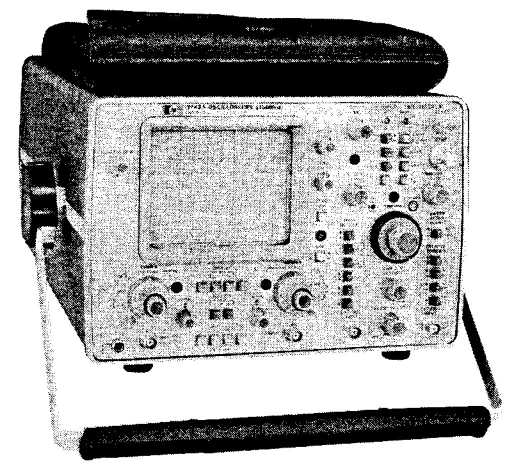
OPERATORS GUIDE

1742A OSCILLOSCOPE



RSE GROUP

(MASTER)

HEWLETT PACKARD

SAFETY SUMMARY

The following general safety precautions must be observed during operation of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Hewlett-Packard Company assumes no liability for the customer's failure to comply with these requirements.

GROUND THE INSTRUMENT.

To minimize shock hazard, the instrument chassis and cabinet must be connected to an electrical ground. The instrument is equipped with a three-conductor ac power cable. The power cable must either be plugged into an approved three-contact outlet or used with a three-contact to two-contact adapter with the grounding wire (green) firmly connected to an electrical ground (safety ground) at the power outlet. The power jack and mating plug of the power cable meet International Electrotechnical Commission (IEC) safety standards.

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE.

Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

DO NOT REMOVE INSTRUMENT COVERS.

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made by qualified maintenance personnel.Service instructions for this instrument are provided in a separate Operating and Service Manual.

DANGEROUS PROCEDURE WARNINGS.

Warnings such as the example below, precede potentially dangerous procedures throughout this manual! Instructions contained in the warnings must be followed.

WARNING

Dangerous voltages, capable of causing death, are present in this instrument.
Use extreme caution when handling, installing or operating.

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OPERATORS GUIDE

MODEL 1742A
OSCILLOSCOPE

Manual Part Number 01742-90904
Microfiche Part Number 01742-90804

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MODEL 1742A OPERATORS GUIDE

OPERATING INSTRUCTIONS

GENERAL INFORMATION.

This Operators Guide will acquaint you with the Model 1742A features, capabilities, accessories, power requirements, and controls. To aid in operating the oscilloscope, initial turn-on procedures, adjustments, and a functional check are provided. Detailed explanations in the Applications Section of this manual show how you can use varied capabilities of the 1742A to best advantage in a variety of electrical measurements. Model 1742A specifications and general characteristics are listed in tables 1 and 2. Service information is available in a separate service manual.

DESCRIPTION.

The Hewlett-Packard Model 1742A is a dual-channel, 100-MHz, delayed-sweep oscilloscope designed for general-purpose bench or field use. The dual-channel dc to 100 MHz vertical deflection system has 12 calibrated deflection factors from 5 mV/div to 20 V/div. A maximum sensitivity of 1 mV/div to 40 MHz is provided on both channels by means of a 5X vertical magnification. Selectable input impedance of either 50 ohms or 1 megohm permits impedance selection that best meets measurement application.

The 1742A provides the two-marker, time-interval measurement feature in addition to the traditional delayed sweep mode. When using the two-marker ΔT mode, the time interval is scaled and the output (as a voltage) is applied to rear-panel connectors for readout on a 3 1/2-digit DVM. With Option 034 the time interval voltage is internally connected and read out on a built-in DMM on the top of the oscilloscope.

The horizontal deflection system has calibrated sweep rates from 2 s/div to 0.05 μs/div and delayed-sweep rates from 20 ms/div to 0.05 μs/div. A 10X magnifier expands all sweeps by a factory of 10 and extends the fastest sweep to 5 ns/div. In alternate or chop modes, a trigger-view control will display three signals: the channel A signal, the channel B signal, and the trigger signal. When using trigger view in the alternate mode along with the ΔT sweep mode, the time interval start marker appears on the trigger waveform and the stop marker appears coincident in time on the channel A and channel B waveforms. This allows you to correlate the time between the trigger signal and the channel A and channel B signals. In trigger-view operation, center screen represents the trigger threshold point, allowing you to see the triggering level location. With the A VS B control, an X-Y mode of operation is possible. The channel A input (Y-axis) is plotted versus the channel B input (X-axis). The CRT has 8- by 10-cm major divisions on an internal graticule.

ACCESSORIES FURNISHED.

One Blue Light Filter, HP Part No. 01740-02701
One Front-panel Cover, HP Part No. 5040-0516
One Vinyl Storage Pouch, HP Part No. 1540-0292
One 7.5-ft Power Cord, HP Part No. 8120-1521
Two 2-meter 10:1 Divider Probes, HP Model 10041A
One 0.5 A Slow-Blow Fuse for 220/240-V operation, HP Part No. 2110-0202

ACCESSORIES AVAILABLE.

The following accessories are available for the 1742A:
Models 1007A and 1114A - Testmobiles
Model 1120A - 500 MHz Active Probe
Model 1125A - Impedance Converter Probe
Model 10002A - 50:1 Divider Probe, 1.5 m (5 ft) long
Model 10020A - Resistive Divider Probe Kit
Model 10021A - 1:1 Divider Probe, 1 m (3.3 ft) long
Model 10040A - 10:1 Divider Probe, 1 m (3.3 ft) long
Model 10042A - 10:1 Divider Probe; 3 m (9.8 ft) long
Model 10140A - Collapsible Viewing Hood
Model 10491B - Rack Mount Adapter
Model 10173A - RFI Filter and Contrast Screen
HP Part No. 01715-69501 - Kit for installing Option 034

OPTIONS.

The following standard options extend the usefulness of 1742A:

OPTION 001: Supplies a fixed ac power cord in place of the normal detachable power cord.

OPTION 034: Provides a built-in Digital Multimeter that can be used for time interval measurements or as a separate digital multimeter.

OPTION 090: Deletes the two Model 10041A divider probes normally supplied. You may specify other probes listed that are more suited to your requirements.

OPTION 101: Single pushbutton interface option for operation with the HP Model 1607A Logic State Analyzer. The A vs B mode of operation is deleted.

OPTION 102: Option 102 is the Option 101 with an additional special adapter plate (HP Part No. 5061-1213). The adapter plate is used to attach the 1742A and the 1607A instruments together as a single unit.

OPTION 580: This option provides the instrument with a special bottom cover to meet Canadian Fire Safety Codes.

OPTION 900: Power cord option for use in Great Britain and Singapore. 2.3 m (7.5 ft), removable, 240 V max, 3-conductor 90° IEC.

OPTION 901: Power cord option for use in Australia and New Zealand. 2.3 m (7.5 ft), removable, 240 V max, 3-conductor IEC.

OPTION 902: Power cord option for use in East and West Europe. 2.3 m (7.5 ft), removable, 240 V max, 3- conductor 90° IEC.

OPTION 906: Power cord option for use in Switzerland only. 2.0 m (6.5 ft), removable, 240 V max, 3-conductor 90° CEE22/V.

Table 1. Specifications

VERTICAL DEFLECTION (TWO CHANNELS)

RISE TIME: ≤3.5 ns (measured from 10% to 90% points of 6-division input step).

BANDWIDTH: dc to 100 MHz measured 3-dB down from 8-div reference. Bandwidth may be limited to approximately 20 MHz by BW LIMIT switch.

Lower 3-dB Limit, ac Coupling: ~10 Hz (~1 Hz with 10:1 probe).

DEFLECTION FACTOR

Ranges: 5 mV/div to 20 V/div in 12 calibrated position in 1, 2, 5 sequence, accurate within 3%. With vernier uncalibrated, continuously variable between ranges and to at least 50 V/div on 20 V/div range.

INPUT RC (SELECTABLE)

AC and DC: 1 megohm ±2% shunted by approximately 20 pF.

50 Ohm: 50 ohms ±3%.

Table 1. Specifications (Cont'd)

MAXIMUM INPUT VOLTAGE

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

50 Ohm: 5 Vrms

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 div with one vernier adjusted for optimum rejection.

VERTICAL MAGNIFICATION (X5)

BANDWIDTH: 3 dB down from 8-division reference signal.

DC-COUPLED: dc to ~40 MHz (ac-coupled; ~10 Hz to 40 MHz).

RISE TIME: ≤9 ns (measured from 10% to 90% points of 8- division input step).

DEFLECTION FACTOR: increases sensitivity of each deflection factor setting by a factor of five with a maximum sensitivity of 1 mV on channels A and B. (Recommended only for use on .005 V and .01 V ranges.)

MAIN AND DELAYED SWEEPS

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

*50 ms to 2s add 1%

Sweep Vernier (Main Only): continuously variable between all ranges and extends slowest sweep to at least 5 s/div. Front-panel UNCAL light indicates when vernier is not in CAL position.

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

CALIBRATED SWEEP DELAY

DELAY TIME RANGE: 0.5 to 10 x MAIN TIME/DIV setting; 100 ns to 2s (minimum delay 150 ns).

Table 1. Specifications (Cont'd)

DIFFERENTIAL TIME MEASUREMENT ACCURACY (OVER FIRST 10CM OF SWEEP):

Main Time Base Setting	Option 034	**External DVM	Dial
*100 ns/div to 20 ms/div	±(.5 + .05% of full scale)	±(.5 + .05% of full scale	±(.5 + .1% of full scale
50 ms/div to 2 s/div	±(1 + .1% of full scale)	±(1 + .1% of full scale	±(1 + .1% of full scale

* On 100 ns/div range, specification applies after 1 cm of sweep.

** Plus accuracy of the external DVM.

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.

TIME INTERVAL (Δ TIME MODE)

TIME INTERVAL OUTPUT VOLTAGE: varies from 50 V to 100 mV full scale. Full scale output voltage can be determined by multiplying the number on the TIME/DIV dial by 10 V(e.g., 0.05 s, 0.05 ms, or 0.05 μs per division gives 0.5V output full scale).

ACCURACY: measurement accuracy is the Time Interval Accuracy plus the external DVM accuracy.

TRIGGERING

INTERNAL: dc to 25 MHz on signals causing 0.3 division or more vertical deflection, increasing to 1 division of vertical deflection at 100 MHz in all display modes. Increase signal level by 2 when in CHOP and by 5 when MAG X5 is used.

EXTERNAL: dc to 50 MHz on signals of 50 mV p-p or more increasing to 100 mV p-p at 100 MHz. Increase signal level by 2 when in CHOP.

LEVEL AND SLOPE

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

External: continuously variable through ±1V on either slope of the trigger signal; ±10 V in ÷ 10.

MAXIMUM INPUT VOLTAGE

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

Table 1. Specifications (Cont'd)

TRIGGER VIEW

Displays the internal or external trigger signal. In alternate or chop mode (dual channel) channel A, channel B, and the trigger signal are displayed. In channel A or B mode (single channel), trigger view overrides that channel and displays the trigger signal. Displayed amplitude of the internal trigger signal is approximately the same as the on-screen vertical signal. Deflection factor of the external trigger signal is 100 mV/div or 1V/div in EXT ÷ mode. Trigger point of the main sweep is approximately at the point that the displayed trigger signal crosses center screen. With identically timed signals applied to a vertical channel and the external trigger input, the trigger signal is delayed by 2.5 ns ±1 ns.

A VS B OPERATION

BANDWIDTH

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

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°, dc to 100 kHz.

CATHODE-RAY TUBE AND CONTROLS

Z-AXIS INPUT: +4 V, >50-ns width pulse blanks trace of any intensity, usable to 10 MHz for normal intensity. Input R, 1 kilohm ±10%. Maximum input ±20 V (dc + peak ac).

GENERAL

CALIBRATOR

Type: approximately 1.4-kHz square wave, <0.1 μs rise time.

Voltage: 1 V p-p into >1 megohm; 0.1 V p-p into 50 ohms.

Accuracy: ±1%.

REAR PANEL OUTPUTS: Main and delayed gates, 0 V to >+2.5 V; Δ Time out.

Table 2. General Characteristics

VERTICAL DEFLECTION (TWO CHANNELS)

DISPLAY MODES: channel A; channel B (Normal or Invert); Alternate; chopped (approximately 250 kHz rate); A+B; and Trigger View.

INPUT COUPLING: selectable for AC or DC, 50 ohms (dc), or ground. Ground position disconnects input connector and grounds amplifier input.

SIGNAL DELAY: input signals are delayed sufficiently to view leading edge of input pulse without advanced trigger.

HORIZONTAL DEFLECTION

DISPLAY MODES: main, delayed, A start/B start, MAG X10, and A vs B.

TRIGGERING

MAIN SWEEP

Normal: sweep is triggered by internal or external signal.

Automatic: bright baseline displayed in absence of input signal. Triggering is same as normal above 45 Hz.

Single: sweep occurs once with same triggering as normal; reset pushbutton arms sweep and lights indicator.

DELAYED SWEEP

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

Trig'd: delayed sweep is armed and triggerable at end of delay period from selected sources.

TRIGGER SOURCE

Selectable from channel A, channel B, composite, or line frequency (composite triggering on displayed signal except in chop; in chop, channel A is trigger source).

External Input RC: approximately 1 megohm shunted by approximately 20 pF.

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

AC: attenuates signals below approximately 20 Hz.

LF Rej: (main sweep only) attenuates signals below approximately 4 kHz.

HF Rej: (main sweep only) attenuates signals above approximately 4 kHz.

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

MAIN INTENSIFIED

DELAYED SWEEP: intensifies that part of main time base to be expanded to full screen in delayed time base mode. Stop control adjusts position of intensified portion of sweep.

Table 2. General Characteristics (Cont'd)

ΔTIME MODE: intensifies two parts of main time base to be expanded to full screen in delayed time base mode. START control positions the first intensified portion of the sweep and the STOP control positions the second intensified portion of the sweep.

TIME INTERVAL (Δ TIME MODE)

FUNCTION: measures time interval between two events on channel A (channel A display); between two events on channel B (channel B display); or between two events starting from an event on either channel A or B and ending with an event on either channel A or B (alternate display).

CATHODE-RAY TUBE AND CONTROLS

TYPE: post accelerator, approximately 15 kV accelerating potential; aluminized P31 phosphor.

GRATICULE: 8- by 10-div internal graticule; 0.2-div subdivisions on major horizontal and vertical axes. 1 div = 1 cm. Internal flood gun graticule illumination.

BEAM FINDER: returns trace to CRT screen regardless of setting on horizontal, vertical, or intensity controls.

REAR-PANEL CONTROLS: astigmatism and trace align.

GENERAL

POWER: 100, 120, 220, 240 Vac, ±10%, 48 to 440 Hz, 100 VA maximum.

WEIGHT: (with accessories) net, 13 kg (28.6 lb).

DIMENSIONS: see outline drawing.

OPERATING ENVIRONMENT

Temperature: 0°C to 55°C.

Humidity: up to 95% relative humidity at 40°C.

Altitude: to 4600 m (15 000 feet).

Vibration: vibrated in three planes for 15 minutes each with 0.254 mm (0.010 in.) excursion 10 to 55 Hz.

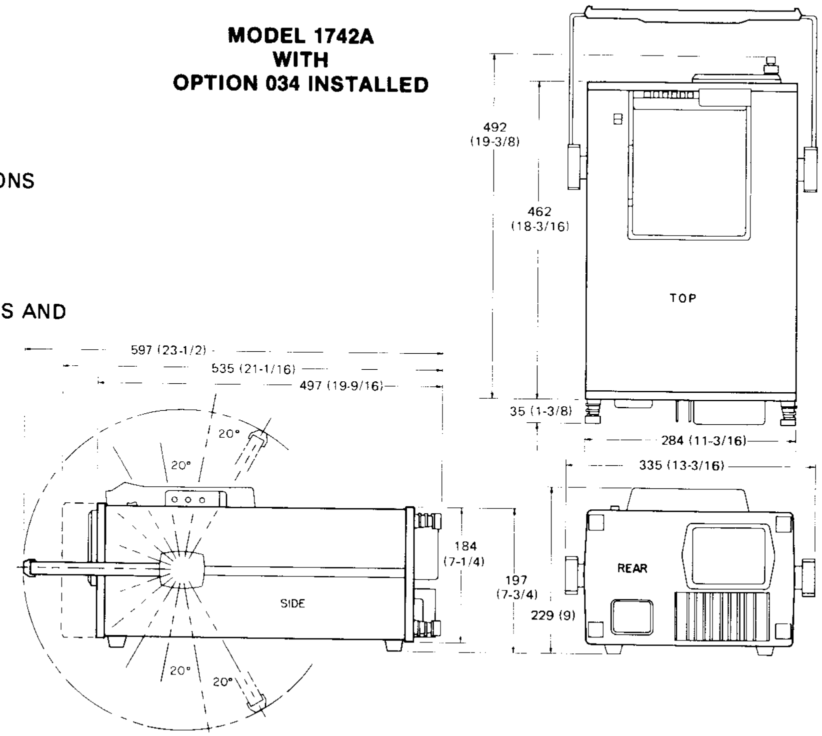
Table 2. General Characteristics (Cont'd)

**MODEL 1742A
WITH
OPTION 034 INSTALLED**

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).



PREPARATION FOR USE.

WARNING

Read the Safety Summary at the front of this guide before installing or operating the instrument.

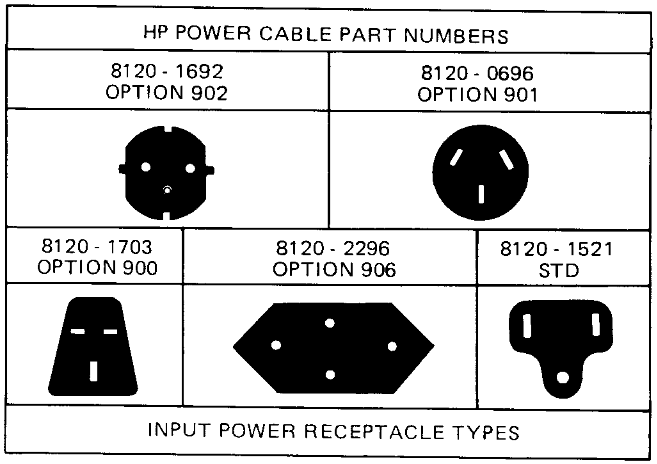


Figure 1. Power Cables Available

POWER CORD. The power cord required depends on the ac input voltage and the country in which the instrument is to be used. Figure 1 illustrates standard power receptacle (wall outlet) configurations. The HP part number shown above each receptacle drawing specifies the power cord equipped with the appropriate power cord is not included with your instrument, notify the nearest HP Sales/Service Office and a replacement cord will be provided.

POWER REQUIREMENTS. Model 1742A can be operated from any power source supplying 100 V, 120 V, 220 V, or 240 V ac ±10%, single-phase, 48 to 440 Hz. Power dissipation is 100 VA (maximum). The instrument is normally set at the factory for 120-volt operation.

CAUTION

Instrument damage may result if the line voltage selection switch is not set correctly for the proper input power source.

To change the instrument from one voltage to another, proceed as follows:

1. Verify that the 1742A power cord is not connected to any input power source.

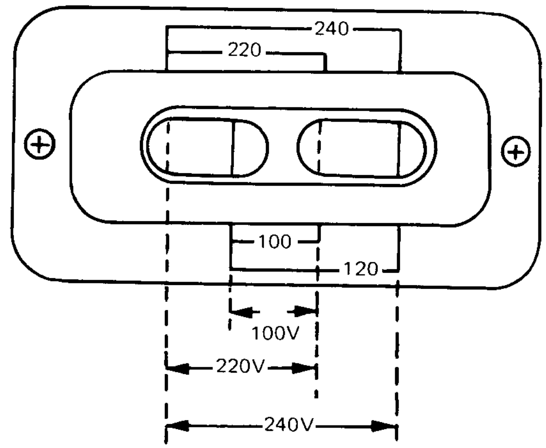


Figure 2. Line Voltage Selection Switch Settings

2. Stand instrument on rear-panel legs and use a blade-type screwdriver to position power selector switches through opening in bottom cover. Figure 2 shows switches set for 120-V operation.

3. Move LINE VOLTAGE SELECT switches to appropriate position.

4. Replace line fuse (rear-panel) with 0.5-ampere fuse for 220/240 V (HP Part No. 2110-0202) or 1-ampere fuse for 100/120 V (HP Part No. 2110-0007). Both fuses are Slow-blow/time delay type fuses.

5. Connect input power cord to selected power source.

CONTROLS AND CONNECTORS.

The front- and rear-panel photograph (figure 21) is located at the rear of this guide on a foldout page for easy reference while reading any part of this guide. The following paragraphs describe each control and connector. The descriptions have index numbers that are keyed to the illustration. Refer to the Applications Section for information about using the 1742A for making measurements.

1 **SCALE ILLUM.** Adjusts CRT background illumination for good contrast between background and graticule. Useful to illuminate graticule when viewing in dark area, photographing - if camera has no light source, or for prefogging film.

2 **LINE.** Switch turns instrument power on and off.

3 **LINE INDICATOR.** Indicator lights when instrument power is on.

(4) **BEAM FIND.** Returns display to viewing area relative to its off-screen position.

(5) **BEAM INTENSITY.** Controls brightness of CRT display.

(6) **FOCUS.** Adjusts writing beam for sharpest trace. Always keep display focused to prevent damaging CRT internally.

(7) **Main TRIGGER LEVEL.** Selects amplitude point on trigger signal that starts main sweep.

(8) **MAG X10.** Magnifies horizontal display 10 times and expands fastest sweep time to 5 ns/div.

(9) **SINGLE.** Sweep occurs once with same triggering as in NORM. After each sweep, trigger circuit must be manually RESET (10).

(10) **RESET.** Momentary pushbutton that arms trigger circuit in single-sweep mode. After RESET (10), sweep can be triggered by internal or external trigger signal or by rotating TRIGGER LEVEL control (7) through zero.

(11) **Reset Lamp.** When lit, indicates trigger circuit is armed. Lamp goes off at end of sweep and remains off until trigger circuit is again armed by pressing RESET (10).

(12) **AUTO/NORM.** AUTO sweep mode (pushbutton out). Free running sweep provides bright display in absence of trigger signal. Trigger signal input (internal or external) of 45 Hz or more overrides AUTO operation and sweep triggering is same as in NORM mode.
NORM sweep mode (pushbutton in) requires internal or external signal to generate sweep and must be used if input frequency is less than 45 Hz.

(13) & (14) **POSITION.** Coarse (13) and FINE (14) adjustments position display horizontally.

(15) **SIGNAL OVERLAY (ΔT=0).** Screwdriver adjustment to overlap displays in Δt mode with STOP (18) control set to 0.00.

(16) **ΔTIME ON/OFF.** In OFF position, switch turns off second delayed sweep marker, providing conventional delayed sweep operation.

(17) **START.** Selects delay time between start of main sweep and start of time interval measurement.

(18) **STOP.** Selects end point of time interval measurement.

(19) **A START/B START.** A START position sets first delayed sweep marker on channel A and second delayed sweep marker on channel B. This allows time interval measurement from reference point on Channel A to ending point on channel B. B START position sets first delayed sweep marker on channel B and second delayed sweep marker on channel A. This allows time interval measurements from reference point on channel B to ending point on channel A.

(20) **DLYD.** Selects delayed sweep mode of display.

(21) **MAIN.** Selects main sweep mode for display.

(22) **A VS B.** Selects X-Y mode of operation with channel A input (Y-axis) plotted versus channel B input (X-axis).

OPTION 101. Deletes A VS B function and adds logic state display. When the 1742A is connected to an HP Model 1607A Logic State Analyzer, pressing STATE DSPL (22) displays 16-word table of 16-bit words. See Applications Section for details.

(23) **Delayed TRIGGER LEVEL.** Selects amplitude point of trigger signal that starts delayed sweep.

(24) **Main TIME/DIV.** Inner knob controls main sweep rate. Rate indicated by numbers displayed in knob skirt opening.

(25) **Delayed TIME/DIV.** Outer rotating section selects delayed sweep rate. Rate indicated by marker on outer knob. An interlock is incorporated so delayed sweep is always faster than main sweep. When rotated out of OFF position in MAIN mode of operation, portion of main sweep is intensified, indicating STOP (18) position of delayed sweep with respect to main sweep.

(26) & (27) **AUTO/TRIG'D.** In AUTO (26), delayed sweep starts immediately after delay interval which is product of either START (17) control setting or STOP (18) control setting and main TIME/DIV (24) setting. In TRIG'D (27) delayed trigger circuit is armed after delay interval and delayed sweep must be triggered internally or externally by trigger signal. (NOTE: the two marker ΔTime System is active only in the AUTO mode of operation.)

(28) ⌐/¬. Two position switch that selects slope of event that triggers delayed sweep when in TRIG'D mode.

(29) **Delayed AC/DC.** Selects delayed sweep trigger coupling.

(30) **Delayed INT/EXT.** Selects internal or external delayed sweep triggering.

(31) **Delayed EXT ÷ 10.** Attenuates external trigger signal by factor of 10.

(32) **Delayed EXT TRIG INPUT.** BNC connector for delayed external trigger signal.

(33) **TIME/DIV VERNIER.** Provides continuous adjustment of main TIME/DIV between calibrated positions, extending slowest sweep to 5 s/div.

(34) **UNCAL.** Lights when TIME/DIV VERNIER (33) is out of CAL detent position, and indicates that sweep is not calibrated.

(35) **TRIGGER HOLDOFF.** Increase time between sweeps and aids triggering on complex displays such as digital words.

(36) **⎍/⎍.** Two position switch that selects slope of internal or external trigger signal used to start main sweep.

(37) **LF REJ.** Attenuates internal or external trigger signals below 4 kHz. This is useful to condition high-frequency signals for best synchronization by eliminating unwanted low-frequency signals such as power line interference.

(38) **HF REJ.** Attenuates internal or external trigger signals above 4 kHz. This is useful to condition low-frequency signals for best synchronization by eliminating unwanted high-frequency signals such as RF.

LINE. Selecting both LF REJ (37) and HF REJ (38) removes all internal and external trigger signals and applies input ac power frequency for triggering.

(39) **Main AC/DC.** Selects main sweep trigger coupling.

(40) **Main INT/EXT.** Selects internal or external main sweep triggering.

(41) **Main EXT ÷ 10.** Attenuates external trigger signal by factor of 10.

(42) **Main EXT TRIG INPUT.** BNC connector for main external trigger signal.

(43) **ALT.** Channel A and B signals are displayed alternately on consecutive sweeps.

(44) **Channel A.** Displays channel A input signal.

(45) **Channel B.** Displays channel B input signal.

A + B. Pressing both channel A (44) and channel B (45) displays the algebraic sum of channel A and channel B input signals. If channel B display is inverted (press CH B INVT (52)), A minus B display results.

(46) **CHOP.** Channel A and B signals are displayed simultaneously by switching between channels at a 250-kHz rate.

(47) **TRIGGER A.** Selects sample of channel A signal as a trigger signal when INT/EXT (40) is in INT.

(48) **TRIGGER B.** When in INT (40), sample of channel B signal is selected as trigger signal.

COMP. Engaging both trigger A (47) and trigger B (48) selects composite trigger. When display mode is set to channel A, channel B, ALT, or A + B, sweep is triggered by displayed signal. When in CHOP, sweep is triggered by channel A signal only.

(49) **TRIG VIEW.** Displays main sweep trigger signal. A fixed sensitivity of 100 mV/div or 1 V/div with EXT ÷ 10 (41) can be selected in external trigger. TRIGGER LEVEL (7) positions display vertically. Center screen indicates trigger threshold level with respect to trigger signal. If ALT (43) or CHOP (46) is selected, three signals are displayed: channel A, selected trigger signal (at center screen), and channel B. If external trigger signal is selected, you can correlate time between trigger signal and channel A and channel B signals. If you select single channel, trigger view overrides that channel to display selected trigger signal.

(50) **MAG X5.** Magnifies vertical presentation five times, and increases maximum sensitivity to 1 mV/div. Bandwidth is decreased to 40 MHz. Recommended on 5 mV/div and 10 mV/div ranges only.

(51) **BW LIMIT.** Reduces bandwidth of channel A and channel B to 20 MHz.

(52) **CH B INVT.** Inverts polarity of channel B signal. In A + B (44) & (45) mode, pressing CH B INVT (52) results in A minus B display.

NOTE

In the following descriptions for controls 53 through 58, only channel A controls and connectors are discussed. Channel B controls and connectors are identical in function.

53 **POSN.** Varies vertical position of channel A display.

54 **Coupling.** Selects capacitive (AC), direct (DC), or 50-ohm coupling of input signal. GND position disconnects input signal and grounds input to vertical preamplifier.

55 **VOLTS/DIV.** Selects vertical deflection factor in 1, 2, 5 sequence from 0.005 V/div to 20 V/div, accurate within 3% with vernier 56 in CAL position.

56 **Vernier.** Provides continuous control of deflection factor between calibrated VOLTS/DIV ranges. Vernier range is at least 2.5 to 1.

57 **UNCAL.** Lights when vernier control is out of detent position to indicate VOLTS/DIV is uncalibrated.

58 **INPUT.** BNC connector to apply signals to channel A vertical amplifier. Impedance and coupling are selected by 54.

59 **GROUND POST** ⏚. Convenient ground connector. Useful to ensure common ground with equipment under test.

60 **CAL 1V.** Provides 1-V peak-to-peak (within 1%) square-wave voltage signal recurring at a rate of 1.4 kHz (100 mV peak-to-peak when terminated in 50Ω).

61 **Z-AXIS INPUT.** BNC connector for intensity modulation of CRT display. +4-volt, >50-ns width pulse blanks trace of any intensity. Do not apply more than ±20 V (dc + peak ac).

62 **TRACE ALIGN.** Screwdriver adjustment to align horizontal trace with graticule.

63 **ASTIGMATISM.** Screwdriver adjustment used in conjunction with FOCUS 6 to achieve clean sharp spot or trace. Adjustment is easier with stationary spot.

64 **MAIN GATE OUTPUT.** Provides rectangular output of +2.5 V coincident with main sweep.

65 **DLY'D GATE OUTPUT**. Provides rectangular output of +2.5 V coincident with the delayed sweep.

66 - 68 **1607A INPUTS - Option 101 only.**

66 **Z-AXIS.** Intensity input from HP Model 1607A.

67 **VERT**. Y-axis input from HP Model 1607A.

68 **HORIZ**. X-axis input from HP Model 1607A.

69 **LINE INPUT**. Connector for ac power cord.

70 **FUSE**. 1A 250 V slow-blow for 100-V or 120-V operation 0.5A 250 V slow-blow for 220-V or 240-V operation.

71 Δ **TIME OUT.** Banana-jack connectors for time-interval measurement. Voltage output and position of main TIME/DIV control 24 indicates time interval in s, ms, or μs.

TURN-ON PROCEDURE.

Before turning on the oscilloscope, please read the instructions in the Safety Summary (at the front of this guide) and in the power cord and power requirements paragraphs. You should also become familiar with the controls and their functions by reading the Controls and Connectors Section and by referring to figure 21 at the back of this guide. To turn on the Model 1742A perform the following steps:

1. Set BEAM INTENSITY 5 fully counterclockwise.
2. Set vertical DISPLAY to ALT 43.
3. Set internal TRIGGER to A 47.
4. Set vertical verniers 56 for channel A and Channel B to CAL detent.
5. Set CH B INVT switch 52 to out position.
6. Set vertical coupling control 54 for channel A and channel B to GND.
7. Set vertical POSN control 53 to midrange.
8. Set horizontal POSITION control 13 to midrange.
9. Set main TIME/DIV control 24 to 1 mSEC.

10. Set delayed TIME/DIV control 25 to OFF.

11. Set TIME/DIV VERNIER 33 to CAL detent.

12. Set AUTO/NORM switch 12 to AUTO.

13. Set main INT/EXT trigger switch 40 to INT.

14. Set LINE switch 2 to ON position and allow 15-minute warm-up period.

15. Adjust BEAM INTENSITY 5 for barely visible trace.

OPERATOR'S ADJUSTMENTS.

Perform the following checks and adjustments to verify that the 1742A is operating properly:

TRACE ALIGN: If the oscilloscope is moved from one magnetic environment to another, the trace align coil may need adjustment to align the horizontal trace with the graticule. To align the trace properly, proceed as follows:

1. Obtain basic display as described in TURN-ON procedure.

2. Using channel A POSN control 53, set trace to center horizontal graticule line.

3. Using nonmetallic allignment tool, adjust TRACE ALIGN 62 (rear panel) for best alignment of trace with horizontal graticule line.

ASTIGMATISM AND FOCUS. Astigmatism and focus controls may need adjustment to obtain a sharp display. If so, proceed as follows:

1. Obtain basic display as described in TURN-ON procedure.

2. Set BEAM INTENSITY control 5 fully counterclockwise.

3. Select A VS B 22 horizontal mode of operation.

4. Adjust BEAM INTENSITY control 5 to observe spot.

5. Position spot near center of CRT using vertical POSN 53 and horizontal POSITION 13 controls.

6. Adjust FOCUS control 6 (front panel) and ASTIGMATISM control 63 (rear panel) for best defined spot.

PROBE COMPENSATION. Probe compensation may be required because of variations in total input resistance and capacitance from one oscilloscope to another. To accomplish probe compensation, proceed as follows:

1. Obtain basic display as described in TURN-ON procedure.

2. Connect divider probe cable to channel A INPUT connector 58.

3. Connect divider probe tip to CAL 1 V terminal 60.

4. Set channel A input coupling 54 to DC.

5. Set channel A VOLTS/DIV control 55 for square-wave display with two to three divisions of vertical deflection.

6. Set main TIME/DIV control 24 for horizontal display of at least two full square waves (0.2 mSEC range).

7. Adjust divider probe compensation for correct display (see figure 3).

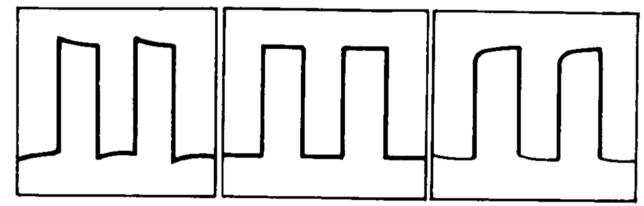


Figure 3. Divider Probe Adjustment Display

DISPLAY/READOUT ZERO. This adjustment compensates for differential delays in the input amplifier and probes of both oscilloscope channels. It calibrates the 0.00 setting of the time interval STOP dial 18 or the 0.000 indication of the LED on the digital multimeter. Perform this adjustment whenever the test setup is changed. Proceed as follows:

1. Apply input signal to channel A or B INPUT 58.

2. Select channel A or B vertical DISPLAY 44 or 45 and internal trigger 47 or 48.

3. Adjust appropriate VOLTS/DIV 55 and vernier 56 for full five-division display of signal.

4. Select main TIME/DIV 24 sensitivity that displays at least one full signal cycle.

5. Set delayed TIME/DIV 25 to sweep speed approximately five times faster than main TIME/DIV 24 sweep speed (if possible).

6. Set ΔTIME ON/OFF 16 switch to ON position.

7. Adjust time interval START 17 to place first intensified marker on point of interest on displayed trace.

8. Set time interval STOP 18 dial to 0.00. If using Option 034 Digital Multimeter (or external multimeter), readjust time interval STOP 18 to obtain indication as close as possible to 0.000 on multimeter LEDs.

9. Engage DLYD 20 pushbutton switch. Two intensified portions of waveform are now expanded on screen.

10. With indication of 0.000 on multimeter, or 0.00 on time interval STOP 18 dial, two display segments should be perfectly overlapped. If not, adjust front-panel SIGNAL OVERLAY ΔT=0 15 to overlay two signal segments displayed.

11. If using only one signal channel, this completes adjustment. If using two signal channels, connect probe from other channel to same signal source as first channel (same signal applied to both channels simultaneously).

12. Select ALT 43 display and internal triggering 47 or 48.

13. Set time interval mode 19 to CH A START or CH B START, as desired.

14. Press the MAG X10 8 display pushbutton.

15. With indication of 0.000 on multimeter or 0.00 on the time interval STOP 18 dial, two display segments should be perfectly overlapped. If not, readjust front-panel SIGNAL OVERLAY (ΔT=0) 15 to overlay two signal segments displayed.

OPERATOR'S FUNCTIONAL CHECK.

The 1742A operation can be checked without additional test equipment by using the CAL 1 V output as a signal source. These tests functionally check each display mode and front-panel controls. To check the instrument specifications, refer to the operating and service manual.

The operator's check must be performed in the sequence given. Do not attempt to start a procedure in mid-sequence because succeeding steps may depend on previous control settings and correct results may be unobtainable.

1. Set 1742A controls as follows:

CHANNEL A

VOLTS/DIV 55	.2
Coupling 54	DC
Vernier 56	CAL detent
POSN 53	as required
DISPLAY 44	A
CH B INVT 52	out

TIME BASE

POSITION 13	as required
TIME/DIV VERNIER 33	CAL detent
Horizontal Display 21	MAIN
Main TIME/DIV 24	0.5 mSEC
Delayed TIME/DIV 25	OFF
AUTO/NORM 12	AUTO
Main INT/EXT 40	INT
Main Trigger Slope 36	_⌐
Main TRIGGER LEVEL 7	as required
Delayed TRIGGER LEVEL 23	ccw
TRIGGER HOLDOFF 35	MIN
MAG X10 8	OUT
Δ TIME ON/OFF 16	ON
A START/B START 19	A START
START 17	fully ccw
STOP 18	fully ccw

2. Set INTENSITY 5, FOCUS 6, and POSN 53 controls for desired baseline display.

3. Apply CAL 1 V 60 output directly to channel A INPUT 58.

4. Adjust main TRIGGER LEVEL 7 for stable display. Observe approximately seven positive-going pulses.

5. Set delayed TIME/DIV 25 to 0.1 mSEC. Observe intensified portion of sweep.

6. Adjust time interval START control 17 until intensified portion of trace is centered on CRT.

7. Set horizontal display for DLYD 20 operation. Observe that intensified portion is expanded to 10 divisions.

8. Set horizontal display for MAIN 21 operation.

9. Vary time interval START control 17. Observe that intensified portion moves smoothly along display.

10. Set time interval START control 17 fully counterclockwise.

11. Vary time interval STOP control 18. Observe that second intensified segment moves smoothly along display.

12. Set delayed TIME/DIV 25 of OFF position.

13. Rotate TIME/DIV VERNIER 33 fully counterclockwise. Observe 18 or more pulses between first and eleventh graticule lines.

14. Disconnect CAL 1V 60 from channel A INPUT 58.

15. Set main TIME/DIV 24 to .1 SEC.

16. Set main TRIGGER LEVEL 7 fully clockwise.

17. Set AUTO/NORM switch 12 to NORM.

18. Select SINGLE 9 operation.

19. Press RESET pushbutton 10. Observe RESET indicator 11 is on.

20. Rotate main TRIGGER LEVEL 7 fully counterclockwise. Observe one sweep; RESET indicator 11 extinguishes after sweep.

21. Set AUTO/NORM switch 12 to AUTO.

22. Select MAIN 21 operation.

23. Set vertical display for ALT 43 mode.

24. Set main TIME/DIV 24 to 5 μSEC.

25. Vary time interval STOP control 18. Only marker on channel B should move.

26. Vary time interval START 17. Both markers should move together.

27. Set A START/B START 19 to B START.

28. Repeat steps 25 and 26. Now, time interval STOP control 18 affects marker on channel A.

OBTAINING BASIC DISPLAYS.

The following procedures will help you in obtaining commonly used displays. Before performing the procedures, complete the TURN ON procedure and adjust the following controls:

Channel A coupling (54)	DC
Channel A VOLTS/DIV (55)	.02
Main TIME/DIV (24)	.5 mSEC
START (17)	fully ccw
STOP (18)	fully ccw

NORMAL SWEEP DISPLAY

1. Connect Model 10041A (10:1 divider probe) to channel A INPUT connector (58) and CAL 1 V terminal (60).

2. Adjust channel A POSN (53) to align base of square-wave display on second graticule line from bottom, and adjust main TRIGGER LEVEL (7) for stable display. Observe square-wave display with amplitude of 5 divisions and approximately seven positive going pulses.

MAGNIFIED SWEEP DISPLAY

1. Accomplish NORMAL SWEEP DISPLAY.

2. Adjust horizontal POSITION (13) to place portion of waveform to be magnified on center graticule of CRT (figure 4a).

3. Press MAG X10 (8) and adjust horizontal fine POSITION (14) for precise placement of magnified display (figure 4b).

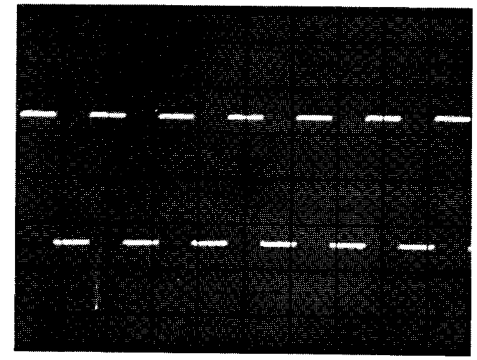


Figure 4a. Normal Display

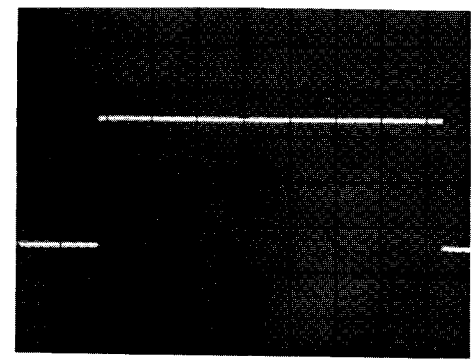


Figure 4b. Magnified Display

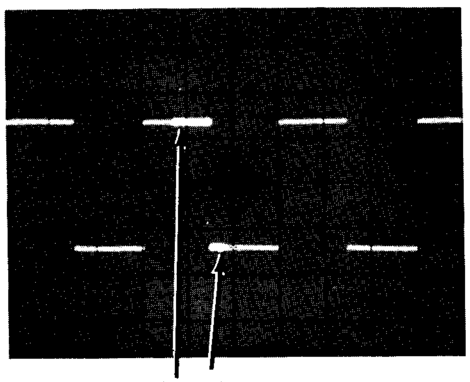


Figure 5a. Normal Display with Intensified Area

DELAYED SWEEP DISPLAY

1. Accomplish NORMAL SWEEP DISPLAY.

2. Set ΔTIME ON/OFF 16 to OFF position.

3. Set delayed TIME/DIV 25 to 0.1 mSECS. Observe intensified portion of square wave. Adjust BEAM INTENSITY 5 for comfortable viewing level.

4. Adjust time interval STOP 18 until intensified portion of trace is over display segment you wish to investigate (figure 5a).

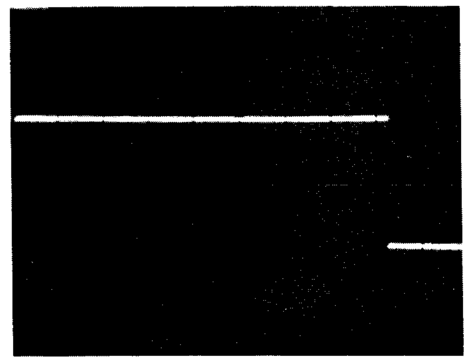


Figure 5b. Delayed Sweep Display

5. Press DLYD pushbutton 20 and note intensified portion of trace is now displayed across entire CRT (figure 5b).

6. Readjust time interval STOP 18 to observe other pulses in pulse train.

For a more complete description of delayed sweep, refer to the Timer Interval Measurement Application in this operators guide.

A VS B DISPLAY

1. Apply vertical (Y-axis) signal to channel A INPUT connector 58. Apply horizontal (X-axis) signal to channel B INPUT connector.

2. Engage A VS B pushbutton 22.

3. Adjust channel A and channel B VOLTS/DIV controls 55 for desired vertical and horizontal scale factors.

4. Channel A POSN 53 will adjust vertical positioning of display. Horizontal POSITION 13 will adjust horizontal positioning of display.

5. If display is not visible, press BEAM FIND 4 and adjust channel A and channel B VOLTS/DIV controls 55 until display is compressed. Next, center display with channel A POSN 53 and horizontal POSITION 13. Release BEAM FIND 4 and adjust FOCUS 6 for sharp display.

TIME-INTERVAL MEASUREMENT (ΔT) APPLICATIONS.

Time-interval measurements are made between any two points on the same or different waveforms. In time-interval measurements, both channels of the oscilloscope may be used. The horizontal distance is measured from a reference point on one waveform to another reference point on either the same or a different waveform.

The ΔT measurement technique offered by this instrument eliminates the need to count divisions and interpolate between divisions which can introduce errors, increase measurement times, and reduce repeatability. The controls and indicators dedicated to the ΔT measurement technique are discussed in the following subparagraphs. Applications for the technique follow these discussions.

TIME-INTERVAL MODE SWITCHES. The time-interval mode switches consist of ΔTIME ON/OFF 16, A START/B START 19, and DLYD 20. Time-interval measurements can be made between any two points on a single trace, from any point beginning on the channel A trace to any point ending on the channel B trace or from any point beginning on the channel B trace to any point ending on the channel A trace. Time-interval mode switch A START/B START 19 simplifies measurement selections. This switch elimintes the need to disconnect input signals and reconnect them to opposite channels whenever exact delayed sweep measurements are made from an occurrence on one channel to an occurrence on the other channel.

Single Channel Displays. The A START/B START switch 19 can be set to either position during single-channel displays. Regardless of which setting is selected, the start marker will always appear ahead of the stop marker on a single trace.

When ΔTIME ON/OFF switch (16) is set to OFF, the second marker is turned off, and time-interval measurements are made in the conventional manner. With delayed sweep (DLYD (20)) selected, the time-interval STOP control is adjusted to place the first point of interest on some reference line on the CRT. The number on the multimeter LED display or time-interval STOP dial (18) is recorded. Then the time-interval STOP control is readjusted to bring the second point of interest to the same reference line on the CRT. Again, the number on the multimeter display or the time-interval STOP dial is recorded. Finally, the number obtained at the first point of interest is subtracted from the number obtained at the second point of interest. The result is the measurement of horizontal separation between the two points. If the DMM display was used for the calculation, the result is the time interval in the units indicated on the main TIME/DIV control (24). If the STOP dial (18) was used for the calculation, then the result of the subtraction must be multiplied by the main TIME/DIV (24) setting.

NOTE

When delayed AUTO/TRIG'D switch is in the TRID'D (27) position, the time-interval feature (ΔTIME) is disabled. Output from ΔTIME OUT connectors (or DMM on Option 034) will indicate the position of the STOP control (18), not the time interval being displayed.

By setting A START/B START switch (19) to either the A START or B START position, time-interval measurements can be made between any two signal points using the DLYD mode. In this mode, the two points of interest are overlapped on the screen. The multimeter (if used) will indicate the exact time interval between the two points overlapped. If no multimeter is used, the dial of the time-interval STOP control (18) will indicate the exact spacing (in graticule divisions of the main sweep) between the two points overlapped.

Dual-Channel Display. The A START/B START switch (19) eliminates the requirement of always applying the start event to channel A. To make a measurement from some point on the channel A trace to a point on the channel B trace, the time-interval mode switch is set to A START. The START marker will appear on the channel A trace and the STOP marker will appear on the channel B trace. When the two points are adjusted to overlap, the time-interval STOP dial (18) and DMM will indicate the space between the two markers. Then to make a corresponding measurement from some point on the channel B trace back to some later point on channel A, the A START/B START switch (19) is set to B START. The signals and channels are undisturbed. Only the two markers change places. (See figure 6.)

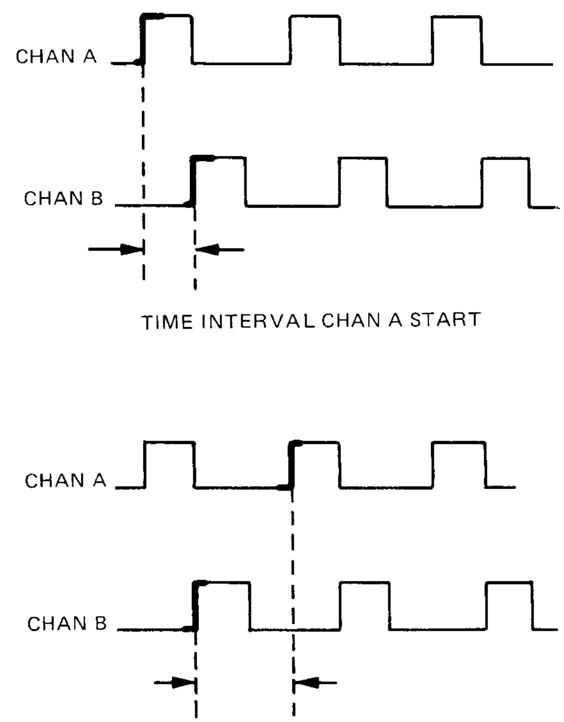


Figure 6. Time Interval Start Selection

Three-Channel Display. The trigger-view feature of the 1742A allows the user to compare two separate events which have a common occurrence (such as a clock signal, reset signal, etc.). When using trigger view in the ALT 43 or CHOP 46 mode of operation along ith the ΔT sweep mode, the time-interval start marker appears on the trigger waveform and the stop marker appears coincident in time on the channel A and channel B waveforms. To accomplish three-channel measurements, the common occurrence signal is applied as an external trigger signal to the main EXT TRIG INPUT connector 42 and EXT 40 triggering is selected. The two time-related signals are applied to the channel A and channel B INPUT connectors 58. ALT 43 and TRIG VIEW 49 operations are then selected. Other front-panel controls are set so that a good view of the entire time interval to be measured is presented on the CRT. The START control 17 places the intensified segment on the trigger signal over the start event. The channel A and channel B signals will each display an intensified segment associated with the STOP control 18. As the STOP control 18 is varied, the intensified segments on channel A and channel B will move in unison. The time interval between the trigger signal event and the event on either channel A or channel B selected by the STOP control 18 will be indicated on the Option 034 Digital Multimeter LEDs (or computed from the STOP 18 dial setting).

TIME-INTERVAL READOUTS. The Model 1742A provides for the use of a DMM (digital multimeter) to simplify time-interval measurements. A built-in DMM, Hewlett-Packard Option 034, is available for this instrument. It can easily be installed using the kit available (HP Part No. 01715-69501). It indicates exact time intervals between the start and stop markers directly in seconds, milliseconds, or microseconds.

The operator can also connect any digital multimeter of his choice to the ΔTIME OUT 71 pair of connectors on the rear panel of the 1742A. To preserve accuracy of the 1742A, use a 3 1/2-digit (or greater) DMM for digital readout of time interval measurements.

The 1742A supplies an analog voltage to the Option 034 DMM and to the ΔTIME OUT 71 rear-panel connections. The analog voltage is dc and is directly proportional to the position of the time-interval STOP dial 18.

When no DMM is available to indicate time intervals measured, use the 10-turn dial of the time-interval STOP control 18. This dial is calibrated in divisions of main sweep separation between the time-interval START and time-interval STOP markers.

USE OF OPTION 034 DMM. To use the Option 034 Digital Multimeter for time-interval measurements, the DMM POWER switch must be ON and the front-panel DC VOLTS pushbutton must be engaged (because the analog voltage applied is dc).

The two-position switch built into the Option 034 top cover must be in the forward position to obtain time-interval measurements of displayed waveforms. In the rear switch position, the analog dc voltage is disconnected from the meter and the multimeter connections at the side of the the unit are enabled for normal multimeter measurements.

PULSE PERIOD AND PULSE WIDTH MEASUREMENTS. Pulse period is usually measured from the 50% amplitude point of one pulse leading edge to the 50% amplitude point on the next leading edge. Pulse width is normally measured between the 50% amplitude points on the leading and trailing edges of the pulse. The ΔTIME technique improves accuracy of pulse period and pulse width measurements by allowing you to overlap the points of interest on the display. To measure pulse period or pulse width, proceed as follows:

1. Apply signal to channel A or channel B INPUT connector 58.

2. Select channel A 44 or channel B 45 DISPLAY and channel A 47 or channel B 48 TRIGGER (whichever is appropriate).

3. Set A START/B START switch 19 to A START or B START, as applicable.

4. Adjust VOLTS/DIV switch 55 for convenient display of pulse amplitude.

5. Select main TIME/DIV 24 sensitivity that places second occurrence of measurement as far as possible toward right-hand edge of CRT.

6. Set delayed TIME/DIV control 25 to sweep speed approximately five times faster (if possible) than main TIME/DIV 24 setting.

7. Set ΔTIME ON/OFF switch 16 to ON position.

8. Adjust time-interval START 17 to place first intensified marker at beginning of time interval to be measured.

9. Adjust time-interval STOP 18 to place second intensified marker at end point of time interval to be measured.

10. Engage DLYD pushbutton 20. Both the beginning and ending segments of time interval to be measured should appear on screen.

11. Adjust time-interval START 18 to place 50% point of first leading edge at center vertical graticule line.

12. Adjust time-interval STOP 18 to overlap 50% point of next pulse leading edge (for pulse period measurements) or to overlap 50% point of pulse trailing edge (for pulse width measurements) at center vertical line. (See figure 7 or 8 as applicable.)

13. Using Option 034 Digital Multimeter (or external DVM) read actual pulse width or pulse period directly from multimeter. Refer to main TIME/DIV 24 setting to determine whether output is in s, ms, or μs.

14. If not using Option 034 or external DVM, read interval measured in divisions from time-interval STOP control 18. Then multiply number of divisions by main TIME/DIV control 24 setting to determine actual pulse width or pulse period.

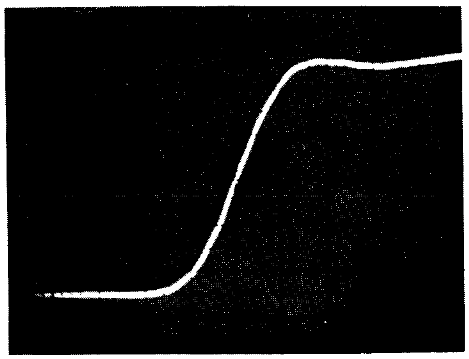


Figure 7. Pulse Period Measurement

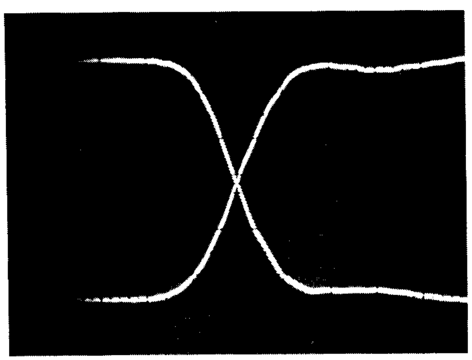


Figure 8. Pulse Width Measurements

TRANSITION MEASUREMENTS. Transition measurements are normally made between the 10% and 90% points on a pulse with the vernier adjusted for a full 5-division vertical display. Calibrated 20% and 80% points are provided. Maximum resolution for this measurement is achieved when the main TIME/DIV sweep speed is set as fast as possible while still being able to accurately position the waveform at the 10% and 90% points. The 10% and 90% points are conveniently marked on the CRT graticule.

To measure signal transition time, proceed as follows:

1. Apply signal to channel A or channel B INPUT connector 58.

2. Select channel A 44 or channel B 45 DISPLAY and channel A 47 or channel B 48 TRIGGER (whichever is appropriate).

3. Set A START/B START switch 19 to A START or B START, as applicable.

4. Adjust appropriate VOLTS/DIV switch 55 and vernier 56 for full five-division display of signal.

5. Select main TIME/DIV 24 sensitivity that places second occurrence of transition as far as possible toward right-hand edge of CRT.

6. Set delayed TIME/DIV control 25 to sweep speed approximately five times faster (if possible) than main TIME/DIV 24 setting.

7. Set Δ TIME ON/OFF switch 16 to ON position.

8. Adjust time-interval START control 17 to place first intensified marker on 10% point of waveform leading edge.

9. Adjust time-interval STOP control 18 to place second intensified marker on 90% point of waveform leading edge.

10. Engage DLYD pushbutton 20. Both intensified portions of waveforms are expanded on screen.

11. Adjust time-interval START 17 to place 10% point on convenient vertical graticule line.

12. Adjust time-interval STOP 18 to place 90% point on same vertical graticule line. (See figure 9.)

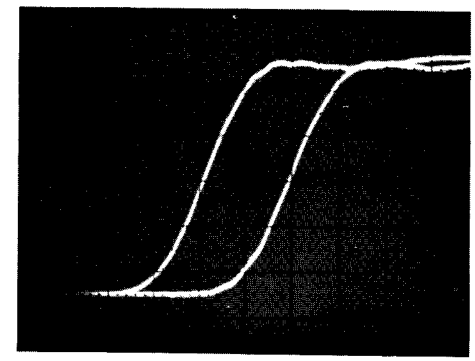


Figure 9. Transition Time Measurement

13. Using Option 034 Digital Multimeter (or external DVM), read actual pulse transition time directly from multimeter. Refer to main TIME/DIV 24 setting to determine whether output is in s, ms, or μs.

14. If not using Option 034 or external DVM, read interval between the 10% and 90% points as measure of CRT divisions on time-interval STOP 18 dial. Multiply number of divisions by main TIME/DIV dial 24 setting to determine signal transition time.

DUTY CYCLE MEASUREMENTS. The duty cycle is expressed as the ratio of pulse width to pulse period (width/period = duty cycle). Duty cycle measurements are important in systems where a pulse must remain within certain limitations to allow for pulse recognition.

The accuracy of duty cycle measurements depends upon the length of the time interval over which the pulse width and period are measured. To increase measurement accuracy for low duty cycle signals, increase the main time base sweep speed when measuring the pulse width. Use the preceding pulse width and pulse period measurement technique.

SIGNAL FREQUENCY OR PULSE REPETITION RATE. The repetition rate or frequency of a signal is the reciprocal of the period. Use the pulse period measurement application procedure to determine the period of a signal. Then take the reciprocal of the period to determine repetition rate or frequency. Use the following formula:

$$\frac{1}{\text{time (in seconds) of period}}$$

Example: If a period of 0.8 ms is measured, then:

$$\frac{1}{0.8\text{ ms}} = \frac{1}{8 \times 10^{-4}\text{ Sec}} = 0.125 \times 10^{4}\text{ Hz} = 1.25\text{ kHz}$$

PROPAGATION DELAY MEASUREMENTS. By selecting ALT or CHOP mode of operation, ΔTIME measurements can be made between an event on channel A and event on channel B. The A START/B START switch 19 on the 1742A permits measuring from an event on channel A to an event on channel B, or from an event on channel B to an event on channel A. To measure propagation delay between signals in the two channels, proceed as follows:

1. Apply one signal to channel A and other signal to channel B INPUT connectors 58.

2. Select either ALT 43 or CHOP 46 DISPLAY and internal TRIGGER to A 47.

NOTE

External triggering may be used if the external trigger is from the same channel where the start event occurs. When using external triggering, time-interval readings must be adjusted to compensate for the difference between the external trigger and the two inputs channels.

3. Adjust each VOLTS/DIV switch 55 to obtain usable display on each channel.

4. Set A START/B START switch 19 to select channel where measurement will begin. If measurement will start from point on channel A, set A START/B START 19 to A START. If measurement will start from point on channel B, set A START/B START 19 to B START.

5. Select main TIME/DIV 24 sensitivity that places second occurrence in the measurement as far as possible toward right-hand edge of CRT.

6. Set delayed TIME/DIV control 25 to sweep speed approximately five time faster (if possible) than main TIME/DIV 24 setting.

7. Set ΔTIME ON/OFF switch 16 to ON position.

8. Adjust time-interval START 17 to position first intensified marker at beginning of desired time interval (one channel). (See figure 10.)

9. Adjust time-interval STOP 18 to position second intensified marker at end of desired time interval (other channel).

10. Engage DLYD pushbutton switch 20. Intensified portion of both waveforms should be present on screen.

11. Adjust time-interval START 17 and associated vertical POSN control 53 to place 50% amplitude point of beginning trace at center vertical graticule line. (see figure 11.)

12. Adjust time-interval STOP 18 and the associated vertical POSN control 53 to superimpose ending trace over beginning trace.

13. Using Option 034 DMM (or external DVM), read actual propagation delay directly from multimeter LED display. Refer to setting of main TIME/DIV 24 to determine whether output is in s, ms or μs. When using cables of unequal length, remember to consider cable delays in this measurement.

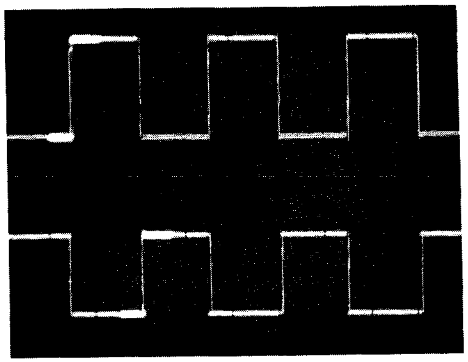


Figure 10. Adjustment of Start and Stop

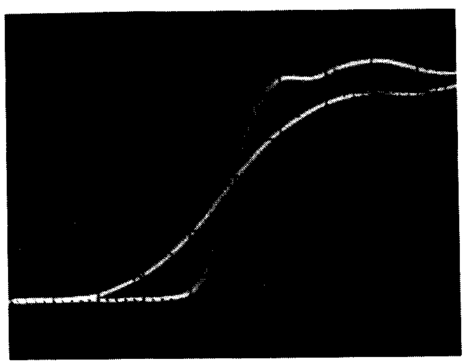


Figure 11. Propagation Delay Measurement

14. If not using DMM or DVM, read divisions and subdivisions of delay directly from dial of time-interval STOP control (18). Multiply this number by main TIME/DIV (24) dial setting. When using cables of unequal length, remember to consider cable delays in this measurement.

ADJUSTING DESIRABLE TIME INTERVAL BETWEEN PULSES. The ΔTIME feature of the 1742A provides ease and accuracy when adjusting for a particular time interval between pulses, such as dual-clock phasing or dual-trigger circuitry. With ΔTIME technique, the two signals are applied to the two oscilloscope channels, and the time-interval controls are adjusted to indicate the desired time interval between pulses. Then the signal source is adjusted until the two signals are superimposed on the CRT. To make this adjustment, proceed as follows:

1. Apply one signal to channel A and other signal to channel B INPUT connectors (58).

2. Select either ALT (43) or CHOP (46) DISPLAY and internal TRIGGER to A (47).

3. Adjust each VOLTS/DIV switch (55) to obtain equal amplitude displays on both channels.

4. Adjust both vertical POSN controls 53 to center traces on CRT.

5. Select main TIME/DIV 24 sensitivity that permits good view of entire time interval to be established.

6. Set delayed TIME/DIV control 25 to sweep speed approximately five time faster (if possible) than main TIME/DIV 25 setting.

7. Set A START/B START switch 19 to select channel which has beginning event, normally reference pulse or waveform. Set to A START if reference signal is on channel A and to B START if reference signal is on channel B.

8. Set ΔTIME ON/OFF switch 16 to ON position.

9. Adjust time-interval STOP control 18 to select desired time interval between pulses. When using Option 034 DMM (or external DVM), multimeter display will indicate time interval adjusted. If not using DMM or DVM, determine 24 horizontal scale factor selected on main TIME/DIV switch 24 and adjust time-interval STOP 18 for number of divisions and subdivision of display equal to desired time interval.

10. Adjust time-interval START 17 to position first intensified marker on pulse which represents beginning of desired time interval.

11. Engage DLYD pushbutton switch 20. Intensified portions of both waveforms should appear on screen.

12. Adjust time-interval START 17 to place first pulse (reference pulse) at center of CRT.

13. Adjust source of signal under test to superimpose two traces. When traces are superimposed, pulses will be separated by time interval selected.

PULSE JITTER MEASUREMENTS. Jitter is a time uncertainty in a waveform caused by random noise or spurious or periodic signals. The ΔTIME technique in the 1742A makes jitter measurements which are both accurate and easy. To measure jitter, proceed as follows:

1. Apply signal to channel A or channel B INPUT connector 58.

2. Select channel A 44 or channel B 45 DISPLAY and channel A 47 or channel B 48 TRIGGER (whichever is appropriate).

3. Set A START/B START (19) as applicable.

4. Adjust appropriate VOLTS/DIV switch (55) and vernier (56) for full six-division display of signal.

5. Adjust main TRIGGER LEVEL (7) until display is as stable as possible.

6. Select main TIME/DIV (24) sensitivity that places next occurrence of transition as far as possible toward right hand edge of CRT.

7. Set delayed TIME/DIV control (25) to sweep speed approximately five times faster (if possible) than main TIME/DIV (24) setting.

8. Set ΔTIME ON/OFF switch (16) to ON position.

9. Adjust time-interval START (17) to place first intensified marker on signal leading edge.

10. Set time-interval STOP (18) to 0.00.

11. Engage DLYD pushbutton (20).

12. Adjust time-interval START (17) to place trace at center of CRT.

13. Adjust time-interval STOP (18) to separate second trace and then return it to point where it just contacts first trace. (See figure 12.)

14. Using Option 034 DMM (or external DVM), read actual pulse jitter from multimeter display. Refer to setting of main TIME/DIV switch (24) to determine whether value displayed is in s, ms, or μs.

15. If not using DMM or DVM, read number of CRT divisions and subdivisions directly from display. Multiply this number by sensitivity selected on main TIME/DIV (24) to determine exact time duration of jitter.

Figure 12a. No AC Touch

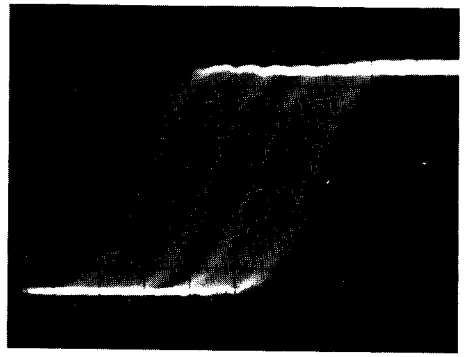


Figure 12b. Random Peaks Contact

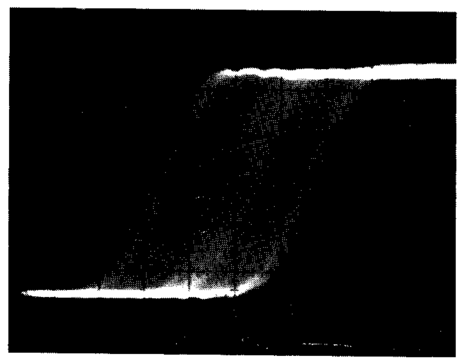


Figure 12c. Correct Jitter Display - Even Density

PHASE DIFFERENCE MEASUREMENTS USING TIME DELAY. The phase difference between two signals of the same frequency can be determined up to the frequency limit of the vertical amplifier by using ΔTIME techniques. Use the following procedure:

1. Apply reference signal to channel A INPUT 58.

2. Select channel A DISPLAY 44 and internal TRIGGER to A 47.

3. Select main TIME/DIV switch 24 sensitivity which provides display of one complete signal cycle.

4. Set ΔTIME ON/OFF 16 to ON position.

5. Adjust time-interval START 17 and STOP 18 until first marker on first leading edge and second marker on second leading edge).

NOTE

Delayed TIME/DIV 25 must be in some position other than OFF to observe intensified markers.

6. Engage DLYD pushbutton 20.

7. Readjust time-interval STOP 18 to overlap both traces on CRT.

8. Using Option 034 DMM (or external DVM), record indication. If not using DMM or DVM, record setting of time-interval STOP 18 dial. Do not change main TIME/DIV 24 setting after this step.

9. Engage MAIN pushbutton 21.

10. Connect other signal to channel B INPUT connector 58.

11. Select either ALT 43 or CHOP 46 DISPLAY.

12. Select either A START or B START 19. Channel carrying signal with advanced phase shift is start channel.

13. Adjust time-interval STOP 18 to place marker on stop channel trace at same relative position as marker on start channel trace (example: both markers on leading edges).

14. Engage DLYD pushbutton 20.

15. Readjust time-interval STOP 18 to overlap both traces on CRT.

16. Using Option 034 DMM (or external DVM), record indication. If not using DMM or DVM, record setting of time-interval STOP dial 18.

17. To determine phase difference between signals take ratio of number recorded in steps 15 and 8, subtract 1, and multiply by 360.

Example: If 5.26 was recorded in step 15 and 3.02 was recorded in step 8, then phase difference between signals is (5.26/3.02-1) 360 = 267° degrees of phase difference.

CONVENTIONAL MEASUREMENTS USING DMM ONLY. It may be convenient to use the Option 034 DMM (or external DVM) to make time-interval measurements in the conventional mode of operation (ΔTIME ON/OFF in OFF position). To accomplish this method of time-interval measurement proceed as follows:

1. Apply signal to channel A or channel B INPUT connector 58.

2. Select channel A 44 or channel B 45 DISPLAY and channel A 47 or channel B 48 TRIGGER (whichever is appropriate).

3. Adjust appropriate VOLTS/DIV switch 55 for proper display.

4. Select main TIME/DIV (24) sensitivity that places second occurrence of transition as far as possible toward right-hand edge of CRT.

5. Set delayed TIME/DIV (25) to sweep speed approximately five times faster (if possible) than main TIME/DIV (24) setting.

6. Set ΔTIME ON/OFF (16) to OFF position.

7. Adjust time-interval STOP (18) to place intensified marker over starting point of event to be measured.

8. Engaged DLYD pushbutton (20).

NOTE

Do not move horizontal POSITION controls (13) and (14) during these measurements.

9. Readjust time-interval STOP (18) to place starting event on center vertical graticule line of CRT.

10. Note indication on DMM (or external DVM).

11. Engage MAIN pushbutton (21).

12. Adjust time-interval STOP control (18) to place intensified marker over stopping point of event to be measured.

13. Engaged DLYD pushbutton (20).

14. Readjust time-interval STOP control (18) to place stopping event on center vertical graticule line of CRT.

15. Note indication on DMM (or external DVM).

16. Subtract indication noted in step 10 from indication noted in step 15. This is time interval of event being measured in s, ms or μs as determined by main TIME/DIV control (25) setting.

VOLTAGE MEASUREMENT APPLICATIONS.

Voltage measurements can be made between any point on a waveform and a 0-volt reference (absolute voltage) or between any two points on a waveform (voltage difference). (See figure 13.)

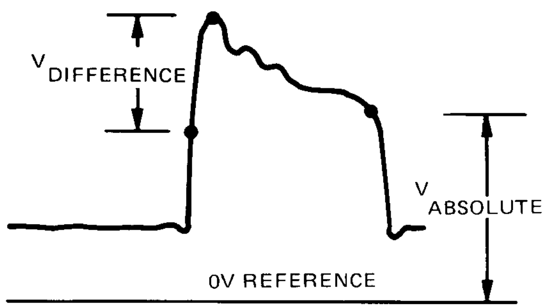


Figure 13. Types of Voltage Measurements

DC AND ABSOLUTE VOLTAGE MEASUREMENTS. The following procedure can be used to make absolute voltage measurements with respect to a 0-volt reference, and to determine the dc component of an input signal.

1. Connect signal to channel A or B INPUT connector 58.

2. Set coupling 54 to DC and adjust main TRIGGER LEVEL 7 for stable display.

3. Adjust vertical POSN 53 VOLTS/DIV 55, and main TIME/DIV 24 for well centered display. Make sure that associated verniers 56 and 33 are in their CAL detent positions.

4. Set input coupling 54 to GND and AUTO/NORM 12 to AUTO. Trace defines level of zero volt. If level is below signal, signal is positive. If level is above signal, signal is negative.

5. Adjust vertical POSN control 53 to set trace on convenient graticule line to establish 0-volt reference level. Do not move vertical POSN control 53 after this step.

6. Return coupling 54 to DC.

7. Measure distance in divisions between reference line and any point of interest on signal.

8. Multiply number of divisions obtained in step 7 by VOLTS/DIV 55 setting to determine signal voltage. Include attenuation factor if using probe.

Example: Assume vertical deflection of 7 divisions, waveform above reference line, and VOLTS/DIV setting of 0.2 (figure 14). Absolute Voltage = 7 x 0.2 = 1.4 volts. Waveform is above reference line so voltage is positive.

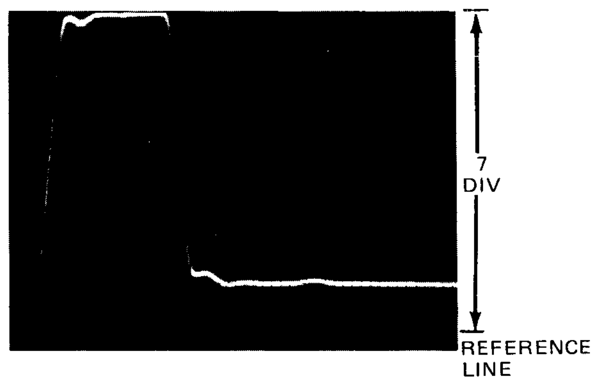


Figure 14. Absolute Voltage Measurements

PEAK-TO-PEAK VOLTAGE MEASUREMENTS. Displays of ac voltages contain amplitude errors due to frequency response of the instrument. With increasing signal frequencies, the amplitude of the errors increases. To obtain displays with less than 10% amplitude error the frequency of the signal being measured must be less than half the specified bandwidth of the oscilloscope. A frequency equal to the specified bandwidth of the oscilloscope will display a voltage amplitude on the CRT that is 3 dB down from the actual amplitude of the applied signal. Frequency rolloff of the instrument must be considered when making voltage measurements with an oscilloscope. To measure peak-to-peak voltage of an input signal, proceed as follows:

1. Connect signal to channel A or B INPUT connector or 58.

2. Set coupling 54 to AC and adjust main TRIGGER LEVEL 7 for stable display.

3. Adjust vertical POSN 53 VOLTS/DIV 5, and main TIME/DIV 24 for well centered display of at least three cycles duration and at least three divisions of amplitude. Make sure that VOLTS/DIV vernier 56 is in CAL detent position.

4. Using vertical POSN control 53, place negative peaks of input signal on horizontal graticule line near bottom of CRT.

5. Using horizontal POSITION control 13, place one positive peak of signal on center vertical graticule line.

6. Count number of vertical divisions from most negative to most positive portions of waveform (estimate to nearest tenth of division; see figure 15).

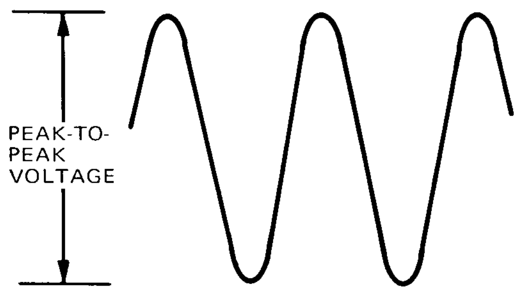


Figure 15. Peak-to-Peak Measurement

7. Multiply number of divisions noted in step 6 by setting of VOLTS/DIV switch 55. If signal is derived through divider probe, multiply result of this step by attenuation factor of probe. Remember to consider amplitude attenuation caused by frequency roll off of oscilloscope.

AVERAGE VOLTAGE MEASUREMENTS USING OSCILLOSCOPE. To measure average voltage using the oscilloscope alone, proceed as follows:

1. Connect signal to channel A or B INPUT connector 58.

2. Set coupling 54 to GND and AUTO/NORM 12 to AUTO. Trace level is zero volt.

3. Switch coupling 54 to DC and measure absolute voltage at point of interest on waveform. (See figure 16A.)

4. Switch coupling 54 to AC and measure absolute voltage to same point on waveform. (See figure 16B.)

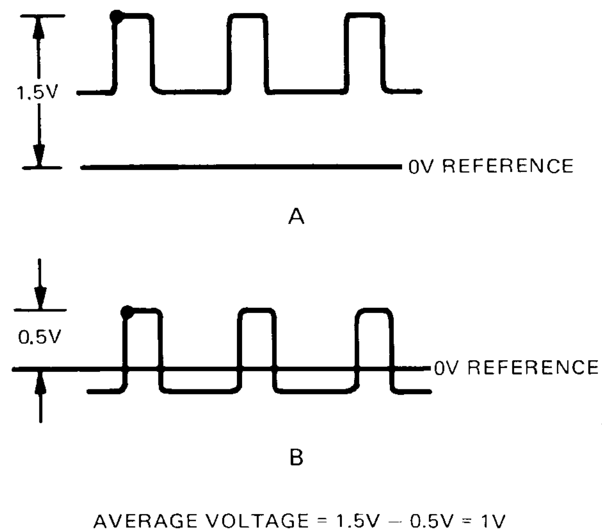


Figure 16. Average Voltage Measured with Oscilloscope

5. Difference between first and second voltage measurements is average voltage.

AVERAGE AND RMS VOLTAGE MEASUREMENTS USING OPTION 034 DVM. The Option 034 DMM is an average-responding meter calibrated in rms. To measure rms voltage using the DMM, proceed as follows:

1. Set two-position switch on 1742A top cover to rear position.

2. Set DMM controls as follows:

POWER	ON
DC/AC (~)	~ (IN)
VOLTS (V)	(IN)
AUTO HOLD	AUTO (OUT)
AMPS (A) AND KΩ	(OUT)

CAUTION

Do not connect the leads to any ac voltages greater than 707 V rms.

3. Connect test leads from VΩ (HI) and COM (LOW) on DMM to signal under test. Digital Multimeter will automatically select best meter range for measurement and display rms voltage with maximum resolution. To measure average voltage, set DC/AC for dc voltage (out).

AMPLITUDE COMPARISON MEASUREMENTS. When measuring the amplitude of a signal, it may be helpful to obtain a deflection factor not calibrated on the VOLTS/DIV switch. This can be done by using a signal of known amplitude (reference signal) and adjusting the VOLTS/DIV vernier to obtain the desired deflection factor. Amplitude comparison measurements may be desirable when calibrating an instrument. By using this method, the accuracy of your measurement depends upon the reference signal accuracy. To make measurements by amplitude comparison, proceed as follows:

1. Apply reference signal to channel A INPUT connector 58, and set DISPLAY and internal TRIGGER 47 to A.

2. Adjust main TIME/DIV 24 to display several signal cycles.

3. Adjust VOLTS/DIV 55 and vernier 56 to obtain display with exact number of divisions of vertical deflection. Greater accuracy is obtained with greater vertical deflection. Do not readjust vernier 56 after this step.

4. Calculate scale factor (sf) by the following formula:

$$sf = \frac{\text{Reference signal amplitude (volts)}}{\text{Display amplitude in DIV}}$$

Example: Assume reference signal amplitude of 40 volts, VOLTS/DIV setting of 5, and display amplitude of six divisions.

$$sf = \frac{40}{6 \times 5} = 1.3$$

5. Disconnect reference signal and connect signal to be measured.

6. Set VOLTS/DIV 55 for measurable display amplitude. Do not readjust vernier 56.

7. Use following formula to calculate amplitude of signal being measured:

Signal Amplitude = VOLTS/DIV setting multiplied by sf (step 4) multiplied by display amplitude (step 6).

Example: Assume signal amplitude of 5 divisions, VOLTS/DIV setting of 2, and scale factor of 1.3.
Signal amplitude = 5 x 2 x 1.3 = 13 volts

8. You can also calculate value of unknown signal as percentage of reference signal.

Example: Assume reference signal has display amplitude of eight divisions. In this case, each division is equal to 12.5% of total reference signal amplitude. If unknown signal is applied and it has amplitude of 6.2 divisions, then amplitude of unknown signal is:

Unknown signal amplitude = 6.2 DIV x 12.5% = 77.5% of reference signal amplitude.

COMMON-MODE REJECTION. Frequently, signals of interest are offset by undesired dc or low frequency voltage ac components that prevent use of vertical ranges sensitive enough to make good measurements. Often a signal similar to the unwanted component can be connected to the opposite channel, inverted, and added algebraically to the signal of interest to cancel the unwanted component.

True dc components can usually be eliminated by selecting ac input coupling. The ability of an oscilloscope to cancel ac common-mode signals varies with amplitude and frequency of the signals. Very high common-mode amplitudes may not be completely cancelled. Good common-mode rejections should be achieved with common-mode signal amplitudes of up to two screen diameters (16 CRT divisions). With high-frequency common-mode signals, minor components may be impossible to eliminate from the display. The lower the frequency of the common-mode signal, the better the common-mode rejection of the oscilloscope.

To use the common-mode rejection technique, proceed as follows:

1. Apply signal to be measured (with unwanted component) to channel A INPUT 58.

2. Apply signal similar to unwanted component to channel B INPUT 58. (See figure 17.)

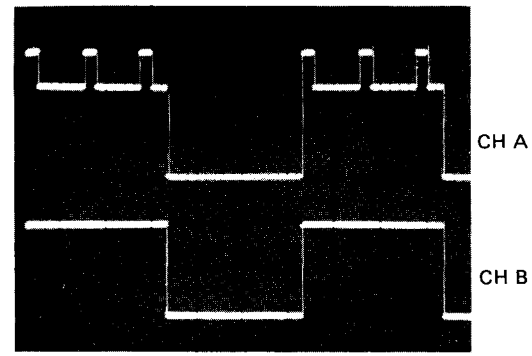


Figure 17. Common-Mode Signals

3. Set coupling as required and select ALT 43 DISPLAY mode.

4. Adjust VOLTS/DIV 55 and vernier 56 so that display on channel B is approximately equal in amplitude to unwanted component on channel A.

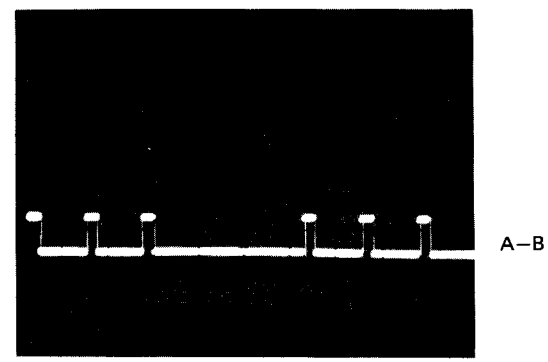


Figure 18. Resultant Display

5. Set the oscilloscope controls as follows:

TRIGGER	A 47
CH B INPUT	INVT 52
DISPLAY	A+B 44 and 45

6. With either channel A or B VOLTS/DIV vernier 56, adjust for minimum deflection in common-mode signal. The resultant display will either subtract all of unwanted component or display desired signal larger than common-mode signal. (See figure 18.)

OPTION 101 - LOGIC STATE DISPLAY.

This option allows you to use the 1742A with an HP Model 1607A Logic State Analyzer to aid in the analysis of digital systems that depend on sequences of logic states to control their operation.

Horizontal, vertical, and Z-axis signals from the Model 1607A convert the 1742A into a 16-channel logic state analyzer. You can switch from logical state to electrical analysis by pressing one pushbutton, a real convenience. To connect the 1742A to the 1607A, place the 1742A on top of the 1607A, and using three Model 10502A cables, connect 1607A rear-panel outputs HORIZ, VERT, and Z-AXIS to the corresponding oscilloscope rear-panel inputs. Check 1742A operation with the 1607A as follows:

NOTE

Clock and data probes do not have to be connected to the 1607A for this procedure.

1. Press STATE DSPL 22 on Model 1742A.

2. Set Model 1607A controls as follows:

POWER	OFF
OFF/WORD	WORD
Sample Mode	SINGLE
COLUMN BLANKING	fully ccw
Z-AXIS	ON
All other pushbuttons	disengaged

3. Apply power 2 to 1742A and 1607A. Adjust 1742A FOCUS control 6 for sharpest display; 16-word table of ones and zeros will be displayed. If table is not displayed, press 1607A power switch on and off until 1607A starts up in display mode.

NOTE

The following adjustments apply to the Model 1607A.

4. Adjust HORIZ SIZE control for six-division wide display and VERT SIZE control for eight-division high display. Adjust HORIZ and VERT POSN controls to center display.

5. Set BYTE to 3 BIT and notice that display format changes from four-bit bytes to three-bit bytes.

6. Set LOGIC to NEG and note that all zeros change to ones and all ones change to zeros.

7. Rotate COLUMN BLANKING control clockwise and observe that vertical columns are blanked, starting with most significant bit.

8. Rotate COLUMN BLANKING control fully clockwise and note that least significant bit column remains on CRT.

9. Rotate COLUMN BLANKING control fully counterclockwise.

10. Set trigger mode to START DSPL and observe that first word is intensified.

11. Set trigger mode to END DSPL and note that last word is intensified.

12. Set DELAY ON/OFF to ON. Setting DELAY thumbwheels from 0 to 15 will move intensifed word on display. For delays greater than 15, intensified word will not be displayed.

The following example explains how you can use the Option 101 in logic state and electrical analysis to find the location of a fault in digital program flow.

Since a fault in an algorithmic state machine will cause an erroneous state to exist in the program flow, it is desirable to start troubleshooting using program flow. When you find the fault location, you can more easily find the specific cause using conventional time analysis techniques. With Option 101, the 1742A and 1607A provide logic state and timing analysis displays.

Assume our algorithmic state machine is a 60-second timer that is terminating its count prematurely. By observing the logic state flow with the 1742A and 1607A, the premature termination point can easily be found. In this example, the malfunction is at count 25 (see figure 19). In this case we triggered on word 20. Notice the timer proceeded normally until word 24, when it reset to zero.

The 1607A supplied an external trigger to the 1742A; triggering the time display on the word we selected (word 20). A probe was connected from channel A on the 1742A to the least significant bit channel on the timer. Another probe was connected from channel B to the reset line on the timer. By switching the 1742A STATE

Least Significant Bit

BCD "10's" Column	BDC "1's" Column	Word	
0010	0000	20	← TRIGGER WORD
0010	0001	21	
0010	0010	22	
0010	0011	23	
0010	0100	24	
0000	0000	0	← ERROR
0000	0010	2	
0000	0011	3	
0000	0100	4	
0000	0101	5	
0000	0110	6	
0000	0111	7	
0000	1000	8	
0000	1001	9	
0001	0000	10	

Figure 19. Logic State Display

DSPL pushbutton 22 to the off position, we obtained a time display starting with word 20 (see figure 20).

You will notice that channel A pulses are normal until after word 24. The pulse at word 25 started to go high, but was not completed. Instead, the timer reset and started again at zero. Looking at the reset line on channel B, we see a glich at word 25.

In this example, you can see the advantage of being able to switch from logic state to electrical analysis and interrogate inputs, outputs, and control lines for transients and glitches.

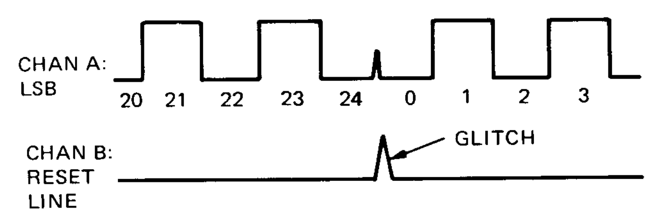


Figure 20. Glitch on Timer Reset Line Causing Timer to Reset Prematurely

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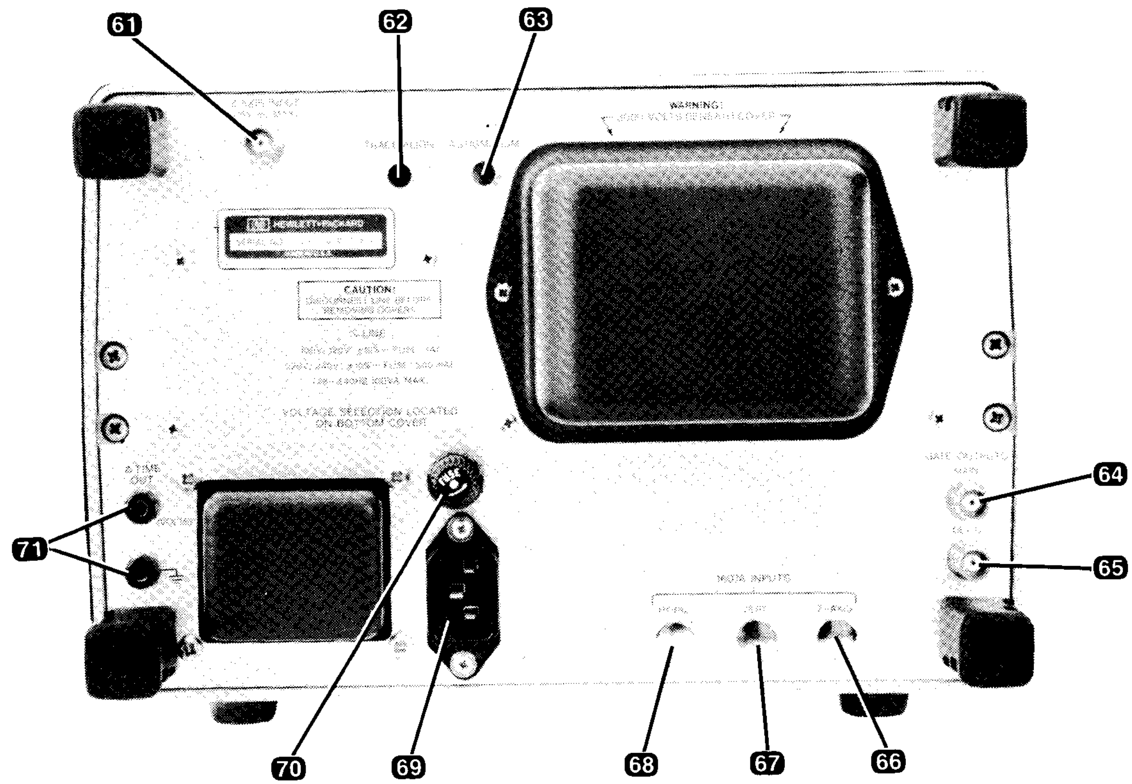

Figure 21.
Front- and Rear-Panel Controls

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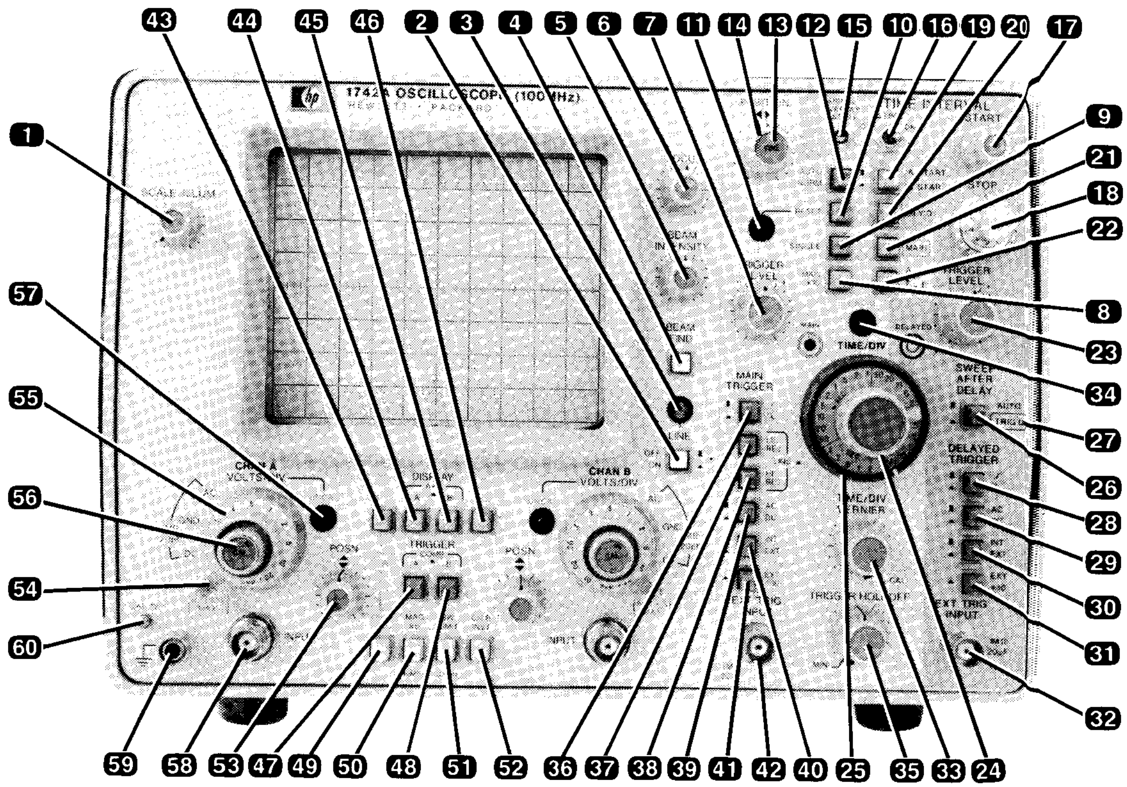

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