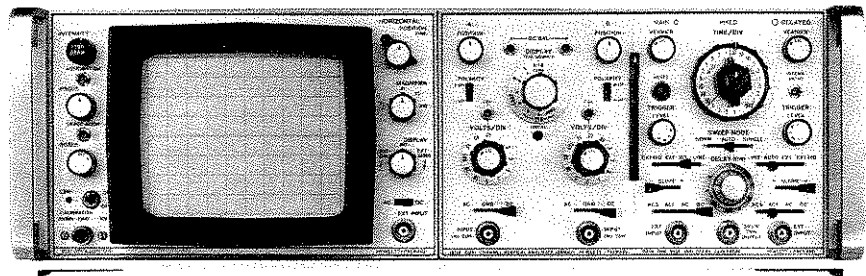
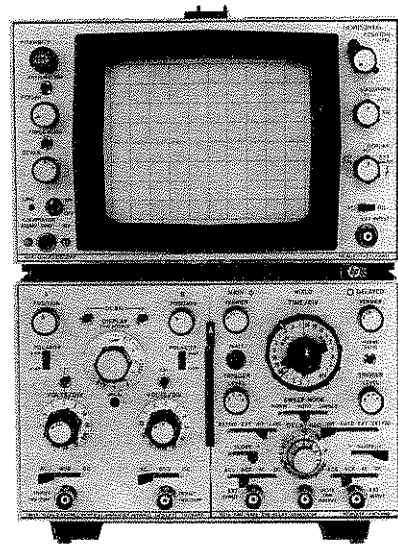


#115

OPERATING AND SERVICE MANUAL

OSCILLOSCOPE

180C/D



HEWLETT **hp** PACKARD



OPERATING AND SERVICE MANUAL

MODEL 180C/D OSCILLOSCOPE

**(Including Options 002, 003, 007, 010, 011, 013,
580, 602, 607, 611, 631, H03, and H51)**

SERIAL NUMBERS

This manual applies directly to instruments with serial numbers prefixed 1351A (180C), 1340A (180D), and 1341A (180D-H51).

With changes described in Section VII, this manual also applies to instruments with serial numbers prefixed from 1125A through 1315A and 1434A.

For additional information about serial numbers, see **MANUAL IDENTIFICATION AND CHANGES** in Section I.

HEWLETT-PACKARD COMPANY/COLORADO SPRINGS DIVISION
1900 GARDEN OF THE GODS ROAD, COLORADO SPRINGS, COLORADO, U.S.A.

Manual Part Number: 00180-90935.
Microfiche Part Number: 00180-90835.

PRINTED: AUGUST 1976

MANUAL CHANGES

MANUAL IDENTIFICATION

Model Number: 180C/D
Date Printed: AUG 1976
Part Number: 00180-90935

This supplement contains important information for correcting manual errors and for adapting the manual to instruments containing improvements made after the printing of the manual.

To use this supplement:

Make all ERRATA corrections.

Make all appropriate serial number related changes indicated in the tables below.

Serial Prefix or Number	Make Manual Changes	Serial Prefix or Number	Make Manual Changes
1447A 180C)	1		
1446A (180D)	1		
1504A (180D-H51)	1		

▲ NEW ITEM

▲ CHANGE 1

A5T1: Change HP Part No. and Mfr Part No. to 00180-60802.

NOTE

Manual change supplements are revised as often as necessary to keep manuals as current and accurate as possible. Hewlett-Packard recommends that you periodically request the latest edition of this supplement. Free copies are available from all HP offices. When requesting copies quote the manual identification information from your supplement, or the model number and print date from the title page of the manual.

18 February 1977

Page 1 of 1

HEWLETT  PACKARD

Printed in U.S.A.

SAFETY SUMMARY

The following general safety precautions must be observed during all phases of operation, service, and repair 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 electrical 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.

KEEP AWAY FROM LIVE CIRCUITS.

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made by qualified maintenance personnel. Do not replace components with power cable connected. Under certain conditions, dangerous voltages may exist even with the power cable removed. To avoid injuries, always disconnect power and discharge circuits before touching them.

DO NOT SERVICE OR ADJUST ALONE.

Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

USE CAUTION WHEN EXPOSING OR HANDLING THE CRT.

Breakage of the Cathode-ray Tube (CRT) causes a high-velocity scattering of glass fragments (implosion). To prevent CRT implosion, avoid rough handling or jarring of the instrument. Handling of the CRT shall be done only by qualified maintenance personnel using approved safety mask and gloves.

DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT.

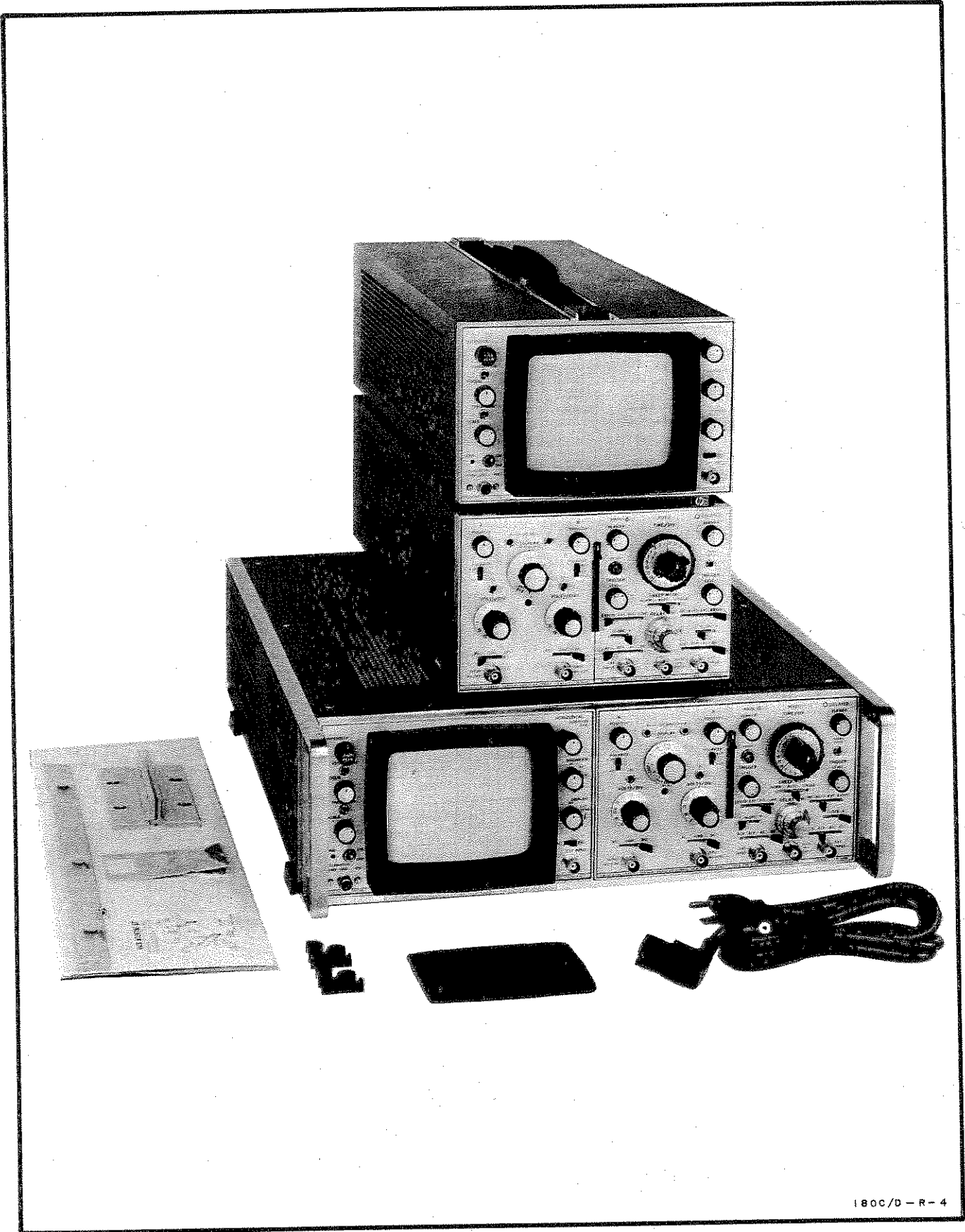
Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to the instrument. Return the instrument to a Hewlett-Packard Sales and Service Office for service and repair to ensure that safety features are maintained.

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, testing, and adjusting.**



180C/D-R-4

Figure 1-1. Models 180C and 180D Oscilloscopes

SECTION I

GENERAL INFORMATION

1-1. INTRODUCTION.

1-2. This manual provides operating and service information for the Hewlett-Packard Models 180C and 180D Oscilloscopes. The manual is divided into eight sections, each covering a specific topic or aspect of the instrument. All schematics are located at the rear of the manual and can be unfolded and used for reference while reading any part of the manual.

1-3. This section contains complete instrument specifications, a description of features, warranty information, data for manual and instrument identification, and information regarding accessories available for use with the instrument. Table 1-2 lists and describes the abbreviations used in this manual.

1-4. INSTRUMENT DESCRIPTION.

1-5. The Model 180C/D (Figure 1-1) is a solid-state, light-weight laboratory and general-purpose oscilloscope with plug-in capabilities. The instrument is designed to display complex high frequency waveforms and to measure alternating and direct-current voltages. Complete instrument specifications are given in Table 1-1.

1-6. The Model 180C is a cabinet type instrument with a built-in tilt stand, convenient carrying handle on top, and feet mounted on both bottom and rear for either bench or upright operation.

1-7. The Model 180D is a rack type instrument with a built-in tilt stand and bottom-mounted feet. It may be bench operated or rack mounted. Figure 1-3 provides the outline dimensions.

1-8. A CRT accelerating potential of 15 kV provides bright visual display and high photographic writing speeds. This simplifies the measurement of low duty cycle signals.

1-9. The Model 180C/D has solid-state circuitry throughout for minimum size and weight with maximum reliability. Power consumption, with plug-ins, is less than 110 watts at normal line voltage. The instrument is convection cooled and designed to operate within specifications at temperatures between 0°C and 55°C with up to 95% relative humidity at 40°C.

1-10. All power supplies, a dual output calibrator, horizontal amplifier, gate amplifier and the CRT are contained in the instrument. Operation at either 115V or 230V ac is selectable by a switch located on the rear panel of the oscilloscope.

1-11. Located on the rear panel are connectors for time base output of main and delayed gate, and main and delayed sweep signals. Connection for input of an external signal for intensity modulation (Z-axis input) is also provided at the rear panel.

1-12. The Model 180C/D is designed to operate with a number of different plug-ins. Presently available plug-ins provide a wide choice of operating capabilities such as wide bandwidth, dual or four channel operation, single or delayed sweeps and sampling or time-domain reflectometer operation.

1-13. To facilitate servicing, the modular power supply may be disconnected and removed from the instrument for access to all components. It may also be operated from the built-in extender cable to simplify and speed up maintenance.

1-14. A calibrator provides a square-wave signal of approximately 1 kHz with a risetime of less than 3 usec. The calibrator output is available at the front panel at amplitudes of 250 mV and 10V p-p with an accuracy of $\pm 1\%$. The signal may be used to check horizontal and vertical deflection factors and to compensate divider probes.

1-15. The oscilloscope horizontal amplifier accepts sweep signals from the time base plug-in or an external source. The external input bandwidth is dc to 5 MHz dc-coupled, and 5 Hz to 5 MHz ac-coupled.

1-16. Three horizontal deflection factor ranges are front panel selectable: 1 V/div (X1) $\pm 5\%$, 0.2 V/div (X5) $\pm 5\%$, and 0.1 V/div (X10) $\pm 5\%$. In addition, a vernier control provides continuous adjustment between ranges for external inputs. The maximum external input level is 300 Vdc, ac-coupled, with a dynamic range of $\pm 20V$.

1-17. A beam finder pushbutton control assists the operator in rapidly bringing a displaced beam on screen. Its use increases intensity and reduces vertical and horizontal amplifier gain to quickly locate trace position.

1-18. CATHODE-RAY TUBE.

1-19. The Model 180C/D used a post-accelerator aluminumized CRT with an eight by ten division display area. Each division equals 1 cm, and 0.2-div subdivisions are provided on the major axes. The graticule is internal to the CRT which eliminates display parallax. A safety faceplate is fitted to the front of the CRT for operator protection.

1-20. The standard CRT supplied has P31 phosphor. Other phosphors with or without internal graticule are available.

Refer to Section VII of this manual for information on available phosphors or contact the nearest HP Sales/Service Office regarding special CRT requirements.

1-21. WARRANTY.

1-22. This instrument is certified and warranted as stated on the inside front cover of this manual.

1-23. In all correspondence with a Hewlett-Packard Sales/Service Office concerning an instrument, reference the complete serial number and model of this instrument.



The warranty may be void for instruments having a mutilated serial number tag.

1-24. INSTRUMENT IDENTIFICATION.

1-25. Hewlett-Packard uses a serial number for instrument identification (Figure 1-2). The first numerical group is the serial prefix number. It identifies a series of instruments. The last numerical group identifies a particular instrument in the series. The serial number appears on a plate located on the rear panel.

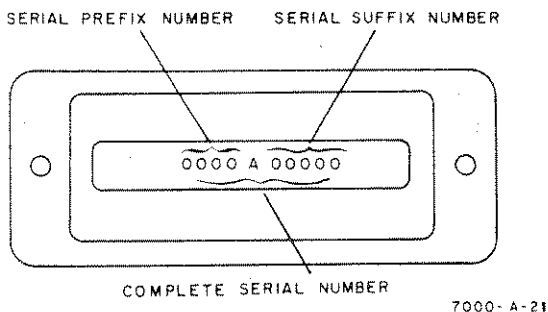


Figure 1-2. Instrument Identification

1-26. MANUAL IDENTIFICATION AND CHANGES.

1-27. The information in this manual applies directly to instruments (as manufactured) with a serial prefix as indicated on the title page. If the serial prefix of your instrument is different from that on the title page, a MANUAL CHANGES insert sheet, or Section VII of the manual, will describe the changes necessary to adapt this manual to provide the correct information.

1-28. Technical corrections (if any) to this manual due to known errors in print are called Errata and are shown on the manual changes sheet. Also shown are changes in parts which are applicable to all instruments should replacement become necessary. These are indicated as preferred replacement parts.

1-29. For information on manual coverage of any HP instrument, contact the nearest HP Sales/Service Office (addresses are listed at the rear of this manual).

1-30. ACCESSORIES FURNISHED.

1-31. The Model 180C/D is equipped with a screen mesh contrast filter. The filter snaps into place under the light shield to provide greater contrast and improved viewing under ambient light conditions. It may be removed if preferred.

1-32. A detachable power cord is supplied with each instrument. The three-conductor power cord and instrument receptacle conform to International Electrotechnical Commission (IEC) safety standards.

1-33. The Model 180D is supplied with all parts and hardware required for rack mounting. Refer to Section II of this manual for installation information.

1-34. Two probe hangers are furnished with each oscilloscope. Model 180C hangers are factory installed while probe hangers for the Model 180D are furnished for user installation.

1-35. AVAILABLE ACCESSORIES.

1-36. MOBILE TEST STANDS.

1-37. A series of mobile test stands are available for the Models 180C and 180D. The Model 1002B Testmobile is intended for use with the cabinet Model 180C. The Model 1117B Testmobile is intended for use with rack-model instruments such as the Model 180D.

1-38. COVERS.

1-39. A front-panel cover of fiberglass material, HP Model 10166A, can be used to provide front-panel protection for the cabinet Model 180C, and a metal cover for the rack Model 180D is available as HP Part No. 5060-0437.

1-40. CAMERAS.

1-41. The HP Model 197A is a general purpose camera with an electronic shutter and an optional ultra-violet light which illuminates internal gratitudes, providing accurate recordings of oscilloscope displays. The film back can be moved through 11 detented positions for multiple exposures and the continuous reduction ratio allows the entire film area to be used. Model 197A is supplied with a Polaroid pack film back for Type 107 film. Interchangeable backs on Model 197A allow selection of either Polaroid Flat Pack (Model 10353A), or Graflok 4x5-inch (Model 10352A).

Table 1-1. Model 180C/D Specifications

CATHODE- RAY TUBE AND CONTROLS

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

GRATICULE: 8 x 10 div internal graticule, 0.2 div subdivisions on major axes. (1 div = 1 cm.) Front panel recessed screwdriver adjustment aligns trace with graticule. Scale control illuminates CRT phosphor when viewing with hood or taking photographs.

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

INTENSITY MODULATION (External Input)

Input: approx +2V, ≥ 50 ns pulse width (≤ 10 MHz sine wave) will blank trace of normal intensity.

Input R: approx 5k ohms.
Maximum Input: ± 20 V (dc + pk ac).

PHOTOGRAPHIC WRITING SPEED: 1500 cm/ usec. Measured using 10,000 ASA film without film fogging and a camera with f/1.3 lens, and a 1: 0.5 object-to-image ratio. Writing speed may be increased substantially by using film fogging techniques, P11 phosphor and faster camera lenses.

CALIBRATOR

TYPE: approx 1 kHz square wave, < 3 usec risetime.

VOLTAGE: two outputs, 250 mV p-p and 10V p-p into ≥ 1 megohm; accuracy, $\pm 1\%$.

HORIZONTAL AMPLIFIER

EXTERNAL INPUT

Bandwidth: dc to 5 MHz dc-coupled; 5Hz to 5 MHz ac-coupled.

Deflection Factor: 1 V/div, x1; 0.2 V/div, x5; 0.1 V/div, x10; accuracy $\pm 5\%$. Vernier provides continuous adjustment between ranges.

Dynamic Range: ± 20 V.

Maximum Input: 600 Vdc (ac-coupled input).

Input RC: approx 1 megohm shunted by approx 30 pF.

INTERNAL SWEEP

Magnifier: x5, x10, accuracy $\pm 5\%$ (with 3% accuracy time base).

OUTPUTS

Four rear panel, emitter follower outputs provide main and delayed gates, main and delayed sweeps, or vertical and horizontal outputs when used with TDR/Sampling plug-ins. Maximum current available, ± 3 mA. Outputs will drive impedances of ≥ 1000 ohms without distortion.

ENVIRONMENT

(Mainframe operates within specifications over the following ranges.)

TEMPERATURE: 0 to 55°C.

HUMIDITY: to 95% relative humidity to 40°C.

ALTITUDE: to 15,000 ft.

VIBRATION: vibrated in three planes for 15 min each with 0.010 in. excursion, 10 to 55 Hz.

GENERAL

POWER: 115 or 230V, $\pm 10\%$; 48 to 440 Hz; normally < 110 W with plug-ins at normal line. Maximum mainframe power, 200 VA.

DIMENSIONS:

Cabinet Model 180C: 7-7/8 in. wide, 11-3/8 in. high, 21-1/4 in. deep behind panel (200 x 289 x 540 mm).

Rack Model 180D: see outline drawing.

ACCESSORIES FURNISHED: 7-1/2 ft power cord; blue contrast filter (HP P/N 5060-0548) rack mounting hardware and 2 probe holders (HP P/N 5040-0464) are also supplied with 180D Rack Model.

OPTIONS

Refer to Section VII for listing of options.

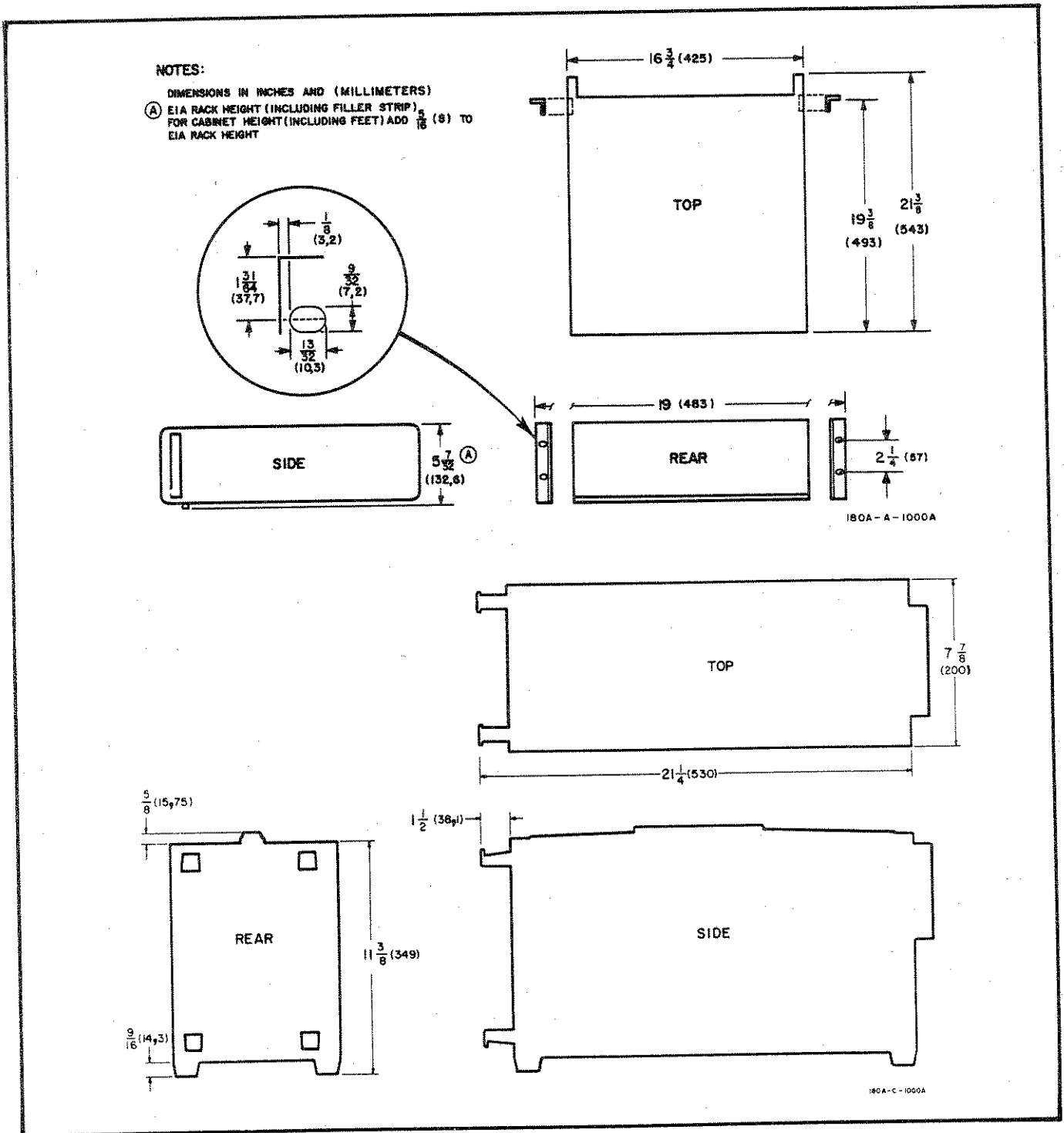


Figure 1-3. Model 180C and 180D Dimensions

1-43. SERVICE EQUIPMENT.

1-42. The HP Model 123A (with 10369A Adapter) is an economical, easy-to-use camera for general purpose oscilloscope photography which uses standard Polaroid flat-pack self-processing film. Most oscilloscope photographic applications can be solved with this camera.

1-44. For ease of calibration and maintenance, the HP Model 10407B Plug-in Extender can be obtained. It provides for removal of the vertical and time base plug-ins from the oscilloscope mainframe and exposes components and adjustments of the plug-ins for servicing.

1-45. OTHER ACCESSORIES.

1-46. Additional RFI shielding for the CRT display can be obtained by using the Model 10178A Metal Mesh Contrast Filter in place of the filter supplied.

1-47. Cameras, probes, viewing hoods, terminations and other accessory items are available for specialized requirements. Information on these and the above described accessories may be obtained from HP Sales/Service Offices listed in the rear of this manual.

Table 1-2. Reference Designators and Abbreviations.

REFERENCE DESIGNATORS							
A	= assembly	E	= misc. electrical part	P	= plug	U	= integrated circuit (unrepairable)
AT	= attenuator, resistive termination	F	= fuse	PS	= power supply	V	= vacuum tube, neon bulb, photocell, etc.
B	= motor, fan	FL	= filter	Q	= transistor	VR	= voltage regulator (diode)
BT	= battery	H	= hardware	R	= resistor	W	= cable
C	= capacitor	J	= Jack	RT	= thermistor	X	= socket
CP	= coupling	K	= relay	S	= switch	Y	= crystal
CR	= diode	L	= inductor	T	= transformer	Z	= network
DL	= delay line	LS	= speaker	TB	= terminal board		
DS	= device signaling (lamp)	M	= meter	TP	= test point		
		MP	= mechanical part				

ABBREVIATIONS							
A	= ampere(s)	FET	= field-effect transistor(s)	n	= nano (10^{-9})	rfl	= radio frequency interference
ampl	= amplifier(s)	G	= giga (10^9)	nc	= normally closed	rms	= root mean square
assy	= assembly	gnd	= ground(ed)	no.	= normally open	rww	= reverse working voltage
amplitd	= amplitude	H	= henry(ies)	npn	= negative-positive-negative	SCR	= silicon controlled rectifier
bd	= board(s)	hr	= hour(s)	ns	= nanosecond	sec	= second(s)
bp	= bandpass	HP	= Hewlett-Packard	pc	= printed (etched) circuit(s)	std	= standard
c	= centi (10^{-2})	Hz	= hertz	pk	= peak	trmr	= trimmer
C	= carbon	if.	= intermediate freq.	php	= positive-negative-positive	u	= micro (10^{-6})
ccw	= counterclockwise	intl	= internal	p/o	= part of	usec	= microsecond
coax.	= coaxial	k	= kilo (10^3)	p-p	= peak-to-peak	V	= volts
coef	= coefficient	lb	= pound(s)	prgm	= program	var	= variable
com	= common	lpf	= low-pass filter(s)	prv	= peak inverse voltage(s)	w/	= with
CRT	= cathode-ray tube	m	= milli (10^{-3})	ps	= picosecond	w/o	= without
cw	= clockwise	M	= mega (10^6)	pwv	= peak working voltage	wiv	= working inverse voltage
d	= deci (10^{-1})	ms	= millisecond	rf	= radio frequency		
dB	= decibel						
ext	= external						
F	= farad(s)						

SECTION II

INSTALLATION

2-1. INTRODUCTION.

2-2. This section of the manual contains inspection and installation procedures for the Model 180C/D Oscilloscope. In addition, packing and claims procedures are discussed in the event damage occurs during shipment.

2-3. INITIAL INSPECTION.

2-4. The instrument was carefully inspected, mechanically and electrically, prior to shipment. On receipt, inspect it for any mechanical damage which may have occurred during shipment and test the electrical performance.

2-5. Check for physical damage such as bent or broken parts and dents or scratches. If damage is found, refer to the recommended claims procedure. Retain the packaging material for future use.

2-6. Check the electrical performance of the instrument as soon as possible after receipt. The performance check is contained in Section V of this manual. This check will verify that the instrument is operating to the specifications listed in Table 1-1.

2-7. The initial performance and accuracy of this instrument are certified as stated in the warranty on the inside front cover of this manual. If the instrument does not operate as specified, refer to the recommended claims procedure.

2-8. CLAIMS.

2-9. If physical damage is found or if the instrument is not within specifications when received, notify the carrier and the nearest Hewlett-Packard Sales/Service Office immediately. The Sales/Service Office will arrange for repair or replacement of the instrument without waiting for a claim to be settled with the carrier.

2-10. The warranty statement for this Hewlett-Packard instrument is on the inside front cover of this manual. Contact the nearest HP Sales/Service Office for information and assistance with warranty claims.

2-11. REPACKING FOR SHIPMENT.

2-12. If the instrument is to be shipped to a Hewlett-Packard Sales/Service Office, attach a tag to it showing owner's name, address, instrument model number and serial number, and a description of the service required.

2-13. Use the original shipping carton and packaging materials for reshipment. If they are not available, the

HP Sales/Service Office will provide information and recommendations on material to be used.

2-14. PREPARATION FOR USE.

2-15. POWER REQUIREMENTS.

2-16. The standard Model 180C/D requires a 115V or 230V $\pm 10\%$, single-phase, 48 to 440 Hz power source capable of supplying 200 VA maximum or approximately 110 watts at normal line voltage with plug-ins installed.

2-17. 115V OPERATION. This instrument, as shipped, is ready for operation on 115V ac. Before applying power, check the rear-panel slide switch, labeled SELECTOR, for proper position. It should be set so the legend 115 is visible. Check the fuse to determine that it is the proper value to provide protection for 115V operation of the instrument.

2-18. 230V OPERATION. If the instrument is to be operated from a 230V ac power source, set the rear-panel SELECTOR slide switch to 230. Replace the fuse with the proper value for 230V operation.

2-19. THREE-CONDUCTOR POWER CABLE.

2-20. This instrument is equipped with a three-conductor power cable that, when connected to an appropriate receptacle, grounds the instrument through the offset pin. The power cable required depends on the ac input voltage, and the country in which the instrument is to be used. Figure 2-1 illustrates the standard power receptacle (wall outlet) configurations that are used throughout the United States and in other countries. The HP part number shown adjacent to each receptacle drawing is the part number for a power cable equipped with a mating plug for that receptacle. If the appropriate power cable is not included with the instrument, notify the nearest Hewlett-Packard Sales/Service Office and a replacement cable will be provided.

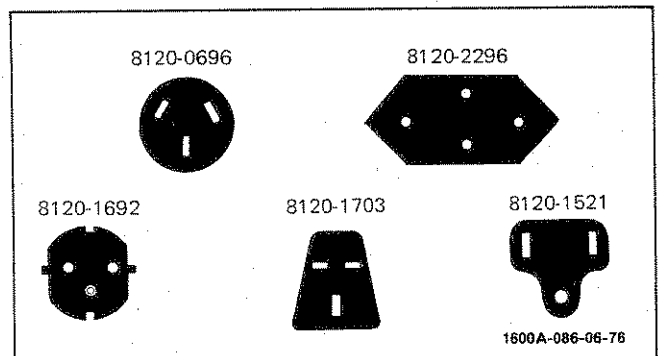


Figure 2-1. Power Receptacles

2-21. When operating the Model 180C/D from a two-contact power outlet, use a three-conductor to two-conductor adapter. Preserve the safety feature by grounding the adapter flexible (third) lead. A suitable three-pin to two-pin adapter is available from Hewlett-Packard. Order HP Part No. 1251-0048.

2-22. INSTRUMENT MOUNTING.

2-23. The Model 180C is intended for bench use. It has a built-in tilt stand and feet mounted on both bottom and rear for bench or upright operation.

2-24. The Model 180D is intended for either bench or rack use. It has a built-in tilt stand and feet mounted on the bottom for bench use. It may be rack mounted as described below.

2-25. **BENCH USE.** To use the tilt stand, lift the front of the instrument or place it vertically on the rear feet. The tilt stand is folded and locked into place against the cabinet bottom cover. Hold the instrument steady and squeeze the two tilt stand legs together to release them from the lock. Pull the stand toward the front of the instrument. When fully forward, release the legs and they will lock into position. The tilt stand will support the instrument with the front elevated.

2-26. **RACK MOUNTING.** A kit for converting the Model 180D to a rack mount configuration is supplied with each instrument. Instructions for making the conversion are given below. See Figure 2-2 for parts identification.

a. Detach tilt stand by pressing it away from front feet. Remove all plastic feet by depressing metal button and sliding feet free.

b. Remove aluminum trim strip from each side of instrument with thin blade tool.

c. Attach rack mounting flange in space where trim strip was removed (use screws provided with kit). Large notch of flange should be positioned at bottom of instrument.

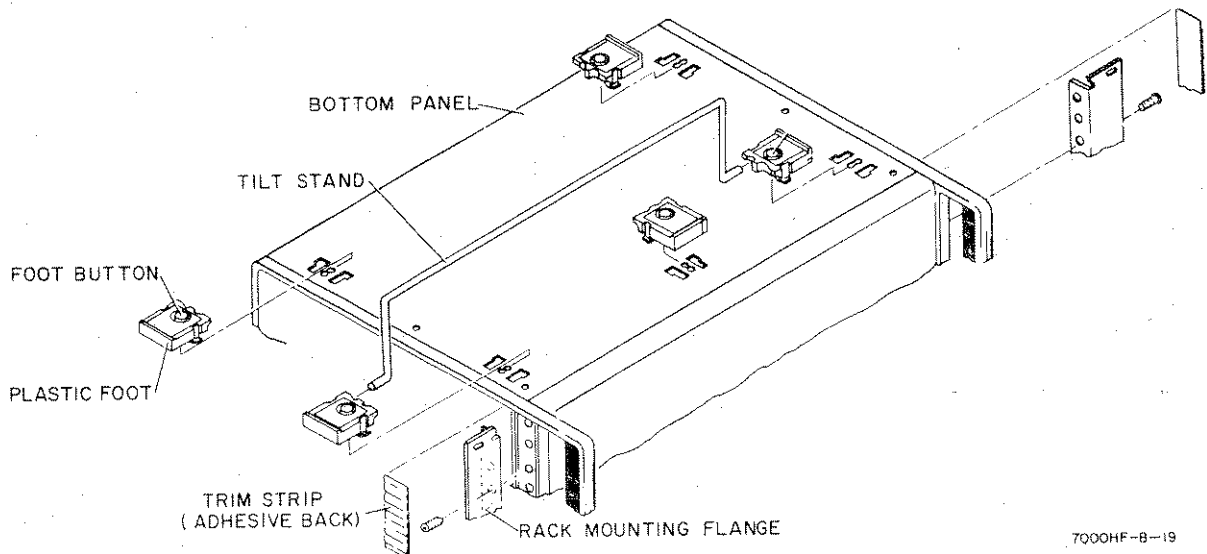
2-27. INSTRUMENT COOLING.

2-28. This instrument does not require forced-air-cooling when operated at room temperature or between 0 and +55 degrees C. Normal air circulation will maintain a reasonable operating temperature within the instrument.

2-29. Perforations in the covers provide for the required air flow. Do not obstruct them. Provide several inches of clearance around the top, rear and sides. Adequate air flow from the bottom of the instrument is provided by the mounting feet.

2-30. CONTRAST FILTER.

2-31. The contrast filter is designed to be easily removed from the CRT bezel. Use of the contrast filter provides comfortable viewing when the instrument is operated in normal and high ambient light.



7000HF-B-19

Figure 2-2. Rack Mount Procedure

2-32. The contrast filter is located behind the light shield. When a camera is attached for use, removal of the filter may be desirable.

2-33. To remove the plastic light shield, squeeze it at midpoint at top and on bottom. Apply pressure until upper and lower ears clear the slots in the bezel. Pull forward and remove.

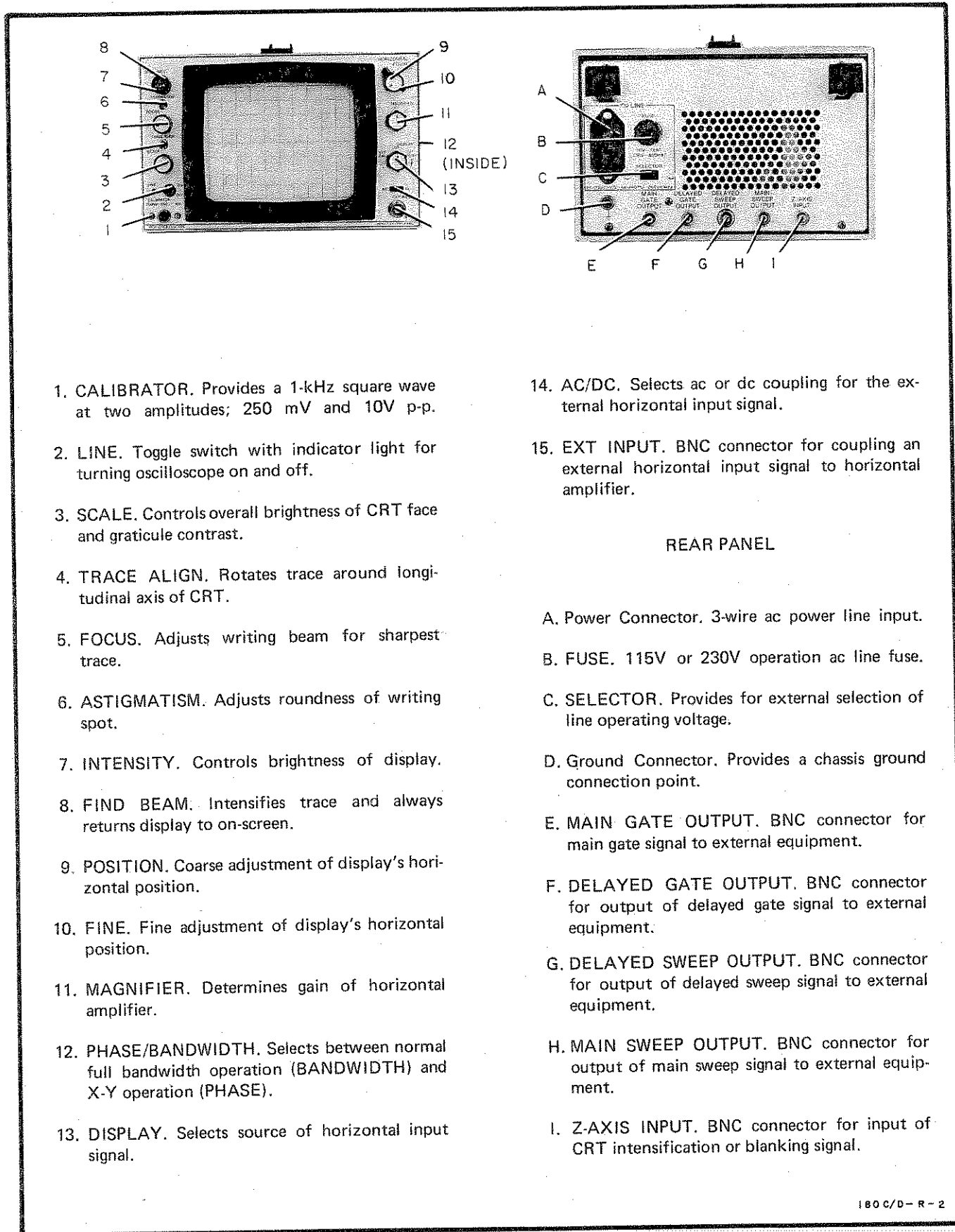
2-34. Remove the contrast filter, which is held in the bezel by a loose pressure fit.

2-35. INSTRUMENT COMPATIBILITY.

2-36. The Model 180C/D Oscilloscope is designed to operate with a wide variety of time base and vertical plug-ins. Table 3-1 lists the plug-ins currently available.

Note

Plug-ins specifically designed for use with the 500-MHz Model 183A/B/C/D Oscilloscope will not fit into or operate in the Model 180C/D. A mechanical interlock is provided on these plug-ins which prevents their full insertion into the Model 180C/D. Additionally, the Model 180C/D does not supply the required operating power.



1. CALIBRATOR. Provides a 1-kHz square wave at two amplitudes; 250 mV and 10V p-p.
2. LINE. Toggle switch with indicator light for turning oscilloscope on and off.
3. SCALE. Controls overall brightness of CRT face and graticule contrast.
4. TRACE ALIGN. Rotates trace around longitudinal axis of CRT.
5. FOCUS. Adjusts writing beam for sharpest trace.
6. ASTIGMATISM. Adjusts roundness of writing spot.
7. INTENSITY. Controls brightness of display.
8. FIND BEAM. Intensifies trace and always returns display to on-screen.
9. POSITION. Coarse adjustment of display's horizontal position.
10. FINE. Fine adjustment of display's horizontal position.
11. MAGNIFIER. Determines gain of horizontal amplifier.
12. PHASE/BANDWIDTH. Selects between normal full bandwidth operation (BANDWIDTH) and X-Y operation (PHASE).
13. DISPLAY. Selects source of horizontal input signal.

14. AC/DC. Selects ac or dc coupling for the external horizontal input signal.
15. EXT INPUT. BNC connector for coupling an external horizontal input signal to horizontal amplifier.

REAR PANEL

- A. Power Connector. 3-wire ac power line input.
- B. FUSE. 115V or 230V operation ac line fuse.
- C. SELECTOR. Provides for external selection of line operating voltage.
- D. Ground Connector. Provides a chassis ground connection point.
- E. MAIN GATE OUTPUT. BNC connector for main gate signal to external equipment.
- F. DELAYED GATE OUTPUT. BNC connector for output of delayed gate signal to external equipment.
- G. DELAYED SWEEP OUTPUT. BNC connector for output of delayed sweep signal to external equipment.
- H. MAIN SWEEP OUTPUT. BNC connector for output of main sweep signal to external equipment.
- I. Z-AXIS INPUT. BNC connector for input of CRT intensification or blanking signal.

Figure 3-1. Operating Controls and Connectors

SECTION III

OPERATION

3-1. INTRODUCTION.

3-2. This section of the manual presents information on the operation, function and capabilities of the instrument controls. Information regarding control turn-on procedures and front panel adjustments is explained to assist the operator in properly setting up and using the Model 180C/D.

3-3. GENERAL.

3-4. The Model 180C/D is designed to operate with plug-in time bases and vertical amplifiers, or plug-in sampling and time-domain reflectometers. These plug-ins are accommodated in the lower or right-hand portion of the instrument. The required operating power is obtained from the oscilloscope mainframe. Time base and vertical amplifier units must be locked together before being installed in the mainframe.

3-5. The vertical amplifier is always installed in the left-hand side and the time base on the right-hand side of the plug-in compartment. Refer to the plug-in operating and service manuals for mating and installation instructions. Sampling and TDR plug-ins use the entire active plug-in compartment.

3-6. FRONT PANEL CONTROLS AND CONNECTORS.

3-7. All operating controls and front panel adjustments are identified and described in Figure 3-1. The information presented gives the operator a quick reference regarding the operating function of each. Additional information regarding some of these is explained below in greater detail.

3-8. CALIBRATOR.

3-9. The calibrator has two outputs, 10V and 250 mV peak-to-peak, negative-going from ground, with an amplitude accuracy of $\pm 1\%$. The output is a square wave at a frequency of approximately 1 kHz. Risetime of the signal is less than 3 microseconds. These outputs are useful for checking vertical and horizontal sensitivity calibration, and divider probe calibration. A 3-way binding post provides a convenient ground connection point and may be used with banana plug, wire or spade-lug connection.

3-10. SCALE.

3-11. This control adjusts the overall brightness of the CRT face. It should be adjusted for good contrast

between the background and the graticule. The SCALE control is useful when using a hood to view the display or when photographing waveforms. Rotate the SCALE control counterclockwise to OFF when graticule illumination is not needed.

3-12. TRACE ALIGN.

3-13. A screwdriver adjustment is used to compensate for external magnetic fields that may affect alignment of the horizontal trace with the graticule. Use it to position the trace parallel to the graticule horizontal lines. The alignment should be checked when the instrument is moved to a new location and adjustment made whenever necessary.

3-14. FOCUS AND ASTIGMATISM.

3-15. These controls are used to obtain a display of uniform focus. Adjust both controls for the sharpest display possible.

3-16. FIND BEAM.

3-17. Occasionally the CRT beam may be driven offscreen by large dc input levels or improper control settings. Pressing the pushbutton increases intensity and reduces horizontal and vertical amplifier gains enough to always return a displaced beam to the viewing area. This enables the operator to determine the action necessary to center the display. All operating controls function while the FIND BEAM control is depressed. Obtaining a centered display may require adjustment of the deflection factor, horizontal and vertical position, coupling, trigger level or intensity. If the controls are properly set, the display will remain visible when FIND BEAM is released.

Note

Option 011 and 611 instruments do not increase intensity when FIND BEAM is pressed. Use the INTENSITY control to set intensity to viewing level.

3-18. LINE POWER SWITCH.

3-19. This toggle switch applies or removes ac line input power to the instrument. When ON, an indicator lamp, located next to the switch, is lit. Power for the lamp is obtained from the low voltage power supply. Both sides of the ac power line input are interrupted when switched to OFF.

3-20. HORIZONTAL DISPLAY.

3-21. Either of two modes of operation can be selected with this control. It selects the origin of the input signal applied to the horizontal amplifier. When INT is selected, the input signal to the horizontal amplifier is obtained from the time base plug-in. With the DISPLAY control positioned to EXT CAL, the sweep signal input from the plug-in is disconnected, and the EXT INPUT signal is used to develop the display sweep.

Note

Time base plug-ins are normally adjusted to provide a sweep length greater than 10 divisions. Refer to the applicable time base operating and service manual for adjustment information.

3-22. HORIZONTAL EXTERNAL COUPLING.

3-23. An external input signal may be connected to the horizontal amplifier via the EXT INPUT BNC connector when DISPLAY is set to EXT. The coupling switch is used to select ac coupling (capacitive coupling) or dc coupling to the amplifier.

3-24. HORIZONTAL MAGNIFIER.

3-25. This switch controls the gain of the horizontal amplifier in three steps. When INT DISPLAY is selected and MAGNIFIER is set to X1, the displayed sweep speed is as selected at the time base plug-in. When switched to X5, the gain is increased five times, and when set to X10, the gain is increased 10 times. Time base selected sweep speeds are thus increased X5 or X10 the indicated sweep speed.

3-26. When an EXT INPUT signal is selected to drive the horizontal amplifier, 1 volt of signal will result in 1 division of deflection in X1, 5 divisions of deflection in X5 and 10 divisions of deflection in X10.

3-27. EXTERNAL SENS.

3-28. The deflection factor of an external input signal can be continuously varied to decrease deflection by a factor of approximately 10 by using this control. When the vernier is in the maximum clockwise position (CAL detent), the horizontal amplifier is calibrated to provide 1.0 V/div deflection in the X1 magnifier range, 0.25 V/div in the X5 range, and 0.1 V/div in the X10 range. Counterclockwise rotation from the CAL POSITION decreases the uncalibrated gain.

3-29. REAR PANEL CONTROLS AND CONNECTORS.

3-30. Rear panel controls and connectors are identified and described in Figure 3-1. Additional information regarding these is explained below in greater detail.

3-31. OUTPUTS.

3-32. Four BNC connectors on the rear panel of the Model 180C/D are provided to supply signals from the time base or sampling plug-in to external equipment. The low impedance outputs are isolated from the high impedance input signals. The period of the signal output is directly related to the main and delayed sweep speed selected for the time base plug-in or the vertical and horizontal outputs when used with sampling plug-ins. Refer to the operating and service manual for the plug-in to determine signal identification.

3-33. The time base output of the MAIN SWEEP OUTPUT and the DELAYED SWEEP OUTPUT is a positive-going ramp of about 5 volts amplitude. The time base output of the MAIN GATE OUTPUT and the DELAYED GATE OUTPUT is a negative-going pulse of about 2.5 volts amplitude. These outputs can supply 3 mA and will drive impedances as low as 1000 ohms without distortion.

3-34. Z-AXIS INPUT.

3-35. An external signal can be utilized to control the CRT intensity. The intensity modulation signal is applied directly to the CRT intensity gate amplifier. A pulse of approximately +2V amplitude and a width of at least 50 nanoseconds or a +2V continuous wave (cw) input of 10 MHz or lower will blank a trace of normal intensity. Input of a negative signal can be used for display intensification.

3-36. AC LINE INPUT.

3-37. A three-conductor ac power cord is provided for ac input. A power line ground is obtained through the power cord. Also located on the rear panel is the SELECTOR line slide switch which allows operation from either 115V or 230V ac line power. Fuses are provided for both 115V and 230V operation, and must be changed to the proper value when line input is switched.

3-38. PHASE/BANDWIDTH SWITCH.

3-39. A PHASE/BANDWIDTH switch is located within the instrument on the horizontal amplifier assembly. The instrument top cover must be removed for access to this switch. Positioning the PHASE/BANDWIDTH switch to PHASE causes an external horizontal input signal to be delayed the same amount of time as the vertical input signal. This delay allows the Model 180C/D to be used for phase measurement. The switch should always be in the BANDWIDTH position unless the instrument is being used for phase measurement.

3-40. PLUG-IN UNITS.

3-41. The Model 180C/D Oscilloscope requires time base and vertical or sampling plug-in units. The deflection sensitivity of the CRT may vary slightly with different units. Vertical plug-ins should be calibrated when first installed or when shifted between oscilloscopes. The time

base and vertical plug-ins must be locked together prior to insertion into the Model 180C/D. Consult the respective plug-in operating and service manuals for operation and capability information. Table 3-1 lists the plug-ins currently available.

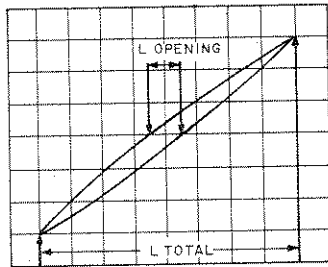
3-42. PHASE MEASUREMENT.

3-43. Section V of this manual contains the adjustment procedure. Accurate phase measurements may be made at frequencies up to 100 kHz.

Table 3-1. Available Plug-ins

Vertical Plug-ins									Sampling (Vertical Section)		
Model No.	1801A	1803A	1804A	1805A	1806A	1807A	1808A	1809A	1810A	1815A/B	1811A
Bandwidth MHz	50	40 (30)	50	100	0.5	35	75	100	1 GHz	4 or 12.4 GHz	4 or 18 GHz
Min. deflection factor/div	5 mV (500 uV opt 001 cascad- ed)	10 mV (1 mV cascad- ed)	20 mV	5 mV	100 uV	10 mV	5 mV	10mV	2 mV	5 mV	2 mV
Channels	2 (opt 001, 1 cascad- ed)	1 diff	4	2 (1 cascad- ed)	2 (both diff)	2	2	4	2	1	2
Input RC	1 MΩ/ 25 pF	1 MΩ/ 27 pF	1 MΩ/ 25 pF	1 MΩ/ 13 pF or 50Ω	1 MΩ/ 45 pF	1 MΩ/ 27 pF	1 MΩ/ 12 pF or 50Ω	1MΩ/ 12pF or 50Ω	50Ω	50Ω	50Ω
Differential input	yes	yes (with dc offset)	no	yes	yes	yes	yes	yes	yes	no	yes
Time Base Plug-ins					Sampling (Time Base Section)			TDR			
Model No.	1820C	1821A	1824A	1825A	1810A	1815A/B	1811A	1818A	1815A/B		
Ext Trig Freq. (MHz)	150	100	150	150	<1 GHz	18 GHz with trigger countdown	18 GHz with trigger countdown	<160 ps risetime	<35 ps risetime		
Int Trig Freq.	Determined by Vertical Amplifier Plug-in				1 GHz			TDR System	TDR		
Sweep Speeds/div	5 ns* 1 sec	10 ns* 1 sec	5 ns* 1 sec	5 ns* 1 sec	100 ps (expand- ed) - 50 usec	10 ps - 1 usec	10 ps (expand- ed) - 1 usec	Calibrated in feet, meters, and nano- seconds	1815A calibrated in feet,		
Delayed and mixed sweep	No	Yes	Expand- ed X100	Yes	No	No	No		1815B calibrated in meters.		
*Includes X10 mainframe magnification.											

3-44. To measure phase, set the internal PHASE/BANDWIDTH switch to PHASE and connect the input signals to the vertical amplifier input and the oscilloscope HORIZONTAL EXT INPUT. Set the HORIZONTAL DISPLAY to EXT. A display similar to Figure 3-2 will be observed. The size of the opening of the display is a relative indication of the phase difference of the input signals.



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Figure 3-2. Phase Measurement

3-45. To obtain a more exact measurement of the phase difference, center the display in the X-axis and Y-axis. Increased measurement accuracy will be obtained by using horizontal and vertical deflection factors which result in maximum display size. The phase shift in degrees is determined by the following:

$$\theta = \sin^{-1} \left(\frac{L \text{ opening}}{L \text{ total}} \right)$$

3-46. As an example, assume that L total is 8 divisions. If L opening is 1 division, the phase shift is approximately 7 degrees.

Note

Make certain that the switch is returned to BANDWIDTH position after making phase measurements. This will allow full horizontal bandwidth operation.

3-47. BRIGHT DISPLAY PHOTOGRAPHY.

3-48. The standard CRT (aluminized P31 phosphor) used in the Model 180C/D has an accelerating potential of approximately 15 kV. This provides a bright display and makes possible a very high measurement capability of low duty cycle signals. Photographic writing speed is at least 1500 centimeters/microsecond using standard 10,000 ASA Polaroid (®) film, and a camera (with $f/1.3$ lens and a 1: 0.5 object-to-image ratio) without employing film-fogging techniques.

3-49. Higher writing speeds are readily achieved by using film-fogging techniques, a CRT with P11 phosphor, and

a camera with faster lenses. Additional information is provided in the following paragraphs and more detailed data can be obtained from Application Note 115, Principles of Cathode-ray Tubes, Phosphors, and High-speed Oscillography, available on request from HP Sales/Service Office.

3-50. PHOTOGRAPHIC WRITING SPEED.

3-51. The capability of an oscilloscope-camera-film system to record a high-speed one-time signal is described as the writing speed of the system. Many factors affect this performance. Basic information which will assist the operator in achieving the maximum capability of the system is provided here.

3-52. FILM. Type 410 Polaroid film has an ASA speed index of 10,000. This is an ultra high-speed film which is particularly useful for single-shot oscilloscope recording. The film is a high contrast type and produces very useable photographs for examination or reproduction. Its extreme sensitivity is helpful in recording the low light level obtained from CRT display of a very high speed transient waveform.

3-53. CRT SPOT SIZE AND SPEED. Uniformity of spot size over the CRT display area will result in best resolution and detail. The oscilloscope focus and astigmatism controls should be adjusted to obtain the sharpest spot for the intensity setting required.

3-54. Trace focus can vary at different sweep speeds. Oscilloscope focus should be set at the sweep speed and intensity level which will be used to display the signal to be photographed. When photographing a single-shot signal, the focus can be set by using a test signal input having a repetition rate of less than 10 milliseconds. As the speed of the spot increases, more exposure time or a higher intensity display may be required for film recording of the signal.

3-55. EXPOSURE. Evaluation of the signal to be photographed may make it desirable to overexpose one portion of a signal to capture the part which is of greater interest. This occurs because the speed of the spot (ie: spot writing speed) very directly affects the light output of the CRT. As an example: if the risetime of a fast pulse is the detail desired, display and photographic parameters could be set to capture this, while the flat-top portion might be overexposed and its detail uncertain. This occurs since the spot speed would be high for the risetime portion of the pulse and slower over the flat top portion.

3-56. CRT INTENSITY. The intensity level used to present a display for viewing or photography has a great effect on the oscilloscope writing rate and the proper photographic exposure. Small changes in intensity levels are usually compensated for by the overall range of film latitude. This results in a good exposure within a fairly wide range of exposure variables.

3-57. **SINGLE SHOT.** Signals of extremely short duration will require use of a high intensity level. The fast writing rate of the Model 180C/D is ideal for displaying single-shot signals. As a general rule, extended exposure times sufficient to make use of the phosphor after-glow will assist in recording very short duration signals.

3-58. CAMERA FOCUSING.

3-59. Make certain that the camera is focused properly, since decreased writing speeds will result from a defocused film image. The CRT calibration graticule is internally etched on the viewing face, and the trace and graticule are in the same object plane. Focusing the camera accurately on the graticule will provide the sharpness desired.

3-60. If it is necessary to use a large lens aperture, the depth of field is reduced and accurate focusing can become an important factor.

3-61. FILM POST-FOGGING.

3-62. After exposure to the displayed signal, a controlled exposure of Polaroid film to a light source can increase the effective writing speed. At very low light levels, little change in Polaroid film density occurs over considerable variation in light intensity. This occurs because near the threshold of film sensitivity, exposure and the resulting film contrast is a non-linear relationship. Additional exposure to light can effectively increase the low-level sensitivity of the film and provide greater viewing contrast.

3-63. Post-fogging is simple to accomplish with the Model 180C/D. The SCALE control provides this capability. It allows illuminating the CRT phosphor (and contrasting graticule) by flooding the face of the CRT with low-level excitation.

3-64. If the signal to be photographed is very fast, the post-fogging time should be longer than that required for maximum contrast of slower speed signals.

3-65. If desired, photography of the displayed signal and graticule may be accomplished simultaneously. Use of the SCALE control makes it unnecessary to illuminate the graticule by ultraviolet light, as provided in some cameras. It can be turned off, and the SCALE control can be quickly set to provide the desired level of graticule illumination.

3-66. PHOTOGRAPHIC PROCEDURE.

Note

When using high-speed ASA 10,000 film, allow the CRT phosphor to decay for 2 minutes after the camera viewing port is closed and before the photograph is taken. This will allow phosphor excitation by ambient light to decay and prevent film overexposure with long shutter times. (Allow 3 minutes if P11 CRT is installed.)

3-67. REPETITIVE SIGNAL.

- a. Adjust Model 180C/D, time base and vertical amplifier controls to obtain the desired signal display.
- b. Adjust INTENSITY and FOCUS for sharpest trace.
- c. Adjust SCALE for desired graticule contrast.
- d. Expose film using shutter and aperture settings based on type of film employed and camera characteristics.

3-68. SINGLE SIGNAL.

- a. Adjust Model 180C/D time base and vertical amplifier controls to obtain the desired signal display using a test signal to establish vertical deflection, trigger control and sweep time settings.
- b. Adjust INTENSITY and FOCUS for sharpest trace. Use a low repetition rate signal or single-shot signal in single-sweep operation while making these adjustments so that best approximation of the desired signal parameters is obtained.
- c. Set camera controls for desired operation, usually time or bulb.
- d. Open camera shutter and allow sweep to trigger on signal.
- e. Adjust SCALE control for desired level of graticule illumination and post-fog film if necessary for extremely fast signals. A very low level of illumination, small lens opening and fast shutter speed will provide adequate post-fogging.

Note

Increased writing speed can also be obtained by a controlled exposure of Polaroid film to a light source before exposure to the displayed signal. This is called pre-fogging. Either post-fogging or pre-fogging techniques may be used. Results are approximately equivalent.