

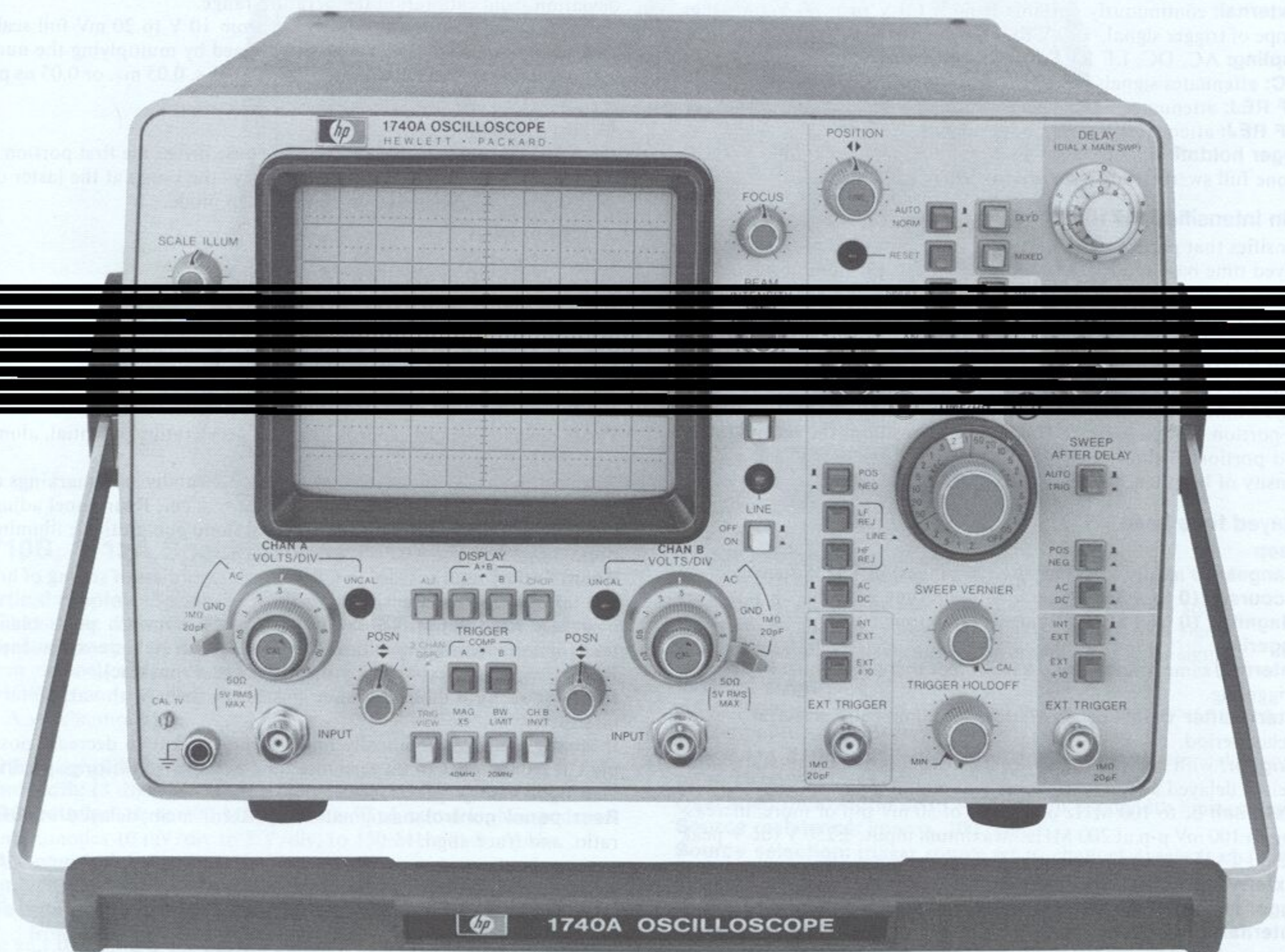
# OSCILLOSCOPES

## 100 MHz, dual channel, variable persistence/storage

### Models 1740A & 1741A

- Dual channel, 5 mV/div to 100 MHz
- 3rd Channel trigger view
- Selectable input impedance

- 100 cm/ $\mu$ s storage writing speed (1741A)
- Single shot auto-store (1741A)
- Auto-erase (1741A)



## 1740A, 1741A (new) Description

### Introduction

The Hewlett-Packard Model 1740A and 1741A 100 MHz, 5 mV/div, dual-channel oscilloscopes offer the high performance necessary to meet the demanding requirements of both laboratory and field applications. The 1740A/1741A have the performance and features to make accurate measurements with ease. The carefully designed front panel includes a large, high-resolution CRT with logically arranged controls which reduce operator learning time and make repetitive measurements easier. Several features that make these oscilloscopes more versatile than the average 100 MHz portable oscilloscope include a third channel trigger view for viewing the external trigger signal with both vertical channels; an X5 vertical magnifier for 1 mV/div deflection factors on both channels; selectable input impedance (1 M $\Omega$ /50 $\Omega$ ) for general purpose probing and precise rise time measurement; and in the 1740A a Logic State Display option for convenient switching between logic state and electrical analysis.

### 1740A 8 x 10 cm CRT

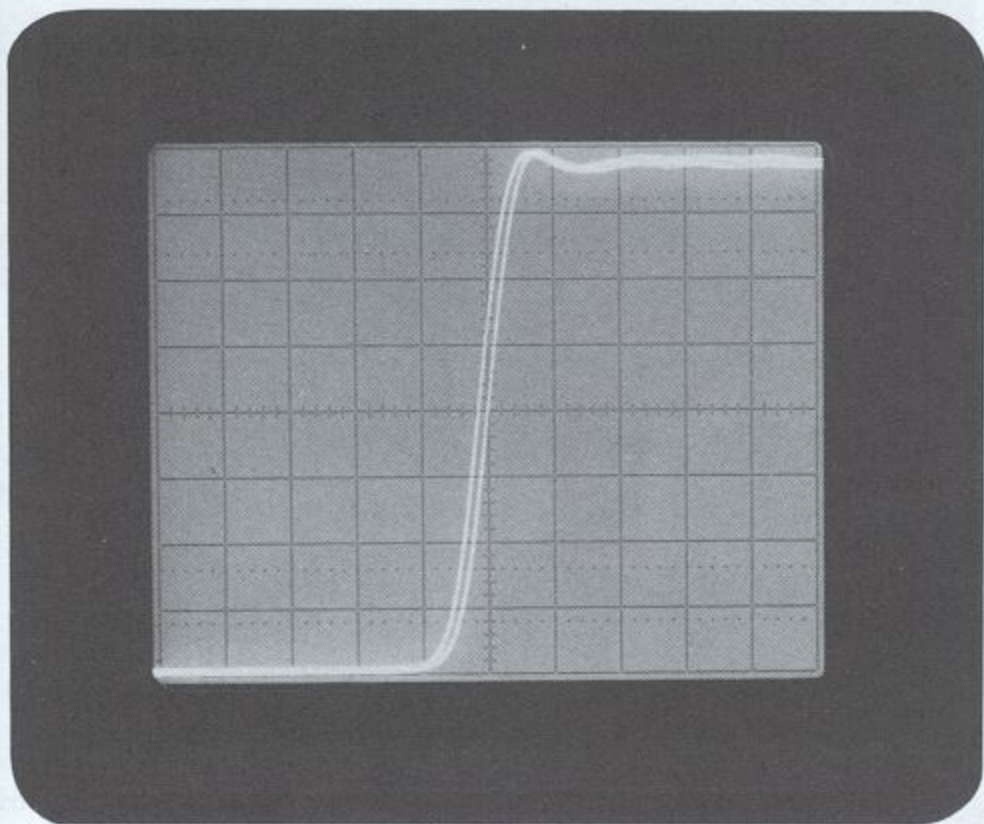
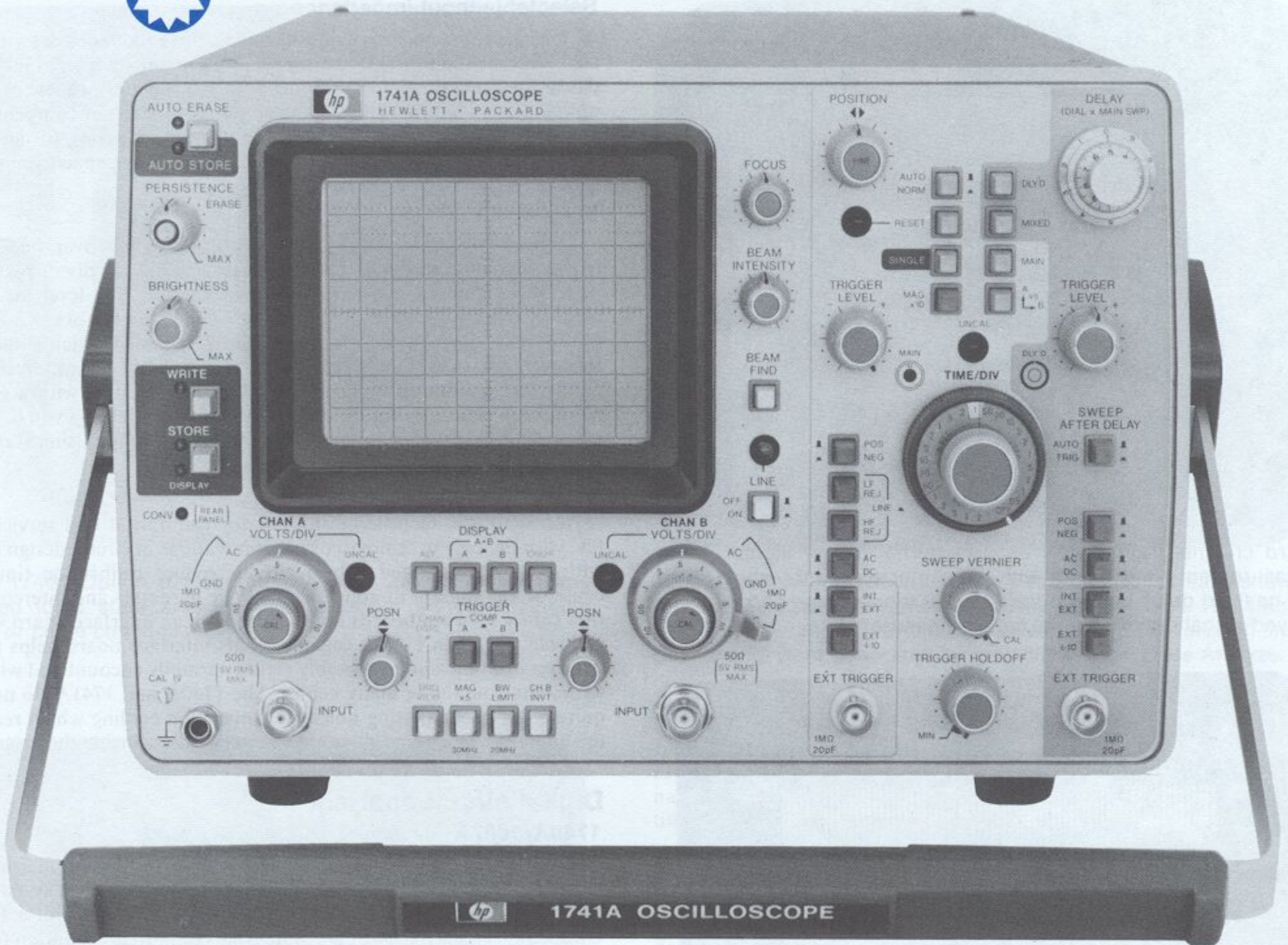
The CRT has a crisp, bright trace over the fully specified 8 x 10 cm display area. An accelerating potential of 15 kV makes the display

compatible with the 5 ns/cm sweep speeds for easier viewing of low rep rate, fast transition time signals. The small spot size of the lab quality CRT along with the no parallax internal graticule makes critical and difficult timing measurements easier to perform. An internal floodgun uniformly illuminates the CRT phosphor for high quality trace photos with a sharp well defined internal graticule.

### 1741A Storage CRT

The Hewlett-Packard storage and variable persistence CRT offers a well defined trace with a storage writing speed of greater than 100 cm/ $\mu$ s and a burn resistant storage surface which is ideal for digital and general purpose applications. Storage operation is extremely easy with indicators that clearly show the mode of operation. A press of the store pushbutton automatically switches the 1741A to a deep store mode, with no screen illumination, for maximum storage time. Another press of the store pushbutton displays the stored trace.

For viewing low rep rate fast rise time signals, the variable persistence mode allows you to adjust the trace for an optimum display. By adjusting the persistence to match the rep rate you can integrate a trace to provide a sharp, clear display for accurate measurements of low duty-cycle pulse trains such as those from disc, tape, or drum peripheral units.



Exceptionally fine trace in the variable persistence mode permits high resolution timing measurements as shown with this dual trace, alternate sweep display at a sweep speed of 5 ns/div.

For maximum convenience in single-shot applications, an auto-store mode which operates in the single-shot mode, makes it easy to capture random events. To prevent the possibility of recording the wrong event, the 1741A automatically switches to the Normal triggering mode when single-shot mode of operation is selected. When your event occurs, the 1741A triggers and automatically switches from the Write mode to the Store mode which is shown by the indicators. To view the signal, a press of the Store/Display pushbutton displays your trace. For convenience, a push of the Erase pushbutton erases the CRT and resets the time base.

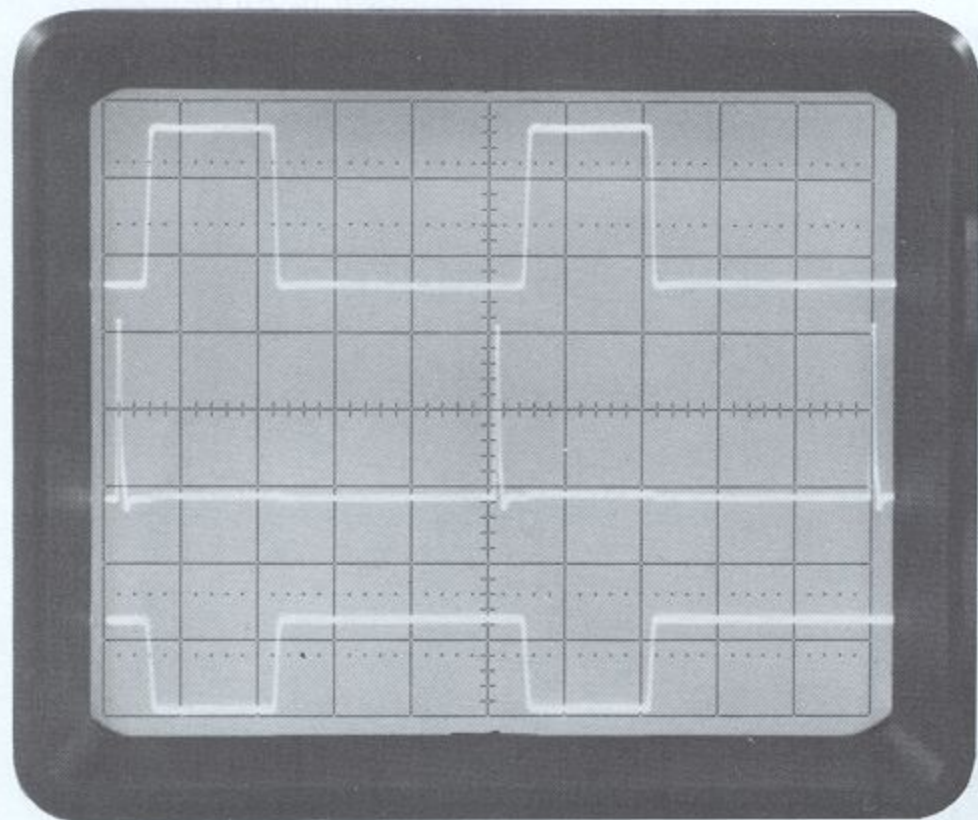
An auto-erase mode allows the 1741A to operate as if it is in a repetitive, single-shot mode even when a continuous signal is available. When in the auto-erase mode, the 1741A automatically switches to maximum persistence which provides maximum trace retention between erasures. This mode is convenient for setup of single-shot events by making it easier to obtain the optimum focus and intensity for a particular signal. Additionally, if you are displaying more than one trace, such as two or three channels, the 1741A will wait for the required number of sweeps to be displayed before automatically erasing the display.

### 3rd channel trigger view

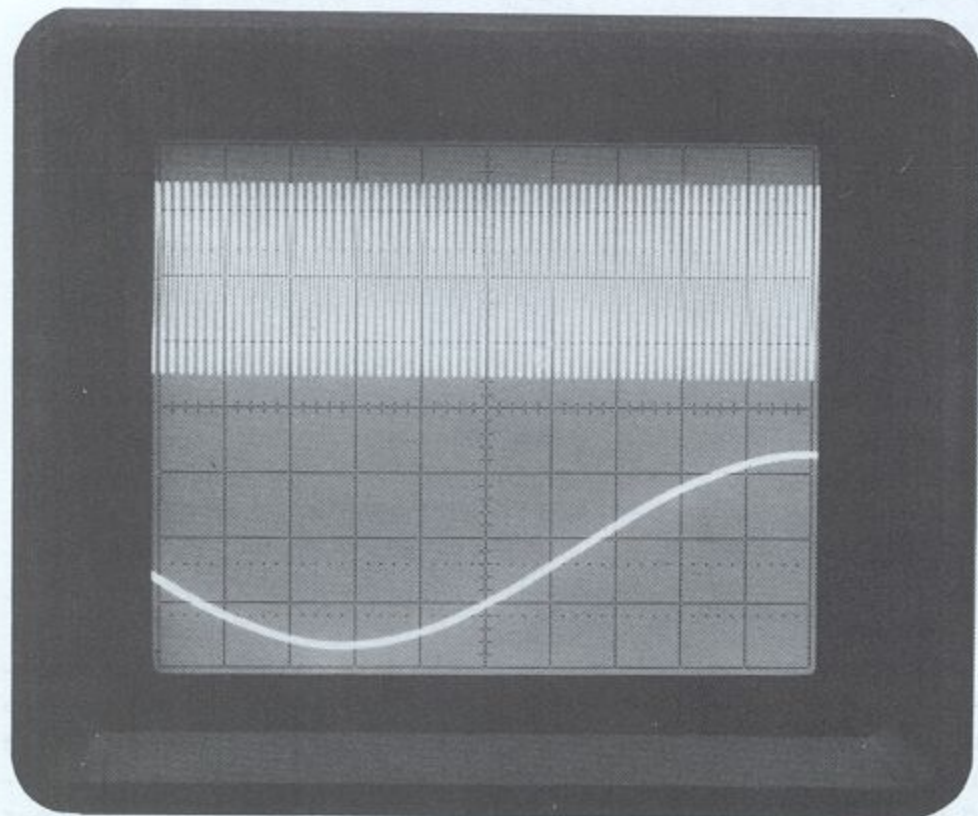
In many applications, especially in digital circuits, it is necessary to use external trigger sources to maintain proper timing relationships and to know the time relationship of the trigger signal to the displayed events. By pressing the Trigger View pushbutton while in al-

# OSCILLOSCOPES

## Model 1740A (cont.)



Third channel trigger view of the external trigger signal offers measurement convenience with the center screen threshold. The 2.5 ns fixed delay between the external trigger input and the displayed signal permits easier timing measurements.



Triggering ability on two signals widely separated in frequency is clearly shown with these signals which have a ratio of 1000 to 1 while triggering in the composite mode.

ternate or chop mode, the external trigger signal is displayed as a third channel with the trigger threshold at center screen. By adjusting the trigger level control, you can see which portion of the trigger signal is initiating the sweep. With the External Trigger input in the 1:1 mode, the deflection factor is 100 mV/div which is compatible with ECL levels and in the  $\div 10$  mode is 1 V/div which is compatible with TTL levels.

### Stable flexible triggering

Stable internal triggering to greater than 100 MHz requires only 1 div of vertical deflection. To prevent annoying trace shift, the internal trigger sync take-off is immediately after the attenuator which maintains a stable display regardless of changes in position, vernier, or polarity controls. A full complement of easy-to-use pushbutton trigger controls assures you of the desired trigger signal conditioning for your measurement. In the external mode, triggering to 100 MHz only requires 100 mV and 50 mV to 50 MHz.

### Selectable input impedance

For maximum measurement flexibility, these scopes have switch-selectable 1 megohm or 50 ohm inputs. This permits a high input impedance for general purpose probing with 10:1 divider probes for minimum circuit loading. The 50 ohm input with internal compensation and low reflections provides faithful pulse reproduction for accurate transition time measurements in circuits where low capacitive loading is required.

### Vertical amplifiers

Vertical deflection factors are 5 mV/div to 20 V/div over the full 100 MHz bandwidth, full temperature range, and  $8 \times 10$  div display area with 3% attenuator accuracy. For two channel low level measurements requiring 1 mV/div and 2 mV/div deflection factors to 30 MHz (40 MHz in the 1740A), a X5 magnifier is included which eliminates the need for cascading. This low level capability permits measurements on tape and disc heads or power supply ripple with a convenient front panel pushbutton. The 20 V/div setting allows you to make convenient measurements of power line signals while using standard 10:1 divider probes.

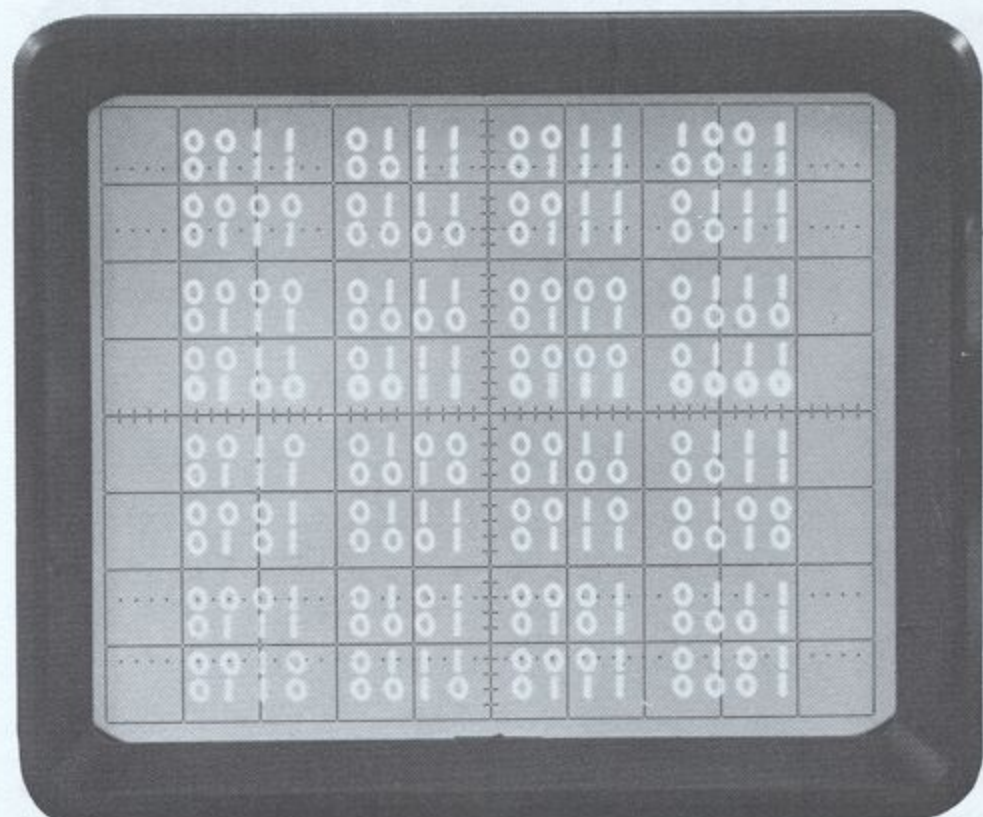
### Serviceability

Access to the uncluttered interior for calibration and servicing is fast with the easy to remove covers. Innovations in circuit design along with custom integrated hybrid circuits reduce calibration time because of a minimum of adjustments. Wire harnesses and interconnection cables between boards are reduced with an interface board which connects the main boards together. This interface board helps to reduce service time and reassembly errors normally encountered with instruments containing many cables. The 1740A and 1741A do not require a fan or ventilating holes for convection cooling which reduces the amount of dust and dirt that can accumulate inside the scope.

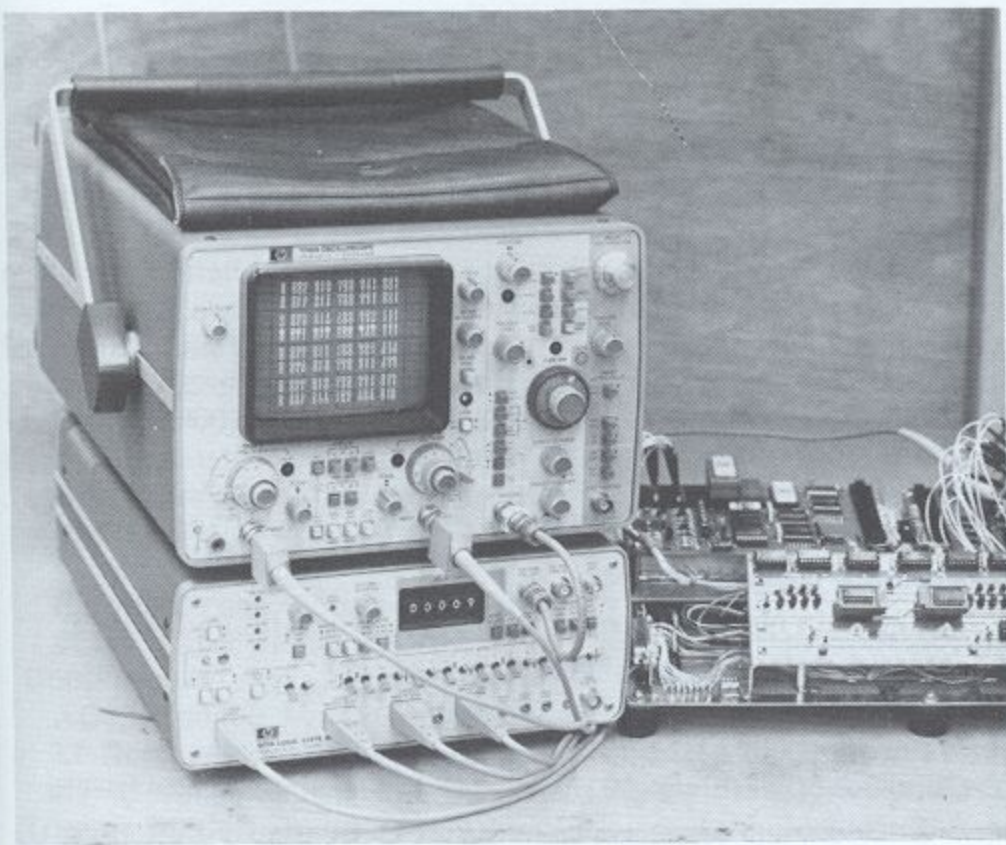
### Digital circuit analysis

#### 1740A/1607A

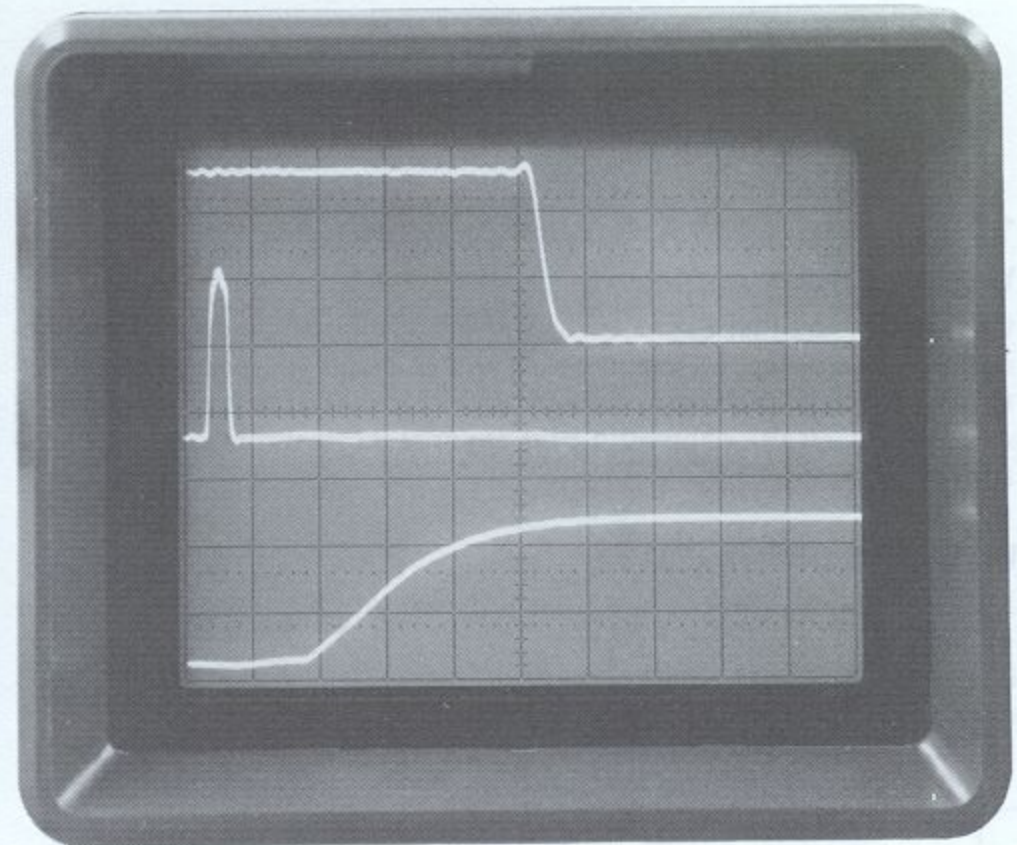
With the increasing use and complexity of digital circuits in new products, the debugging and troubleshooting of a digital system can be very difficult. The Hewlett-Packard 1740S, consisting of a 1740A Option 101 and a 1607A Logic State Analyzer, offers a solution to digital troubleshooting with the combination of logic state and electrical analysis. The 1740A Logic State Display option adds rear-panel inputs with internal switching circuits for single pushbutton switching between the standard front panel inputs and the rear panel state display inputs without changing cables. This single pushbutton switch-



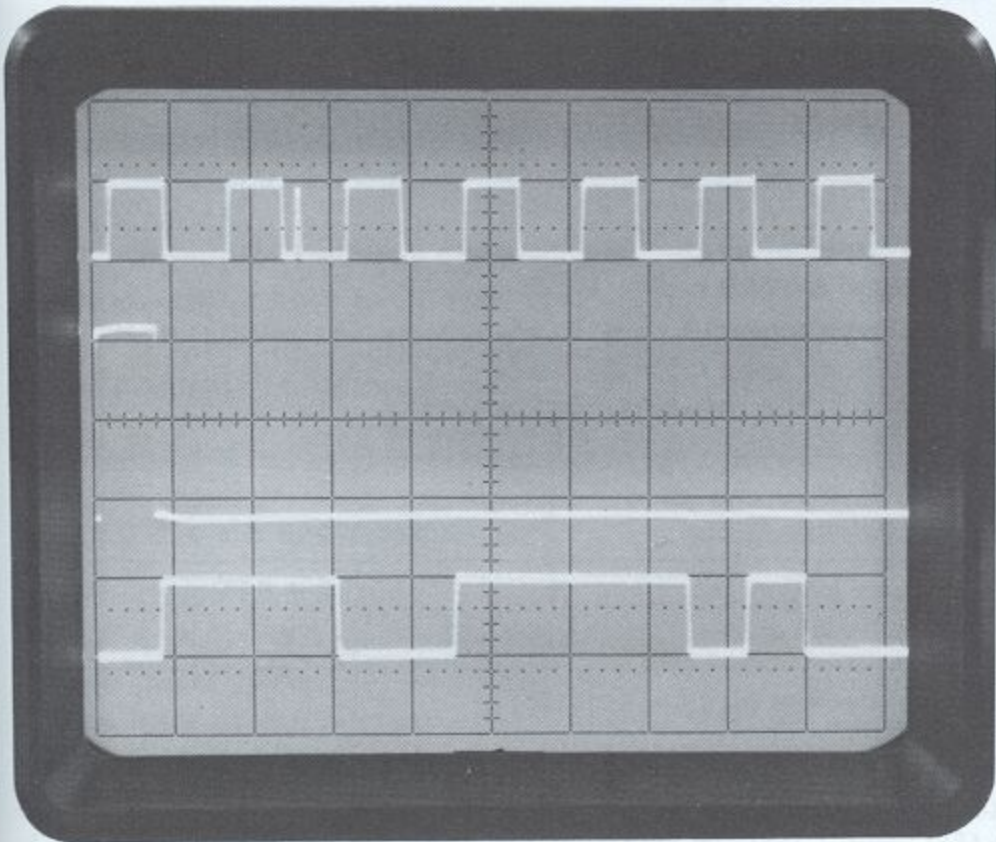
Word triggering with the Analyzer's digital memory and digital delay permits viewing events leading up to and following the trigger word for faster troubleshooting.



Model 1740A Option 101 offers convenient one button switching between logic state and electrical analysis without changing probe or cable connections.



Time relationship of two very low rep rate signals is clearly shown with the variable persistence capability of the 1741A. The stable triggers required for this alternate sweep display to maintain time relationship were generated by the 1600A Logic State Analyzer.



Analog display of digital data shows race condition pulse (top trace) which is defined in time by the 3rd channel trigger view. With the trigger signal defined by a 16-bit word you know when the problem occurs to reduce troubleshooting time.

ing capability is very useful when digital word-flow errors require analysis of electrical parameters to determine corrective measures.

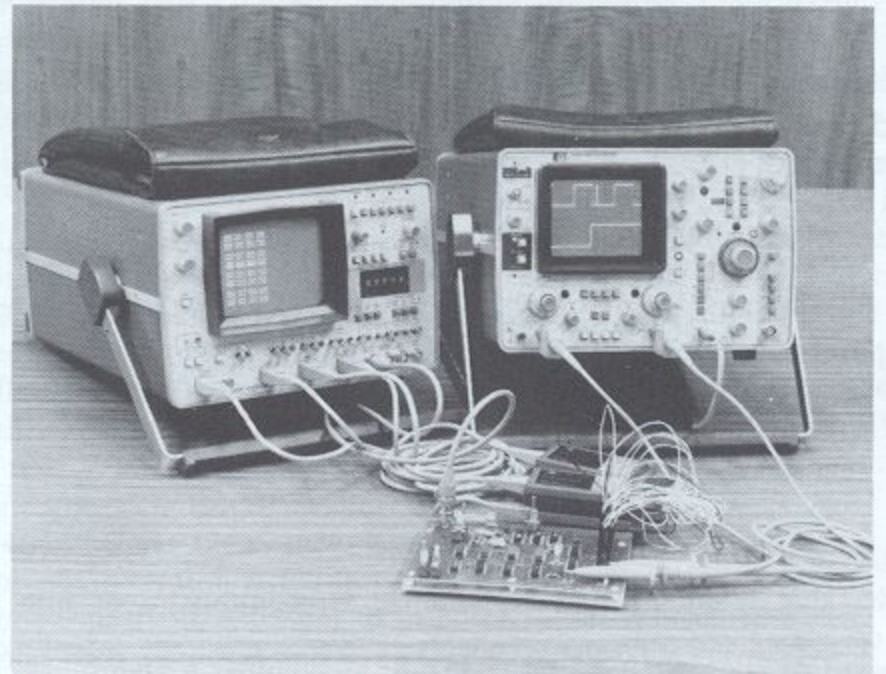
The 1607A's digital Delay mode makes it possible to position the 16 word oscilloscope display window a desired number of clock pulses from the trigger word. The Delay mode coupled with the End Display mode allows you to monitor the events that lead up to and follow a fault. By comparing the algorithm with the data display, erroneous operation is quickly identified.

Switching to the electrical analysis mode permits probing of the cir-

cuit nodes to determine if an electrical problem exists that could be causing the machine to improperly execute an instruction. This internal switching between state and electrical analysis requires no resetting of controls or changing of cables.

#### 1741A/1600A

Combining the variable persistence and storage capabilities of the 1741A with the 1600A Logic State Analyzer's real time analysis of data flow provides the ideal instruments for both design and troubleshooting applications in digital environments. A pattern trigger and/or digital delay output from the 1600A allows synchronization of the word-format display with the 1741A's display of the digital signal's electrical characteristics. In addition, the 1600A offers a map mode of operation that provides an overall view of machine operation and aids in locating lost programs.



Using the 1600A Logic State Analyzer in conjunction with the 1741A permits simultaneous monitoring of digital data flow and electrical analysis to determine improper circuit operation.

# 1740A and 1741A Specifications

## Vertical display modes

Channel A; channel B; channels A and B displayed alternately on successive sweeps (ALT); channels A and B displayed by switching between channels at an approximate 250 kHz rate with blanking during switching (CHOP); channel A plus channel B (algebraic addition); and trigger view.

## Vertical amplifiers (2)

Bandwidth and Rise Time at all deflection factors from 0°C to +55°C.

**Bandwidth:** (1740A) 3 dB down from 8 div reference signal; (1741A) 3 dB down from 6 div reference signal.

**DC-coupled:** dc to 100 MHz in both 50Ω and 1 MΩ input modes.

**AC-coupled:** approx. 10 Hz to 100 MHz, 1 Hz with 10:1 divider probes.

**Bandwidth limit:** limits upper bandwidth to approx. 20 MHz.

**Rise Time:** ≤3.5 ns measured from 10% to 90% points of a 6 div input step.

### Deflection factor

**Ranges:** 5 mV/div to 20 V/div (12 calibrated positions) in 1, 2, 5 sequence, accurate within 3%.

**Vernier:** continuously variable between all ranges, extends maximum deflection factor to at least 50 V/div. UNCAL light indicates when vernier is not in the CAL position.

**Polarity:** channel B may be inverted, front panel pushbutton.

**Delay line:** input signals are delayed sufficiently to view leading edge of input pulse without advanced trigger.

**Input coupling:** selectable AC or DC, 50Ω (dc), or ground. Ground position disconnects input connector and grounds amplifier input.

### Input RC (selectable)

**AC or DC:** 1 MΩ ±2% shunted by approx. 20 pF.

**50 ohm:** 50Ω ±3%.

### Maximum input

**AC or DC:** 250 V (dc + peak ac) or 500 V p-p at 1 kHz or less.

**50 ohms:** 5 V rms.

### A+B operation

**Amplifier:** bandwidth and deflection factors are unchanged; channel B may be inverted for A-B operation.

**Differential (A-B) common mode:** CMRR is at least 20 dB from dc to 20 MHz. Common mode signal amplitude equivalent to 8 divisions with one vernier adjusted for optimum rejection.

## Vertical magnification (X5)

**Bandwidth:** 3 dB down from 8 div reference signal.

**DC-coupled:** (1740A) dc to approx. 40 MHz; (1741A) dc to approx. 30 MHz.

**AC-coupled:** (1740A) approx. 10 Hz to 40 MHz; (1741A) approx. 10 Hz to 30 MHz.

**Rise time:** (1740A) ≤9 ns, (1741A) ≤12 ns (measured from 10% to 90% points of 8 div input step).

**Deflection factor:** increases sensitivity of the 5 and 10 mV/div deflection factor settings by a factor of 5 for a maximum sensitivity of 1 mV on channels A and B.

## Trigger source

Selectable from channel A, channel B, composite, or line frequency.

**Channel A:** all display modes triggered by channel A signal.

**Channel B:** all display modes triggered by channel B signal.

**Composite:** all display modes triggered by displayed signal except in Chop. In Chop mode trigger signal is derived from channel A.

**Line frequency:** trigger signal is derived from power line frequency.

## Trigger view

Displays internal or external trigger signal. In Alternate or Chop mode, channel A, channel B, and the trigger signals are displayed. In channel A or B mode, Trigger View overrides that channel. Internal trigger signal amplitude approximates vertical signal amplitude. External trigger signal deflection factor is approx. 100 mV/div or 1 V/div in EXT ÷10. Triggering point is approx. center screen. With identically timed signals to a vertical input and the Ext trigger input, trigger signal delay is 2.5 ns ±1 ns.

## Horizontal display modes

Main, main intensified, mixed, delayed, mag X10, and A vs. B.

## Main and delayed time bases

### Ranges

**Main:** 50 ns/div to 2 s/div (24 ranges) in 1, 2, 5 sequence.

**Delayed:** 50 ns/div to 20 ms/div (18 ranges) in 1, 2, 5 sequence.

### Accuracy

Sweep Time/Div	*Accuracy		Temp Range
	X1	X10	
50 ns to 20 ms	±3%	±4%	0°C to +15°C +15°C to +35°C +35°C to +55°C
	±2%	±3%	
	+3%	+4%	

\*Add 1% for 50 ms to 2 s ranges.

**Main sweep vernier:** continuously variable between all ranges, extends slowest sweep to at least 5 s/div. UNCAL light indicates when vernier is not in CAL position.

**Magnifier (X10):** expands all sweeps by a factor of 10, extends fastest sweep to 5 ns/div.

## Calibrated sweep delay

**Delay time range:** 0.5 to 10 × Main Time/Div settings of 100 ns to 2 s (minimum delay 150 ns).

## Differential time measurement accuracy

Main Time Base Setting	*Accuracy (+15°C to +35°C)
100 ns/div to 20 ms/div	±(0.5% + 0.1% of full scale)
50 ms/div to 2 s/div	±(1% + 0.1% of full scale)

\*Add 1% for temperatures from 0°C to +15°C and +35°C to +55°C.

**Delay jitter:** <0.002% (1 part in 50 000) of maximum delay in each step from +15°C to +35°C; <0.005% (1 part in 20 000) from 0°C to +15°C and +35°C to +55°C.

## Triggering

### Main sweep

**Normal:** sweep is triggered by internal or external signal.

**Automatic:** bright baseline displayed in absence of input signal. Above 40 Hz, triggering is same as normal. For stable triggering at approx. 40 Hz and below, use Normal triggering.

**Single:** automatically switches triggering to Normal and the sweep occurs once with same triggering as Normal, reset pushbutton arms sweep and lights indicator. (1741A) Single sweep is also initiated with Erase pushbutton, sweep is armed after the erase cycle.

### Delayed sweep (sweep after delay)

**Auto:** delayed sweep automatically starts at end of delay.

**Trig:** delayed sweep is armed and triggerable at end of delay period.

**Internal:** dc to 25 MHz on signals causing 0.3 divisions or more vertical deflection increasing to 1 division of vertical deflection at 100 MHz in all display modes (required signal level is increased by 2 when in

Chop mode and by 5 when X5 vertical magnifier is used). Triggering on Line frequency is also selectable.

**External:** dc to 50 MHz on signals of 50 mV p-p or more increasing to 100 mV p-p at 100 MHz (required signal level is increased by 2 when in Chop mode).

**External input RC:** approx. 1 mΩ shunted by approx. 20 pF.

**Maximum external input:** 250 V (dc + peak ac) or 500 V p-p at 1 kHz or less.

#### Level and slope

**Internal:** at any point on the positive or negative slope of the displayed waveform.

**External:** continuously variable from +1 V to -1 V on either slope of the trigger signal, +10 V to -10 V in divide by 10 mode ( $\div 10$ ).

**Coupling:** AC, DC, LF REJ, or HF REJ.

**AC:** attenuates signals below approx. 20 Hz.

**LF Reject (Main Sweep):** attenuates signals below approx. 4 kHz.

**HF Reject (Main Sweep):** attenuates signals above approx. 4 kHz.

**Trigger holdoff (main sweep):** increases sweep holdoff time in all ranges.

#### Calibrated mixed time base

Dual time base in which the main time base drives the first portion of sweep and the delayed time base completes the sweep at the faster delayed sweep. Also operates in single sweep mode. Accuracy, add 2% to main time base accuracy.

#### A vs. B operation

##### Bandwidth

**Channel A (Y-axis):** same as channel A.

**Channel B (X-axis):** dc to 5 MHz.

**Deflection factor:** 5 mV/div to 20 V/div (12 calibrated positions) in 1, 2, 5 sequence.

**Phase difference between channels:**  $<3^\circ$ , dc to 100 kHz.

#### Cathode-ray tube and controls (1740A)

**Type:** Hewlett-Packard, 12.7 cm (5 in.) rectangular CRT, post accelerator, approx. 15 kV accelerating potential, aluminized P31 phosphor.

**Graticule:** 8 × 10 div (1 div = 1 cm) internal non-parallax graticule, 0.2 subdivision markings on major horizontal and vertical axes and markings for rise time measurements. Internal floodgun graticule illumination.

**Beam finder:** returns trace to CRT screen regardless of setting of horizontal, vertical, or intensity controls.

**Z-axis input (intensity modulation):** +4 V,  $\geq 50$  ns width pulse blanks trace of any intensity, usable to  $\leq 10$  MHz for normal intensity. Input R, 1 kΩ  $\pm 10\%$ . Maximum input  $\pm 20$  V (dc + peak ac).

**Rear panel controls:** astigmatism and trace align.

#### Cathode-ray tube and controls (1741A)

**Type:** Hewlett-Packard, 12.7 cm (5 in.) rectangular CRT, post accelerator, approx. 7.5 kV accelerating potential, aluminized P31 phosphor.

**Graticule:** 8 × 10 div (1 div = 0.85 cm) internal, non-parallax graticule, 0.2 subdivision markings on major horizontal and vertical axes, with markings for rise time measurements. Graticule illumination is achieved with Persistence control set to minimum.

**Beam finder:** returns trace to CRT screen regardless of setting of horizontal and vertical controls.

**Z-axis input (intensity modulation):** +4 V,  $\geq 50$  ns width pulse blanks trace of any intensity, usable to  $\leq 10$  MHz for normal intensity. Input R, 1 kΩ  $\pm 10\%$ . Maximum input  $\pm 20$  V (dc + peak ac).

**Operating modes:** write, store, display, auto-store, auto-erase, and conventional (rear panel control).

#### Persistence (with brightness control full ccw)

**Variable:** approx., 100 ms to 1 min.

**Conventional:** natural persistence of P31 phosphor (approx. 40  $\mu$ s).

**Storage writing speed:**  $\geq 100$  cm/ $\mu$ s (118 div/ $\mu$ s) over center 7 × 9 div (with viewing hood).

#### Storage time

**Display mode:** at least 10s at 22°C.

**Store mode:** at least 30s at 22°C.

**Brightness:** approx. 170 cd/m<sup>2</sup> (50 fl).

**Erase time:** approx 300 ms.

**Rear panel controls:** astigmatism, trace align, conventional push-button and view time.

#### General

**Rear panel outputs:** main and delayed gates, 0.8 V to  $>+2.5$  V capable of supplying approx. 5 mA.

#### Amplitude calibrator (0°C to +55°C)

Output voltage	1 V p-p into $>1$ MΩ 0.1 V p-p into 50Ω	$\pm 1\%$
Rise time	$\leq 0.1$ $\mu$ s	
Frequency	approx. 1.4 kHz	

**Power:** 100, 120, 220, 240 V ac  $\pm 10\%$ ; 48 to 440 Hz; 100 VA max.

**Weight:** (1740A) net, 13 kg (28.6 lb). Shipping, 17.7 kg (39 lb.); (1741A) net 13.8 kg (30.5 lb). Shipping 17.7 kg (39 lb).

**Operating environment:** temperature 0°C to +55°C; humidity to 95% relative humidity at +40°C; altitude, to 4600 m (15 000 ft); vibration, vibrated in three planes for 15 min. each with 0.254 mm (0.010 in.) excursion, 10 to 55 Hz.

**Dimensions:** 335 mm (13 $\frac{3}{16}$  in.) wide, 197 mm (7 $\frac{3}{4}$  in.) high, 1740A 597 mm (23 $\frac{1}{2}$  in.) long with handle, 492 mm (19 $\frac{3}{8}$  in.) long without handle, 1741A 616 mm (24 $\frac{1}{4}$  in.) long with handle, 552 mm (21 $\frac{3}{4}$  in.) long without handle.

**Accessories furnished:** one blue light filter HP P/N 01740-02701, one front panel cover, one 2.3 m (7.5 ft) power cord, one vinyl accessory storage pouch, one Operators Guide and one Service Manual, two Model 10006D 10:1 divider probes approx. 1.8 m (6 ft.) long. The 1741A also includes one Model 10173A RFI filter and contrast screen, and one Model 10140A viewing hood.

#### Options

**001:** fixed power cord (U.S. only) in lieu of detachable power cord

**Price**

add \$15

**101 (1740A):** Logic State Display single pushbutton (Gold Button) interface Option for operation with the HP Model 1607A Logic State Analyzer. Permits single pushbutton switching between functional 16 channel logic state analysis and electrical analysis of digital data. Option 101 removes the A vs. B mode and replaces it with the State Display pushbutton and adds interface circuits for switching between front panel inputs and rear panel logic state inputs.

add \$105

#### Logic state analysis equipment required for Option 101 (1740A)

**Model 1607A:** Model 1607A 16-Bit Logic State Analyzer includes three data probes and one clock probe.

\$2900

**Four Model 10502A:** 23 cm (9 in.) cables. Three for X, Y, and Z interconnections and one for pattern triggering connection to the oscilloscope.

\$15 ea.

**1740S:** Model 1740S includes 1740A 100 MHz oscilloscope with Option 101, Model 1607A Logic State Analyzer, four 10502A 23 cm (9 in.) BNC interconnecting cables with a bracket and strap (HP P/N 5061-1213) for combining into a single package.

\$5175

#### Model number and name

1740A 100 MHz Oscilloscope

\$2095

1741A 100 MHz Storage Oscilloscope

\$3950