels are overlaid. Each channel display is eight divisions high.

Display Modes

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 indefinitely.

Table 1-2. Supplemental Characteristics (Continued)

Display Modes (Continued)

AVERAGING: the number of averages can be varied from 1 to 2048 in powers of 2. 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; the average does not converge to a final value after n acquisitions.

GRATICULES: Full grid, axes with tic marks, or frame with tic marks.

DISPLAY COLORS: a default color selection is setup in the instrument. Different colors are used for Display background, Channel 1/Function 1, Channel 2/Function 2, background text, highlighted text, Advisories, Markers, overlapping waveforms and Memories. If desired, the colors used may be changed from the front panel or from HP-IB.

MEASUREMENT AIDS

Markers: dual voltage markers and dual time markers are available. Voltage markers can be assigned to either channel or to both channels, memories and functions.

Automatic Edge Finders: the time markers can be assigned automatically to any displayed edge of either polarity on either channel or both channels, memories and functions. The voltage markers establish the threshold reference for the time markers in this mode.

Automatic Pulse Parameter Measurements: the following pulse parameter measurements can be performed automatically (as defined by IEEE standard 194-1977, "IEEE Standard Pulse Terms and Definitions").

Frequency	Top magnitude
Period	Base magnitude
Pulse duration	Preshoot
Rise time	Overshoot
Fall time	RMS volts
Pulse amplitude	Duty cycle

Waveform Math: two independent functions are provided for waveform math. The operators are +, -, invert, versus and only. Either of the two vertical channels or any of the four waveform memories can be used as operands for the waveform math. If turned on, Function 1 is displayed in lieu of Channel 1 and Function 2 is displayed in lieu of Channel 2.

Table 1-2. Supplemental Characteristics (Continued)

SETUP AIDS

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

Auto-Scale: pressing Auto-Scale causes vertical and horizontal deflection factors and the trigger source to be set for a display appropriate to the signals applied to the inputs. Requires a duty cycle >0.1%, frequency >50Hz, and amplitude >20 mV peak. Operative only for relatively stable input signals.

Save-Recall: ten front panel setups may be saved in non-volatile memory. If Auto-Scale is inadvertently pressed, pressing Recall followed by Auto-Scale, restores the instrument to the state prior to the last Auto-Scale executed.

Waveform Memories: four memories are provided for storage of waveforms. Only one waveform may be stored in each of these memories. These memories can be used as sources for either measurements or functions. Two additional memories are provided to store pictures. Each of these two waveform picture memories is a pixel map of the display. Any number of waveform pictures may be written into to each picture memory. Once stored, individual waveforms cannot be accessed from the picture memories. The display of any of the six memories can be turned on or off without affecting their contents. Waveforms in memory are displayed in a different color from live waveforms.

POWER REQUIREMENTS

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

Power: 350 watts maximum, 650 VA maximum.

DIMENSIONS

Refer to outline drawing.

WEIGHT

Net: approximately 25.5 kg (56 lb).

Shipping: approximately 30.5 kg (67 lb).

Table 1-2. Supplemental Characteristics (Continued)

ENVIRONMENTAL CONDITIONS

Temperature

OPERATING: 0°C to +55°C (+32°F to +131°F).

Note: see Specification Note 1.

NON-OPERATING: -20°C to +75°C (-4°F to +167°F).

Humidity

OPERATING: up to 90% relative humidity at +40°C (+104°F).

NON-OPERATING: up to 95% relative humidity at +65°C (+149°F).

Altitude

OPERATING: up to 4600 metres (15,000 ft).

NON-OPERATING: up to 15,300 metres (50,000 ft).

Vibration: vibrated in three orthogonal axes for 15 minutes each axes; 0.38 mm (0.015 in.) peak-to-peak excursion; 5 to 55 Hz; 1 minute/octave sweep.

NOTES:

- 1. DIMENSIONS ARE FOR GENERAL INFORMATION ONLY. IF DIMENSIONS ARE REQUIRED FOR BUILDING SPECIAL ENCLOSURES, CONTACT YOUR HP FIELD ENGINEER.
- 2. DIMENSIONS ARE IN MILLIMETRES AND (INCHES).

