# OSCILLOSCOPES

## General-Purpose and Troubleshooting

### HP 54600 Series

## Performance Characteristics

### Vertical system

| | |
|---|---|
| **Channels 1 and 2** | 2 mV/div to 5 V/div |
| Accuracy[1] | ±1.5% |
| Vernier accuracy[1] | Fully calibrated: ±3% |
| Bandwidth (−3dB), ac-coupled | dc to 100/150 MHz[2]<br>10 Hz to 100/150 MHz[2] |
| Rise time | <3.5/2.33 ns[2] (calculated) |
| Coupling | dc, ac, and ground |
| **Channels 3 and 4** | 0.1 and 0.5 V/div |
| Accuracy[1] | ±1.5% |
| Bandwidth (−3dB) | dc to 100/250 MHz[2] |
| Rise time | <3.5/1.4 ns[2] (calculated) |
| Coupling | dc and ground |
| **Math functions** | CH 1 + CH 2 |
| **Cursor accuracy**[1,3] | |
| Single cursor | Vertical accuracy ±1.2% of full scale ±0.5% of position value |
| Dual cursor | Vertical accuracy ±0.1% of full scale |
| **Bandwidth limit** (channels 1 and 2) | ≈20 MHz |
| **Inversion** | CH 1 and CH 2 |
| **CMRR** | ≈20 dB at 50 MHz |
| **Dynamic range** | ±8 div from center screen |
| **Input R&C** | 1 MΩ, ≈13 pf |
| **Maximum input** | 400 V (dc + peak ac) |

### Horizontal system

| | |
|---|---|
| **Sweep speeds, main and delayed** | 5 s/div to 2 ns/div |
| **Accuracy** | ±0.01% |
| **Resolution** | 100 ps |
| **Vernier accuracy** | ±0.05% |
| **Cursory accuracy** (t and 1/f)[3] | ±0.01% ±0.2% of full scale ±200 ps |
| **Delay jitter** | 10 ppm |
| **Pre-trigger delay** (negative time) | 10 div |
| **Post-trigger delay** (trigger to start of sweep) | At least 2560 div or 50 ms. Not to exceed 100 s. |

### Delayed sweep

| | |
|---|---|
| **Main sweep** | Delayed sweep |
| 5 s/div to 10 ms/div | Up to 200 × main |
| 5 ms/div and faster | Up to 2 ns/div |

### Trigger system

| | |
|---|---|
| **Sensitivity all channels** | dc to 25 MHz, 0.35 div or 3.5 mV |
| Channels 1 and 2 | dc to 100/150 MHz[2], 1 div or 10 mV |
| Channels 3 and 4 | dc to 100/250 MHz[2], 1 div or 10 mV |
| **Sources** | HP 54601A and 54602A: Channels 1, 2, 3, 4, or line. HP 54600A: Channels 1, 2, line, and external. |
| **Coupling** | ac, dc, LF reject, HF reject, and noise reject. LF & HF: −3db at 50 kHz. |
| **Modes** | Auto, Autolevel, Normal, Single, and TV |
| **TV triggering** | TV line and field. Requires 0.5 div of composite sync for stable display (Channels 1 and 2). |
| **Holdoff** | Adjustable from 200 ns to 13 s |

### External trigger (HP 54600A only)

| | |
|---|---|
| **Range sensitivity** | ±18 V<br>dc to 25 MHz: 50 mV<br>dc to 100 MHz: 100 mV |
| Coupling | dc, HF reject and noise reject |
| Input R&C | 1 MΩ, ≈ 13 pF |
| Maximum input | 400 V (dc + peak ac) |

### X-Y operation

| | |
|---|---|
| **Z-blanking** | TTL high-blanks trace |
| **Bandwidth** | X and Y same as vertical system |
| **Phase difference** | ±3° at 100 kHz |

### Display system

| | |
|---|---|
| **Display** | 7-in raster CRT |
| **Resolution** | 255 vertical × 500 horizontal points |
| **Controls** | Front-panel intensity control |
| **Graticule** | 8 × 10 grid or frame |
| **Autostore** | Saves previous sweeps in half-bright display and the most recent sweep in full-bright display |

### Acquisition system

| | |
|---|---|
| **Max sample rate** | 20 MSa/s |
| **Resolution** | 8 bits |
| **Simultaneous channels** | Channels 1 and 2 or channels 3 and 4 |
| **Record length** | 4,000 points (2,000 points single shot) |
| **Max update rate** | 1,000,000 points/s |
| **Single shot Bandwidth** | 2 MHz, single channel<br>1 MHz, dual channel |
| **Peak detect** | 50-ns glitch capture (100-ns dual channel) at sweep speeds of 50 μs/div and greater |
| **Average** | Number of averages selectable from 8, 64, 256 |

### Advanced functions

| | |
|---|---|
| **Automatic measurements** | Continuously updated |
| Voltage | Vavg, Vrms, Vpp, Vtop, Vbase, Vmin, and Vmax |
| Time | Frequency, period, +width, −width, duty cycle, rise time, and fall time |
| Cursors | Manually or automatically placed |
| **Setup functions** | |
| Autoscale | Sets the vertical and horizontal deflection and the trigger level |
| Save/recall | 16 front-panel setups |
| Trace memory | 2 volatile pixel memories |
| **TV functions** | |
| Line counting | Delay time calibrated in NTSC and PAL line numbers |
| HP 54602A only: All-field trigger (both fields selected) | Oscilloscope triggers on the vertical sync pulse in both fields, allowing use with noninterlaced video |

### General

| | |
|---|---|
| **Power requirements** | |
| Line voltage range | 100 Vac to 240 Vac |
| Line voltage selection | Automatic |
| Line frequency | 45 Hz to 440 Hz |
| Max power consumption | 220 VA |
| **Environmental characteristics** | Meets the requirements of MIL-T-28800D for type III, class 3, style D equipment as described later in this table |
| **Ambient temperature** | |
| Operating | −10° C to +55° C |
| Nonoperating | −51° C to +71° C |
| **Humidity**[4] | |
| Operating | 95% RH at 40° C for 24 h |
| Nonoperating | 90% RH at 65° C for 24 h |
| **Altitude** | |
| Operating | To 4,500 m (15,000 ft) |
| Nonoperating | To 15,000 m (50,000 ft) |
| **EMI (Commercial)**<br>**EMI (MIL-T-28800D)** | Meets FTZ 1046 class B |
| CE01, CE03, CE07 | Full limits |
| CS01, CS02, CS06 | Full limits |
| RE01 | 15 dB relaxtion to 20 kHz; exceptioned from 20 kHz to 50 kHz |
| RE02<br>With Opt 002 installed | Full limits of class A1e and A1f |
| Without Opt 002 installed | 10-dB relaxation from 14 kHz to 100 kHz |
| RS02 | Exceptioned |
| RS03<br>With Opt 001 installed | Slight trace shift from 80 MHz to 200 MHz |
| **Vibration** | Operating 15 min along each of the 3 major axes: 0.025-in peak-to-peak displacement 10 Hz to 55 Hz in 1-min cycles. Held for 10 min at 55 Hz (4 g at 55 Hz). |
| **Shock** | Operating 30 g, 1/2 sine, 11-ms duration, 3 shocks/axis along major axis. Total of 18 shocks. |
| **Size** (excluding handle) | |
| Width | 322 mm (12.7 in) |
| Height | 172 mm (6.8 in) |
| Depth | 317 mm (12.5 in) |
| **Weight** | 6.2 kg (14 lbs) |
| **Safety** | CSA certification, IEC 348 |

[1] Temperature is ±10° C from calibration.
[2] Use full scale of 80 mV for 2 mV/div and 5 mV/div ranges.
[3] Use full scale of 50 ns for 2 ns/div.
[4] Tested to Hewlett-Packard environmental specification section 758 for class B-1 products.
[5] Second number is characteristic for the HP 54602A only.

## HP 54655A and 54656A Test Automation Modules Operating Characteristics

The characteristics that follow apply to HP 54600 Series oscilloscopes with the module installed.

| | |
|---|---|
| **Trace memories** | 2, nonvolatile |

### Step sequencing

| | |
|---|---|
| **Number of steps** | 100, nonvolatile |
| **Instrument setup** | Entire front-panel setup. When mask template testing is used, automatic measurements will not be displayed. |
| **Messages** | Label (60 characters); pass, fail min, and fail max messages (30 characters each) |
| **Branching** | Branch based on the test result of pass, fail min, or fail max. |
| **Operator-access permission** | None: Mode allows use of only soft keys for sequencing.<br>Adjust: Mode allows use of soft keys, V/div knobs, position knobs, delay knob, and time/div knob.<br>All: Mode allows use of all keys and knobs. |
| **Sequencing control** | 3 soft keys control the sequencing: Next, Previous, and Reset. |
| **Editing** | Copy a single step or mask template to a destination step. |

### Mask template testing

| | |
|---|---|
| **Number of mask templates** | 40, nonvolatile |
| **Mask template generation** | Automask generates mask templates from Autostore data with variable tolerance; mask editor allows pixel-by-pixel editing and line-drawing editing; smooth mask function performs a running average of 3 pixels. |
| **Test region** | Pixel-by-pixel selectable |
| **Adjust mode** | Adjustment mode is optimized for fastest screen update; some of the displayed data may not be tested. |
| **Fail region** | Inside: Signal fails if it falls inside the region bounded by the max and min limit line.<br>Outside: Signal fails if it falls outside the region bounded by the max and min limit lines. |
| **Failure indication** | Failure-zone indicator shows where the signal fails the mask template. |

### Hard-copy output

| | |
|---|---|
| **Printer/plotter supported** | HP ThinkJet, HP QuietJet, HP PaintJet, or HP LaserJet printer; HP-GL–compatible plotter.<br>HP 54656A only: Epson FX-80 or compatible printer. |

### RS-232 configurations

| | |
|---|---|
| **Connector type** | With adapter cable connected, the end of the cable is a 25-pin DTE port. A printer cable is required to connect to either hard-copy devices or computer. |
| **Protocols** | XON/XOFF, hard wire |
| **Data bits** | 8 |
| **Stop bits** | 1 |
| **Parity** | None |
| **Baud rates** | 1200, 2400, 9600, 19200 |

### Programmability

All instrument settings and operating modes may be remotely programmed via RS-232 or HP-IB (IEEE 488).

### Input/output (HP 54656A only)

| | |
|---|---|
| **Input lines** | 2 lines for remote control of the Next, Previous, and Reset functions during sequencing. |
| **Output lines** | 5 output lines definable in each step. Selections are on, off, pulse at start of step, pulse at end of step, pass, fail, fail min, and fail max. Output level is 0–5 V; output resistance is 120 Ω max. Output current is ≃24 mA. |

## HP 54657A and 54658A Measurement/Storage Modules Operating Characteristics

The characteristics that follow apply to HP 54600 Series oscilloscopes with the module installed.

### Automatic measurements

| | |
|---|---|
| **Voltage** | Vamp, Vavg, Vrms, Vpp, Vpre, Vovr, Vtop, Vbase, Vmin, and Vmax |
| **Time** | Delay, duty cycle, frequency, period, phase angle, rise time, fall time, +width, and −width |
| **Thresholds** | User selectable among 10%/90%, 20%/80%, or absolute voltage levels |
| **Measurement formats** | Voltage, time, percentage, and phase angle |
| **Waveform math functions** | Addition, subtraction, multiplication, differentiation, integration, and FFT. |

### Mask template testing

| | |
|---|---|
| **Number of mask templates** | 2, nonvolatile |
| **Mask generation** | Automask generates mask template from displayed data with variable tolerance. Mask editor allows pixel-by-pixel editing. |
| **Test region** | Pixel-by-pixel resolution |
| **Fail region** | Inside: Signal fails if it falls inside the region bounded by the max and min limit lines.<br>Outside: Signal fails if it falls outside the region bounded by the limit lines. |
| **Failure indication** | Failure-zone indicator shows where the signal fails the mask template. |

### Trace memory (all nonvolatile)

| | |
|---|---|
| **Locations 1–3** | High-speed storage without compression |
| **Locations 4–100** | Storage with compression; number of traces is a function of complexity. Storage time is approximately 7 s. |
| **Real-time clock** | 24-h format with battery backup. Can be set from front panel. |

### Hard-copy output

| | |
|---|---|
| **Printer/plotter supported** | HP ThinkJet, HP QuietJet, HP PaintJet, or HP LaserJet printer; HP-GL–compatible plotters.<br>HP 54658A only: Epson FX-80 or compatible printer |

### Programmability

All instrument settings and operating modes may be remotely programmed via RS-232 or HP-IB (IEEE 488).

### RS-232 configurations (HP 54658A only)

| | |
|---|---|
| **Connector type** | 25-pin DTE port; a printer cable is required to connect with hard-copy devices or with a computer. |
| **Protocols** | XON/XOFF, hard wire |
| **Data bits** | 8 |
| **Stop bits** | 1 |
| **Parity** | None |
| **Baud rates** | 1200, 2400, 9600, 19200 |

# OSCILLOSCOPES

## General Purpose and Troubleshooting

### HP 54600 Series

| Ordering Information | Price |
|---|---|
| **HP 54600A** Two-Channel, 100-MHz Oscilloscope<br>Includes two 1.5 m 10X probes (10071A), operating and service manual, and line cord. | $2,495 ☎ |
| **HP 54601A** Four-Channel, 100-MHz Oscilloscope<br>Includes two 1.5 m 10X probes (10071A), operating and service manual, and line cord. | $2,895 ☎ |
| **HP 54602A** Four-Channel, 150-MHz Oscilloscope<br>Includes two 1.5 m 10X probes (10071A), operating and service manual, and line cord. | $3,270 ☎ |
| **Accessories** | |
| **HP 54650A** HP-IB Interface Module | $475 ☎ |
| **HP 54651A** RS-232 Interface Module | $475 ☎ |
| **HP 54652A** Parallel Interface Module | $275 ☎ |
| **HP 54653A** ScopeLink Software | $200 ☎ |
| **HP 54654A** Operator's Training Kit | $200 |
| **HP 54655A** Test Automation Module with HP-IB Interface | $750 ☎ |
| **HP 54656A** Test Automation Module with RS-232 Interface | $800 ☎ |
| **HP 54657A** Measurement/Storage Module with HP-IB Interface | $750 ☎ |
| **HP 54658A** Measurement/Storage Module with RS-232 Interface | $750 ☎ |
| **HP 10079A** CRT Trace Camera | $595 |
| **HP 10070A** 1.5 m 1X Probe | $55 |
| **HP 85901A** ac Power Source | $1,290 ☎ |
| **Options** | |
| **Opt 101** Accessory Pouch and Front-Panel Cover (HP 10098A) | $50 ☎ |
| **Opt 102** Two Additional 10071A Probes (HP 54601A, 54602A only) | $110 |
| **Opt 103** Operator's Training Kit (HP 54654A)<br>Consists of a training signal board and lab workbook. After completing these labs, an operator will be able to make measurements and operate the oscilloscope without any additional training. | $200 |
| **Opt 104** Carrying Case (HP 5041-9409)<br>Designed to protect the oscilloscope for shipment or for checking as airline baggage. | $290 |
| **Opt 105** ScopeLink Software (HP 54653A)<br>MS-DOS® software that interfaces the scope (with either HP-IB or RS-232 module installed) to a PC for storage, analysis, or easy integration of waveform data into desktop publishing software. | $200 |
| **Opt 090** Delete Probes | – $110 |
| **Opt 908** Rackmount Kit (HP 5062-7345)<br>7-in EIA standard rack | $255 ☎ |
| **Opt W50** Additional Two-Year Warranty (for a total of five years) | |
| **HP 54600A** | $45 |
| **HP 54601A** | $45 |
| **HP 54602A** | $85 |

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☎ For off-the-shelf shipment, call 800-452-4844.

### For the Educators

These oscilloscopes are ideally suited for classroom use. Contact your local Hewlett-Packard sales office for details on specific education discount programs.

## HP 54600 Interfacing and Hard Copy Output Information

### Compatibility Chart

The following table describes the devices supported by the HP 54600 Series oscilloscopes

| | HP-IB modules | RS-232 modules | Parallel modules |
|---|---|---|---|
| HP-PCL Printers | Yes | Yes | Yes |
| HP-GL Plotters | Yes | Yes | N/A |
| Epson Printers (FX-80 or Compatible) | Yes | Yes | Yes |
| Computers | Yes | Yes | N/A |

| Ordering Information | Price |
|---|---|
| **HP Printers and Plotters** | |
| **HP 2225A** ThinkJet Printer | $595 |
| **HP 2227A** QuietJet Printer | $849 |
| **HP 33481A** LaserJet IIIP Printer | $1,595 |
| **HP 7440A** Color Pro Plotter | $1,395 |
| **HP 7475A** Plotter | $1,995 |
| **HP-IB Cables** | |
| **HP 10833A** 1 m Cable | $80 |
| **HP 10833B** 2 m Cable | $90 |
| **HP 10833C** 4 m Cable | $100 |
| **HP 10833D** 0.5 m Cable | $80 |
| **RS-232 Cables** | |
| **For connection to printers and plotters:** | |
| **HP 13242G** 5 m, 25 Pin (M) to 25 Pin (M) | $49 |
| **HP 17255M** 1.5 m, 25 Pin (M) to 25 Pin (M) | $44 |
| **For connection to IBM PC/XT computers:** | |
| **HP 17255D** 1.5 m, 25 Pin (M) to 25 Pin (F) | $44 |
| **HP 92219J** 5 m, 25 Pin (M) to 25 Pin (F) | $61 |
| **For connection to HP Vectra computers:** | |
| **HP 24542G** 3 m, 25 Pin (M) to 9 Pin (F) | $45 |
| **Parallel Cable** | |
| **HP 92284A** Cable | $39 |