

Errata

Title & Document Type: 54120B Mainframe Service
Manual - July 1989

Manual Part Number: 54120-90908

Revision Date: July 1989

HP References in this Manual

This manual may contain references to HP or Hewlett-Packard. Please note that Hewlett-Packard's former test and measurement, semiconductor products and chemical analysis businesses are now part of Agilent Technologies. We have made no changes to this manual copy. The HP XXXX referred to in this document is now the Agilent XXXX. For example, model number HP8648A is now model number Agilent 8648A.

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Agilent Technologies

MANUAL CHANGES

MANUAL IDENTIFICATION

Model Number: HP 54120B

Date Printed: July 1989

Part Number: 54120-90908

This supplement contains important information for correcting errors in the manual and for adapting the manual to instruments containing improvements that were 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 table.

| Serial Prefix | Make Manual Changes | Serial Prefix | Make Manual Changes |
|---------------|---------------------|---------------|---------------------|
| 2944A | 1 | | |
| 3008A | 1, 2 | | |
| 3012A | 1, 2, 3 | | |
| 3035A | 1, 2, 4, | | |
| 3051A | 1, 2, 4, 5 | | |
| 3149A | 1, 2, 4, 5, 6 | | |

◆ NEW ITEM

Errata

This errata inclusion provides a drawing for the Replaceable Parts section to help you locate cables in the mainframe. The Table of Contents page is also updated.

Replace the Contents-5 page with the page in this document.

Add page 5-11 to the end of the Replaceable Parts section.

Change 1

The following changes were made to the Replaceable Parts pages. The changes are documented on the new pages that are a part of change 5.

A14 changed to HP part number 2090-0226 Color CRT Module.

MP13, right side cover 5061-9523, was removed from the Replaceable Parts list.

MP12, MP14, MP15, and MP16, changed in quantity from 1 to 2.

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.



Change 2

The following changes were made to the Replaceable Parts pages. The changes are documented on the new pages that are a part of change 5.

A2 changed to HP part number 54111-66527, CD = 7

*A2 changed to HP part number 54111-69527, CD = 3

Change 3

The part number of the A11 assembly was changed as indicated below. However, the A11 assembly was changed again to a new part number in change 4. Therefore, you will find the change 4 part numbers for the A11 assembly in the replaceable parts list.

A11 changed to HP part number 54110-66515, CD = 2

*A11 changed to HP part number 54110-69515, CD = 8

Change 4

The following changes were made to the Replaceable Parts pages. The changes are documented on the new pages that are a part of change 5.

A11 changed to HP part number 54110-66516, primary power supply assembly.

Change 5

The following changes were made to the Replaceable Parts pages. The changes are documented on the new pages that are a part of change 5.

This prefix change covers changes to PC assemblies that are transparent at the assembly replacement level of maintenance.

◆ Change 6

Replace: Title page, Printing History pages iii and iv, Replaceable Parts pages 5-8, 5-9, and 5-10.

A14 changed to HP part number 2090-0251, CD = 6

H7 was added, HP part number 54110-1214, Hex Nut, Qty = 4, CD = 3

MP13 was added, HP part number 54111-00608, Display Shield, Qty = 1, CD = 7

MP30 changed to HP part number 54110-1214, CD = 2

MP31 changed to HP part number 54110-1215, CD = 3

Service Manual

HP 54120B

Digitizing Oscilloscope Mainframe

Serial Numbers

This manual applies directly to instruments
prefixed with serial number:

3149A

With changes described within, this manual also
applies to instruments with serial prefixes:

3051A
3035A
3012A
3008A
2944A
2926A
2909A

For Additional Information about serial numbers see
Instruments Covered by This Manual
in Section 1.

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Herstellerbescheinigung

Hiermit wird bescheinigt, dass das Gerät/System HP 54120B in Übereinstimmung mit den Bestimmungen von Postverfügung 1046/84 funkentstört ist.

Der Deutschen Bundespost wurde das Inverkehrbringen dieses Gerätes/Systems angezeigt und die Berechtigung zur Überprüfung der Serie auf Einhaltung der Bestimmungen eingeräumt.

Zusatzinformation für Mess- und Testgeräte

Werden Mess- und Testgeräte mit ungeschirmten Kabeln und/oder in offenen Messaufbauten verwendet, so ist vom Betreiber sicherzustellen, dass die Funkentstörbestimmungen unter Betriebsbedingungen an seiner Grundstücksgrenze eingehalten werden.

Manufacturer's Declaration

This is to certify that this product HP 54120B meets the radio frequency interference requirements of directive 1046/84. The German Bundespost has been notified that this equipment was put into circulation and was granted the right to check the product type for compliance with these requirements.

Additional Information for Test and Measurement Equipment

Note: If test and measurement equipment is operated with unshielded cables and/or used for measurements on open set-ups, the user must insure that under these operating conditions, the radio frequency interference limits are met at the border of his premises.

Printing History

New editions are complete revisions of the manual. Update packages, which are issued between editions, contain additional and replacement pages to be merged into the manual by the customer. The dates on the title page change only when a new edition is published.

A software and/or firmware code may be printed before the date; this indicates the version level of the software and/or firmware of this product at the time of the manual or update was issued. Many product updates and fixes do not require manual changes and, conversely, manual corrections may be done without accompanying product changes. Therefore, do not expect a one to one correspondence between product updates and manual updates.

| | | |
|-----------|---------------|-------------|
| Edition 1 | July 1989 | 54120-90908 |
| Update 1 | October 1989 | 54120-90908 |
| Update 2 | February 1990 | 54120-90908 |
| Update 3 | March 1990 | 54120-90908 |
| Update 4 | August 1990 | 54120-90908 |
| Update 5 | January 1991 | 54120-90908 |
| Update 6 | March 1991 | 54120-90908 |
| Update 7 | January 1992 | 54120-90908 |

List of Effective Pages

The List of Effective Pages gives the date of the current edition and of any pages changed in updates to that edition. Within the manual, any page changed since the last edition is indicated by printing the date the changes were made on the bottom of the page. If an update is incorporated when a new edition of the manual is printed, the change dates are removed from the bottom of the pages and the new edition date is listed in Printing History and on the title page.

| Pages | Effective Date |
|---|-----------------------|
| all | July 1989 |
| Title page, iii, iv, 5-8, 5-9 | October 1989 |
| Title page, iii, iv, 5-8 | February 1990 |
| Title page, iii, iv, 5-8 | March 1990 |
| Title page, iii, iv, 5-8 | August 1990 |
| Title page, iii, iv, 5-8, and 5-9 | January 1991 |
| Contents-5, 5-11 | March 1991 |
| Title page, iii, iv, 5-8, 5-9, and 5-10 | January 1992 |

List of Illustrations

- 1-3 Figure 1-1. HP 54120B Dimensions

- 2-2 Figure 2-1. Rear Panel of Mainframe and Test Set

- 4-10 Figure 4-1. CRT Adjustment Sequence
- 4-11 Figure 4-2. PIN AMP Adjustment
- 4-11 Figure 4-3. PIN PHASE Adjustment
- 4-13 Figure 4-4. Purity Magnet Centering
- 4-13 Figure 4-5. Purity Magnet Adjustment Raster
- 4-14 Figure 4-6. Landing and Purity Adjustment Guide
- 4-15 Figure 4-7. Static Convergence
- 4-16 Figure 4-8. Y BOW Adjustment
- 4-16 Figure 4-9. Y BOW CROSS Adjustment
- 4-16 Figure 4-10. V.STAT TOP Adjustment
- 4-17 Figure 4-11. V.STAT BOTTOM Adjustment
- 4-17 Figure 4-12. H.AMP Adjustment
- 4-17 Figure 4-13. H.TILT Adjustment

- 5-4 Figure 5-1. Top View
- 5-5 Figure 5-2. Bottom View
- 5-6 Figure 5-3. Front Panel
- 5-6 Figure 5-4. Rear Panel
- 5-7 Figure 5-5. Left Side View
- 5-7 Figure 5-6. Right Side View
- 5-11 Figure 5-7. Mainframe Cable Locations

- 6A-2 Figure 6A-1. Major Assembly Locations
- 6A-4 Figure 6A-2. Primary Power Supply Mounting Screws
- 6A-7 Figure 6A-3. CRT Bezel Removal Pressure Locations
- 6A-8 Figure 6A-4. Front Panel Mounting Screws
- 6A-10 Figure 6A-5. Color CRT Module Mounting Screws
- 6A-13 Figure 6A-6. Fan Housing Mounting Screws
- 6A-15 Figure 6A-7. Color Display Assembly Mounting Screws
- 6A-15 Figure 6A-8. Motherboard Mounting Screws

- 6B-2 Figure 6B-1. System Block Diagram
- 6B-7 Figure 6B-2. ADC Assembly Block Diagram
- 6B-10 Figure 6B-3. Horizontal Control Assembly Block Diagram
- 6B-13 Figure 6B-4. I/O Assembly Block Diagram
- 6B-16 Figure 6B-5. Microprocessor Assembly Block Diagram
- 6B-19 Figure 6B-6. Color Display Assembly Block Diagram
- 6B-22 Figure 6B-7. Power Supply Assembly Block Diagrams

- 6D-3 Figure 6D-1. Main Troubleshooting Flowchart
- 6D-4 Figure 6D-2. Display Troubleshooting Flowchart Part 1
- 6D-5 Figure 6D-3. Display Troubleshooting Flowchart Part 2
- 6D-6 Figure 6D-4. Softkey Number Assignments
- 6D-7 Figure 6D-5. Keyboard Cable Pin Numbers
- 6D-8 Figure 6D-6. Keyboard Troubleshooting Flowchart

| | |
|-------|---|
| 6D-10 | Figure 6D-7. Core Subsystem Troubleshooting Flowchart |
| 6D-11 | Figure 6D-8. Power Supply Troubleshooting Flowchart 1 |
| 6D-12 | Figure 6D-9. Power Supply Troubleshooting Flowchart 2 |
| 6D-13 | Figure 6D-10. Power Supply Troubleshooting Flowchart 3 |
| 6D-15 | Figure 6D-11. Power Supply Troubleshooting Flowchart 4 |
| 6D-16 | Figure 6D-12. Color CRT Module Input Connections |
| 6D-16 | Figure 6D-13. Vertical and Horizontal Sync. Waveforms |
| | |
| A2-6 | Figure A2-1. Test Port Return Cables |
| A2-6 | Figure A2-2. Minimum Bend Radius |
| A2-8 | Figure A2-3. Viewing the Trigger Signal |
| A2-8 | Figure A2-4. Attenuating the TDR Signal |
| A2-9 | Figure A2-5. HP 11667B Power Splitter Schematic |
| A2-9 | Figure A2-7. HP 11667B Power Splitter |
| | |
| A3-1 | Figure A3-1. Allowable Temperature, Humidity, Pressure |
| A3-4 | Figure A3-2. Typical SWR of SMA and APC 3.5 Connectors |
| | |
| A4-3 | Figure A4-1. Visual Inspection of APC 3.5 Connectors |
| A4-5 | Figure A4-2. Mechanical Dimensions of Connector Faces |
| A4-6 | Figure A4-3. Mechanical Dimensions of the Short Circuit |
| A4-6 | Figure A4-4. Precision 3.5 mm Connector Gauges |
| A4-7 | Figure A4-5. Zeroing Precision 3.5 mm Connector Gauges |
| A4-7 | Figure A4-6. Measuring Precision 3.5 mm Male Connectors |
| A4-7 | Figure A4-7. Measuring Precision 3.5 mm Female Connectors |
| A4-9 | Figure A4-8. Connecting Devices |
| A4-9 | Figure A4-9. Counter Rotation Technique |

List of Tables

| | |
|------|--|
| 1-4 | Table 1-1. Recommended Equipment List |
| | |
| 2-4 | Table 2-1. Power Cord Configurations |
| | |
| 5-2 | Table 5-1. List of Manufacturers' Codes |
| 5-3 | Table 5-2. Reference Designators and Abbreviations |
| 5-8 | Table 5-3. Replaceable Parts List |
| | |
| 6D-6 | Table 6D-1. Row and Column Key Assignments |
| 6D-7 | Table 6D-2. Keyboard Ribbon Cable Signal Description |
| 6D-9 | Table 6D-3. Core Subsystem Diagnostic Routines |
| 6D-9 | Table 6D-4. Power Supply Distribution |

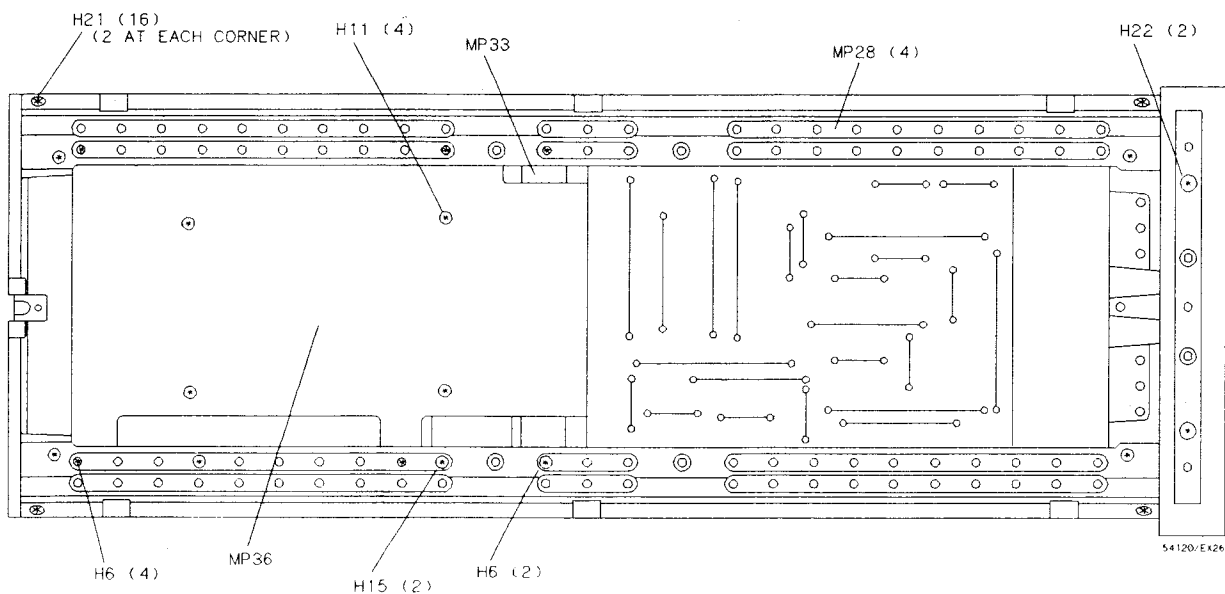


Figure 5-5. Left Side View

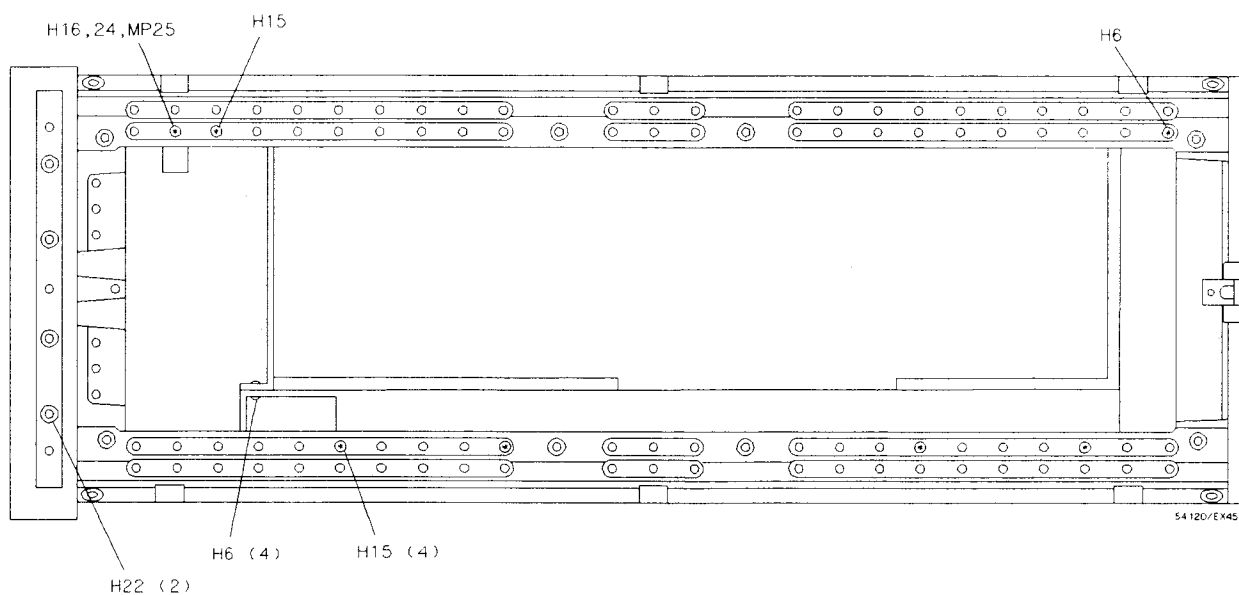


Figure 5-6. Right Side View

Table 5-3. Replaceable Parts List

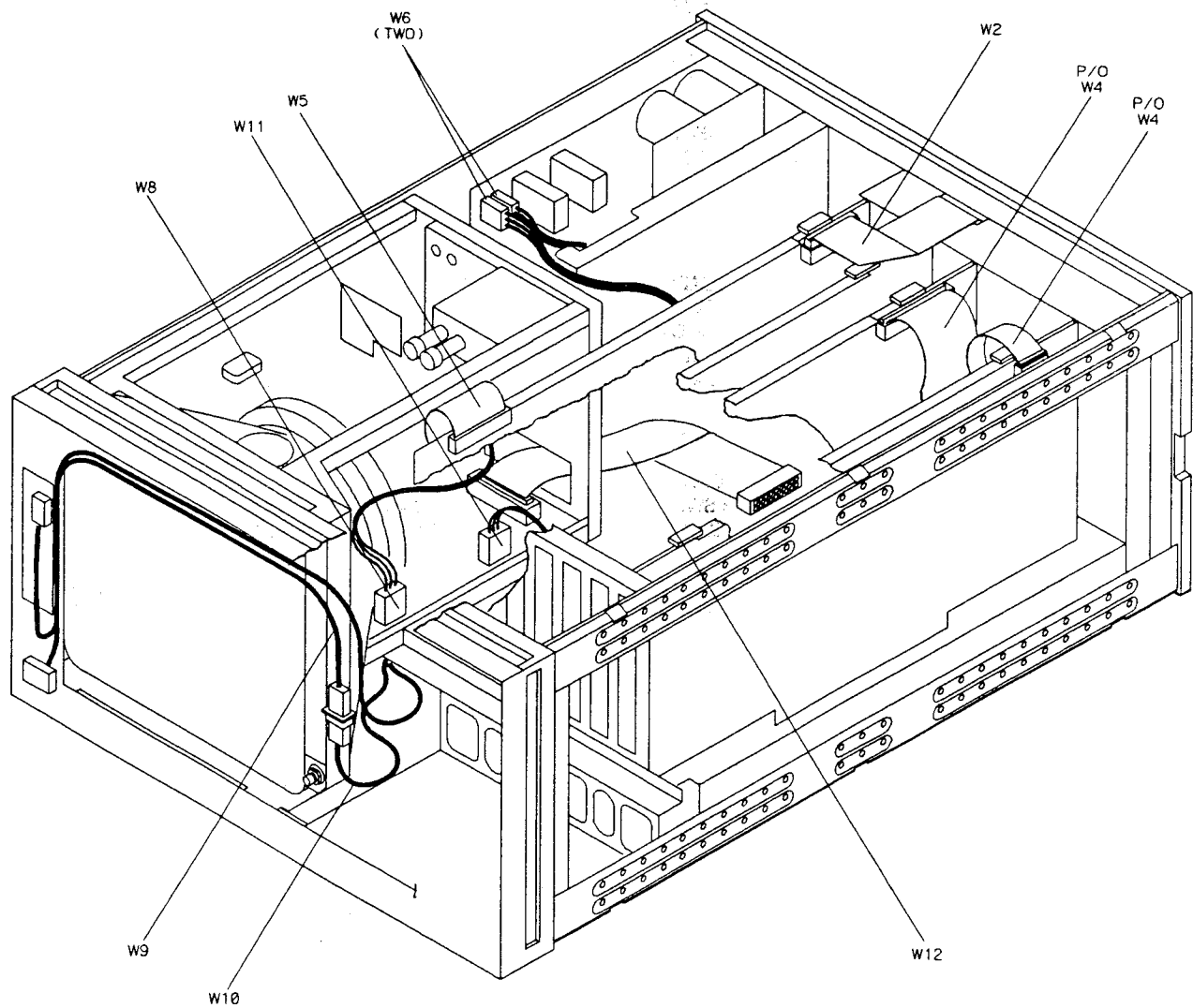
| Reference Designator | HP Part Number | CD | Qty | Description | Mfr Code | Mfr Part Number |
|----------------------|----------------|----|-----|---|----------|-----------------|
| *EXCHANGE ASSEMBLIES | | | | | | |
| *A1 | 54111-69506 | 8 | 0 | I/O ASSEMBLY | 28480 | 54111-69506 |
| *A2 | 54111-69527 | 3 | 0 | MICROPROCESSOR ASSEMBLY | 28480 | 54111-69527 |
| *A3 | 54122-69501 | 6 | 0 | HORIZONTAL CONTROL ASSEMBLY | 28480 | 54122-69501 |
| *A4 | 54120-69502 | 5 | 0 | ADC ASSEMBLY | 28480 | 54120-69502 |
| *A6 | 54110-69514 | 7 | 0 | COLOR DISPLAY ASSEMBLY | 28480 | 54110-69514 |
| | | | | | | |
| *A11 | 54110-69516 | 3 | 0 | PRIMARY POWER SUPPLY ASSEMBLY | 28480 | 54110-69516 |
| *A12 | 54110-69510 | 3 | 0 | ANALOG POWER SUPPLY ASSEMBLY | 28480 | 54110-69510 |
| *A13 | 54110-69506 | 7 | 0 | DIGITAL POWER SUPPLY ASSEMBLY | 28480 | 54110-69506 |
| | | | | | | |
| A1 | 54111-66506 | 2 | 1 | I/O ASSEMBLY | 28480 | 54111-66506 |
| A2 | 54111-66527 | 7 | 1 | MICROPROCESSOR ASSEMBLY | 28480 | 54111-66527 |
| A3 | 54122-66501 | 0 | 1 | HORIZONTAL CONTROL ASSEMBLY | 28480 | 54122-66501 |
| A4 | 54120-66502 | 9 | 1 | ADC ASSEMBLY | 28480 | 54120-66502 |
| A5 | 54110-66511 | 8 | 1 | MOTHER BOARD ASSEMBLY | 28480 | 54110-66511 |
| | | | | | | |
| A6 | 54110-66514 | 1 | 1 | COLOR DISPLAY ASSEMBLY | 28480 | 54110-66514 |
| A7 | 54110-66509 | 4 | 1 | CRT CONTROL ASSEMBLY | 28480 | 54110-66509 |
| A8 | 54100-66520 | 7 | 1 | MENU KEYBOARD | 28480 | 54100-66520 |
| A9 | 54110-66502 | 7 | 1 | FUNCTION KEYBOARD | 28480 | 54110-66502 |
| A10 | 54100-66505 | 8 | 1 | CONTROL KEYBOARD | 28480 | 54100-66505 |
| | | | | | | |
| A11 | 54110-66516 | 9 | 1 | PRIMARY POWER SUPPLY ASSEMBLY | 28480 | 54110-66516 |
| A12 | 54110-66510 | 7 | 1 | ANALOG POWER SUPPLY ASSEMBLY | 28480 | 54110-66510 |
| A13 | 54110-66506 | 1 | 1 | DIGITAL POWER SUPPLY ASSEMBLY | 28480 | 54110-66506 |
| A14 | 2090-0251 | 6 | 1 | COLOR CRT MODULE | 28480 | 2090-0251 |
| A15 | 01980-61062 | 5 | 1 | RPG ASSEMBLY | 28480 | 01980-61062 |
| | | | | | | |
| B1 | 3160-0521 | 3 | 1 | FAN-TUBEAXIAL | 28480 | 3160-0521 |
| | | | | | | |
| E1 | 8160-0577 | 4 | 1 | RFI GROUND STRIP | 28480 | 8160-0577 |
| | | | | | | |
| H1 | 0515-1384 | 8 | 2 | SCREW-MACH M5 X 0.8 10MM-LG | 28480 | 0515-1384 |
| H2 | 0515-1444 | 1 | 4 | SCREW-MACH M3.5 X 0.6 25.4MM-LG PAN-HD | 28480 | 0515-1444 |
| H3 | 0515-1319 | 9 | 8 | SCREW-MACH M3 X 0.5 20MM-LG PAN-HD | 28480 | 0515-1319 |
| H4 | 1251-2942 | 7 | 2 | SCREW LOCK KIT-SUBMIN D CONN | 28480 | 1251-2942 |
| H5 | 1251-1245 | 7 | 3 | COVER SCREW | 28480 | 1251-2945 |
| | | | | | | |
| H6 | 0515-0372 | 2 | 49 | SCREW-MACHINE ASSEMBLY M3 X 0.5 8MM-LG | 28480 | 0515-0372 |
| H7 | 0535-0066 | 3 | 4 | HEX NUT | 28480 | 0535-0066 |
| H8 | 0515-1253 | 0 | 3 | RETAINER RING FOR COVER SCREW2 | 8480 | 0515-1253 |
| H9 | 0515-1444 | 1 | 4 | FOOT SCREW | 28480 | 0515-1444 |
| H10 | 0515-1410 | 1 | 7 | SCREW-MACHINE ASSEMBLY M3 X 0.5 20MM-LG | 28480 | 0515-1410 |
| | | | | | | |
| H11 | 0515-1025 | 4 | 4 | SCREW-MACHINE ASSEMBLY M3 X 0.5 26MM-LG | 28480 | 0515-1025 |
| H12 | 5061-6138 | 2 | 4 | NUT-INSERT M4 X 0.7 X 4.6 OD | 28480 | 5061-6138 |
| H13 | 2190-0763 | 7 | 2 | WASHER-FL MTLC NO. 6 .14-IN-ID .5-IN-OD | 28480 | 2190-0763 |
| H14 | 3050-1238 | 8 | 2 | WASHER-FL NM 9/64 .149-IN-ID .478-IN-OD | 86928 | 3050-1238 |
| H15 | 0515-0433 | 6 | 15 | SCREW-MACHINE ASSEMBLY M4 X 0.7 8MM-LG | 28480 | 0515-0433 |

Table 5-3. Replaceable Parts List

| Reference Designator | HP Part Number | CD | Qty | Description | Mfr Code | Mfr Part Number |
|----------------------|----------------|----|-----|--|----------|-----------------|
| H16 | NOT ASSIGNED | | | | | |
| H17 | 0515-0641 | 8 | 2 | SCREW-THD-RLG M4 X 0.7 10MM-LG PAN-HD | 28480 | 0515-0641 |
| H18 | 0515-0435 | 8 | 4 | SCREW-MACHINE ASSEMBLY M4 X 0.7 14MM-LG | 28480 | 0515-0435 |
| H19 | NOT ASSIGNED | | | | | |
| H20 | 0515-1228 | 9 | 4 | SCREW-MACH M4 X 0.7 6MM-LG 90-DEG-FLH-HD | 28480 | 0515-1228 |
| H21 | 0515-1403 | 2 | 16 | SCREW-SPCL M4 X 0.7 6MM-LG 90-DEG-FLH-HD | 28480 | 0515-1403 |
| H22 | 0515-1269 | 8 | 16 | SCREW-MACH M4 X 0.7 10MM-LG | 28480 | 0515-1269 |
| H23 | 0535-0031 | 2 | 9 | NUT-HEX W/LKWR M3 X 0.5 2.4MM-THK | 28480 | 0535-0031 |
| H24 | NOT ASSIGNED | | | | | |
| H25 | 2950-0043 | 8 | 1 | NUT-HEX-DBL-CHAM 3/82THD .094-IN-THK | 28480 | 2950-0043 |
| H26 | 0380-1686 | 6 | 2 | STANDOFF-HEX 6.5-MM-LG M3 X 0.5-THD | 28480 | 0380-1686 |
| H27 | 2190-0016 | 3 | 1 | WASHER-LK INTL T 3/8 IN .377-IN-ID | 28480 | 2190-0016 |
| H28 | 3050-1176 | 3 | 1 | WASHER-FL NM 3/8 IN .39-IN-ID .562-IN-OD | 86928 | 3050-1176 |
| H29 | 0515-0664 | 5 | 5 | SCREW M3 12MN-L6 PAN-HP T10 | 28480 | 0515-0664 |
| MP1 | 01650-47401 | 7 | 1 | RPG KNOB | 28480 | 01650-47401 |
| MP2 | 5061-9448 | 3 | 1 | BOTTOM COVER | 28480 | 5061-9448 |
| MP3 | 5040-7201 | 8 | 2 | BOTTOM FEET | 28480 | 5040-7201 |
| MP4 | 5040-7222 | 3 | 2 | BOTTOM NON SKID FEET | 28480 | 5040-7222 |
| MP5 | 1460-1345 | 5 | 2 | TILT STAND SST | 28480 | 1460-1345 |
| MP6 | 8160-0590 | 1 | 2 | GROUND RFI STRIP | 28480 | 8160-0590 |
| MP7 | 54110-04103 | 4 | 1 | TOP COVER | 28480 | 54110-04103 |
| MP8 | 0890-0029 | 0 | 1 | TUBING-HS .187-IN-D/.093-IN-RCVD | 28480 | 0890-0029 |
| MP9 | 5001-0441 | 2 | 2 | TRIM STRIP SIDE | 28480 | 5001-0441 |
| MP10 | 5040-7202 | 9 | 1 | TOP TRIM STRIP | 28480 | 5040-7202 |
| MP11 | 54110-40502 | 3 | 4 | REAR FOOT | 28480 | 54110-40502 |
| MP12 | 5060-9948 | 6 | 2 | SIDE COVERS—PERFORATED | 28480 | 5060-9948 |
| MP13 | 54111-00608 | 7 | 1 | DISPLAY SHIELD | 28480 | 54111-00608 |
| MP14 | 5060-9805 | 4 | 2 | STRAP HANDLE | 28480 | 5060-9805 |
| MP15 | 5041-6819 | 4 | 2 | FRONT CAP FOR STRAP HANDLE | 28480 | 5041-6819 |
| MP16 | 5041-6820 | 7 | 2 | REAR CAP FOR STRAP HANDLE | 28480 | 5041-6820 |
| MP17 | NOT ASSIGNED | | | | | |
| MP18 | 5021-5807 | 6 | 1 | FRONT FRAME | 28480 | 5021-5807 |
| MP19 | 54120-00206 | 2 | 1 | FRONT PANEL | 28480 | 54120-00206 |
| MP20 | 54111-00203 | 8 | 1 | FRONT SUB PANEL | 28480 | 54111-00203 |
| MP21 | 54110-40501 | 2 | 1 | DISPLAY BEZEL | 28480 | 54110-40501 |
| MP22 | 16500-00603 | 3 | 1 | FAN SCREEN | 28480 | 16500-00603 |
| MP23 | 0403-0092 | 6 | 1 | BUMPER FOOT-PRS-IN | 28480 | 0403-0092 |
| MP24 | 1400-1362 | 0 | 2 | CLAMP-CABLE .35-DIA .51-WD NYL | 28480 | 1400-1362 |
| MP25 | 1400-0611 | 0 | 2 | CLAMP-FL-CA 1-WD | 06915 | 1400-0611 |
| MP26 | 54111-01203 | 0 | 1 | FRONT CARD CAGE BRACKET | 28480 | 54111-01203 |
| MP27 | 54111-00101 | 5 | 1 | MAIN DECK | 28480 | 54111-00101 |
| MP28 | 5021-5838 | 3 | 4 | SIDE STRUT | 28480 | 5021-5838 |
| MP29 | NOT ASSIGNED | | | | | |
| MP30 | 54110-01214 | 2 | 1 | TOP CRT BRACKET | 28480 | 54110-01214 |

Table 5-3. Replaceable Parts List

| Reference Designator | HP Part Number | CD | Qty | Description | Mfr Code | Mfr Part Number |
|----------------------|----------------|----|-----|--|----------|-----------------|
| MP31 | 54110-01215 | 3 | 1 | BOTTOM CRT BRACKET | 28480 | 54110-01215 |
| MP32 | 54110-01210 | 8 | 1 | BRACKET-COLOR CRT MOD. REAR-ON MODULE | 28480 | 54110-01210 |
| MP33 | 54110-04702 | 9 | 1 | BRACKET-COLOR CRT MOD. REAR-ON FRAME | 28480 | 54110-04702 |
| MP34 | 1400-0679 | 0 | 4 | CLIP-CABLE 'U' SHP, PNL MTG TYPE | 28480 | 1400-0679 |
| MP35 | 54111-04104 | 6 | 1 | POWER SUPPLY COVER-TOP | 28480 | 54111-04104 |
| MP36 | 54110-04106 | 7 | 1 | POWER SUPPLY COVER-SIDE | 28480 | 54110-04106 |
| MP37 | 5021-5808 | 7 | 1 | REAR FRAME | 28480 | 5021-5808 |
| MP38 | 54110-94302 | 4 | 1 | WARNING LABEL | 28480 | 54110-94302 |
| MP39 | 54120-00201 | 7 | 1 | REAR PANEL | 28480 | 54120-00201 |
| MP40 | 54111-05201 | 6 | 1 | AIR PLENUM | 28480 | 54111-05201 |
| MP41 | 7120-4835 | 0 | 1 | LABEL-INFORMATION .75-IN-WD 2-IN-LG PPR | 28480 | 7120-4835 |
| MP42 | 3160-0092 | 3 | 1 | FAN GUARD | 28480 | 3160-0092 |
| MP44 | 54120-04103 | 6 | 1 | FAN COVER | 28480 | 54120-04103 |
| MP45 | 54120-04702 | 1 | 1 | FAN SPACER | 28480 | 54120-04702 |
| S1 | 3101-2911 | 5 | 1 | ROCKER SWITCH (STANDBY) | 28480 | 3101-2911 |
| W1 | 8120-1521 | 6 | 1 | POWER CABLE | 28480 | 8120-1521 |
| W2 | 54100-61602 | 6 | 1 | HPIB CABLE | 28480 | 54100-61602 |
| W3 | 54120-61618 | 8 | 1 | UMBILICAL CABLE 2 METRE | 28480 | 54120-61618 |
| W4 | 54120-61612 | 2 | 1 | MAINFRAME CABLE ASSEMBLY | 28480 | 54120-61612 |
| W5 | 54100-61601 | 5 | 1 | RIBBONCABLE-I/O TO FRONT PANEL | 28480 | 54100-61601 |
| W6 | 54100-61612 | 8 | 2 | CABLE AC BD CO ANAL & DIG BD | 28480 | 54100-61612 |
| W7 | NOT ASSIGNED | | | | | |
| W8 | 54110-61601 | 7 | 1 | 3 WIRE CABLE - COLOR DISPLAY MODULE POWE | 28480 | 54110-61601 |
| W9 | 54111-61610 | 9 | 1 | POWER SWITCH CABLE 2 WIRE-FRONT PANEL ST | 28480 | 54110-61610 |
| W10 | 54111-61611 | 0 | 1 | 2 WIRE CABLE-REAR CABLE STBY SWITCH | 28480 | 54111-61611 |
| W11 | 54110-61611 | 9 | 1 | DISPLAY CONTROL CABLE | 28480 | 54110-61611 |
| W12 | 54110-61607 | 3 | 1 | RIBBON CABLE DISP ASSY TO COLOR MODULE | 28480 | 54110-61607 |



54120E50

Figure 5-7. Mainframe Cable Locations



HP PART NUMBER: 54120-90908

Print Date: July 1989

Manual Changes Print Date: 27 August 1990
Serial Prefix No: 3035A

MANUAL CHANGES

MANUAL IDENTIFICATION

Model Number: HP 54120B

Date Printed: July 1989

Part Number: 54120-90908

This supplement contains important information for correcting errors in the manual and for adapting the manual to instruments containing improvements that were 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 table.

| Serial Prefix or Number | Make Manual Changes | Serial Prefix or Number | Make Manual Changes |
|-------------------------|---------------------|-------------------------|---------------------|
| 2944A | 1 | | |
| 3008A | 1, 2 | | |
| 3012A | 1, 2, 3 | | |
| 3035A | 1, 2, 4 | | |
| | | | |
| | | | |

◆ NEW ITEM

Change 1

The following changes were made to the Replaceable Parts pages. The changes are documented on the new pages that are a part of change 3 below.

A14 changed to HP part number 2090-0226 Color CRT Module.

MP13, right side cover 5061-9523, was removed from the Replaceable Parts list.

MP12, MP14, MP15, and MP16, changed in quantity from 1 to 2.

Change 2

The following changes were made to the Replaceable Parts pages. The changes are documented on the new pages that are a part of change 3 below. Replace

A2 changed to HP part number 54111-66527, CD = 7

*A2 changed to HP part number 54111-69527, CD = 3

Change 3

Replace: Title page, Print History page iii, List of Effective Pages iv, Replaceable Parts pages 5-8 and 5-9.

The following change was made to the Replaceable Parts pages:

A11 changed to HP part number 54110-66515, CD = 2

*A11 changed to HP part number 54110-69515, CD = 8

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.

◆ **Change 4**

Replace: Title page, Print History page iii, List of Effective Pages iv, Replaceable Parts pages 5-8 and 5-9.

The following change was made to the Replaceable Parts pages:

A11 changed to HP part number 54110-66516, primary power supply assembly.

Service Manual

HP 54120B

Digitizing Oscilloscope Mainframe

Serial Numbers

This manual applies directly to instruments
prefixed with serial number:

3035A

With changes described within, this manual also
applies to instruments with serial prefixes:

3012A

3008A

2944A

2926A

2909A

For Additional Information about serial numbers see
Instruments Covered By This Manual

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Herstellerbescheinigung

Hiermit wird bescheinigt, dass das Gerät/System HP 54120B in Übereinstimmung mit den Bestimmungen von Postverfügung 1046/84 funkentstört ist.

Der Deutschen Bundespost wurde das Inverkehrbringen dieses Gerätes/Systems angezeigt und die Berechtigung zur Überprüfung der Serie auf Einhaltung der Bestimmungen eingeräumt.

Zusatzinformation für Mess- und Testgeräte

Werden Mess- und Testgeräte mit ungeschirmten Kabeln und/oder in offenen Messaufbauten verwendet, so ist vom Betreiber sicherzustellen, dass die Funkentstörbestimmungen unter Betriebsbedingungen an seiner Grundstücksgrenze eingehalten werden.

Manufacturer's Declaration

This is to certify that this product HP 54120B meets the radio frequency interference requirements of directive 1046/84. The German Bundespost has been notified that this equipment was put into circulation and was granted the right to check the product type for compliance with these requirements.

Additional Information for Test and Measurement Equipment

Note: If test and measurement equipment is operated with unshielded cables and/or used for measurements on open set-ups, the user must insure that under these operating conditions, the radio frequency interference limits are met at the border of his premises.

Printing History

New editions are complete revisions of the manual. Update packages, which are issued between editions, contain additional and replacement pages to be merged into the manual by the customer. The dates on the title page change only when a new edition is published.

A software and/or firmware code may be printed before the date; this indicates the version level of the software and/or firmware of this product at the time of the manual or update was issued. Many product updates and fixes do not require manual changes and, conversely, manual corrections may be done without accompanying product changes. Therefore, do not expect a one to one correspondence between product updates and manual updates.

| | | |
|-----------|---------------|-------------|
| Edition 1 | July 1989 | 54120-90908 |
| Update 1 | October 1989 | 54120-90908 |
| Update 2 | February 1990 | 54120-90908 |
| Update 3 | March 1990 | 54120-90908 |
| Update 4 | August 1990 | 54120-90908 |

List of Effective Pages

The List of Effective Pages gives the date of the current edition and of any pages changed in updates to that edition. Within the manual, any page changed since the last edition is indicated by printing the date the changes were made on the bottom of the page. If an update is incorporated when a new edition of the manual is printed, the change dates are removed from the bottom of the pages and the new edition date is listed in Printing History and on the title page.

| Pages | Effective Date |
|-------------------------------|----------------|
| all | July 1989 |
| Title page, iii, iv, 5-8, 5-9 | October 1989 |
| Title page, iii, iv, 5-8 | February 1990 |
| Title page, iii, iv, 5-8 | March 1990 |
| Title page, iii, iv, 5-8 | August 1990 |

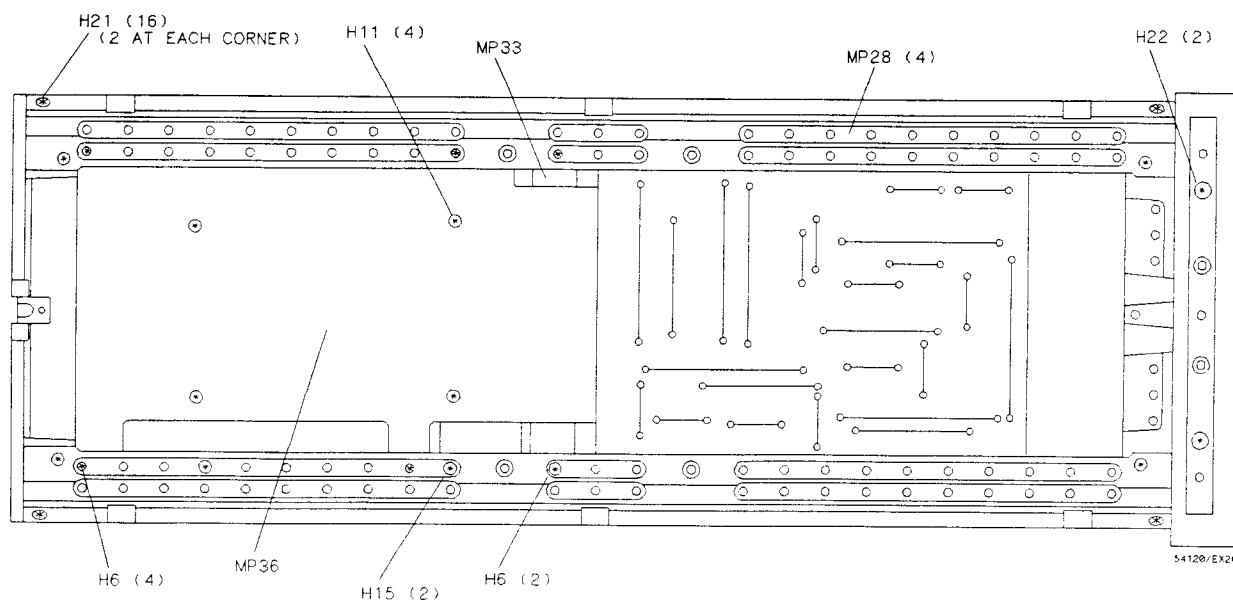


Figure 5-5. Left Side View

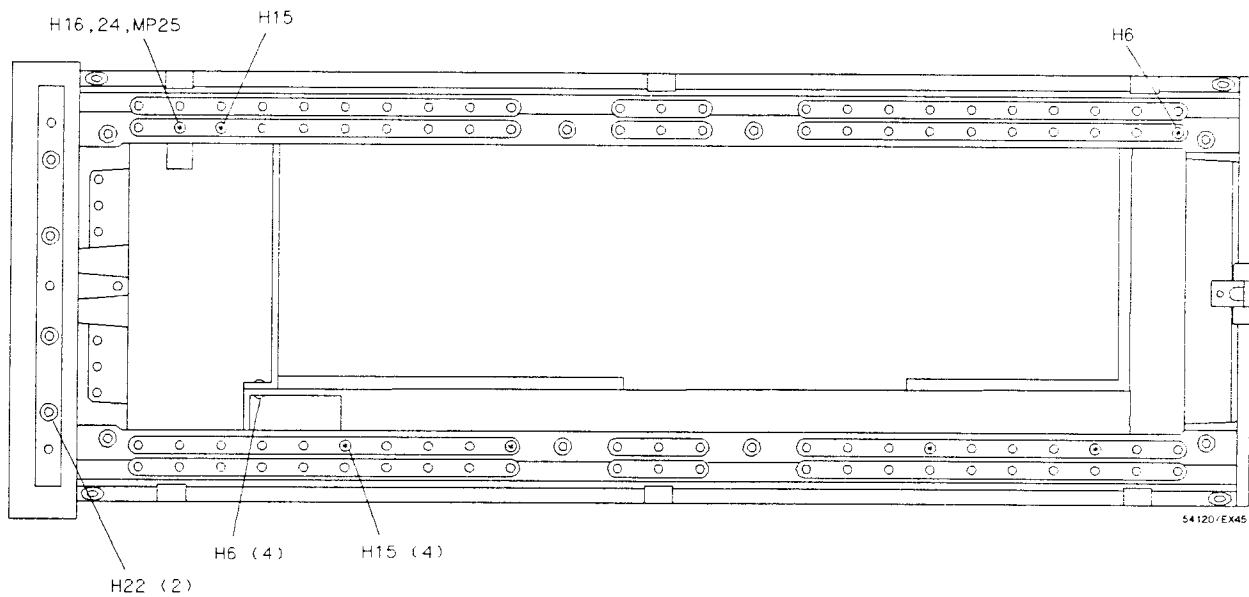


Figure 5-6. Right Side View

Table 5-3. Replaceable Parts List

| Reference Designator | HP Part Number | CD | Qty | Description | Mfr Code | Mfr Part Number |
|-----------------------------|----------------|----|-----|---|----------|-----------------|
| *EXCHANGE ASSEMBLIES | | | | | | |
| *A1 | 54111-69506 | 8 | 0 | I/O ASSEMBLY | 28480 | 54111-69506 |
| *A2 | 54111-69527 | 3 | 0 | MICROPROCESSOR ASSEMBLY | 28480 | 54111-69527 |
| *A3 | 54122-69501 | 6 | 0 | HORIZONTAL CONTROL ASSEMBLY | 28480 | 54122-69501 |
| *A4 | 54120-69502 | 5 | 0 | ADC ASSEMBLY | 28480 | 54120-69502 |
| *A6 | 54110-69514 | 7 | 0 | COLOR DISPLAY ASSEMBLY | 28480 | 54110-69514 |
| | | | | | | |
| *A11 | 54110-69516 | 3 | 0 | PRIMARY POWER SUPPLY ASSEMBLY | 28480 | 54110-69516 |
| *A12 | 54110-69510 | 3 | 0 | ANALOG POWER SUPPLY ASSEMBLY | 28480 | 54110-69510 |
| *A13 | 54110-69506 | 7 | 0 | DIGITAL POWER SUPPLY ASSEMBLY | 28480 | 54110-69506 |
| | | | | | | |
| A1 | 54111-66506 | 2 | 1 | I/O ASSEMBLY | 28480 | 54111-66506 |
| A2 | 54111-66527 | 7 | 1 | MICROPROCESSOR ASSEMBLY | 28480 | 54111-66527 |
| A3 | 54122-66501 | 0 | 1 | HORIZONTAL CONTROL ASSEMBLY | 28480 | 54122-66501 |
| A4 | 54120-66502 | 9 | 1 | ADC ASSEMBLY | 28480 | 54120-66502 |
| A5 | 54110-66511 | 8 | 1 | MOTHER BOARD ASSEMBLY | 28480 | 54110-66511 |
| | | | | | | |
| A6 | 54110-66514 | 1 | 1 | COLOR DISPLAY ASSEMBLY | 28480 | 54110-66514 |
| A7 | 54110-66509 | 4 | 1 | CRT CONTROL ASSEMBLY | 28480 | 54110-66509 |
| A8 | 54100-66520 | 7 | 1 | MENU KEYBOARD | 28480 | 54100-66520 |
| A9 | 54110-66502 | 7 | 1 | FUNCTION KEYBOARD | 28480 | 54110-66502 |
| A10 | 54100-66505 | 8 | 1 | CONTROL KEYBOARD | 28480 | 54100-66505 |
| | | | | | | |
| A11 | 54110-66516 | 9 | 1 | PRIMARY POWER SUPPLY ASSEMBLY | 28480 | 54110-66516 |
| A12 | 54110-66510 | 7 | 1 | ANALOG POWER SUPPLY ASSEMBLY | 28480 | 54110-66510 |
| A13 | 54110-66506 | 1 | 1 | DIGITAL POWER SUPPLY ASSEMBLY | 28480 | 54110-66506 |
| A14 | 2090-0226 | 5 | 1 | COLOR CRT MODULE | 28480 | 2090-0226 |
| A15 | 01980-61062 | 5 | 1 | RPG ASSEMBLY | 28480 | 01980-61062 |
| | | | | | | |
| B1 | 3160-0521 | 3 | 1 | FAN-TUBEAXIAL | 28480 | 3160-0521 |
| | | | | | | |
| E1 | 8160-0577 | 4 | 1 | RFI GROUND STRIP | 28480 | 8160-0577 |
| | | | | | | |
| H1 | 0515-1384 | 8 | 2 | SCREW-MACH M5 X 0.8 10MM-LG | 28480 | 0515-1384 |
| H2 | 0515-1444 | 1 | 4 | SCREW-MACH M3.5 X 0.6 25.4MM-LG PAN-HD | 28480 | 0515-1444 |
| H3 | 0515-1319 | 9 | 8 | SCREW-MACH M3 X 0.5 20MM-LG PAN-HD | 28480 | 0515-1319 |
| H4 | 1251-2942 | 7 | 2 | SCREW LOCK KIT-SUBMIN D CONN | 28480 | 1251-2942 |
| H5 | 1251-1245 | 7 | 3 | COVER SCREW | 28480 | 1251-2945 |
| | | | | | | |
| H6 | 0515-0372 | 2 | 49 | SCREW-MACHINE ASSEMBLY M3 X 0.5 8MM-LG | 28480 | 0515-0372 |
| H7 | NOT ASSIGNED | | | | | |
| H8 | 0515-1253 | 0 | 3 | RETAINER RING FOR COVER SCREW2 | 8480 | 0515-1253 |
| H9 | 0515-1444 | 1 | 4 | FOOT SCREW | 28480 | 0515-1444 |
| H10 | 0515-1410 | 1 | 7 | SCREW-MACHINE ASSEMBLY M3 X 0.5 20MM-LG | 28480 | 0515-1410 |
| | | | | | | |
| H11 | 0515-1025 | 4 | 4 | SCREW-MACHINE ASSEMBLY M3 X 0.5 26MM-LG | 28480 | 0515-1025 |
| H12 | 5061-6138 | 2 | 4 | NUT-INSERT M4 X 0.7 X 4.6 OD | 28480 | 5061-6138 |
| H13 | 2190-0763 | 7 | 2 | WASHER-FL MTLC NO. 6 .14-IN-ID .5-IN-OD | 28480 | 2190-0763 |
| H14 | 3050-1238 | 8 | 2 | WASHER-FL NM 9/64 .149-IN-ID .478-IN-OD | 86928 | 3050-1238 |
| H15 | 0515-0433 | 6 | 15 | SCREW-MACHINE ASSEMBLY M4 X 0.7 8MM-LG | 28480 | 0515-0433 |

Table 5-3. Replaceable Parts List

| Reference Designator | HP Part Number | CD | Qty | Description | Mfr Code | Mfr Part Number |
|----------------------|----------------|----|-----|--|----------|-----------------|
| H16 | NOT ASSIGNED | | | | | |
| H17 | 0515-0641 | 8 | 2 | SCREW-THD-RLG M4 X 0.7 10MM-LG PAN-HD | 28480 | 0515-0641 |
| H18 | 0515-0435 | 8 | 4 | SCREW-MACHINE ASSEMBLY M4 X 0.7 14MM-LG | 28480 | 0515-0435 |
| H19 | NOT ASSIGNED | | | | | |
| H20 | 0515-1228 | 9 | 4 | SCREW-MACH M4 X 0.7 6MM-LG 90-DEG-FLH-HD | 28480 | 0515-1228 |
| H21 | 0515-1403 | 2 | 16 | SCREW-SPCL M4 X 0.7 6MM-LG 90-DEG-FLH-HD | 28480 | 0515-1403 |
| H22 | 0515-1269 | 8 | 16 | SCREW-MACH M4 X 0.7 10MM-LG | 28480 | 0515-1269 |
| H23 | 0535-0031 | 2 | 9 | NUT-HEX W/LKWR M3 X 0.5 2.4MM-THK | 28480 | 0535-0031 |
| H24 | NOT ASSIGNED | | | | | |
| H25 | 2950-0043 | 8 | 1 | NUT-HEX-DBL-CHAM 3/82THD .094-IN-THK | 28480 | 2950-0043 |
| H26 | 0380-1686 | 6 | 2 | STANDOFF-HEX 6.5-MM-LG M3 X 0.5-THD | 28480 | 0380-1686 |
| H27 | 2190-0016 | 3 | 1 | WASHER-LK INTL T 3/8 IN .377-IN-ID | 28480 | 2190-0016 |
| H28 | 3050-1176 | 3 | 1 | WASHER-FL NM 3/8 IN .39-IN-ID .562-IN-OD | 86928 | 3050-1176 |
| H29 | 0515-0664 | 5 | 5 | SCREW M3 12MN-L6 PAN-HP T10 | 28480 | 0515-0664 |
| MP1 | 01650-47401 | 7 | 1 | RPG KNOB | 28480 | 01650-47401 |
| MP2 | 5061-9448 | 3 | 1 | BOTTOM COVER | 28480 | 5061-9448 |
| MP3 | 5040-7201 | 8 | 2 | BOTTOM FEET | 28480 | 5040-7201 |
| MP4 | 5040-7222 | 3 | 2 | BOTTOM NON SKID FEET | 28480 | 5040-7222 |
| MP5 | 1460-1345 | 5 | 2 | TILT STAND SST | 28480 | 1460-1345 |
| MP6 | 8160-0590 | 1 | 2 | GROUND RFI STRIP | 28480 | 8160-0590 |
| MP7 | 54110-04103 | 4 | 1 | TOP COVER | 28480 | 54110-04103 |
| MP8 | 0890-0029 | 0 | 1 | TUBING-HS .187-IN-D/.093-IN-RCVD | 28480 | 0890-0029 |
| MP9 | 5001-0441 | 2 | 2 | TRIM STRIP SIDE | 28480 | 5001-0441 |
| MP10 | 5040-7202 | 9 | 1 | TOP TRIM STRIP | 28480 | 5040-7202 |
| MP11 | 54110-40502 | 3 | 4 | REAR FOOT | 28480 | 54110-40502 |
| MP12 | 5060-9948 | 6 | 2 | SIDE COVERS – PERFORATED | 28480 | 5060-9948 |
| MP13 | NOT ASSIGNED | | | | | |
| MP14 | 5060-9805 | 4 | 2 | STRAP HANDLE | 28480 | 5060-9805 |
| MP15 | 5041-6819 | 4 | 2 | FRONT CAP FOR STRAP HANDLE | 28480 | 5041-6819 |
| MP16 | 5041-6820 | 7 | 2 | REAR CAP FOR STRAP HANDLE | 28480 | 5041-6820 |
| MP17 | NOT ASSIGNED | | | | | |
| MP18 | 5021-5807 | 6 | 1 | FRONT FRAME | 28480 | 5021-5807 |
| MP19 | 54120-00206 | 2 | 1 | FRONT PANEL | 28480 | 54120-00206 |
| MP20 | 54111-00203 | 8 | 1 | FRONT SUB PANEL | 28480 | 54111-00203 |
| MP21 | 54110-40501 | 2 | 1 | DISPLAY BEZEL | 28480 | 54110-40501 |
| MP22 | 16500-00603 | 3 | 1 | FAN SCREEN | 28480 | 16500-00603 |
| MP23 | 0403-0092 | 6 | 1 | BUMPER FOOT-PRS-IN | 28480 | 0403-0092 |
| MP24 | 1400-1362 | 0 | 2 | CLAMP-CABLE .35-DIA .51-WD NYL | 28480 | 1400-1362 |
| MP25 | 1400-0611 | 0 | 2 | CLAMP-FL-CA 1-WD | 06915 | 1400-0611 |
| MP26 | 54111-01203 | 0 | 1 | FRONT CARD CAGE BRACKET | 28480 | 54111-01203 |
| MP27 | 54111-00101 | 5 | 1 | MAIN DECK | 28480 | 54111-00101 |
| MP28 | 5021-5838 | 3 | 4 | SIDE STRUT | 28480 | 5021-5838 |
| MP29 | NOT ASSIGNED | | | | | |
| MP30 | 54110-01201 | 7 | 1 | TOP CRT BRACKET | 28480 | 54110-01201 |

Table 5-3. Replaceable Parts List

| Reference Designator | HP Part Number | CD | Qty | Description | Mfr Code | Mfr Part Number |
|----------------------|----------------|----|-----|--|----------|-----------------|
| MP31 | 54110-01202 | 8 | 1 | BOTTOM CRT BRACKET | 28480 | 54110-01202 |
| MP32 | 54110-01210 | 8 | 1 | BRACKET-COLOR CRT MOD. REAR-ON MODULE | 28480 | 54110-01210 |
| MP33 | 54110-04702 | 9 | 1 | BRACKET-COLOR CRT MOD. REAR-ON FRAME | 28480 | 54110-04702 |
| MP34 | 1400-0679 | 0 | 4 | CLIP-CABLE 'U' SHP, PNL MTG TYPE | 28480 | 1400-0679 |
| MP35 | 54111-04104 | 6 | 1 | POWER SUPPLY COVER-TOP | 28480 | 54111-04104 |
| MP36 | 54110-04106 | 7 | 1 | POWER SUPPLY COVER-SIDE | 28480 | 54110-04106 |
| MP37 | 5021-5808 | 7 | 1 | REAR FRAME | 28480 | 5021-5808 |
| MP38 | 54110-94302 | 4 | 1 | WARNING LABEL | 28480 | 54110-94302 |
| MP39 | 54120-00201 | 7 | 1 | REAR PANEL | 28480 | 54120-00201 |
| MP40 | 54111-05201 | 6 | 1 | AIR PLENUM | 28480 | 54111-05201 |
| MP41 | 7120-4835 | 0 | 1 | LABEL-INFORMATION .75-IN-WD 2-IN-LG PPR | 28480 | 7120-4835 |
| MP42 | 3160-0092 | 3 | 1 | FAN GUARD | 28480 | 3160-0092 |
| MP44 | 54120-04103 | 6 | 1 | FAN COVER | 28480 | 54120-04103 |
| MP45 | 54120-04702 | 1 | 1 | FAN SPACER | 28480 | 54120-04702 |
| S1 | 3101-2911 | 5 | 1 | ROCKER SWITCH (STANDBY) | 28480 | 3101-2911 |
| W1 | 8120-1521 | 6 | 1 | POWER CABLE | 28480 | 8120-1521 |
| W2 | 54100-61602 | 6 | 1 | HPIB CABLE | 28480 | 54100-61602 |
| W3 | 54120-61618 | 8 | 1 | UMBILICAL CABLE 2 METRE | 28480 | 54120-61618 |
| W4 | 54120-61612 | 2 | 1 | MAINFRAME CABLE ASSEMBLY | 28480 | 54120-61612 |
| W5 | 54100-61601 | 5 | 1 | RIBBONCABLE-I/O TO FRONT PANEL | 28480 | 54100-61601 |
| W6 | 54100-61612 | 8 | 2 | CABLE AC BD CO ANAL & DIG BD | 28480 | 54100-61612 |
| W7 | NOT ASSIGNED | | | | | |
| W8 | 54110-61601 | 7 | 1 | 3 WIRE CABLE - COLOR DISPLAY MODULE POWE | 28480 | 54110-61601 |
| W9 | 54111-61610 | 9 | 1 | POWER SWITCH CABLE 2 WIRE-FRONT PANEL ST | 28480 | 54110-61610 |
| W10 | 54111-61611 | 0 | 1 | 2 WIRE CABLE-REAR CABLE STBY SWITCH | 28480 | 54111-61611 |
| W11 | 54110-61611 | 9 | 1 | DISPLAY CONTROL CABLE | 28480 | 54110-61611 |
| W12 | 54110-61607 | 3 | 1 | RIBBON CABLE DISP ASSY TO COLOR MODULE | 28480 | 54110-61607 |

HP 54120B Mainframe



HEWLETT
PACKARD

SERVICE MANUAL

HP 54120B

Digitizing Oscilloscope Mainframe

SERIAL NUMBERS

This manual applies directly to instruments
prefixed with serial number:

2926A

With changes described within, this manual also
applies to instruments with serial prefixes:

2909A

For Additional Information about serial numbers see
INSTRUMENTS COVERED BY THIS MANUAL
in Section 1.

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Manual Part No. 54120-90908
Microfiche Part No. 54120-90808

Printed in U.S.A.: July 1989

Herstellerbescheinigung

Hiermit wird bescheinigt, dass das Gerät/System HP 54120B in Übereinstimmung mit den Bestimmungen von Postverfügung 1046/84 funkentstört ist.

Der Deutschen Bundespost wurde das Inverkehrbringen dieses Gerätes/Systems angezeigt und die Berechtigung zur Überprüfung der Serie auf Einhaltung der Bestimmungen eingeräumt.

Zusatzinformation für Mess- und Testgeräte

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Additional Information for Test and Measurement Equipment

Note: If test and measurement equipment is operated with unshielded cables and/or used for measurements on open set-ups, the user must insure that under these operating conditions, the radio frequency interference limits are met at the border of his premises.



GEWERBEAUFSICHTSAMT STUTTGART

- Zentrale Stelle für Sicherheitstechnik und Vorschriftenwesen in Baden-Württemberg -

Gewerbeaufsichtsamt - Jägerstr. 27 - Postfach 703 - 7000 Stuttgart 1

Hewlett-Packard GmbH
Herrenberger Straße 110

7030 Böblingen

Stuttgart, den 02.06.1986

Fernsprecher

(0711) 2 05 01 (Schönleinszentrum)

Durchwahl 2050- 4798

Aktzeichen: Z 5108/Hewlett-
(Bitte bei Antwort angeben)

Packard/WS/Vg

Betr.: Durchführung der Röntgenverordnung (RöV)
hier: Bauartzulassung gem. § 7 Abs. 2 RöV

Bezug: Ihr Antrag vom 22.05.1986; PSD US-ab

Nachtrag 1

zum Zulassungsschein Nr. BW/218/86/Rö

Aufgrund des § 7 Abs. 2 der Röntgenverordnung vom 1.3.1973 (BGBl. I S. 173) wird die der Firma Hewlett-Packard GmbH, Herrenberger Straße 110, 7030 Böblingen, erteilte Zulassung Nr. BW/218/86/Rö vom 16.01.1986 wie folgt erweitert:

| | |
|--------------------|---|
| Gegenstand: | Digital-Oszilloskop |
| Firmenbezeichnung: | HP Typ 54 111 D HP Typ 54 112 D HP Typ 54 120 A |
| Bauartunterlagen: | Service Manuals Nr. 54 111 - 90 902 vom 21.04.86 Nr. 54 112 - 90 902 vom 24.04.86 Nr. 54 120 - 90 902 vom 26.04.86 |

Die für den Strahlenschutz wesentlichen Merkmale entsprechen der bereits zugelassenen Ausführung.

Typenbezeichnung der Bildröhre, Auflagen, Hinweise und Befristung ergeben sich aus dem Zulassungsschein Nr. BW/218/86/Rö vom 16.01.1986.

Dieser Nachtrag gilt nur im Zusammenhang mit dem vollständigen Text des o.g. Zulassungsscheins.

Reutter
Reutter



Dieses Gerät wurde nach den Auflagen der Zulassungsbehörde einer Stückprüfung unterzogen und entspricht in den für den Strahlenschutz wesentlichen Merkmalen der Bauartzulassung. Die Beschleunigungsspannung beträgt maximal 22,3 kV.

Hewlett-Packard
1900 Garden of the Gods Road
Colorado Springs
Colorado 80907, USA



GEWERBEAUFSICHTSAMT STUTTGART

- Zentrale Stelle für Sicherheitstechnik und Vorschriftenwesen in Baden-Württemberg -

┌ Gewerbeaufsichtsamt · Jägerstr. 22 · Postfach 703 · 7000 Stuttgart 1 ┐

Firma
Hewlett Packard GmbH
Herrenberger Str. 110/130

7030 Böblingen

Stuttgart, den 16.01.1986

Fernsprecher

(07 11) 2 05 01 (Behördenzentrum)

Durchwahl 2050- 4798

Aktenzeichen: Z 5108/HP/Ws/Hh
(Bitte bei Antwort angeben)

Zulassungsschein Nr. BW/218/86/R8

Gemäß § 9 der Röntgenverordnung vom 01.03.1973 (BGBl. I S. 173) wird die Zulassung der Bauart durch den Bauartzulassungsbescheid vom 16.01.1986 mit Aktenzeichen Z 5108/HP/Ws/Hh für den nachfolgend aufgeführten Störstrahler bescheinigt:

| | |
|-----------------------|--|
| Gegenstand | : Digital-Oszilloskop |
| Firmenbezeichnung | : HP Typ 54110D |
| Bildröhre | : Sony Typ M23 JHU 15X |
| Hersteller | : Hewlett-Packard 1900 Garden of the Gods Road Colorado Springs Colorado 80907, USA |
| Betriebsbedingungen | : Hochspannung: max. 22,3 kV Strahlstrom: max. 0,4 mA |
| Zulassungskennzeichen | : BW/218/86/R8 |

Die Bauartzulassung ist befristet bis 16.01.1996.

Für den Strahlenschutz wesentliche Merkmale

1. Die Art und Qualität der Bildröhre,
2. die der Hochspannungserzeugung und -stabilisierung dienenden Bauelemente.

Auflagen:

1. Die Geräte sind bezüglich der für den Strahlenschutz wesentlichen Merkmale entsprechend den vorgestellten und geprüften Mustern und Antragsunterlagen herzustellen.
2. Die Geräte sind einer Stückprüfung daraufhin zu unterziehen, ob sie bezüglich der für den Strahlenschutz wesentlichen Merkmale der Bauartzulassung entsprechen.

Die Prüfung muß umfassen:

- a) Kontrolle der Hochspannung an jedem einzelnen Gerät,
 - b) Messung und Dosisleistung nach Festlegung im Bauartzulassungsbescheid.
3. Die Herstellung und die Stückprüfung sind durch den von der Zulassungsbehörde bestimmten Sachverständigen überwachen zu lassen.
 4. Die Geräte sind deutlich sichtbar und dauerhaft mit dem Kennzeichen

BW/218/86/Rö

zu versehen sowie mit einem Hinweis folgenden Mindestinhalts:

"Die in diesem Gerät entstehende Röntgenstrahlung ist ausreichend abgeschirmt.
Beschleunigungsspannung maximal 22,3 kV."

Hinweis für den Benutzer des Geräts:

Unsachgemäße Eingriffe, insbesondere Verändern der Hochspannung oder Auswechseln der Bildröhre können dazu führen, daß Röntgenstrahlung in erheblicher Stärke auftritt. Ein so verändertes Gerät entspricht nicht mehr dieser Zulassung und darf infolgedessen nicht mehr betrieben werden.

Reutter

Reutter



Dieses Gerät wurde nach den Auflagen der Zulassungsbehörde einer Stückprüfung unterzogen und entspricht in den für den Strahlenschutz wesentlichen Merkmalen der Bauartzulassung. Die Beschleunigungsspannung beträgt maximal 22,3 kV.

Hewlett-Packard
1900 Garden of the Gods Road
Colorado Springs
Colorado 80907, USA

X-RAY RADIATION NOTICE

ACHTUNG

Model 54111D/54112D/54120A

WARNING

Während des Betriebs erzeugt dieses Gerät Röntgenstrahlung. Das Gerät ist so abgeschirmt, daß die Dosisleistung weniger als 36 $\mu\text{A/kg}$ (0,5 mR/h) in 5cm Abstand von der Oberfläche der Kathodenstrahlröhre beträgt. Somit sind die Sicherheitsbestimmungen verschiedener Länder, u.A. der deutschen Röntgenverordnung eingehalten.

Die Stärke der Röntgenstrahlung hängt im Wesentlichen von der Bauart der Kathodenstrahlröhre ab sowie von den Spannungen, welche an dieser anliegen. Um einen sicheren Betrieb zu gewährleisten, dürfen die Einstellungen des Niederspannungs- und Hochspannungsnetzteils nur nach der Anleitung in Kapitel Einstellvorschriften des Service Handbuchs vorgenommen werden.

Die Kathodenstrahlröhre darf nur durch die gleiche Type ersetzt werden. (Siehe Kapitel Ersatzteile für HP-Teilenummern.)

Das Gerät ist in Deutschland zugelassen unter

der Nummer: BW/218/86/ROE

When operating, this instrument emits x-rays; however, it is well shielded and meets safety and health requirements of various countries, such as the X-ray Radiation Act of Germany.

Radiation emitted by this instrument is less than 0.5 mR/hr at a distance of five (5) centimeters from the surface of the cathode-ray tube. The x-ray radiation primarily depends on the characteristics of the cathode-ray tube and its associated low-voltage and high-voltage circuitry. To ensure safe operation of the instrument, adjust both the low-voltage and high-voltage power supplies as outlined in the Adjustments Section of the Service Manual.

Replace the cathode-ray tube with an identical CRT only. Refer to the Replacement Parts Section for proper HP part number.

Number of German License: BW/218/86/ROE

CERTIFICATION

Hewlett-Packard Company certifies that this product met its published specifications at the time of shipment from the factory. Hewlett-Packard further certifies that its calibration measurements are traceable to the United States National Bureau of Standards, to the extent allowed by the Bureau's calibration facility, and to the calibration facilities of other International Standards Organization members.

WARRANTY

This Hewlett-Packard product is warranted against defects in material and workmanship for a period of one year from date of shipment. During the warranty period, Hewlett-Packard Company will, at its option, either repair or replace products which prove to be defective.

For warranty service or repair, this product must be returned to a service facility designated by HP. Buyer shall prepay shipping charges to HP and HP shall pay shipping charges to return the product to Buyer. However, Buyer shall pay all shipping charges, duties, and taxes for products returned to HP from another country.

HP warrants that its software and firmware designated by HP for use with an instrument will execute its programming instructions when properly installed on that instrument. HP does not warrant that the operation of the instrument or software, or firmware will be uninterrupted or error free.

LIMITATION OF WARRANTY

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by Buyer, buyer-supplied software or interfacing, unauthorized modification or misuse, operation outside the environmental specifications for the product, or improper site preparation or maintenance.

NO OTHER WARRANTY IS EXPRESSED OR IMPLIED. HP SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

EXCLUSIVE REMEDIES

THE REMEDIES PROVIDED HEREIN ARE BUYER'S SOLE AND EXCLUSIVE REMEDIES. HP SHALL NOT BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER BASED ON CONTRACT, TORT, OR ANY OTHER LEGAL THEORY.

ASSISTANCE

Product maintenance agreements and other customer assistance agreements are available for Hewlett-Packard products.

For any assistance, contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.

CWA388

Safety Considerations

General Operation

This is a Safety Class I instrument (provided with terminal for protective earthing). **BEFORE APPLYING POWER** verify that the power transformer primary is matched to the available line voltage, the correct fuse is installed, and Safety Precautions are taken (see the following warnings). In addition, note the instrument's external markings which are described under "Safety Symbols."

General Warnings and Cautions

- **BEFORE SWITCHING ON THE INSTRUMENT**, the protective earth terminal of the instrument must be connected to the protective conductor of the (mains) powercord. The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. The protective action must not be negated by the use of an extension cord (power cable) without a protective conductor (grounding). Grounding one conductor of a two-conductor outlet is not sufficient protection.
- Servicing instructions are for use by service-trained personnel. To avoid dangerous electric shock, do not perform any servicing unless qualified to do so.
- If this instrument is to be energized via an auto-transformer (for voltage reduction) make sure the common terminal is connected to the earth terminal of the power source.
- Any interruption of the protective (grounding) conductor (inside or outside the instrument) or disconnecting the protective earth terminal will cause a potential shock hazard that could result in personal injury.
- Whenever it is likely that the protection has been impaired, the instrument must be made inoperative and be secured against any unintended operation.
- Only fuses with the required rated current, voltage, and specified type (normal blow, time delay, etc.) should be used. Do not use repaired fuses or short circuited fuseholders. To do so could cause a shock or fire hazard.
- Do not operate the instrument in the presence of flammable gasses or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.
- Do not install substitute parts or perform any unauthorized modification to the instrument.
- Adjustments described in the manual are performed with power supplied to the instrument while protective covers are removed. Energy available at many points may, if contacted, result in personal injury.
- Any adjustment, maintenance, and repair of the opened instrument under voltage should be avoided as much as possible, and when inevitable, should be carried out only by a skilled person who is aware of the hazard involved.
- Capacitors inside the instrument may still be charged even if the instrument has been disconnected from its source of supply.

Safety Symbols



Instruction manual symbol. The product will be marked with this symbol when it is necessary for the user to refer to the instruction manual in order to protect against damage to the product.



Indicates Hazardous Voltages



Earth terminal (sometimes used in manual to indicate circuit common connected to grounded chassis).

Warning



The **WARNING** sign denotes a hazard. It calls attention to a procedure, practice, or the like, which, if not correctly performed or adhered to, could result in personal injury. Do not proceed beyond a **WARNING** sign until the indicated conditions are fully understood and met.

Caution



The **CAUTION** sign denotes a hazard. It calls attention to an operating procedure, practice, or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product. Do not proceed beyond a **CAUTION** sign until the indicated conditions are fully understood or met.

Printing History

New editions are complete revisions of the manual. Update packages, which are issued between editions, contain additional and replacement pages to be merged into the manual by the customer. The dates on the title page change only when a new edition is published.

A software and/or firmware code may be printed before the date; this indicates the version level of the software and/or firmware of this product at the time of the manual or update was issued. Many product updates and fixes do not require manual changes and, conversely, manual corrections may be done without accompanying product changes. Therefore, do not expect a one to one correspondence between product updates and manual updates.

Edition 1

July 1989

54120-90908

List of Effective Pages

The List of Effective Pages gives the date of the current edition and of any pages changed in updates to that edition. Within the manual, any page changed since the last edition is indicated by printing the date the changes were made on the bottom of the page. If an update is incorporated when a new edition of the manual is printed, the change dates are removed from the bottom of the pages and the new edition date is listed in Printing History and on the title page.

| Pages | Effective Date |
|---------------|----------------|
| all | July 1989 |

Contents

Section 1

General Information

- 1-1 Introduction
 - 1-2 Description
 - 1-2 Specifications & Operating Characteristics
 - 1-2 General Characteristics
 - 1-2 Environmental Conditions
 - 1-2 Power Requirements
 - 1-2 Weight
 - 1-3 Dimensions
 - 1-3 Safety Considerations
 - 1-3 Instruments Covered By This Manual
 - 1-3 Options
 - 1-4 Accessories Supplied
 - 1-4 Accessories Available
 - 1-4 Recommended Test Equipment
 - 1-4 Systemizing
-

Section 2

Installation

- 2-1 Introduction
 - 2-1 Preparation For Use
 - 2-1 Power Requirements
 - 2-1 Line Voltage Selection
 - 2-1 Power Cables
 - 2-1 Operating Environment
 - 2-2 Test Set Connection
 - 2-2 Cleaning
 - 2-3 Storage And Shipment
 - 2-3 Tagging For Service
 - 2-3 Packaging
-

Section 3

Performance Tests

- 3-1 Introduction

Section 4

Adjustments

- 4-1 Introduction
- 4-1 Adjustment Interval
- 4-1 Recommended Test Equipment
- 4-1 Adjustment Sequence
- 4-2 Power Supply Adjustments
 - 4-2 Analog Supply
 - 4-3 Digital Supply
- 4-4 Timebase Delta Current Adjustment
- 4-7 +10 Volt Reference Adjustment
- 4-8 CRT Color Module Introduction
- 4-8 Degaussing the Display
- 4-8 Safety Considerations
- 4-9 CRT Color Module Adjustments
 - 4-11 Geometry Adjustments
 - 4-12 Focus Adjustment
 - 4-12 Landing Adjustment
 - 4-15 Static Convergence
 - 4-15 Dynamic Convergence
 - 4-18 White Balance

Section 5

Replaceable Parts

- 5-1 Introduction
- 5-1 Abbreviations
- 5-1 Replaceable Parts List
- 5-2 Exchange Assemblies
- 5-2 Ordering Information
- 5-2 Direct Mail Order System

Section 6A

Disassembly

- 6A-1 Introduction
- 6A-1 Safety Considerations
- 6A-1 Tools Required
- 6A-3 Card Cage PC Assemblies
- 6A-4 Primary Supply
- 6A-5 Analog Supply
- 6A-6 Digital Supply
- 6A-7 CRT Bezel
 - 6A-7 Function & Menu Keyboards
- 6A-8 Front Panel
 - 6A-9 Display Control
 - 6A-9 Control Keyboard
- 6A-10 Color CRT Module
- 6A-13 Fan
- 6A-14 Color Display Assembly
- 6A-16 Motherboard

Section 6B

Theory

- 6B-1 Introduction
 - 6B-1 System Theory
 - 6B-4 Acquisition Cycle
 - 6B-6 Variable Persistence
 - 6B-6 Average Mode
 - 6B-6 ADC Assembly
 - 6B-9 Horizontal Control Assembly
 - 6B-12 I/O Assembly
 - 6B-15 Microprocessor Assembly
 - 6B-18 Color Display Assembly
 - 6B-21 Power Supply Assemblies
 - 6B-21 Primary Supply
 - 6B-21 Digital Supply
 - 6B-21 Analog Supply
-

Section 6C

Service Menus

- 6C-1 Introduction
- 6C-1 Service Menus
 - 6C-1 CAL Menu
 - 6C-1 Test Menu
 - 6C-1 CRT Setup
 - 6C-1 Color Cal Menu
 - 6-1 HP-IB Menu
 - 6-1 One-key Powerup
 - 6-2 Two-key Powerup
 - 6-2 Cal Menu
 - 6-2 Channel Vertical Cal
 - 6C-2 Channel Skew Cals
 - 6C-2 Channel Atten Cals
- 6C-2 Test Menu
 - 6C-3 Repeat Loop
 - 6C-3 Run From Loop
 - 6C-3 Extended Tests
 - 6C-3 Start/Stop Test
 - 6C-3 Display Errors
 - 6C-3 Display Configuration
- 6C-4 CRT Setup Menu
 - 6C-4 Confidence Test
 - 6C-4 Pattern
- 6C-5 Light Output
- 6C-5 Color Purity

Section 6D

Troubleshooting

- 6D-1 Introduction
- 6D-1 Safety Considerations
- 6D-1 Recommended Test Equipment
- 6D-1 Logic Family Used
- 6D-2 Diagnostic Overview
- 6D-2 One Key-down Powerup
- 6D-2 Two Key-down Powerup
- 6D-6 I/O Assembly Hard Reset
- 6D-6 Keyboard Troubleshooting
- 6D-9 Core Subsystem Troubleshooting
- 6D-9 Power Supply Troubleshooting
- 6D-16 Color Monitor Troubleshooting
- 6D-18 Color CRT Module Troubleshooting
- 6D-19 Firmware Troubleshooting
- 6D-20 Additional Troubleshooting

Appendix A

General Information

- A1-1 Safety and Handling Precautions
- A1-1 Incoming Inspection
- A1-2 Equipment Required But Not Supplied

Accessory Kit Devices

- A2-1 Introduction
- A2-1 7.5 cm Beadless Airline
- A2-3 15 cm Beadless Airline
- A2-3 Model 909D 50 W Terminator
- A2-4 Coaxial Attenuators
- A2-5 Coaxial Short
- A2-5 Test Port Return Cables
- A2-7 Adapter (m-m)
- A2-7 Semi-Rigid L Connectors
- A2-7 Power Splitter

Making Accurate Measurements

- A3-1 Introduction
- A3-1 Operating Conditions and Procedures
- A3-2 Device Specifications
- A3-3 SMA Inspect
- A3-3 Alignment
- A3-3 Mismatch

Making Good Connections

- A4-1 Introduction
- A4-1 Handling Precision 3.5 mm Connectors
- A4-2 Visual Inspection and Cleaning
- A4-4 Mechanical Inspection
- A4-4 Center Conductor
- A4-4 Outer Conductor
- A4-8 Connecting the Devices
- A4-8 Counter-rotation Technique

List of Illustrations

- 1-3 Figure 1-1. HP 54120B Dimensions

- 2-2 Figure 2-1. Rear Panel of Mainframe and Test Set

- 4-10 Figure 4-1. CRT Adjustment Sequence
- 4-11 Figure 4-2. PIN AMP Adjustment
- 4-11 Figure 4-3. PIN PHASE Adjustment
- 4-13 Figure 4-4. Purity Magnet Centering
- 4-13 Figure 4-5. Purity Magnet Adjustment Raster
- 4-14 Figure 4-6. Landing and Purity Adjustment Guide
- 4-15 Figure 4-7. Static Convergence
- 4-16 Figure 4-8. Y BOW Adjustment
- 4-16 Figure 4-9. Y BOW CROSS Adjustment
- 4-16 Figure 4-10. V.STAT TOP Adjustment
- 4-17 Figure 4-11. V.STAT BOTTOM Adjustment
- 4-17 Figure 4-12. H.AMP Adjustment
- 4-17 Figure 4-13. H.TILT Adjustment

- 5-4 Figure 5-1. Top View
- 5-5 Figure 5-2. Bottom View
- 5-6 Figure 5-3. Front Panel
- 5-6 Figure 5-4. Rear Panel
- 5-7 Figure 5-5. Left Side View
- 5-7 Figure 5-6. Right Side View

- 6A-2 Figure 6A-1. Major Assembly Locations
- 6A-4 Figure 6A-2. Primary Power Supply Mounting Screws
- 6A-7 Figure 6A-3. CRT Bezel Removal Pressure Locations
- 6A-8 Figure 6A-4. Front Panel Mounting Screws
- 6A-10 Figure 6A-5. Color CRT Module Mounting Screws
- 6A-13 Figure 6A-6. Fan Housing Mounting Screws
- 6A-15 Figure 6A-7. Color Display Assembly Mounting Screws
- 6A-15 Figure 6A-8. Motherboard Mounting Screws

- 6B-2 Figure 6B-1. System Block Diagram
- 6B-7 Figure 6B-2. ADC Assembly Block Diagram
- 6B-10 Figure 6B-3. Horizontal Control Assembly Block Diagram
- 6B-13 Figure 6B-4. I/O Assembly Block Diagram
- 6B-16 Figure 6B-5. Microprocessor Assembly Block Diagram
- 6B-19 Figure 6B-6. Color Display Assembly Block Diagram
- 6B-22 Figure 6B-7. Power Supply Assembly Block Diagrams

- 6D-3 Figure 6D-1. Main Troubleshooting Flowchart
- 6D-4 Figure 6D-2. Display Troubleshooting Flowchart Part 1
- 6D-5 Figure 6D-3. Display Troubleshooting Flowchart Part 2
- 6D-6 Figure 6D-4. Softkey Number Assignments
- 6D-7 Figure 6D-5. Keyboard Cable Pin Numbers
- 6D-8 Figure 6D-6. Keyboard Troubleshooting Flowchart
- 6D-10 Figure 6D-7. Core Subsystem Troubleshooting Flowchart

| | |
|-------|---|
| 6D-11 | Figure 6D-8. Power Supply Troubleshooting Flowchart 1 |
| 6D-12 | Figure 6D-9. Power Supply Troubleshooting Flowchart 2 |
| 6D-13 | Figure 6D-10. Power Supply Troubleshooting Flowchart 3 |
| 6D-15 | Figure 6D-11. Power Supply Troubleshooting Flowchart 4 |
| 6D-16 | Figure 6D-12. Color CRT Module Input Connections |
| 6D-16 | Figure 6D-13. Vertical and Horizontal Sync. Waveforms |
| A2-6 | Figure A2-1. Test Port Return Cables |
| A2-6 | Figure A2-2. Minimum Bend Radius |
| A2-8 | Figure A2-3. Viewing the Trigger Signal |
| A2-8 | Figure A2-4. Attenuating the TDR Signal |
| A2-9 | Figure A2-5. HP 11667B Power Splitter Schematic |
| A2-9 | Figure A2-7. HP 11667B Power Splitter |
| A3-1 | Figure A3-1. Allowable Temperature, Humidity, Pressure |
| A3-4 | Figure A3-2. Typical SWR of SMA and APC 3.5 Connectors |
| A4-3 | Figure A4-1. Visual Inspection of APC 3.5 Connectors |
| A4-5 | Figure A4-2. Mechanical Dimensions of Connector Faces |
| A4-6 | Figure A4-3. Mechanical Dimensions of the Short Circuit |
| A4-6 | Figure A4-4. Precision 3.5 mm Connector Gauges |
| A4-7 | Figure A4-5. Zeroing Precision 3.5 mm Connector Gauges |
| A4-7 | Figure A4-6. Measuring Precision 3.5 mm Male Connectors |
| A4-7 | Figure A4-7. Measuring Precision 3.5 mm Female Connectors |
| A4-9 | Figure A4-8. Connecting Devices |
| A4-9 | Figure A4-9. Counter Rotation Technique |

List of Tables

| | |
|------|--|
| 1-4 | Table 1-1. Recommended Equipment List |
| 2-4 | Table 2-1. Power Cord Configurations |
| 5-2 | Table 5-1. List of Manufacturers' Codes |
| 5-3 | Table 5-2. Reference Designators and Abbreviations |
| 5-8 | Table 5-3. Replaceable Parts List |
| 6D-6 | Table 6D-1. Row and Column Key Assignments |
| 6D-7 | Table 6D-2. Keyboard Ribbon Cable Signal Description |
| 6D-9 | Table 6D-3. Core Subsystem Diagnostic Routines |
| 6D-9 | Table 6D-4. Power Supply Distribution |

Table Of Contents

General Information

| | |
|--|-----|
| Introduction | 1-1 |
| Description | 1-2 |
| Specifications & Operating Characteristics | 1-2 |
| General Characteristics | 1-2 |
| Environmental Conditions | 1-2 |
| Power Requirements | 1-2 |
| Weight | 1-2 |
| Dimensions | 1-3 |
| Safety Considerations | 1-3 |
| Instruments Covered By This Manual | 1-3 |
| Options | 1-3 |
| Accessories Supplied | 1-4 |
| Accessories Available | 1-4 |
| Recommended Test Equipment | 1-4 |
| Systemizing | 1-4 |

Introduction

A service manual is supplied with the four channel test set you ordered along with the HP 54120B. To complete the service documentation for your system, unpack the four channel test set service manual and place it in the three ring binder supplied with the HP 54120B service manual.

This service manual contains information necessary to test, adjust and service the Hewlett-Packard 54120B Digitizing Oscilloscope Mainframe. This manual is divided into 9 sections as follows:

- 1 - General Information
- 2 - Installation
- 3 - Performance Tests
- 4 - Adjustments
- 5 - Replaceable Parts
- 6A - Disassembly
- 6B - Theory
- 6C - Service Menu Keys
- 6D - Troubleshooting

Information on operating, programming, and interfacing the HP 54120B is contained in the front panel operation reference supplied with each instrument.

The "General Information" section includes a description of the HP 54120B Digitizing Oscilloscope Mainframe, general characteristics, safety considerations, instruments covered by this manual, options, accessories supplied, recommended test equipment, and X-ray license forms. Specifications and operating characteristics are listed with the service manual for the four channel test set.

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

Description

The HP 54120B is a fully programmable digitizing oscilloscope mainframe with a nine inch color display. The mainframe is capable of automated measurements and digital storage.

The color display provides several colors which are mapped to provide specific colors for specific display functions. For example, channel 1 is displayed in yellow, channel 2 in green, and error messages are displayed in red.

The HP 54120B contains extensive self-tests to ensure proper functioning of the oscilloscope. These self-tests are in addition to internal diagnostics that help locate faults efficiently and identify repairs, if a failure does occur.

Specifications & Operating Characteristics

All specifications and instrument operating characteristics are listed with the service manual for the four channel test set.

General Characteristics

The following general characteristics are not specifications, but typical characteristics included as additional information only.

Environmental Conditions

Temperature Operating: +15° C to +35° C (+59° F to +95° F).

Temperature Non-operating: -40° C to +70° C (-40° F to +158° F).

Humidity Operating: Up to 90% relative humidity at +35° C (95° F).

Humidity Non-operating: Up to 95% relative humidity at +65° C (+149° F).

Altitude Operating: Up to 4600 metres (15,000 ft).

Altitude Non-operating: Up to 15,300 metres (50,000 ft).

Vibration Operating: Random vibrations 5-500 Hz, 10 minutes per axis, ~0.3 g (rms).

Vibration Non-operating: Random vibration 5-500 Hz, 10 minutes per axis, = 2.41 g (rms); and swept sine resonant search, 5-500 Hz, 0.75 g (0-peak), 5 minute resonant dwell at 4 resonances per axis.

Power Requirements

Power requirements listed are for the HP 54120B combined with a four channel test set. The four channel test set obtains its power over the provided interface cable from the HP 54120B.

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

Power: 200 watts, 400 VA maximum.

Weight

HP 54120B Net: Approximately 20.5 kg (45 lb).

Dimensions

Dimensions are for general information only. If dimensions are required for building a special enclosure, contact your local Hewlett-Packard sales office. Dimensions are in millimetres and (inches). Refer to figure 1-1.

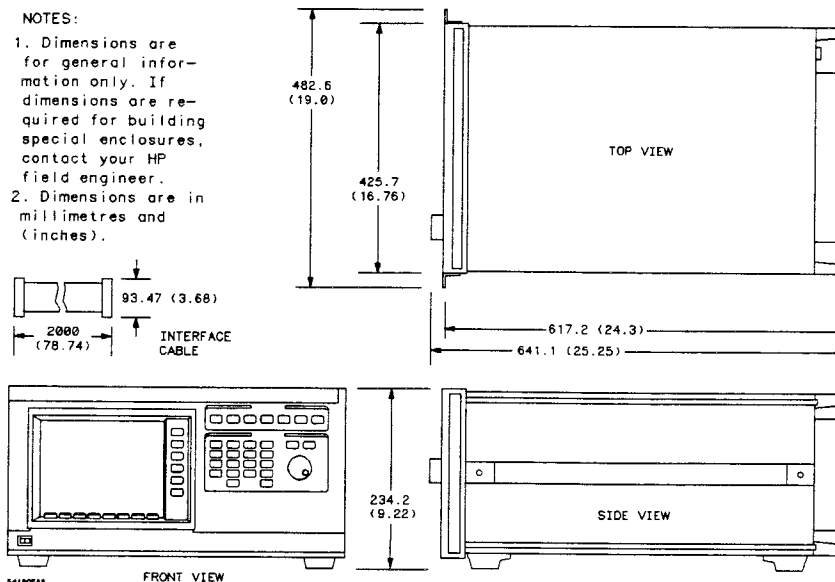


Figure 1-1. HP 54120B Dimensions

Safety Considerations

The appropriate sections contain safety information relevant to the service procedure it describes. Both the HP 54120B and this manual should be reviewed for safety markings and instructions before work is begun. Refer to the pages following the title page for safety summary and safety considerations.

Instruments Covered By This Manual

The HP 54120B's serial number is on the rear panel. Hewlett-Packard uses a two-part serial number consisting of a four-digit prefix and a five-digit suffix separated by a letter (0000A00000). The prefix is the same for all identical oscilloscopes and changes only when a modification is made that affects parts compatibility. The suffix differs for each oscilloscope. This manual applies directly to instruments with the serial prefix shown on the title page.

Options

The following options are available for the HP 54120B:

- Option 908 - Rack mount kit
- Option 910 - Additional copies of front panel operation reference
- Power cord options (see table 2-1)

Accessories Supplied

The following accessories are supplied with the HP 54120B.

- This Service Manual
- Getting Started Guide
- Front Panel Operation Reference
- Programming Reference Manual
- Antistatic mat with wrist strap (HP Part Number 9300-1346)

Accessories Available

The following accessories are available for the HP 54120B:

- Accessory kit HP 54007A
- 6 GHz Probe kit HP 54006A
- 22 ns Delay Line HP 54008A

Recommended Test Equipment

The test equipment recommended for maintaining the HP 54120B is listed in table 1-1. Any equipment which satisfies the critical specifications may be used. Section 4, Adjustments, is the only section which requires test equipment.

Table 1-1. Recommended Test Equipment

| Instrument | Critical Specifications | Model |
|------------|---------------------------|---------|
| DMM | Better than 0.3% accuracy | HP 3478 |
| Clip lead | Alligator to alligator | N/A |

Systemizing

At the factory the HP 54120B Digitizing Oscilloscope Mainframe and the four channel test set are calibrated together as a system. This system will meet all published specifications when shipped from the factory. If the system is split up, (a different four channel test set is used with the HP 54120B) refer to the four channel test set service manual, "General Information" section, systemizing paragraph for your instrument.

Table Of Contents

Installation

| | |
|----------------------------------|-----|
| Introduction | 2-1 |
| Preparation for Use | 2-1 |
| Power Requirements | 2-1 |
| Line Voltage Selection | 2-1 |
| Power Cables | 2-1 |
| Operating Environment | 2-1 |
| Test Set Connection | 2-2 |
| Cleaning | 2-2 |
| Storage and Shipment | 2-3 |
| Tagging for Service | 2-3 |
| Packaging | 2-3 |

Introduction

This section contains installation instructions, information about operating environments, cleaning the HP 54120B, storage, and shipment.

Preparation For Use

Caution

To prevent damage to the instrument, make sure the line voltage selector switch is in the correct setting for your AC voltage source.

Power Requirements

The HP 54120B requires a power source of 115 or 230 Vac $\pm 15\%$ to $\pm 25\%$; 48 to 66 Hz single phase. Power consumption is 200 watts or 400 VA maximum.

Line Voltage Selection

A blade-type screwdriver may be used to change the position of the line select switch on the read panel to the correct voltage selection. Correctly setting the line switch sets the correct circuit breaker trip current. For 100 volt line operation, the line switch must be in the 115 V position.

Power Cables

This instrument is equipped with a three-wire power cable. When connected to an appropriate AC power outlet, this cable grounds the instrument cabinet. The type of power cable plug shipped with the instrument depends on the country of destination. See Table 2-1 for option numbers of available power cables and plug configurations.

Warning

To protect operating personnel from possible injury or death, the chassis must be properly grounded. The proper power cord must be used and the power cord ground must NOT be defeated. Refer to table 2-1 for power cable description and application.

Operating Environment

The operating environment is noted in the General Information section under General Characteristics. Note the non-condensing humidity limitation. Avoid condensation within the instrument because it can cause poor operation or malfunction.

Test Set Connection

Always insure a four channel test set is connected to the HP 54120B before applying power to the HP 54120B.

The HP 54120B Digitizing Oscilloscope Mainframe is connected to a four channel test set by the umbilical cable, HP Part Number 54120-61618. Connect the umbilical cable to the interface cable ports on the mainframe and four channel test set. Refer to figure 2-1. The mainframe supplies all power for the four channel test set over the umbilical cable.

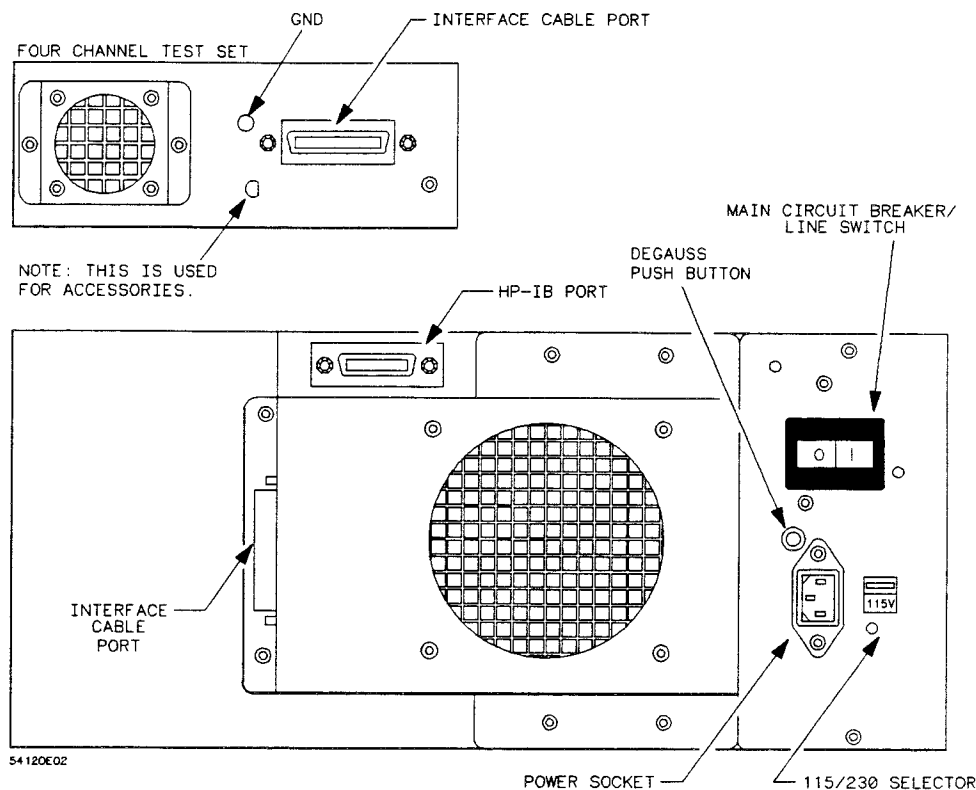


Figure 2-1. Rear Panel of Mainframe and Test Set

Cleaning

When cleaning the HP 54120B, CAUTION must be exercised about which cleaning agents are used. USE MILD SOAP AND WATER. If a harsh soap or solvent is used, the water-base paint finish WILL BE DAMAGED.

Caution 

BE CAREFUL when cleaning the keyboard. Water can damage the keyboard circuit if it seeps under the keys.

Storage And Shipment

The instrument may be stored or shipped in environments with the following limits:

Temperature: -40° C to +70° C (-40° F to +158° F)

Humidity: Up to 95% at +65° C (+149° F)

Altitude: Up to 15,300 metres (50,000 feet)

Tagging For Service

The instrument should also be protected from temperature extremes which cause condensation within the instrument. Condensation within the instrument may cause a malfunction.

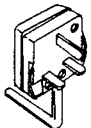

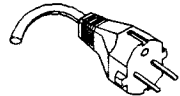
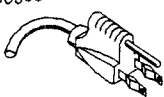
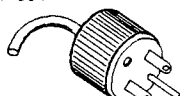
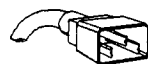
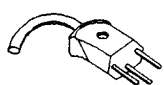
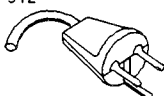

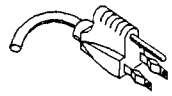
If the instrument is being returned to Hewlett-Packard for servicing, attach a tag indicating the type of servicing required, return address, model number, and full serial number. In any correspondence refer to the instrument by model number and full serial number.

Packaging

Original packaging i.e., containers and material identical to those used in factory packaging are available from Hewlett-Packard. If other packaging is to be used the following general instructions for repackaging with commercially available materials should be followed:

- a. Wrap the oscilloscope in heavy paper or plastic.
- b. Use a strong shipping container. A double wall carton made of 2.4 MPa (350 psi) test material is adequate.
- c. Use a layer of shock absorbing material 75 to 100 mm (3 to 4 inches) thick around all sides of the instrument to provide firm cushioning and prevent movement inside the container. Protect the control panel with cardboard.
- d. Seal the shipping container securely.
- e. Mark the shipping container FRAGILE to ensure careful handling.

Table 2-1. Power Cord Configurations

| PLUG TYPE | CABLE PART NO. | PLUG DESCRIPTION | LENGTH IN/CM | COLOR | COUNTRY |
|---|-------------------------------------|---|----------------------------|--------------------------------------|--|
| OPT 900  250V | 8120-1351 8120-1703 | Straight *BS1363A 90° | 90/228 90/228 | Gray Mint Gray | United Kingdom, Cyprus, Nigeria, Zimbabwe, Singapore |
| OPT 901  250V | 8120-1369 8120-0696 | Straight *NZSS198/ASC 90° | 79/200 87/221 | Gray Mint Gray | Australia New Zealand |
| OPT 902  250V | 8120-1689 8120-1692 8120-2857 | Straight *CEE7-Y11 90° Straight (Shielded) | 79/200 79/200 79/200 | Mint Gray Mint Gray Coco Brown | East and West Europe, Saudi Arabia, So. Africa, India (Unpolarized in many nations) |
| OPT 903**  125V | 8120-1378 8120-1521 8120-1992 | Straight *NEMA5-15P 90° Straight (Medical) UL544 | 90/228 90/228 96/244 | Jade Gray Jade Gray Black | United States, Canada, Mexico, Philippines, Taiwan |
| OPT 904**  250V | 8120-0698 | Straight *NEMA6-15P | 90/228 | Black | United States, Canada |
| OPT 905  250V | 8120-1396 8120-1625 | CEE22-V1 (System Cabinet Use) 250V | 30/76 96/244 | Jade Gray | For interconnecting system components and peripherals. United States and Canada only |
| OPT 906  250V | 8120-2104 8120-2296 | Straight *SEV1011 1959-24507 Type 12 90° | 79/200 79/200 | Mint Gray Mint Gray | Switzerland |
| OPT 912  220V | 8120-2956 8120-2957 | Straight *DHCK107 90° | 79/200 79/200 | Mint Gray Mint Gray | Denmark |
| OPT 917  250V | 8120-4211 8120-4600 | Straight SABS164 90° | 79/200 79/200 | Jade Gray | Republic of South Africa India |
| OPT 918  100V | 8120-4753 8120-4754 | Straight Miti 90° | 90/230 90/230 | Dark Gray | Japan |

Rev. 11NOV88

ART00019

*Part number shown for plug is industry identifier for plug only. Number shown for cable is HP part number for complete cable including plug.

**These cords are included in the CSA certification approval of the equipment.

E=Earth Ground

L=Line

N=Neutral

Performance Tests

Introduction

This section normally contains the performance verification tests. Since there are no specifications for the mainframe to test, there are no performance tests for the mainframe. Refer to the four channel test set service manual for the performance tests.

Table of Contents

Adjustments

| | |
|---|------|
| Introduction | 4-1 |
| Adjustment Interval | 4-1 |
| Recommended Test Equipment | 4-1 |
| Adjustment Sequence | 4-1 |
| Power Supply Adjustments | 4-2 |
| Analog Supply | 4-2 |
| Digital Supply | 4-3 |
| Timebase Delta Current Adjustment | 4-4 |
| + 10 Volt reference Adjustment | 4-7 |
| CRT Color Module Introduction | 4-8 |
| Degaussing the Display | 4-8 |
| Safety Considerations | 4-8 |
| CRT Color Module Adjustments | 4-9 |
| Geometry Adjustments | 4-11 |
| Focus Adjustments | 4-12 |
| Landing Adjustments | 4-12 |
| Static Convergence | 4-15 |
| Dynamic Convergence | 4-16 |
| White Balance | 4-18 |

Introduction

This section describes the adjustments for returning the instrument to peak operating capabilities after repairs have been made or during routine preventive maintenance.



Read the "Safety Summary" at the front of this manual before performing adjustment procedures. The instrument should be disconnected from all voltage sources before it is opened for any adjustments, replacements, maintenance, or repairs.

Adjustment Interval

Adjustments are needed if the test set fails to pass the performance verification test in the test set service manual. Some or all of these adjustments may need to be made after repairs have been completed. Amount of use, environmental conditions, and the user's experience concerning need for adjustment verification will contribute in deciding the adjustment interval. Also refer to the "Performance Test Interval" in the performance tests section of the test set service manual.

Recommended Test Equipment

Table 1-1 lists the recommended test equipment to use for the adjustment procedures. Any equipment that satisfies the critical specifications may be used.

Adjustment Sequence

This is the factory recommended sequence of adjustments.



The mainframe adjustments must be performed before the test set adjustments are performed.

- Power Supply Adjustments
- Timebase Delta Current Adjustment
- +10.000 Reference Voltage Adjustment

Power Supply Adjustments

This procedure is for adjusting the power supply voltages in cases when either the power supplies have been inadvertently misadjusted or when repairs have been made.

Note

The power supply voltages are factory set and rarely require readjustment.

Equipment

This is a list of the recommended test equipment for this adjustment. However, any instrument which satisfies the critical specifications may be used.

| Instrument | Critical Specifications | Model |
|------------|---------------------------|----------|
| DMM | Better than 0.3% accuracy | HP 3478A |

Analog Supply

This adjustment was never installed on HP 54120B mainframes. If you have an older HP 54120A mainframe you need to check to see if your instrument contains A12R61 before continuing with this procedure. A12R61 was the only adjustment on the Analog Power Supply assembly. The test point locations are marked on the power supply cover and on the Analog PC assembly (A12). This procedure adjusts the fan supply voltage.

Note

The instrument must be stabilized at ambient temperature with front-panel power switch to STBY before this adjustment is made. The fan voltage will increase with the instrument's internal temperature. If the instrument is not allowed to cool down, the following voltage measurement and adjustment will be inaccurate.

1. Remove two top rear feet from mainframe.
2. Remove top cover from mainframe.
3. Connect positive voltmeter lead to FAN test point.
4. Connect negative voltmeter lead to -18 V test point.
5. Turn instrument on.
6. Before the instrument warms up, adjust A12R61 for a voltmeter reading of $9.5 \text{ V} \pm 100 \text{ mV}$.

Digital Supply

The test point locations are marked on the power supply cover and on the Digital PC assembly (A13). A13R56 is the only adjustment on the Digital Power Supply assembly. First, the voltage is measured to see if any adjustment is required.

1. Turn instrument on and allow it to warm up for approximately two minutes.
2. Connect positive voltmeter lead to +5 V test point (actual voltage = +5.1 V).
3. Connect negative voltmeter lead to -5 V test point (actual voltage = -5.3 V).
4. The voltmeter should read +10.4 Vdc \pm 10 mV. If the measurement is within specifications, stop here. If the measurement is out of specifications, then continue with steps 5 through 11.
5. Disconnect power cord from rear of instrument and remove voltmeter leads.

Warning



Hazardous voltages capable of causing injury or death are present on the AC Power Supply assembly (A11) when power is applied and for a period of time after power is removed from the instrument. To avoid this hazard, DO NOT remove the power supply shield until the LED on the AC Power Supply assembly (A11) is extinguished. This LED is visible through an inspection hole in the cover labeled "+ 300 V WHEN LAMP IS ON".

6. When the + 300 V lamp is extinguished, remove the top power supply cover.
7. Reconnect positive voltmeter lead to +5 V test point.
8. Reconnect negative voltmeter lead to -5 V test point.
9. Reconnect power cord and turn instrument on. Allow instrument to warm up for approximately two minutes.
10. Adjust A13R56 for a voltmeter reading of +10.4 Vdc \pm 10 mV.
11. Disconnect power cord and wait until +300 V lamp is extinguished.
12. Disconnect voltmeter leads before reinstalling power supply cover.

Timebase Delta Current Adjustment

This is a timebase system adjustment. After this adjustment is made, any four channel test set may be used with this mainframe without degrading the timebase accuracy specifications. A3R29, on the Horizontal Control board, is adjusted for proper delta (change) in output current flow from the fine delay DAC on the Horizontal Control board to the four channel test set is, when delay is switched from 16.000 ns to 19.999 ns.

The procedure consists of three main parts.

1. Steps 1 through 6 measure the resistance of A3R46. This is the resistance value in the ohm's law formula $I = E \div R$ used in step 12.
2. Steps 6 through 12 measure the voltage across A3R46 with the oscilloscope's timebase delay set to 16.000 ns. This is the voltage value in the ohm's law formula $I = E \div R$ used in step 12.
3. Steps 13 through 21 calculate the desired delta current across A3R46 when the oscilloscope's timebase delay is changed from 16.000 ns to 19.999 ns. A3R29 is adjusted if the measured delta current does not equal the desired delta current.

Equipment

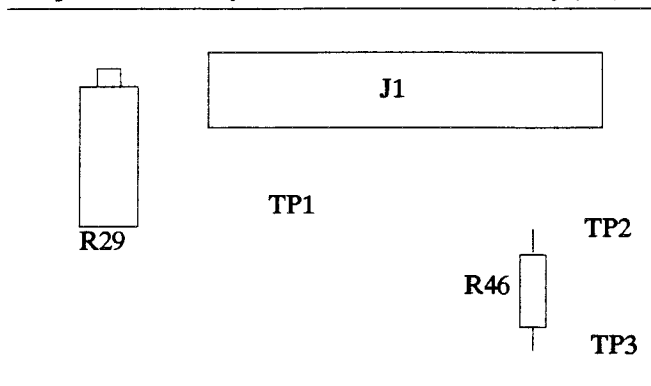
This is a list of the recommended test equipment for this adjustment. However, any instrument which satisfies the critical specifications may be used.

| Instrument | Critical Specifications | Model |
|------------|-------------------------------------|----------|
| DMM | 40 μ V and 24 milliohm accuracy | HP 3478A |
| Clip lead | Alligator to alligator | N/A |

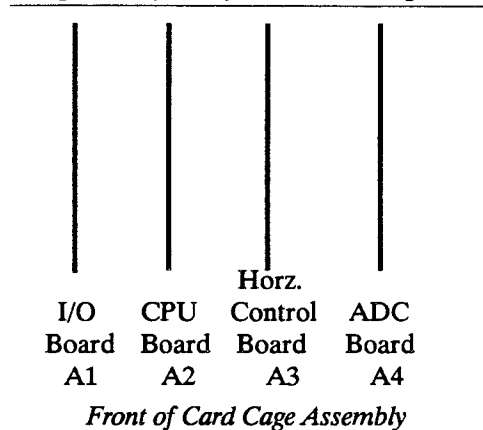
Procedure **Part 1:** Determining R in the ohm's law formula $I = E \div R$

1. Turn mainframe's front-panel power switch to STBY.
2. Place DMM in four-wire resistance measurement mode.
3. Connect one end of alligator clip lead to (A3) TP2.
4. Connect both positive DMM leads to other end of alligator clip lead.
5. Connect both negative DMM leads to ground point TP3.

Top-Rear Corner of Horizontal Control Assembly (A3)



Top View of Mainframe's Card Cage



6. Record resistance reading in steps 12 and 14 (2 places after the decimal are required).
Example: 200.06 Ω . Leave DMM connected across A3R46.

Part 2: Determining E in the ohm's law formula $I = E \div R$

7. Disconnect the ribbon cables which attach to the rear of the horizontal control and ADC assemblies.
8. Change DMM to make voltage measurements.
9. Short Horizontal Control assembly (A3) test point TP1 to TP2.
10. Turn mainframe power on, and set timebase delay to 16 ns.
11. Record DMM voltage reading in step 12 (5 places after the decimal are required).
Example: -1.00039 V.

- | | |
|---|-----------------|
| | Example |
| 12. Record DMM voltage reading from step 11 here _____ V | -1.00039 V |
| Record DMM resistance reading from step 6 here _____ Ω | 200.06 Ω |
| Divide voltage by resistance to obtain current _____ mA | 5.0004 mA |
| (four digits after the decimal are required, and drop the negative sign). | |

The result of the calculation is the fine delay DAC output current at delay value of 16.000 ns. Record this value in step 13.

Part 3: Steps 13 through 21 calculate the value to which A3R29 should be set.

13. Subtract the current result in step 12 from desired delta current 9.7632 mA.
 $9.7632 \text{ mA} - (\text{_____ mA}) = \text{_____ mA}$. Record this value in step 14.

Example: $9.7632 \text{ mA} - 5.0004 \text{ mA} = 4.7628 \text{ mA}$

14. Convert calculated current from step 13 to a voltage value by multiplying it by the resistance value in step 6.

| | |
|---|-----------------|
| | Example |
| Record calculated current from step 13 here _____ mA | 4.7628 mA |
| Record DMM resistance reading from step 6 here _____ Ω | 200.06 Ω |
| Multiply resistance by current to obtain a voltage _____ V | 0.95284576 V |

15. Round voltage value from step 14 to 5 decimal places _____ V 0.95285 V

16. Change mainframe's timebase delay setting to 19.999 ns.

17. With DMM still connected across TP2 and TP3, check DMM voltage reading.
 If voltmeter reading is equal to calculated voltage in step 15, then go to step 18.
 Otherwise, adjust A3R29 for a DMM voltage reading as close as possible to the calculated value in step 15.

18. Turn mainframe's front-panel power switch to STBY.

19. Remove short from TP1 to TP2.

20. Disconnect DMM from mainframe.

21. Reconnect ribbon cable disconnected in step 7.

+ 10 Volt Reference Adjustment

This is a systemizing adjustment which allows any test set to be used with this mainframe without degrading the vertical gain specifications.

Equipment

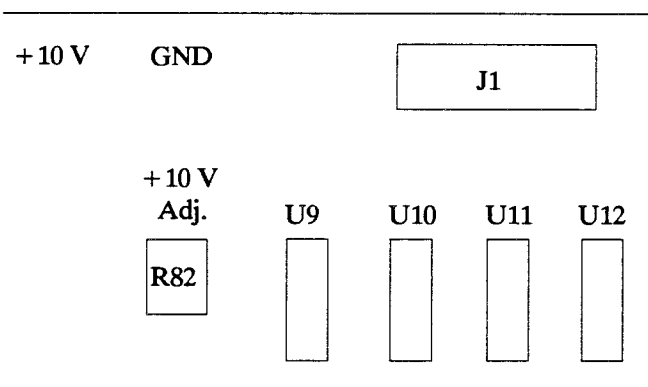
This is a list of the recommended test equipment for this adjustment. However, any instrument which satisfies the critical specifications may be used.

| Instrument | Critical Specifications | Model |
|------------|-------------------------|----------|
| DMM | 0.01% accuracy | HP 3478A |

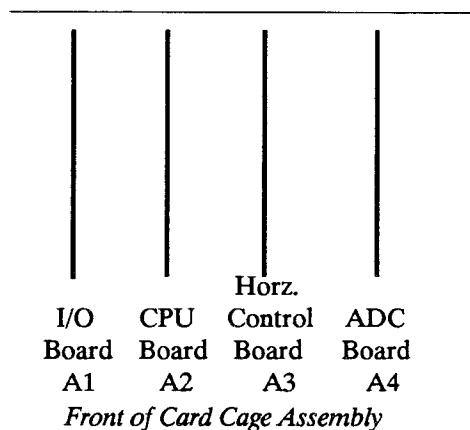
Procedure

1. Turn mainframe's front-panel power switch to STBY.
2. Connect positive DMM lead to +10 V test point on ADC assembly (A4).
3. Connect negative DMM lead to ground test point next to +10 V test point.
4. Turn mainframe's front-panel power switch to ON.
5. Adjust +10 V ADJUST (R82) for $+10\text{ V} \pm 1\text{ mV}$.
6. Disconnect DMM leads from ADC assembly.
7. Reinstall mainframe's top cover and two top rear feet.

Top-Rear Corner of ADC Assembly (A4)



Top View of Mainframe's Card Cage



CRT Color Module Introduction

The CRT color module requires no adjusting when used in a normal environment. The procedure given here is for CRT color convergence. Do not perform these adjustments as part of regular maintenance. Observe the following rules before making the adjustments:

- Do not perform this procedure as normal maintenance.
- Make adjustments only if the instrument has been subjected to extreme magnetic environments and the colors are incorrect.
- Before making any adjustments, try degaussing the unit using the rear panel degaussing switch or a color television type degaussing coil (refer to Degaussing the Display procedure, this section).
- Only qualified personnel who are familiar with color CRT convergence procedures should perform this adjustment.
- Before adjustments are made, mark the position where potentiometers are. This allows you to return the adjustments to their original starting position.

Degaussing the Display

After the instrument has been used for a while, the CRT may become magnetized and color or other data may become distorted. To correct, press the **Degauss** button on the rear panel several times.

If the instrument has been subjected to strong magnetic fields, it may be necessary to degauss the CRT with a conventional television type degaussing coil.

Safety Considerations

Although this instrument has been designed in accordance with international safety standards, general safety precautions must be observed during all phases of operation, service, and repair of the instrument. Failure to comply with the precautions listed in the Safety Summary at the front of this manual, or with specific warnings given throughout this manual, could result in serious injury or death. Service adjustments should be performed only by qualified service personnel.



Read the Safety Summary at the front of this manual before performing adjustment procedures. The apparatus shall be disconnected from all voltage sources before it is opened for any adjustment, replacement, maintenance, or repair.

CRT Color Module Adjustments

The CRT Color Module is adjusted to compensate for external magnetic influences causing misconvergence.

Note

DO NOT PERFORM THESE ADJUSTMENTS DURING ROUTINE CALIBRATION. The earth's magnetic field or the user's environment may cause an unstable display which cannot be corrected by degaussing the screen. The following procedures are provided for those few extreme cases.

Note

DO NOT continue with this procedure before first degaussing the CRT screen with the rear panel degaussing switch. In extreme cases of magnetism, it may be necessary to degauss the CRT with a conventional external television-type degaussing coil. During any of the following adjustments, the CRT module must face west.

Equipment

This is a list of the recommended test equipment for this adjustment. However, any instrument which satisfies the critical specifications may be used.

| Accessory | Critical Specifications | HP Part Number |
|-----------|-----------------------------|----------------|
| N/A | Alignment tool non-metallic | 8710-1355 |

Note

The following adjustments are broken down into groups. Follow their sequence because they interact and depend on each other. Figure 4-1 is a drawing of the adjustment sequence. In some cases not all the adjustment groups are used. For example, if the Geometry Adjustment Group corrects the problem, this will be the only group used.

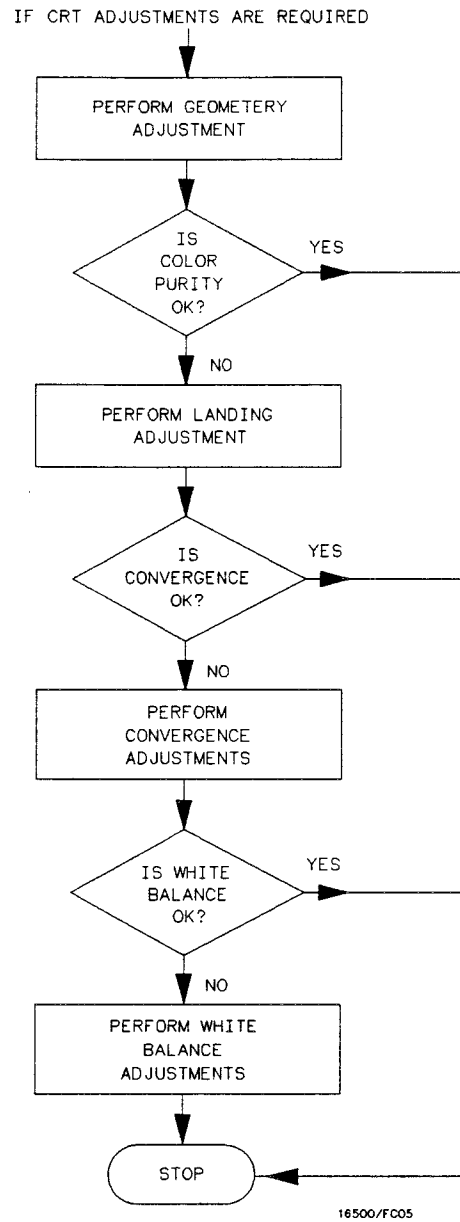
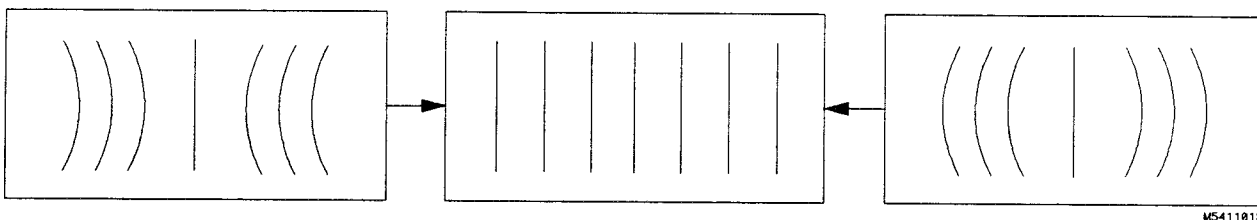


Figure 4-1. CRT Adjustment Sequence

Geometry Adjustments

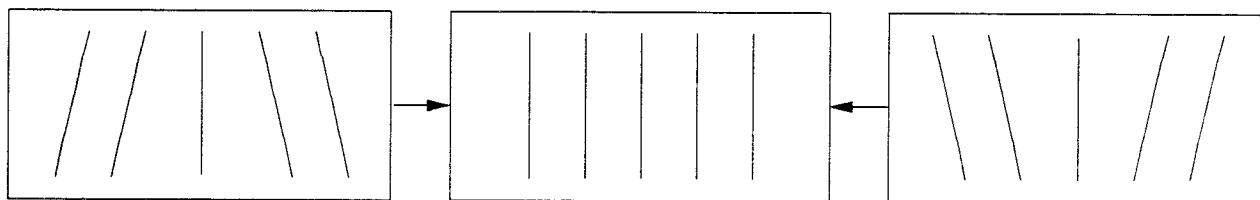
1. Press **Utility** menu key and **CRT SETUP** key.
Press **CRT PATTERN** key until a white cross hatch is displayed on CRT.
2. Preset front-panel **BACKGROUND** control to mechanical center.
3. Preset front-panel **CONTRAST** control maximum clockwise.
4. Preset **H.SUB SHIFT** (RV006) and **V.SUB SHIFT** (RV008) on bottom PC board to mechanical center.
5. With a flexible ruler, adjust **H.SIZE** (RV504) and **V.HEIGHT** (RV502) on left hand side PC board so cross-hatch pattern's border displayed on CRT is 120.5 mm (4.74 in.) vertically and 161 mm (6.34 in.) horizontally.
6. Adjust **V.CENT** (RV510) and **H.CENT** (RV503) on left hand side PC board to center pattern.
7. Adjust **PIN AMP** (RV506) on left hand side PC board to eliminate pincushion distortion in the vertical lines of the cross-hatch pattern. Refer to figure 4-2.



M5411012

Figure 4-2. PIN AMP Adjustment

8. Adjust **PIN PHASE** (RV505) on left side PC board to eliminate pin phase distortion in vertical lines of cross-hatch pattern. Refer to figure 4-3.
9. Adjust **TOP PIN** (RV511) on left hand side PC board until the horizontal line is parallel with center horizontal line.
10. Adjust **BOTTOM PIN** (RV512) on left hand side PC board until the bottom horizontal line is parallel with center horizontal line.



16500B01

Figure 4-3. PIN PHASE Adjustment

Landing, Convergence, and Focus Adjustment Preparation:

1. Remove CRT Display Module from instrument. See disassembly section 6A-9.
2. Reconnect instrument front panel, install front panel and CRT bezel (using two screws to temporarily hold front panel in place).

Steps 3-5 are performed only when the CRT has been replaced.

3. Loosen deflection yoke clamp screw.
4. With CRT Display Module placed to mainframe's left, reconnect module.



Note the original routing of the module power cable for proper routing when module is installed in instrument. Then, route the module power cable from inside the module to the outside (left side) of module for reconnection to the power supplies.

5. Remove deflection yoke spacers by moving deflection yoke rearward and removing spacers.



The deflection yoke spacers are tapered rubber blocks between front of yoke and rear of CRT funnel.

6. Apply power and allow instrument to thermally stabilize for 20 minutes.

Focus Adjustment



Perform the geometry adjustments before making focus adjustment.

1. Press Utility menu key and CRT SETUP key.
Press CRT PATTERN key until a white cross-hatch is displayed on CRT.
2. Adjust FOCUS (RV701) on rear PC board for best overall focus.

Landing Adjustment

1. Press Utility menu key and CRT SETUP key.
Press COLOR PURITY key until a white raster is displayed on CRT.
2. Turn front panel CONTRAST control fully clockwise.
3. Degauss entire CRT screen by pressing DEGAUSSING switch on instrument's rear panel.

Note

In cases where the user's environment or shipping environment has caused high levels of magnetization to take place, it may be necessary to externally degauss the CRT with a conventional television-type degaussing coil to completely degauss the CRT.

4. Set purity magnet tabs to mechanical center. Refer to figure 4-4.
5. Press **COLOR PURITY** key until a green raster is displayed on CRT.

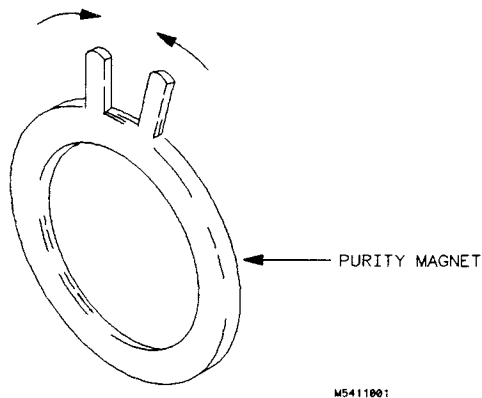


Figure 4-4. Purity Magnet Centering

Step 6 is performed only if the CRT has been replaced.

6. Move deflection yoke rearward until left edge of raster turns red and right side of raster turns blue. Refer to figure 4-5.
7. Adjust purity magnets until green is in center of raster with red and blue bands evenly distributed on sides. Refer to figure 4-5.

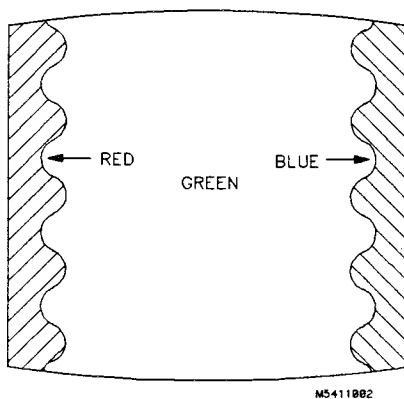


Figure 4-5. Purity Magnet Adjustment Raster

Step 8 is performed only if CRT has been replaced.

8. Move deflection yoke forward until entire raster is green.



Landing adjustment is easier if yoke is moved all the way forward, then moved rearward until raster is completely green.

9. With COLOR PURITY key, replace green raster with red, then with blue raster. Check each raster for proper landing adjustment or color purity.

10. If landing is not correct in step 9, repeat steps 6 through 9 for best compromise. Refer to figure 4-6.

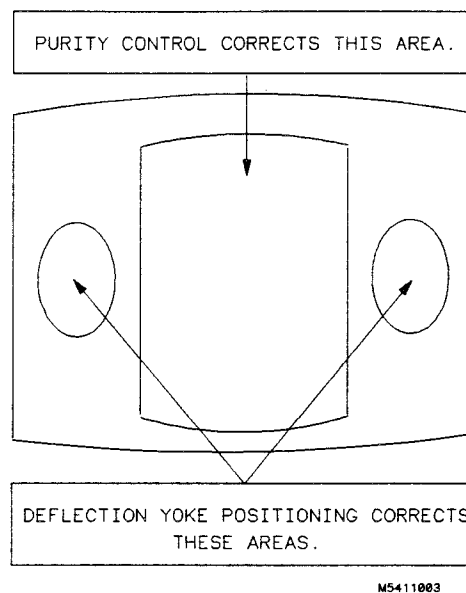


Figure 4-6. Landing and Purity Adjustment Guide

11. If landing is not correct in step 10, readjust purity magnets for best landing of each color.

Step 12 is performed only if the CRT has been replaced.

12. When landing adjustment is complete, tighten deflection yoke clamp screw just enough to keep yoke from moving. **DO NOT** over tighten.



While moving deflection yoke forward and rearward, rotate yoke as necessary to make vertical edges of raster parallel to the sides of the instrument frame.

Static Convergence

1. Preset front-panel BACKGROUND control to mechanical center.
2. Preset front-panel CONTRAST control maximum clockwise.
3. Temporarily disconnect power from instrument and remove PC board shield cover from rear of CRT Display Module by prying evenly on all four sides.
4. Apply power and press Utility menu key and CRT SETUP key.
Press **CRT PATTERN** key until a white cross-hatch pattern is displayed.
5. Check four dots which are around center intersection of cross-hatch pattern for coincidence of blue, red, and green dots. If the dots are not coincident, adjust H.STAT (RV703) on rear PC board to obtain horizontal coincidence and V.STAT (RV803) on bottom PC board to obtain vertical coincidence.
Refer to figure 4-7.

Note

Due to interaction, BEAM LANDING will need to be re-adjusted if either H.STAT or V.STAT adjustments are made. Once BEAM LANDING is readjusted, repeat step 5 above if necessary to obtain center screen coincidence of the dots.

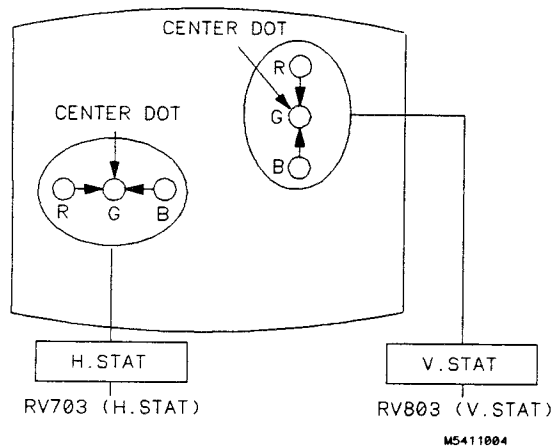


Figure 4-7. Static Convergence

Dynamic Convergence

1. Press **Utility** menu key and **CRT SETUP** key.
Press **CRT PATTERN** key until a white cross-hatch pattern is on CRT.
2. Adjust **Y BOW** (RV805) on bottom PC board to eliminate red, green, and blue bowing at top and bottom of center vertical line. Refer to figure 4-8.
3. Adjust **Y BOW CROSS** (RV804) on bottom PC board to eliminate red, green, and blue orthogonal misalignment at top and bottom of center vertical line. Refer to figure 4-9.

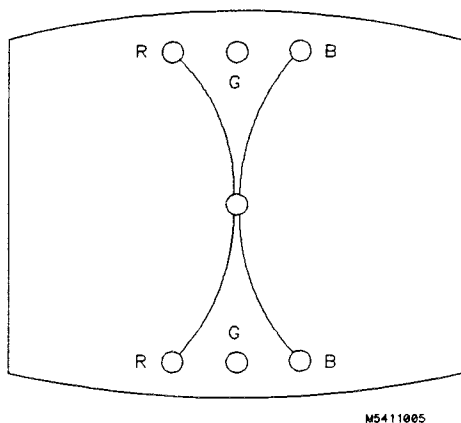


Figure 4-8. Y BOW Adjustment

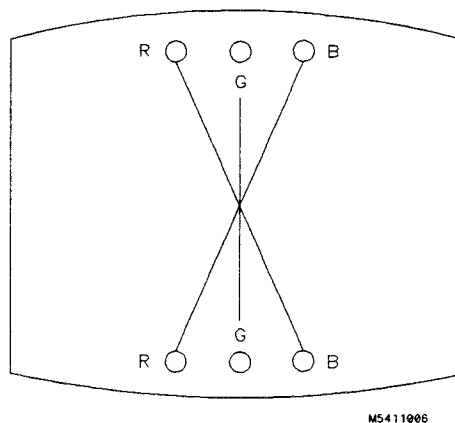


Figure 4-9. Y BOW CROSS Adjustment

4. Adjust **V.STAT TOP** (RV801) and **V.STAT BOTTOM** (RV802) on bottom PC board to obtain coincidence of red, blue, and green at intersection of top and bottom horizontal lines with center vertical line. Refer to figures 4-10 and 4-11.

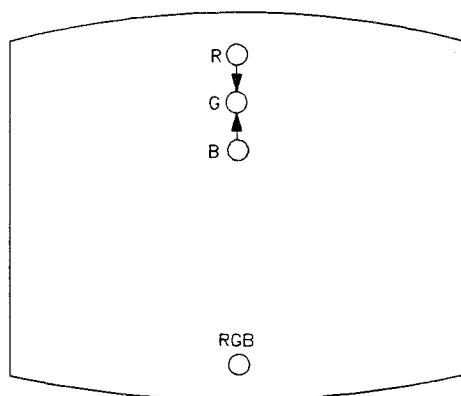


Figure 4-10. V.STAT TOP Adjustment

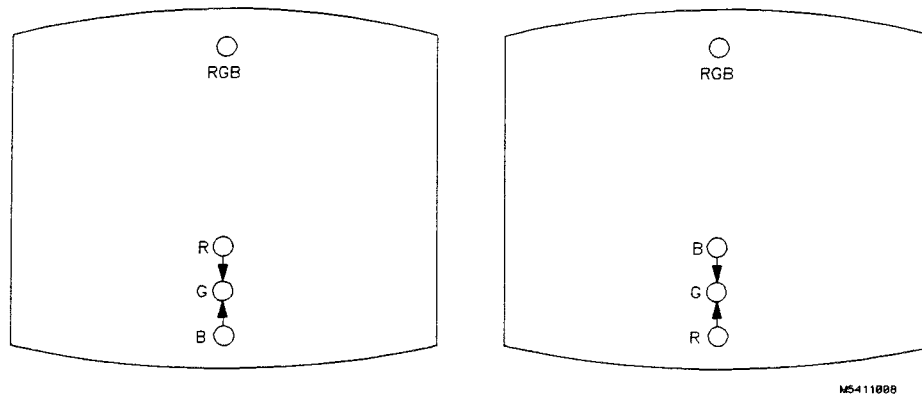


Figure 4-11. V.STAT BOTTOM Adjustment

5. Adjust H.AMP (RV807) on bottom PC board for equal amounts of misconvergence at right and left sides of screen. Refer to figure 4-12.

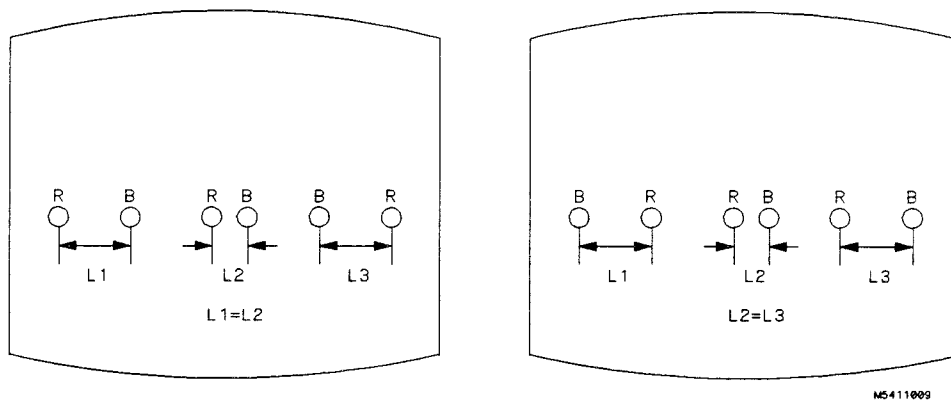


Figure 4-12. H.AMP Adjustment

6. Adjust H.TILT (RV806) on bottom PC board for coincidence of red, green, and blue at right and left sides of screen. Refer to figure 4-13.

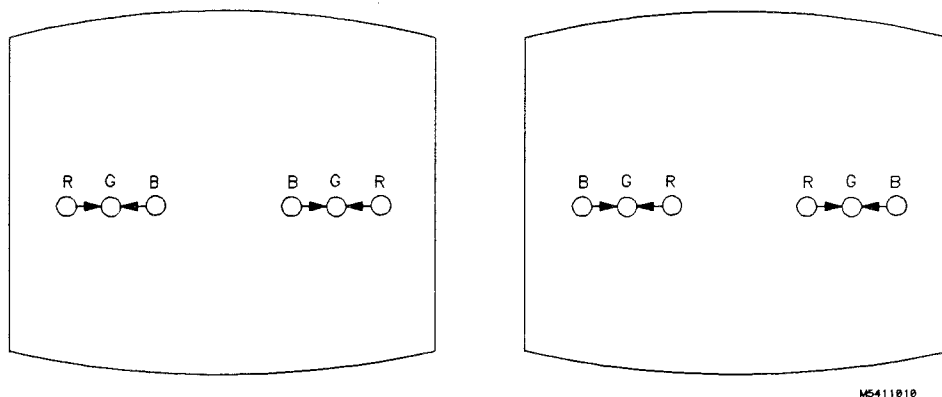


Figure 4-13. H.TILT Adjustment

White Balance

1. Press Utility menu key.
Press **LIGHT OUTPUT** key until a blank raster is on CRT.

Note

The completely blank raster will contain a test for the function keys on the right side of the display. However, it will not affect this adjustment.

2. Set front-panel **BACKGROUND** and **SUB BRT** (RV901) on bottom PC board to mechanical center.
3. Set front-panel **BRIGHTNESS** and **SUB CONT** (RV902) on bottom PC board to mechanical center.
4. Set **G. DRIVE** (RV921), **B. DRIVE** (RV9310), and **R. DRIVE** (RV911) on bottom PC board to mechanical center.
5. Set **G.BKG** (RV721), **B.BKG** (RV731), and **R.BKG** (RV711) on rear PC board fully counterclockwise (CCW).
6. Adjust **SCREEN** (RV702) on rear PC board until either a red, green, or blue raster just starts to become visible. Note which color becomes visible first and do not adjust background control (BKG) for that color in the step 7.
7. Adjust other two background (BKG) controls for best white balance.
8. Press Utility menu key.
Press **COLOR PURITY** key until a white raster is on CRT.
9. Set front panel **BRIGHTNESS** control at maximum.
10. Observe screen and adjust **DRIVE** controls (RV921, RV931, and RV911) on bottom PC board for best white balance.

Note

White balance is checked in two ways. First, with an average piece of white photocopy paper, compare the white on the CRT to the paper. Second, in the **CONFIDENCE TEST** function, the gray scale blocks are checked to make sure the block at the far left of the CRT is visible.

11. Repeat steps 1 through 3 and 6 through 10 for best overall white balance.

Table Of Contents

Replaceable Parts

| | |
|------------------------------------|-----|
| Introduction | 5-1 |
| Abbreviations | 5-1 |
| Replaceable Parts List | 5-1 |
| Exchange Assemblies | 5-1 |
| Ordering Information | 5-2 |
| Direct Mail Order System | 5-2 |

Introduction

This section contains information for ordering parts. Table 5-1 lists the names and addresses that correspond to the manufacturers' code numbers. Table 5-2 lists the abbreviations used in the parts list and throughout this manual. Figures 5-1 through 5-6 are drawings with reference designators included. Table 5-3 is the replaceable parts list.

Abbreviations

Table 5-2 lists the abbreviations used in the replaceable parts list. Abbreviations in the replaceable parts list are always in capital letters. In other sections of this manual abbreviations may be in capital or lower case letters.

Replaceable Parts List

Table 5-3 is a list of replaceable parts and is organized as follows:

- a. Electrical assemblies in alphanumerical order by reference designation.
- b. Chassis mounted parts in alphanumerical order by reference designation.

Information given for each part consists of the following:

- a. Hewlett-Packard part number and the check digit (for HP internal use).
- b. Total quantity (Qty) in the instrument, given only once at the part number's first appearance in the list.
- c. Description of part.
- d. A typical manufacturer of a given part in a five digit code. Refer to table 5-1 for a cross reference from code number to manufacturer name.
- e. The manufacturers' part number.

Exchange Assemblies

Some of the assemblies used in this instrument have been set up on the exchange program. This allows the customer to exchange his faulty assembly with one that has been repaired, adjusted, and performance verified by the factory. The cost is significantly less than that of a new assembly.

Exchange assemblies are listed at the beginning of the replaceable parts table with a star (*) before the reference designator. They have a part number in the form XXXXX-695XX.

Before ordering an exchange assembly, check with your local parts or repair organization for the procedures associated with the exchange assembly program.

Ordering Information

To order a part listed in the replaceable parts table, indicate the Hewlett-Packard part number, check digit, and quantity required. Send the order to the nearest Hewlett-Packard office.

To order a part that is not listed in the replaceable parts table, include the instrument model number, serial number, description and function of part, and total quantity required. Address an order to the nearest Hewlett-Packard sales office.

Direct Mail Order System

Within the USA, Hewlett-Packard can supply parts through a direct mail order system. Advantages of using this system are as follows:

- a. Direct ordering and shipment from HP Parts Center in Mountain View, California. Call your local Hewlett-Packard office for the toll free number
- b. No maximum or minimum on any mail order (there is a minimum order amount for parts ordered through local HP offices when orders require billing and invoicing).
- c. Prepaid transportation (there is a small handling charge for each order).
- d. No invoices. To provide these advantages, check or money order must accompany each order. Mail order forms and specific ordering information are available through your local Hewlett-Packard offices.

Table 5-1. List of Manufacturers' Codes

| Mfr No. | Manufacturer Name | Address | Zip Code |
|---------|-------------------------------------|--------------|----------|
| 04713 | Motorola Semi Conductor Products | Phoenix Az | 85008 |
| 06915 | Pan Asian Paper Product Mfg SDN BHD | Pinang | Malaysia |
| 28480 | Hewlett-Packard Co. Corporate HQ | Palo Alto Ca | 94304 |
| 86928 | Seastrom Mfg Co. | Glendale Ca | 91201 |

Table 5-2. Reference Designator and Abbreviations

| REFERENCE DESIGNATOR | | | | | | | |
|----------------------|---|--------|---|---------|---|---------|---|
| A | = assembly | F | = fuse | Q | = transistor; SCR; triode thyristor | U | = integrated circuit; microcircuit |
| B | = fan; motor | FL | = filter | R | = resistor | V | = electron tube; glow lamp |
| BT | = battery | H | = hardware | RT | = thermistor | VR | = voltage regulator; breakdown diode |
| C | = capacitor | J | = electrical connector (stationary portion); jack | S | = switch; jumper | W | = cable |
| CR | = diode; diode thyristor; varactor | L | = coil; inductor | T | = transformer | X | = socket |
| DL | = delay line | MP | = misc. mechanical part | TB | = terminal board | Y | = crystal unit (piezo-electric or quartz) |
| DS | = annunciator; lamp; LED | P | = electrical connector (moveable portion); plug | TP | = test point | | |
| E | = misc. electrical part | | | | | | |
| ABBREVIATIONS | | | | | | | |
| A | = amperes | DWL | = dowel | MFR | = manufacturer | RND | = Round |
| A/D | = analog-to-digital | ECL | = emitter coupled logic | MICPROC | = microprocessor | ROM | = read-only memory |
| AC | = alternating current | ELAS | = elastomeric | MINTR | = miniature | RPG | = rotary pulse generator |
| ADJ | = adjust(ment) | EXT | = external | MISC | = miscellaneous | RX | = receiver |
| AL | = aluminum | F | = farads; metal film (resistor) | MLD | = molded | S | = Schottky-clamped; seconds(time) |
| AMPL | = amplifier | FC | = carbon film/ composition | MM | = millimeter | SCR | = screw; silicon controlled rectifier |
| ANLG | = analog | FD | = feed | MO | = metal oxide | SEC | = second(time); secondary |
| ANSI | = American National Standards Institute | FEM | = female | MTG | = mounting | SEG | = segment |
| ASSY | = assembly | FF | = flip-flop | MTLC | = metallic | SEL | = selector |
| ASTIG | = astigmatism | FL | = flat | MUX | = multiplexer | SGL | = single |
| ASYNCHRO | = asynchronous | FM | = foam; from | MW | = milliwatt | SHF | = shift |
| ATTEN | = attenuator | FR | = front | N | = nano(10^{-9}) | SI | = silicon |
| AWG | = American wire gauge | FT | = gain bandwidth product | NC | = no connection | SIP | = single in-line package |
| BAL | = balance | FW | = full wave | NMOS | = n-channel metal-oxide-semiconductor | SKT | = skirt |
| BCD | = binary-code decimal | FXD | = fixed | NPN | = negative-positive-negative | SL | = slide |
| BD | = board | GEN | = generator | NPRN | = neoprene | SLDR | = solder |
| BFR | = buffer | GND | = ground(ed) | NRFR | = not recommended for field replacement | SLT | = slot(fed) |
| BIN | = binary | GP | = general purpose | NSR | = not separately replaceable | SOLD | = solenoid |
| BRDG | = bridge | GRAT | = graticule | NUM | = numeric | SPCL | = special |
| BSHG | = bushing | GRV | = groove | OBD | = order by description | SQ | = square |
| BW | = bandwidth | H | = henries; high | OCTL | = octal | SREG | = shift register |
| C | = ceramic; cermet (resistor) | HD | = hardware | OD | = outside diameter | SRQ | = service request |
| CAL | = calibrate; calibration | HDND | = hardened | OP AMP | = operational amplifier | STAT | = static |
| CC | = carbon composition | HG | = mercury | OSC | = oscillator | STD | = standard |
| COW | = counterclockwise | HGT | = height | P | = plastic | SYNCHRO | = synchronous |
| CER | = ceramic | HLCL | = helical | P/O | = part of | TA | = tantalum |
| CFM | = cubic feet/minute | HORIZ | = horizontal | PC | = printed circuit | TBAX | = tubeaxial |
| CH | = choke | HP | = Hewlett-Packard | PCB | = printed circuit board | TC | = temperature coefficient |
| CHAM | = chamfered | HP-IB | = Hewlett-Packard Interface Bus | PD | = power dissipation | TD | = time delay |
| CHAN | = channel | HR | = hour(s) | PF | = picofarads (10^{-12}) | THD | = thread(ed) |
| CHAR | = character | HV | = high voltage | PI | = plug in | THK | = thick |
| CM | = centimeter | HZ | = Hertz | PL | = plate(d) | THRU | = through |
| CMOS | = complementary metal-oxide-semiconductor | I/O | = input/output | PLA | = programmable logic array | TP | = test point |
| CMR | = common mode rejection | ID | = inside diameter | PLST | = plastic | TPG | = tapping |
| CNDCT | = conductor | IN | = inch | PNP | = positive-negative-positive | TPL | = triple |
| CNTR | = counter | INCL | = include(s) | POLYE | = polyester | TRANS | = transformer |
| CON | = connector | INCAND | = incandescent | POS | = positive; position | TRIG | = trigger(ed) |
| CONT | = contact | INP | = input | POT | = potentiometer | TRMR | = trimmer |
| CRT | = cathode-ray tube | INTEN | = intensity | POZI | = poztidrive | TRN | = turn(s) |
| CW | = clockwise | INTL | = internal | PP | = peak-to-peak | TTL | = transistor-transistor |
| D | = diameter | INV | = inverter | PPM | = parts per million | TX | = transmitter |
| D/A | = digital-to-analog | JFET | = junction field-effect transistor | PRCN | = precision | U | = micro(10^{-6}) |
| DAC | = digital-to-analog converter | JKT | = jacket | PREAMP | = preamplifier | UL | = Underwriters Laboratory |
| DARL | = darlington | K | = kilo(10^3) | PRGMBL | = programmable | UNREG | = unregulated |
| DAT | = data | L | = low | PRL | = parallel | VA | = voltampere |
| DBL | = double | LB | = pound | PROG | = programmable | VAC | = volt, ac |
| DBM | = decibel referenced to 1mW | LCH | = latch | PSTN | = position | VAR | = variable |
| DC | = direct current | LCL | = local | PT | = point | VCO | = voltage-controlled oscillator |
| DCDR | = decoder | LED | = light-emitting diode | PW | = potted wirewound | VDC | = volt, dc |
| DEG | = degree | LG | = long | PWR | = power | VERT | = vertical |
| DEMUX | = demultiplexer | LJ | = lithium | R-S | = reset-set | VF | = voltage, filtered |
| DET | = detector | LK | = lock | RAM | = random-access memory | VS | = versus |
| DIA | = diameter | LKWR | = lockwasher | RECT | = rectifier | W | = watts |
| DIP | = dual in-line package | LS | = low power Schottky | RET | = retainer | W/O | = without |
| DIV | = division | LV | = low voltage | RF | = radio frequency | WW | = wirewound |
| DMA | = direct memory access | M | = mega(10^6); megohms; meter(distance) | RGLTR | = regulator | XSTR | = transistor |
| DPDT | = double-pole, double-throw | MACH | = machine | RGTR | = register | XZR | = zener |
| DRC | = DAC refresh controller | MAX | = maximum | RK | = rack | °C | = degree Celsius (Centigrade) |
| DRVR | = driver | | | RMS | = root-mean-square | °F | = degree Fahrenheit |
| | | | | | | °K | = degree Kelvin |

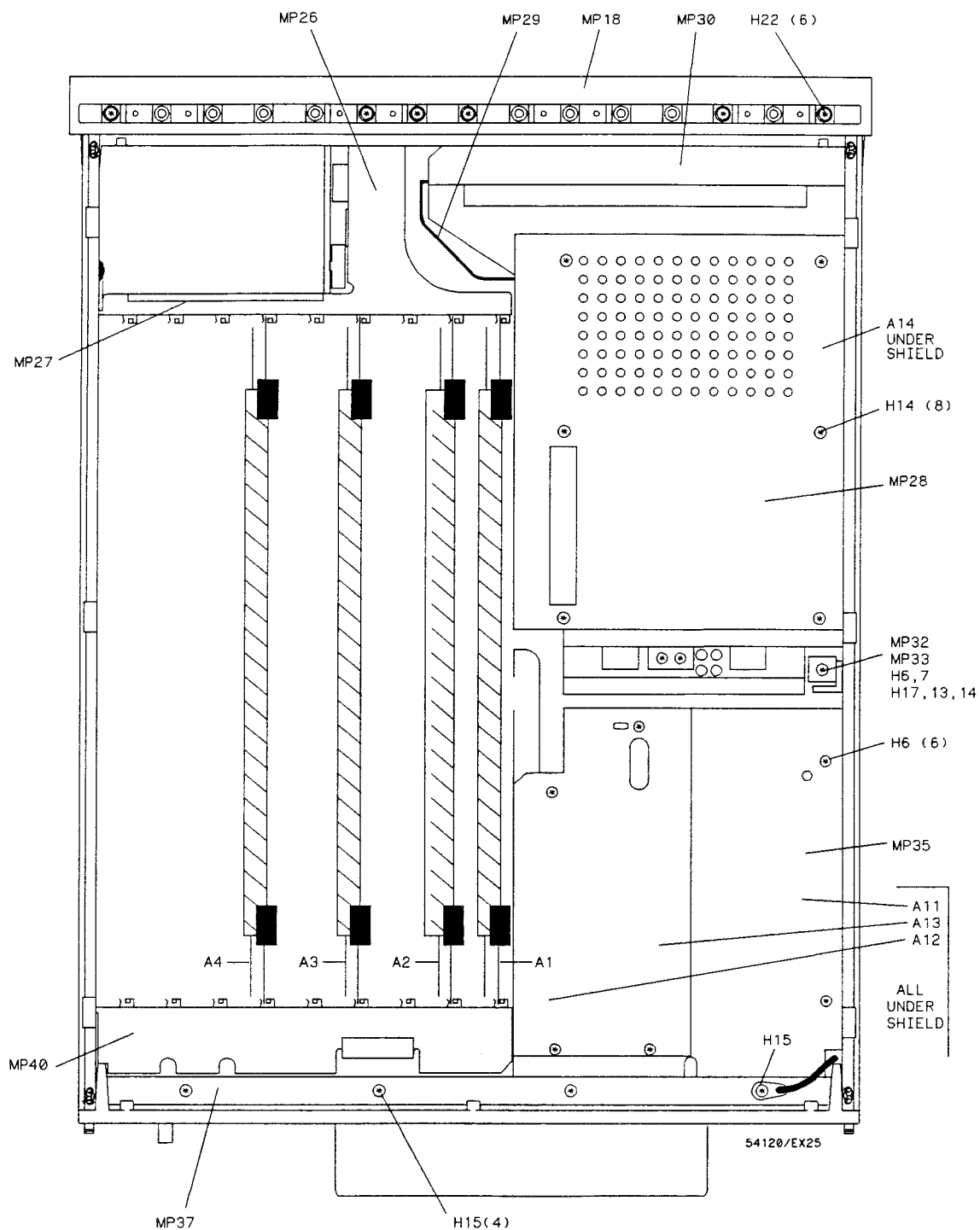


Figure 5-1. Top View

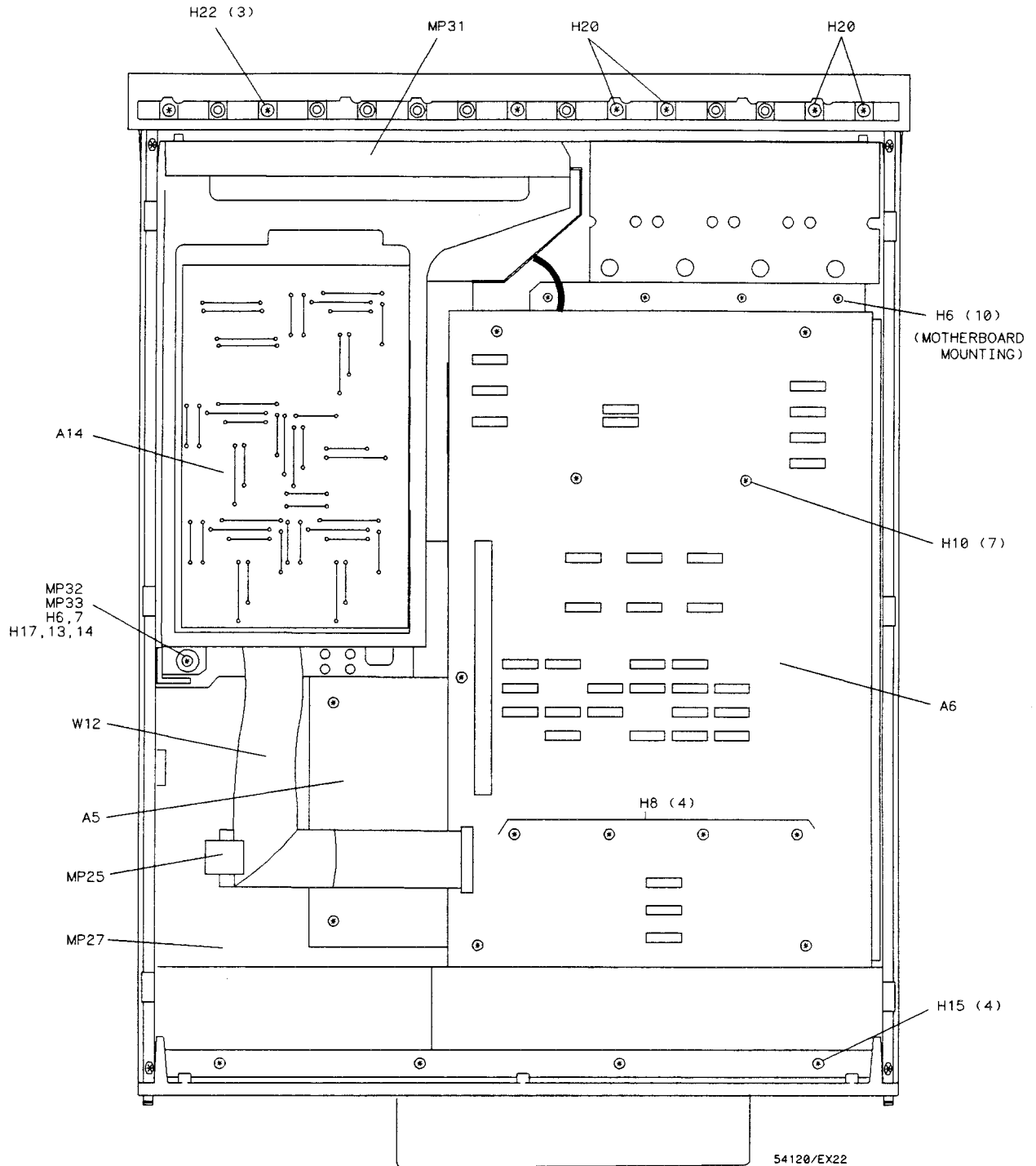


Figure 5-2. Bottom View

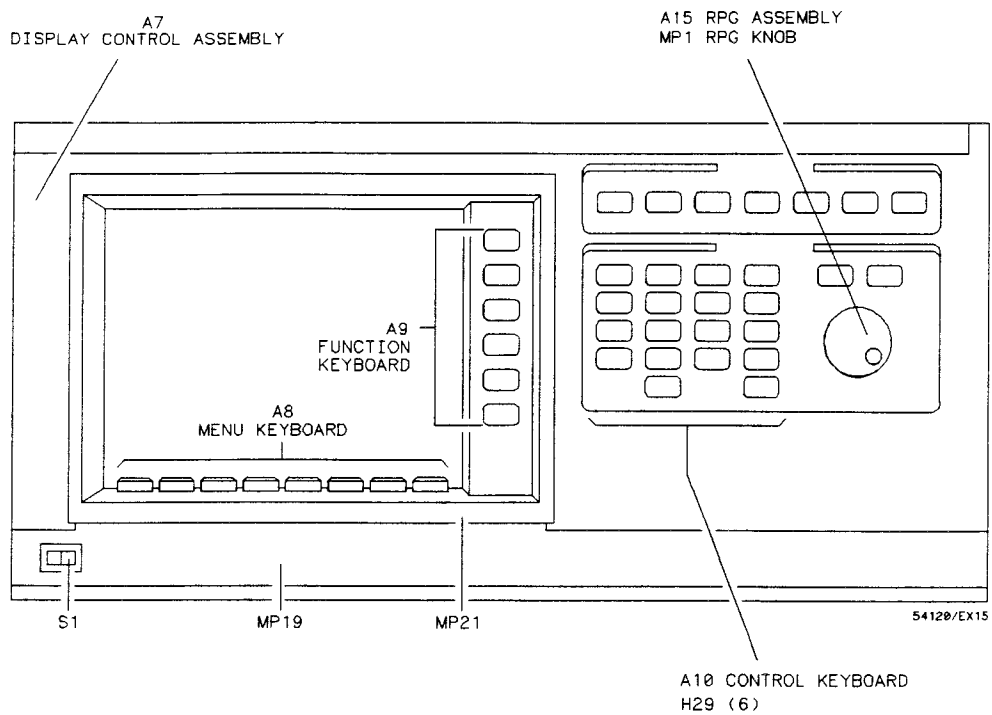


Figure 5-3. Front Panel

- H5 Cover screw
- H8 Retainer ring for cover screw
- H9 Foot screw

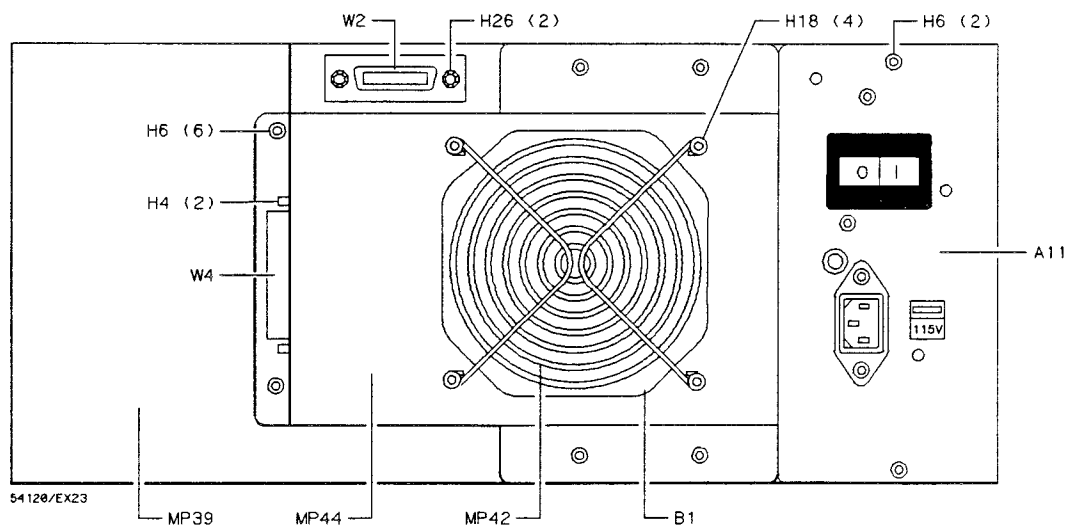


Figure 5-4. Rear Panel

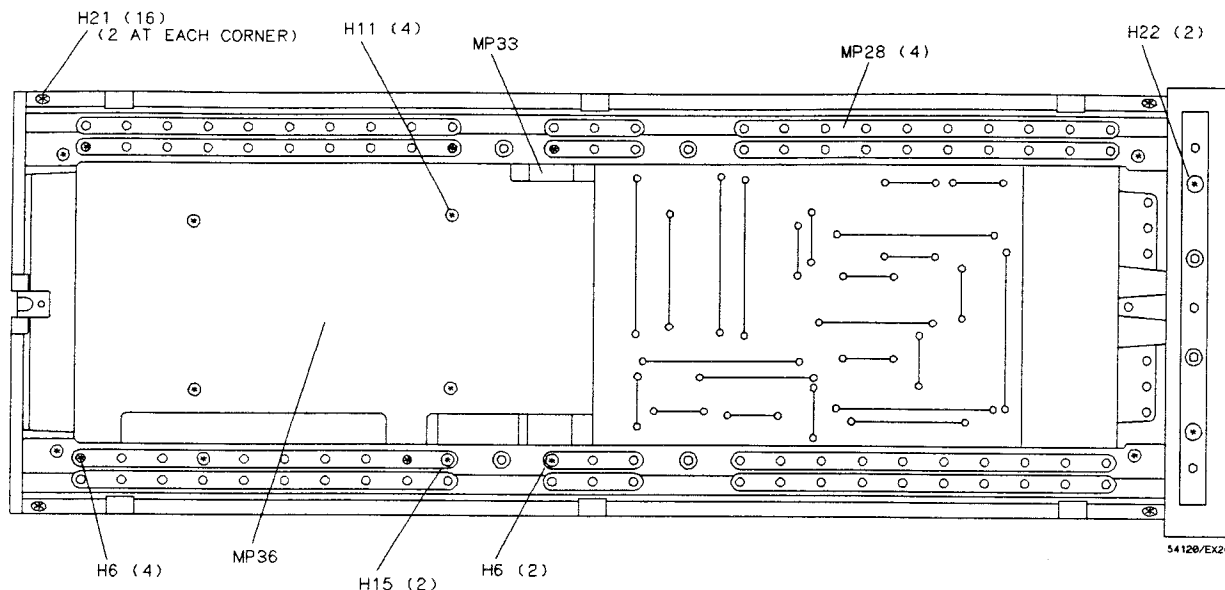


Figure 5-5. Left Side View

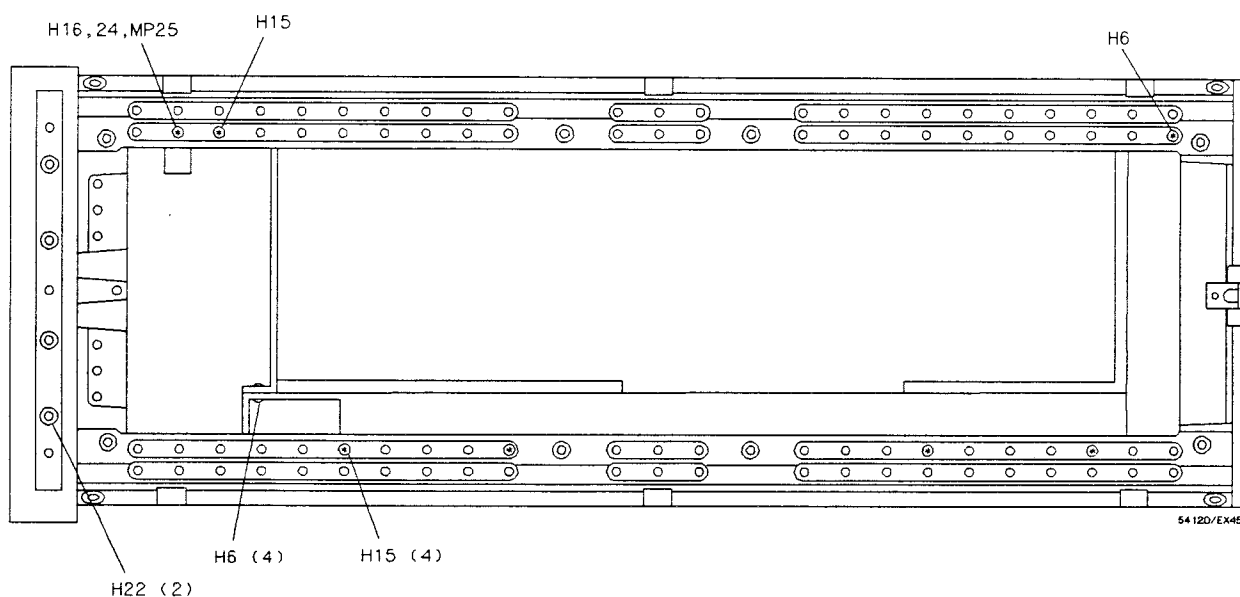


Figure 5-6. Right Side View

Table 5-3. Replaceable Parts List

| Reference Designator | HP Part Number | CD | Qty | Description | Mfr Code | Mfr Part Number |
|----------------------|----------------|----|-----|---|----------|-----------------|
| *EXCHANGE ASSEMBLIES | | | | | | |
| *A1 | 54111-69506 | 8 | 0 | I/O ASSEMBLY | 28480 | 54111-69506 |
| *A2 | 54111-69525 | 1 | 0 | MICROPROCESSOR ASSEMBLY | 28480 | 54111-69525 |
| *A3 | 54122-69501 | 6 | 0 | HORIZONTAL CONTROL ASSEMBLY | 28480 | 54122-69501 |
| *A4 | 54120-69502 | 5 | 0 | ADC ASSEMBLY | 28480 | 54120-69502 |
| *A6 | 54110-69514 | 7 | 0 | COLOR DISPLAY ASSEMBLY | 28480 | 54110-69514 |
| | | | | | | |
| *A11 | 54110-69513 | 6 | 0 | PRIMARY POWER SUPPLY ASSEMBLY | 28480 | 54110-69513 |
| *A12 | 54110-69510 | 3 | 0 | ANALOG POWER SUPPLY ASSEMBLY | 28480 | 54110-69510 |
| *A13 | 54110-69506 | 7 | 0 | DIGITAL POWER SUPPLY ASSEMBLY | 28480 | 54110-69506 |
| | | | | | | |
| A1 | 54111-66506 | 2 | 1 | I/O ASSEMBLY | 28480 | 54111-66506 |
| A2 | 54111-66525 | 5 | 1 | MICROPROCESSOR ASSEMBLY | 28480 | 54111-66525 |
| A3 | 54122-66501 | 0 | 1 | HORIZONTAL CONTROL ASSEMBLY | 28480 | 54122-66501 |
| A4 | 54120-66502 | 9 | 1 | ADC ASSEMBLY | 28480 | 54120-66502 |
| A5 | 54110-66511 | 8 | 1 | MOTHER BOARD ASSEMBLY | 28480 | 54110-66511 |
| | | | | | | |
| A6 | 54110-66514 | 1 | 1 | COLOR DISPLAY ASSEMBLY | 28480 | 54110-66514 |
| A7 | 54110-66509 | 4 | 1 | CRT CONTROL ASSEMBLY | 28480 | 54110-66509 |
| A8 | 54100-66520 | 7 | 1 | MENU KEYBOARD | 28480 | 54100-66520 |
| A9 | 54110-66502 | 7 | 1 | FUNCTION KEYBOARD | 28480 | 54110-66502 |
| A10 | 54100-66505 | 8 | 1 | CONTROL KEYBOARD | 28480 | 54100-66505 |
| | | | | | | |
| A11 | 54110-66513 | 0 | 1 | PRIMARY POWER SUPPLY ASSEMBLY | 28480 | 54110-66513 |
| A12 | 54110-66510 | 7 | 1 | ANALOG POWER SUPPLY ASSEMBLY | 28480 | 54110-66510 |
| A13 | 54110-66506 | 1 | 1 | DIGITAL POWER SUPPLY ASSEMBLY | 28480 | 54110-66506 |
| A14 | 2090-0092 | 3 | 1 | COLOR CRT MODULE | 28480 | 2090-0092 |
| A15 | 01980-61062 | 5 | 1 | RPG ASSEMBLY | 28480 | 01980-61062 |
| | | | | | | |
| B1 | 3160-0521 | 3 | 1 | FAN-TUBEAXIAL | 28480 | 3160-0521 |
| | | | | | | |
| E1 | 8160-0577 | 4 | 1 | RFI GROUND STRIP | 28480 | 8160-0577 |
| | | | | | | |
| H1 | 0515-1384 | 8 | 2 | SCREW-MACH M5 X 0.8 10MM-LG | 28480 | 0515-1384 |
| H2 | 0515-1444 | 1 | 4 | SCREW-MACH M3.5 X 0.6 25.4MM-LG PAN-HD | 28480 | 0515-1444 |
| H3 | 0515-1319 | 9 | 8 | SCREW-MACH M3 X 0.5 20MM-LG PAN-HD | 28480 | 0515-1319 |
| H4 | 1251-2942 | 7 | 2 | SCREW LOCK KIT-SUBMIN D CONN | 28480 | 1251-2942 |
| H5 | 1251-1245 | 7 | 3 | COVER SCREW | 28480 | 1251-2945 |
| | | | | | | |
| H6 | 0515-0372 | 2 | 49 | SCREW-MACHINE ASSEMBLY M3 X 0.5 8MM-LG | 28480 | 0515-0372 |
| H7 | NOT ASSIGNED | | | | | |
| H8 | 0515-1253 | 0 | 3 | RETAINER RING FOR COVER SCREW2 | 8480 | 0515-1253 |
| H9 | 0515-1444 | 1 | 4 | FOOT SCREW | 28480 | 0515-1444 |
| H10 | 0515-1410 | 1 | 7 | SCREW-MACHINE ASSEMBLY M3 X 0.5 20MM-LG | 28480 | 0515-1410 |
| | | | | | | |
| H11 | 0515-1025 | 4 | 4 | SCREW-MACHINE ASSEMBLY M3 X 0.5 26MM-LG | 28480 | 0515-1025 |
| H12 | 5061-6138 | 2 | 4 | NUT-INSERT M4 X 0.7 X 4.6 OD | 28480 | 5061-6138 |
| H13 | 2190-0763 | 7 | 2 | WASHER-FL MTLC NO. 6 .14-IN-ID .5-IN-OD | 28480 | 2190-0763 |
| H14 | 3050-1238 | 8 | 2 | WASHER-FL NM 9/64 .149-IN-ID .478-IN-OD | 86928 | 3050-1238 |
| H15 | 0515-0433 | 6 | 15 | SCREW-MACHINE ASSEMBLY M4 X 0.7 8MM-LG | 28480 | 0515-0433 |

Table 5-3. Replaceable Parts List

| Reference Designator | HP Part Number | CD | Qty | Description | Mfr Code | Mfr Part Number |
|----------------------|----------------|----|-----|--|----------|-----------------|
| H16 | NOT ASSIGNED | | | | | |
| H17 | 0515-0641 | 8 | 2 | SCREW-THD-RLG M4 X 0.7 10MM-LG PAN-HD | 28480 | 0515-0641 |
| H18 | 0515-0435 | 8 | 4 | SCREW-MACHINE ASSEMBLY M4 X 0.7 14MM-LG | 28480 | 0515-0435 |
| H19 | NOT ASSIGNED | | | | | |
| H20 | 0515-1228 | 9 | 4 | SCREW-MACH M4 X 0.7 6MM-LG 90-DEG-FLH-HD | 28480 | 0515-1228 |
| H21 | 0515-1403 | 2 | 16 | SCREW-SPCL M4 X 0.7 6MM-LG 90-DEG-FLH-HD | 28480 | 0515-1403 |
| H22 | 0515-1269 | 8 | 16 | SCREW-MACH M4 X 0.7 10MM-LG | 28480 | 0515-1269 |
| H23 | 0535-0031 | 2 | 9 | NUT-HEX W/LKWR M3 X 0.5 2.4MM-THK | 28480 | 0535-0031 |
| H24 | NOT ASSIGNED | | | | | |
| H25 | 2950-0043 | 8 | 1 | NUT-HEX-DBL-CHAM 3/82THD .094-IN-THK | 28480 | 2950-0043 |
| H26 | 0380-1686 | 6 | 2 | STANDOFF-HEX 6.5-MM-LG M3 X 0.5-THD | 28480 | 0380-1686 |
| H27 | 2190-0016 | 3 | 1 | WASHER-LK INTL T 3/8 IN .377-IN-ID | 28480 | 2190-0016 |
| H28 | 3050-1176 | 3 | 1 | WASHER-FL NM 3/8 IN .39-IN-ID .562-IN-OD | 86928 | 3050-1176 |
| H29 | 0515-0664 | 5 | 5 | SCREW M3 12MN-L6 PAN-HP T10 | 28480 | 0515-0664 |
| MP1 | 01650-47401 | 7 | 1 | RPG KNOB | 28480 | 01650-47401 |
| MP2 | 5061-9448 | 3 | 1 | BOTTOM COVER | 28480 | 5061-9448 |
| MP3 | 5040-7201 | 8 | 2 | BOTTOM FEET | 28480 | 5040-7201 |
| MP4 | 5040-7222 | 3 | 2 | BOTTOM NON SKID FEET | 28480 | 5040-7222 |
| MP5 | 1460-1345 | 5 | 2 | TILT STAND SST | 28480 | 1460-1345 |
| MP6 | 8160-0590 | 1 | 2 | GROUND RFI STRIP | 28480 | 8160-0590 |
| MP7 | 54110-04103 | 4 | 1 | TOP COVER | 28480 | 54110-04103 |
| MP8 | 0890-0029 | 0 | 1 | TUBING-HS .187-IN-D/.093-IN-RCVD | 28480 | 0890-0029 |
| MP9 | 5001-0441 | 2 | 2 | TRIM STRIP SIDE | 28480 | 5001-0441 |
| MP10 | 5040-7202 | 9 | 1 | TOP TRIM STRIP | 28480 | 5040-7202 |
| MP11 | 54110-40502 | 3 | 4 | REAR FOOT | 28480 | 54110-40502 |
| MP12 | 5060-9948 | 6 | 1 | LEFT SIDE COVER-PERFORATED | 28480 | 5060-9948 |
| MP13 | 5061-9523 | 5 | 1 | RIGHT SIDE COVER-PERFORATED | 28480 | 5061-9523 |
| MP14 | 5060-9805 | 4 | 1 | STRAP HANDLE | 28480 | 5060-9805 |
| MP15 | 5041-6819 | 4 | 1 | FRONT CAP FOR STRAP HANDLE | 28480 | 5041-6819 |
| MP16 | 5041-6820 | 7 | 1 | REAR CAP FOR STRAP HANDLE | 28480 | 5041-6820 |
| MP17 | NOT ASSIGNED | | | | | |
| MP18 | 5021-5807 | 6 | 1 | FRONT FRAME | 28480 | 5021-5807 |
| MP19 | 54120-00206 | 2 | 1 | FRONT PANEL | 28480 | 54120-00206 |
| MP20 | 54111-00203 | 8 | 1 | FRONT SUB PANEL | 28480 | 54111-00203 |
| MP21 | 54110-40501 | 2 | 1 | DISPLAY BEZEL | 28480 | 54110-40501 |
| MP22 | 16500-00603 | 3 | 1 | FAN SCREEN | 28480 | 16500-00603 |
| MP23 | 0403-0092 | 6 | 1 | BUMPER FOOT-PRS-IN | 28480 | 0403-0092 |
| MP24 | 1400-1362 | 0 | 2 | CLAMP-CABLE .35-DIA .51-WD NYL | 28480 | 1400-1362 |
| MP25 | 1400-0611 | 0 | 2 | CLAMP-FL-CA 1-WD | 06915 | 1400-0611 |
| MP26 | 54111-01203 | 0 | 1 | FRONT CARD CAGE BRACKET | 28480 | 54111-01203 |
| MP27 | 54111-00101 | 5 | 1 | MAIN DECK | 28480 | 54111-00101 |
| MP28 | 5021-5838 | 3 | 4 | SIDE STRUT | 28480 | 5021-5838 |
| MP29 | NOT ASSIGNED | | | | | |
| MP30 | 54110-01201 | 7 | 1 | TOP CRT BRACKET | 28480 | 54110-01201 |

Table 5-3. Replaceable Parts List

| Reference Designator | HP Part Number | CD | Qty | Description | Mfr Code | Mfr Part Number |
|----------------------|----------------|----|-----|--|----------|-----------------|
| MP31 | 54110-01202 | 8 | 1 | BOTTOM CRT BRACKET | 28480 | 54110-01202 |
| MP32 | 54110-01210 | 8 | 1 | BRACKET-COLOR CRT MOD. REAR-ON MODULE | 28480 | 54110-01210 |
| MP33 | 54110-04702 | 9 | 1 | BRACKET-COLOR CRT MOD. REAR-ON FRAME | 28480 | 54110-04702 |
| MP34 | 1400-0679 | 0 | 4 | CLIP-CABLE 'U' SHP, PNL MTG TYPE | 28480 | 1400-0679 |
| MP35 | 54111-04104 | 6 | 1 | POWER SUPPLY COVER-TOP | 28480 | 54111-04104 |
| MP36 | 54110-04106 | 7 | 1 | POWER SUPPLY COVER-SIDE | 28480 | 54110-04106 |
| MP37 | 5021-5808 | 7 | 1 | REAR FRAME | 28480 | 5021-5808 |
| MP38 | 54110-94302 | 4 | 1 | WARNING LABEL | 28480 | 54110-94302 |
| MP39 | 54120-00201 | 7 | 1 | REAR PANEL | 28480 | 54120-00201 |
| MP40 | 54111-05201 | 6 | 1 | AIR PLENUM | 28480 | 54111-05201 |
| MP41 | 7120-4835 | 0 | 1 | LABEL-INFORMATION .75-IN-WD 2-IN-LG PPR | 28480 | 7120-4835 |
| MP42 | 3160-0092 | 3 | 1 | FAN GUARD | 28480 | 3160-0092 |
| MP44 | 54120-04103 | 6 | 1 | FAN COVER | 28480 | 54120-04103 |
| MP45 | 54120-04702 | 1 | 1 | FAN SPACER | 28480 | 54120-04702 |
| S1 | 3101-2911 | 5 | 1 | ROCKER SWITCH (STANDBY) | 28480 | 3101-2911 |
| W1 | 8120-1521 | 6 | 1 | POWER CABLE | 28480 | 8120-1521 |
| W2 | 54100-61602 | 6 | 1 | HPIB CABLE | 28480 | 54100-61602 |
| W3 | 54120-61618 | 8 | 1 | UMBILICAL CABLE 2 METRE | 28480 | 54120-61618 |
| W4 | 54120-61612 | 2 | 1 | MAINFRAME CABLE ASSEMBLY | 28480 | 54120-61612 |
| W5 | 54100-61601 | 5 | 1 | RIBBONCABLE-I/O TO FRONT PANEL | 28480 | 54100-61601 |
| W6 | 54100-61612 | 8 | 2 | CABLE AC BD CO ANAL & DIG BD | 28480 | 54100-61612 |
| W7 | NOT ASSIGNED | | | | | |
| W8 | 54110-61601 | 7 | 1 | 3 WIRE CABLE - COLOR DISPLAY MODULE POWE | 28480 | 54110-61601 |
| W9 | 54111-61610 | 9 | 1 | POWER SWITCH CABLE 2 WIRE-FRONT PANEL ST | 28480 | 54110-61610 |
| W10 | 54111-61611 | 0 | 1 | 2 WIRE CABLE-REAR CABLE STBY SWITCH | 28480 | 54111-61611 |
| W11 | 54110-61611 | 9 | 1 | DISPLAY CONTROL CABLE | 28480 | 54110-61611 |
| W12 | 54110-61607 | 3 | 1 | RIBBON CABLE DISP ASSY TO COLOR MODULE | 28480 | 54110-61607 |

Table Of Contents

Disassembly

| | |
|-------------------------------------|-------|
| Introduction | 6A-1 |
| Safety Considerations | 6A-1 |
| Tools Required | 6A-1 |
| Card Cage PC Assemblies | 6A-3 |
| Primary Supply | 6A-4 |
| Analog Supply | 6A-5 |
| Digital Supply | 6A-6 |
| CRT Bezel | 6A-6 |
| Function & Menu Keyboards | 6A-7 |
| Front Panel | 6A-8 |
| Control Keyboard | 6A-9 |
| Display Control | 6A-9 |
| Color CRT Module | 6A-10 |
| Fan | 6A-13 |
| Color Display Assembly | 6A-14 |
| Motherboard | 6A-16 |

Introduction

This section contains removal and replacement procedures for HP 54120B Digitizing Oscilloscope Mainframe assemblies.

Safety Considerations

The following warnings and cautions must be followed for your protection and to avoid damage to the equipment.

Warning

This instrument is equipped with a standby switch on the front panel that **DOES NOT** de-energize the power supply. To avoid shock hazards capable of causing injury or death, the main power switch on the rear panel must be used to de-energize the instrument or the power cable must be disconnected when the instrument must be de-energized.

Warning

These procedures are used while repairing an instrument that has protective covers removed and may have had power applied. Maintenance should be performed only by trained service personnel who are aware of the hazards involved (for example, fire and electrical shock). Read the Safety Summary in the front of this manual.

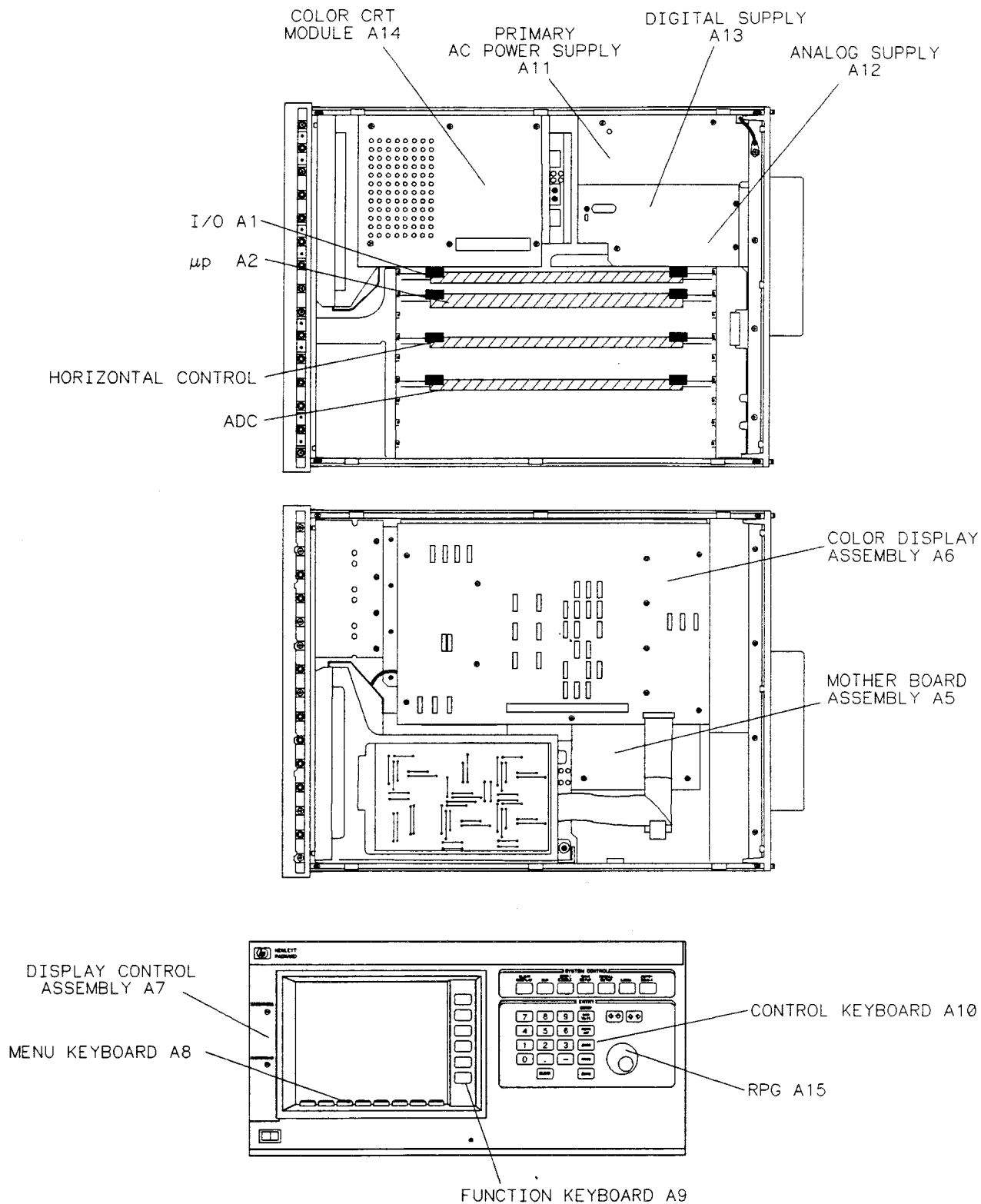
Caution

Do not remove or replace any of the circuit board assemblies in the instrument unless instrument power is removed. The boards contain components which may be damaged if the board is removed or replaced when instrument power is applied.

Tools Required

The hardware requires TORX™ type tools for removal and replacement. Sizes required for the procedures in this section are #10 and #15. A medium posi drive is used for the top cover.

If the display must be replaced, an 8 mm wrench or driver is also required.



54120/EX46

Figure 6A-1. Major Assembly Locations

Card Cage PC Assemblies

The following procedures should be followed when disassembling the instrument. Particular care should be taken when inserting the card cage assemblies into the mainframe to avoid bending the connector pins. There are only four cables connecting to the card cage assemblies. These four cables are different in size and their proper connection is easily determined.

Removal

1. Disconnect power cable.
2. Remove top rear feet and top cover.
3. Disconnect any cables from assembly to be removed.
4. Refer to the illustration on top of the power supply shield. Release PC assembly by pulling the flexible plastic extractors away from the assembly shield, then up.
5. Remove the assembly from the connector by pulling up on the extractors.

Replacement

1. Insert PC assembly shield edges in proper guides.
2. Keep the extractors up while sliding the assembly in.
3. While keeping assembly properly aligned in guides, push it in. As the top edge of the assembly becomes level with the top of the card cage the connector will start to engage. Keep assembly level and apply even pressure until connector is seated.
4. Reconnect all cables which were disconnected from any assemblies.

Caution

Do not use the extractors to lever the assembly into the connector. Using the extractors makes it too easy to apply excessive force that might bend misaligned connector pins. If the connector will not seat, remove the assembly and check for bent pins. Bent pins are very expensive and time consuming to replace on the motherboard SIB connector. Avoid pinching cables between the assembly and the mainframe.

Primary Supply

Removal

1. Disconnect power cable.
2. Remove rear feet from top right corner and left side.
3. Remove top and left side covers.

Caution

Hazardous voltages capable of causing injury or death are present when the power supply shields are removed and AC power is applied to the instrument. To avoid this hazard make sure the AC power cable is disconnected before continuing with this procedure.

4. Through the hole in the top power supply shield, observe the red LED on the primary power supply. This LED indicates the presence of 300 volts. It will stay illuminated until the filter capacitors discharge. Wait until this LED is no longer illuminated before proceeding (approximately three minutes).
5. Remove top power supply shield (six screws).
6. Remove the screw that attaches the ground wire (green/yellow) to top corner of rear frame.
7. Remove the three cables at the top front of the primary power supply PC assembly.
8. Remove four screws from power supply side cover. Refer to figure 6A-2.
9. Remove two screws which attach power supply assembly to rear panel. Refer to figure 6A-2.

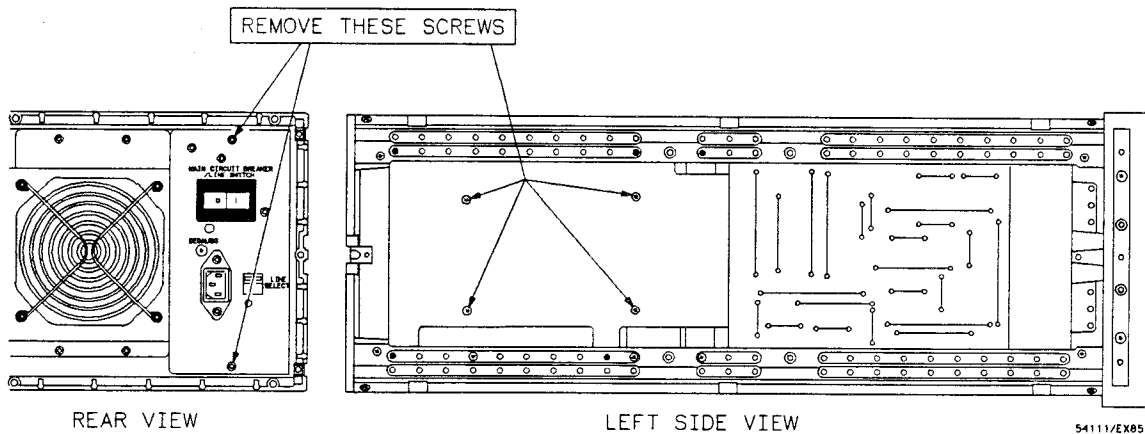


Figure 6A-2. Primary Power Supply Mounting Screws

10. Turn instrument onto its left side. Pull the power supply assembly rearward until the STBY switch cable at the rear of power supply assembly can be disconnected. Disconnect the cable.

11. Pull supply rearward until it clears the instrument.

Replacement

1. Reverse removal procedure to install supply.



Power supply safety grounding will be defeated if ground wire removed in step 6 above is not reconnected. To avoid a defeated ground, make sure the green/yellow wire is re-attached to top rear corner of the rear frame.

Analog Supply

Removal

1. Disconnect power cable.

2. Remove top rear feet and top cover.



Hazardous voltages capable of causing injury or death are present when the power supply shields are removed and AC power is applied to the instrument. To avoid this hazard make sure the AC power cable is disconnected before continuing with this procedure.

3. Through the hole in the top power supply shield, observe the red LED on the primary power supply. This LED indicates the presence of 300 volts. It will stay illuminated until the filter capacitors discharge. Wait until this LED is no longer illuminated before proceeding (approximately three minutes).

4. Remove top power supply shield (six screws).

5. Disconnect the analog power supply input cable from the top front corner of the primary power supply.

6. Use a flat-blade screwdriver to loosen the captive screw at the bottom front of the supply.

7. It may be easier to remove the analog supply by first removing the I/O assembly from the mainframe. However, this will cause a loss of all front panel calcs, any stored front panel setups, and all stored waveforms.

8. Release power supply board connector by pulling board straight up and off the guide posts.

Replacement

1. Reverse the removal procedure to install assembly.

Digital Supply

Removal

1. Disconnect power cable.
2. Remove top rear feet and top cover.

Warning

Hazardous voltages capable of causing injury or death are present when the power supply shields are removed and AC power is applied to the instrument. To avoid this hazard make sure the AC power cable is disconnected before continuing with this procedure.

3. Through the hole in the top power supply shield, observe the red LED on the primary power supply. This LED indicates the presence of 300 volts. It will stay illuminated until the filter capacitors discharge. Wait until this LED is no longer illuminated before proceeding (approximately three minutes)
4. Remove top power supply shield (six screws).
5. Disconnect the Digital Power Supply input cable from the top front corner of the Primary Power Supply.
6. Use a flat-blade screwdriver to loosen the captive screw at the front bottom of the supply.
7. Release power supply board connector by pulling board straight up and off guide posts.
8. Remove the supply from instrument by lifting front edge of board first then rotating board up and out.

Replacement

1. Reverse removal procedure to install board.

CRT Bezel

The keyboards at the side and bottom of the CRT can be removed by first removing the CRT bezel.

Removal

1. While pushing down on top edge of bezel Refer to figure 6A-3, pull top edge away from front panel until holding tabs are clear of the front panel.
2. Lift bezel slightly and pull bottom of bezel away from front panel.
3. Pull bezel away from front panel just far enough to gain access to the ribbon cable connectors on control keyboard. They are just to the right of the bezel opening in the front panel.
4. Disconnect the two ribbon cable connectors from the control keyboard.

Function & Menu Keyboards

5. If either the function or menu keyboard needs replaced, they are each attached to the bezel with two screws.

Replacement

1. Reverse the removal procedure to install bezel.

Note

The ribbon cables must be reconnected as follows: function keyboard cable (right side of bezel) to top connector on control keyboard and menu keyboard cable (bottom of bezel) to bottom connector on control keyboard.

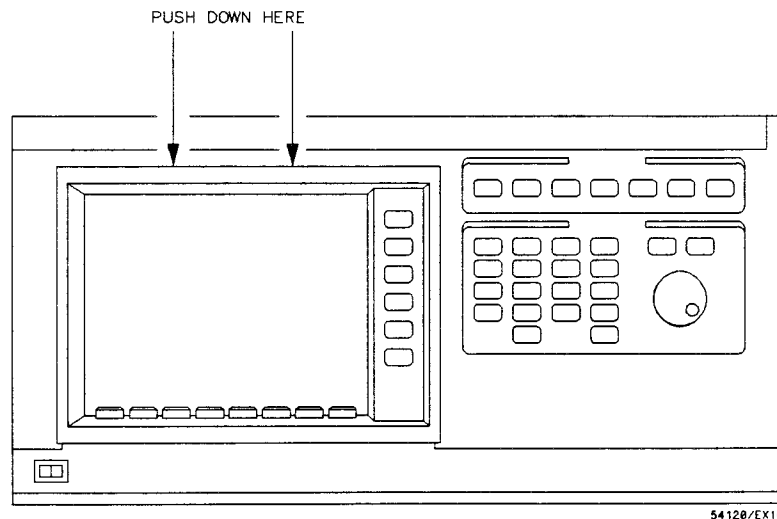


Figure 6A-3. CRT Bezel Removal Pressure Locations

Front Panel

Use steps 1 through 10 to remove front panel, steps 1 through 11 to remove display control, and steps 1 through 10 and steps 12 and 13 to remove control keyboard.



It is not necessary to remove the front panel to remove the keyboards around the CRT bezel. See the previous removal procedure.

Removal

1. Disconnect power cable.
2. Remove rear feet and top, bottom, and side covers.
3. Remove top, and side trim strips from the front frame by carefully prying up at the strip's ends with a flat blade screwdriver.
4. Remove two front panel screws that are under each side trim strip.
5. Remove six front panel screws as shown in figure 6A-4.

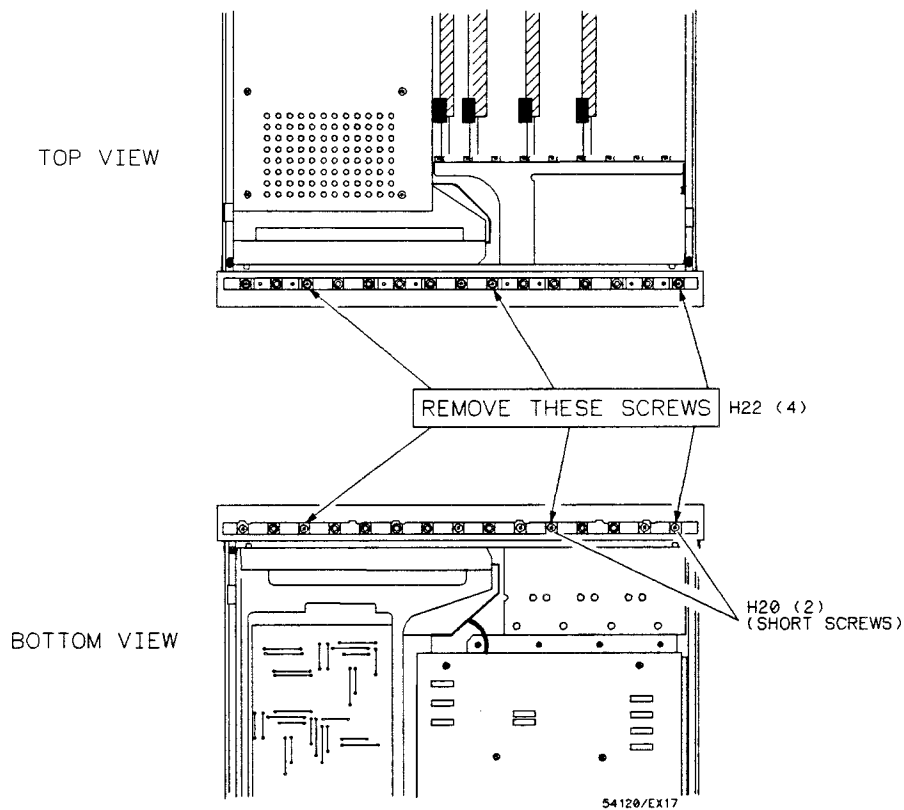


Figure 6A-4. Front Panel Mounting Screws

6. Set instrument in its normal operating position.
7. Disconnect the STBY switch by separating the two-wire interconnect just to the right of the CRT.
8. Pull front panel just far enough to gain access to the cable connector on the CRT control board (left side of front panel) and disconnect the cable.
9. Open the two cable ties: top left, inside front panel and top right of CRT, and remove the cables.
10. Disconnect the large ribbon cable from the control keyboard and remove the front panel from the instrument.

Display Control

11. Remove two screws attaching the display control assembly.

Control Keyboard

12. Disconnect the RPG cable at the control keyboard and the two cables from the CRT bezel keyboards.

Note

The menu keyboard (right side of bezel) cable connects to the top connector and the function keyboard (bottom of bezel) cable connects to the bottom connector on the control keyboard.

13. Remove five screws to remove the board.

14. Pass RPG cable through hole in control keyboard.

Replacement

1. Reverse the procedure to replace any of these assemblies.

Color CRT Module Removal

The color CRT module is replaceable only as a complete unit.

1. Remove front panel. Refer to front panel removal paragraph.
2. Disconnect the flat wide ribbon cable from the color display assembly and remove cable from clip.
3. Remove four screws that attach the color display module to the front frame. Refer to figure 6A-5.
4. Remove two screws attaching side of module to left side corner struts. Refer to figure 6A-5.
5. Slowly pull module forward until the power cable (small three-wire) can be disconnected at the primary power supply board.
6. Continue pulling module forward until it clears the instrument.

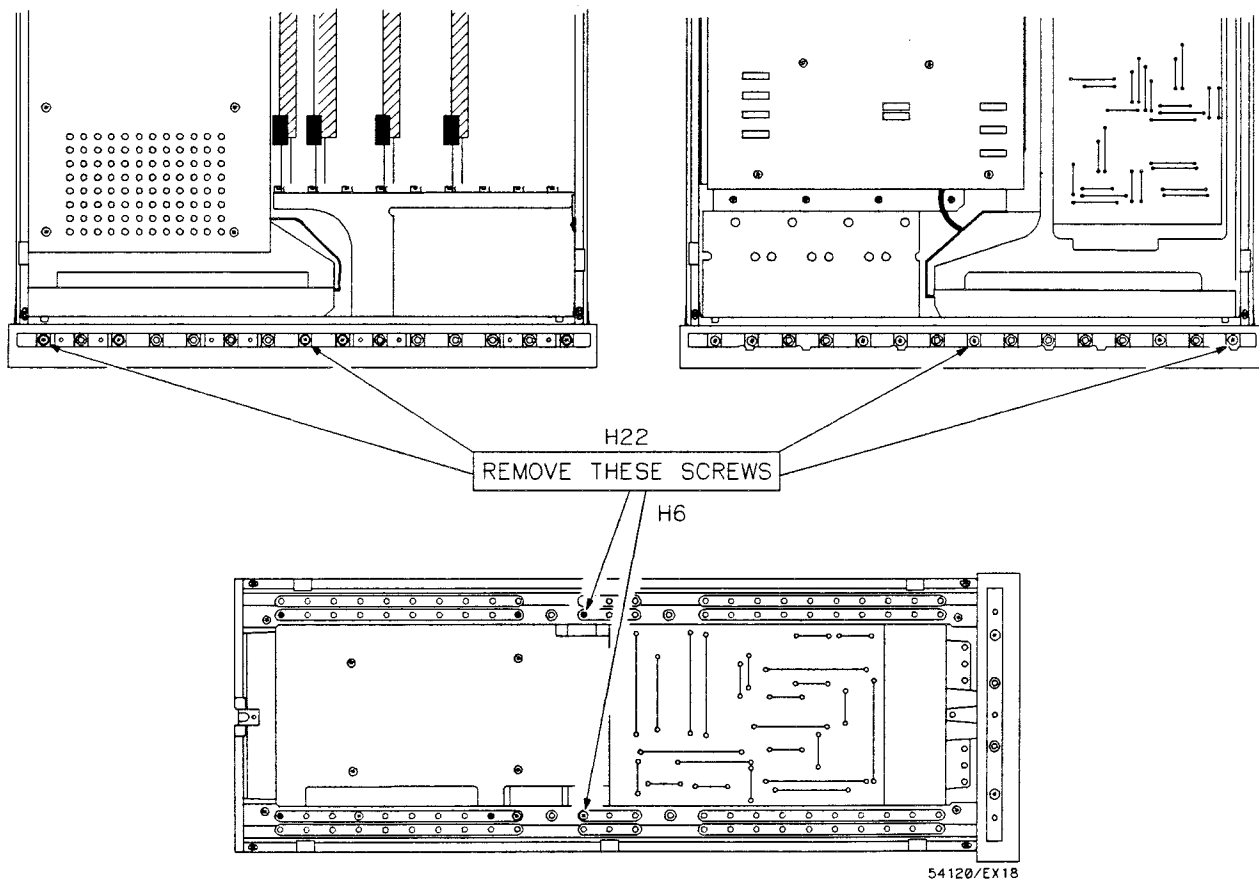


Figure 6A-5. Color CRT Module Mounting Screws

Replacement

It is necessary to use the following procedure to remove several items from the inoperative color CRT module and install them on the new one. These parts are not included with a new color monitor module.

Transfer Parts To New Module

1. Remove the eight small screws that hold the shield to the top and side of the inoperative module.



These screws are special self-tapping screws, different from the screws in the rest of the instrument. They must be used for mounting the shield on the new module. Do not use them for any other purpose.

2. Use an 8 mm wrench to remove the four nuts on the front of the inoperative module and remove the shield.
3. Remove the front mounting brackets and put the 8 mm nuts back on the module.
4. Remove the 8 mm nuts from the new module, do not remove any other hardware, and install the front mounting brackets.
5. Install the shield on the new module. Place it over the two front mounting screws and front mounting brackets.
6. Install the four 8 mm nuts but leave them loose so the shield can move.
7. Use the special self-tapping screws (step 1) to fasten the top and side of the shield. They will be hard to start while they are tapping the holes. Be careful that excessive tightening does not strip the self-tapped holes.
8. Tighten the 8 mm nuts at the front of the module.
9. The rear bracket is two brackets connected together by shock mounting hardware. Remove the two screws that hold the bracket assembly to the rear of the inoperative module.



These screws are special self-tapping screws that must be used for mounting the bracket assembly on the new display. Do not use them for any other purpose.

10. Mount the rear bracket assembly on the new module. The screws will be hard to start because they must self-tap the mounting holes. Be careful that excessive tightening does not strip the self-tapped holes.
11. Note the routing of the power cable and CRT control cable and one at a time, remove them and install them on the new module.

12. Remove the wide flat ribbon cable from the old module and install it on the new one.

Install New Module

13. Install the new module most of the way into the instrument. Avoid pinching cables as module is being installed.
14. Connect the power cable to the appropriate connector at the top front corner of the primary power supply and slide module the rest of the way in.
15. Install, but do not tighten, the two rear and four front mounting screws. Refer to figure 6A-5.
16. Install the front panel. Use the steps given in the front panel procedure except for steps 3, 2, and 1.
17. Push the module forward, closing as much as possible the gap between the CRT and the bezel. Tighten the two rear and four front mounting screws.
18. Complete the rest of the instrument assembly by doing steps 3, 2, and 1 of the front panel procedure.

Fan

Removal

1. Disconnect power cable.
2. Remove bottom rear feet and bottom cover.
3. Disconnect fan power cable from rear corner of motherboard.
4. Remove fan housing mounting screws as shown in in the figure 6A-6.
5. While noting fan cable routing, carefully remove fan housing from instrument.

Replacement

1. Reverse removal procedure to install fan. Be sure fan power cable does not get pinched between fan and rear panel.

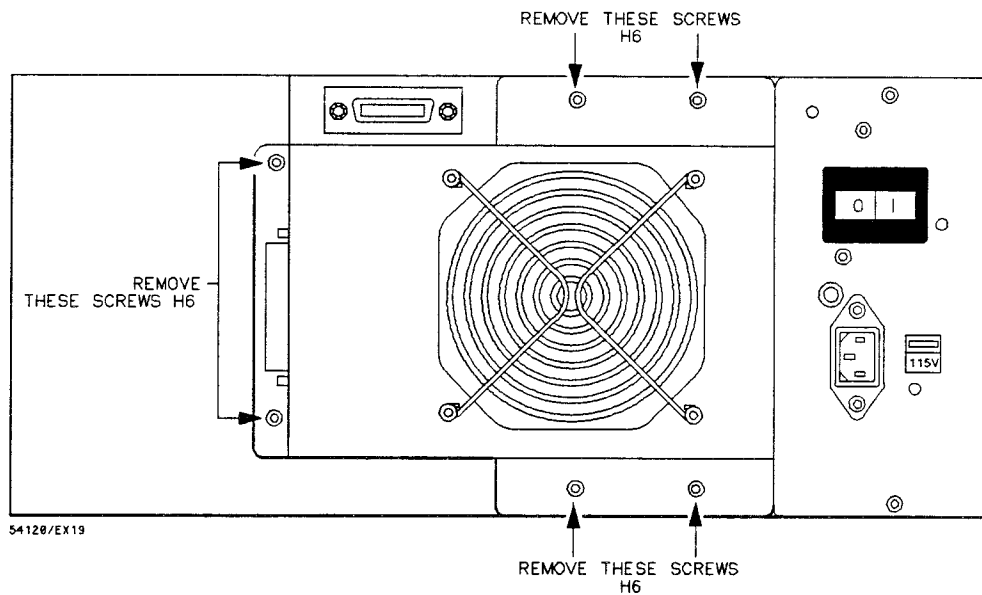


Figure 6A-6. Fan Housing Mounting Screws

Color Display Assembly

Removal

1. Disconnect power cable.
2. Remove bottom rear feet and bottom cover.
3. Disconnect wide ribbon cable from color display assembly.
4. Refer to figure 6A-7 to remove eleven assembly mounting screws.
5. Carefully lift board straight up to disengage motherboard connector.

Note

The display assembly to motherboard connector will exhibit some removal resistance while the board is being removed. It is recommended the major lifting force be exerted on the edge of the color display assembly at the connector.

6. Note the "comb" type connector used between the color display assembly and motherboard. It consists of two separate combs held in place on the color display assembly by a connector guide and two screws. If the assembly is being replaced, this connector guide and the two comb connectors must be removed from the old assembly and installed on the new one. The connector DOES NOT come with the new assembly.

Replacement

1. Install the comb connectors and connector guide on color display Assembly.
2. Reverse removal procedure to install assembly. Use additional care when inserting the connector pins into connector on motherboard.

Note

Power for the color display assembly is obtained from the motherboard by the four short mounting screws. Their positions are marked +5 and GD on the board. These mounting screws must be installed and tightened before proper operation of the instrument can be expected.

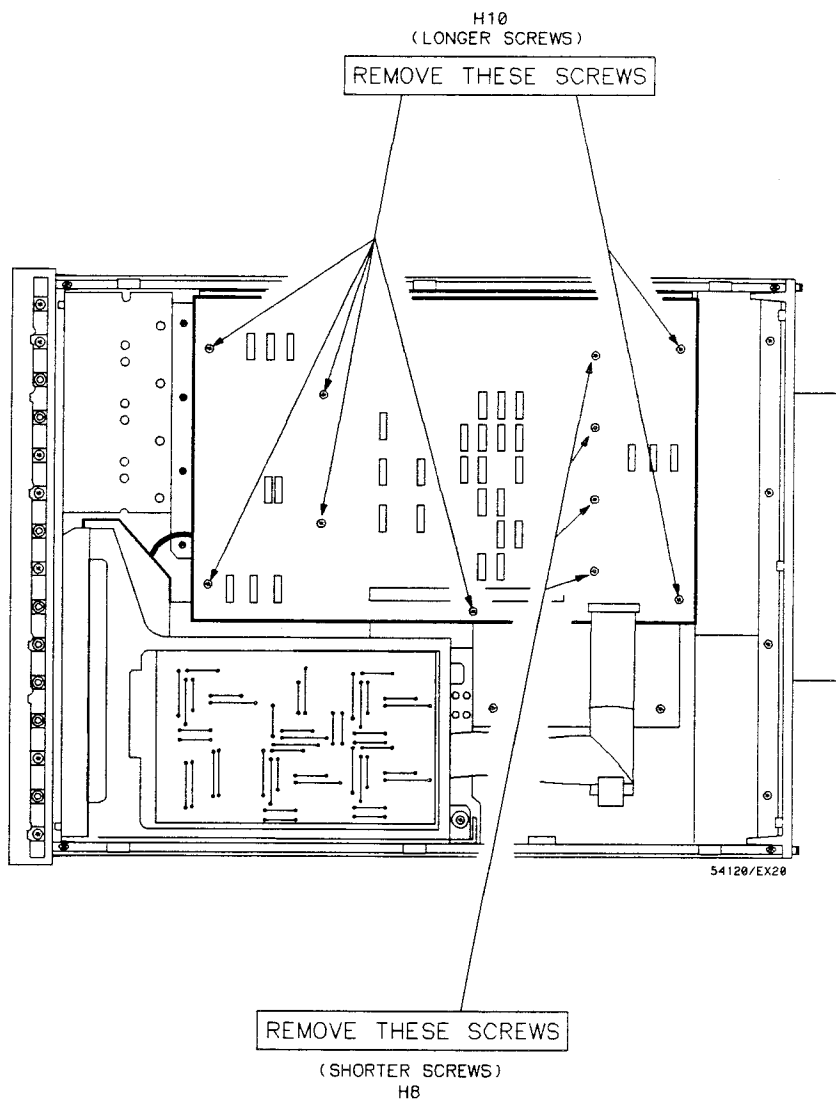


Figure 6A-7. Color Display Assembly Mounting Screws

Motherboard

Removal

1. Disconnect power cable.
2. Remove rear feet and all covers.
3. Remove all card cage PC boards. Refer to card cage assembly removal paragraph.
4. Remove analog power supply and digital power supply. Refer to digital power supply removal paragraph.
5. Remove color display assembly. Refer to color display assembly removal paragraph.
6. Disconnect fan power cable connector from rear corner of motherboard.
7. Loosen the STBY switch cable by removing the two nylon cable clamps from bottom of motherboard. Squeeze the clamps and pull them from the holes in the board.
8. Remove the remaining mounting screws and remove board. Refer to figure 6A-8.

Replacement

1. Reverse removal procedure to install board.

Note

The motherboard and display board share some of the same mounting screws. Therefore, when installing the motherboard install only the screws removed in step 8 above. Refer to figure 6A-8.

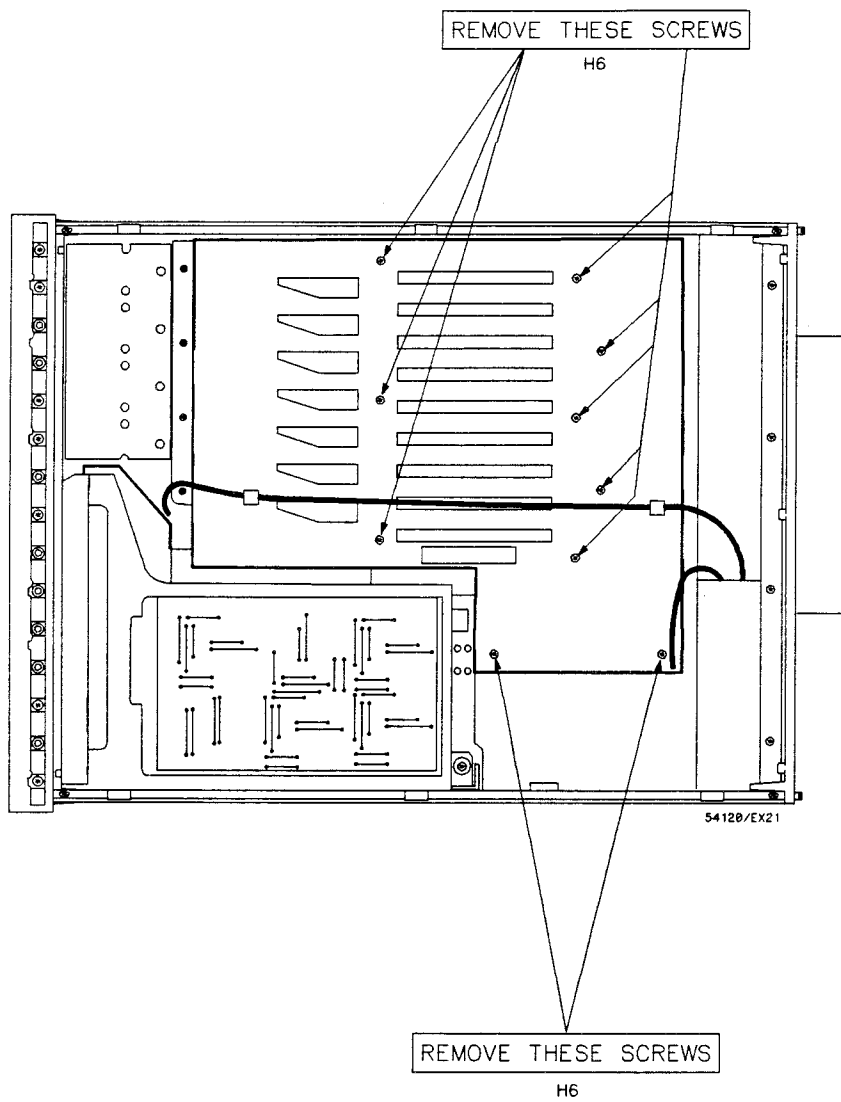


Figure 6A-8. Motherboard Mounting Screws

Table Of Contents

Theory

| | |
|---------------------------------------|-------|
| Introduction | 6B-1 |
| System Theory | 6B-1 |
| Acquisition Cycle | 6B-4 |
| Varriable Persistence | 6B-6 |
| Average Mode | 6B-6 |
| ADC Assembly | 6B-6 |
| Horizontal Control Assembly | 6B-9 |
| I/O Assembly | 6B-12 |
| Microprocessor Assembly | 6B-15 |
| Color Display Assembly | 6B-18 |
| Power Supply Assemblies | 6B-21 |
| Primary Supply | 6B-21 |
| Digital Supply | 6B-21 |
| Analog Supply | 6B-21 |

Introduction

This section is the theory of operation for the HP 54120B Digitizing Oscilloscope Mainframe. It includes overall system block diagrams and system theory of operation, printed circuit assembly (PCA) block diagrams and PCA block level theory of operation.

System Theory

This theory of operation refers to the System Block Diagram, figure 6B-1. It includes the mainframe and four channel test set, and is presented in block diagram format with a brief description of each block's basic functions. The theory's purpose is to help give a basic understanding of the instrument's overall operation as an aid in troubleshooting to the board level.

Motherboard

Each of the four card cage assemblies (A1 through A4) plug into the motherboard (A5). The 9 motherboard connectors each have a hard-wired identification code (0 through 8). Each plug-in assembly has a built-in identification code. Therefore, any assembly can be placed in any motherboard connector and the microprocessor (CPU) can identify what type of assembly is in each slot. This information can be displayed on the HP 54120B CRT by pressing **Utility** menu, then **Test** menu, then **Display Configuration**. Note that the microprocessor's position is displayed as an empty slot. The factory configuration is the preferred assembly locations. For troubleshooting purposes, any assembly may be temporarily placed in any location. However, some cables may be too short to reach all motherboard locations.

Power Supplies

There are three power supply assemblies within the HP 54120B mainframe system. The primary power supply (A11) receives its input from the power line on the rear panel. The rear panel contains an EMI (electromagnetic interference) circuit and the main circuit breaker. The primary power supply contains voltage regulation to output 300 volts used by the analog supply (A13) and digital supply (A12), and 120 volts used by the color CRT module A14. The analog power supply regulates the 300 volt input, and supplies ± 18 volts and ± 8 volts for the instrument's analog circuits. The digital power supply regulates the 300 volts to supply ± 5 volts for the instrument's digital circuits. Both of these power supplies have their own ground systems which are isolated from each other. Therefore, voltage measurements must be made to the proper common points.

Front Panel Interface

The front panel contains system control keys, softkeys, a keypad, and a knob. All these devices are on or wired through the control keyboard (A10). All information from the control keyboard is input to the I/O assembly through a large ribbon cable connected near the front of the I/O assembly. The keypad and softkeys are set up in a matrix so that the I/O assembly can scan the lines of keys by outputting a pulse on each line. If a key is closed (pressed), the I/O assembly will detect the return of the pulse on another line. By knowing which line the pulse was output on and which line the pulse was returned on, the I/O assembly can determine which key was pressed. These key scan lines are passed through the large ribbon cable from the I/O assembly.

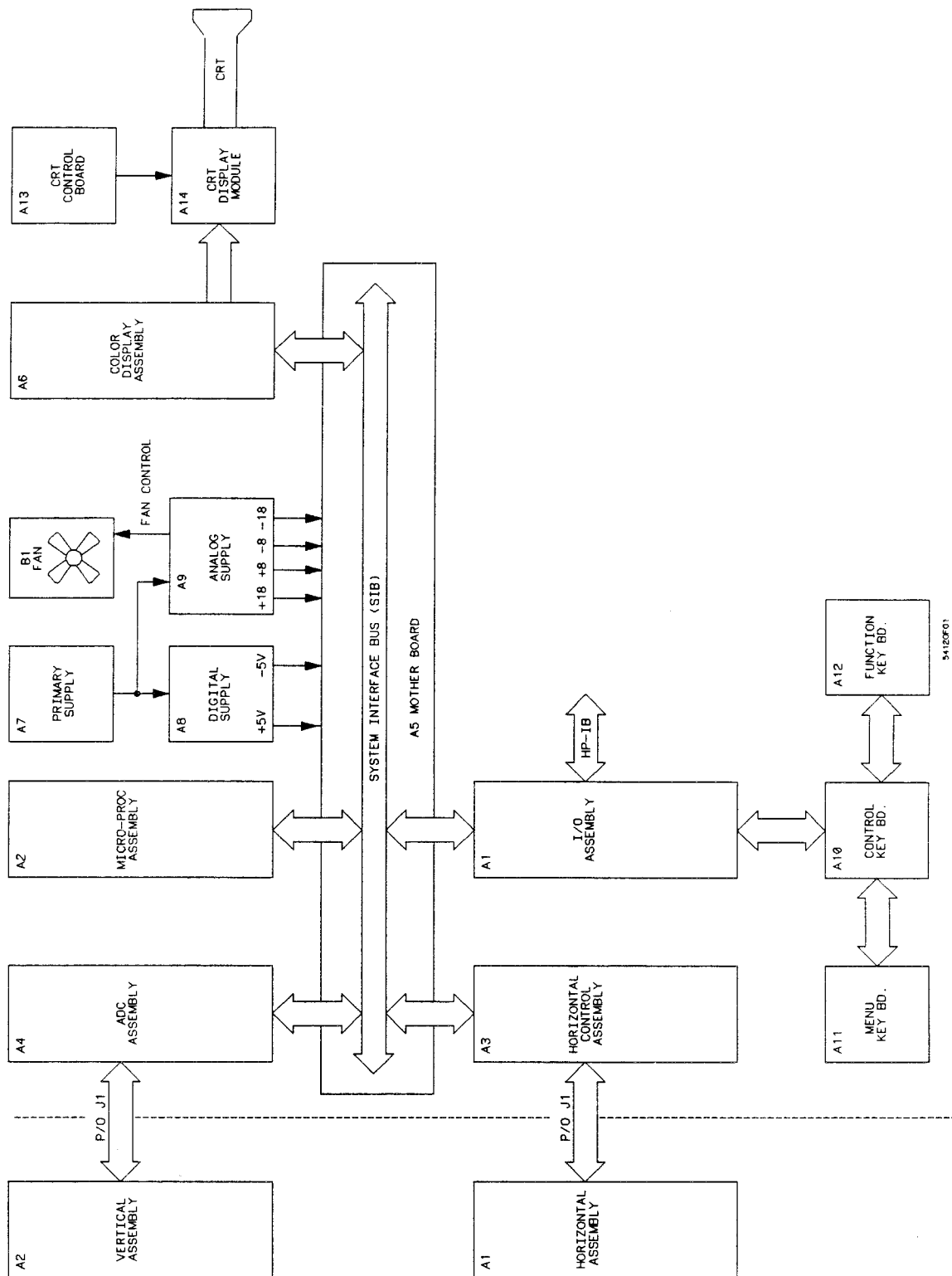


Figure 6B-1. System Block Diagram

| | |
|--------------------------------------|---|
| Display System | The color CRT module receives horizontal and vertical sync pulses, and character and graphics data from the color display assembly (A6). These signals are connected to the color CRT module through a ribbon cable from the side of the color display assembly. The color CRT module creates the sweep signals, blanking, and voltages required to display information on the CRT. |
| HP-IB System | The HP-IB connector on the rear panel of the instrument is connected by a ribbon cable to the top rear of the I/O assembly. The I/O assembly contains an HP-IB interface integrated circuit to convert data to proper HP-IB format |
| System Interface Bus | All digital data is moved between the HP 54120B mainframe assemblies over the system interface bus (SIB). The SIB has data, address, and control lines all under the CPU's control. Many of the assemblies have a local data bus (LDB) which is under the assembly's own control. The SIB and the local data buses must not be confused. In most cases data and addresses are accepted by an assembly from the SIB under CPU control, then the data is manipulated by that assembly on its local data bus. |
| Microprocessor (CPU) Assembly | The microprocessor assembly has a 68000 microprocessor, 384k bytes of ROM, 32k bytes of non-volatile RAM (battery back-up), programmable timer, and bus request/bus grant circuits. The assembly has an internal data bus, so it can process data without tying up the System Interface Bus. Data is moved on the SIB under control of the 68000 microprocessor. The assembly also has logic circuits so it can operate with another microprocessor on the SIB, in which case the bus request/bus grant circuits would be used. In the HP 54120B only one microprocessor is used, therefore the bus request/bus grant signals are tied to the proper logic levels so the 68000 microprocessor will have control of the SIB when required. |
| Display Assembly | The display assembly has 128k bytes of dynamic RAM (DRAM) used as the dot memory to store signal data to be displayed. It also has a character generator and character refresh circuits for the characters that will be displayed. The assembly produces vertical and horizontal sync signals so signal and character data are displayed on the CRT at the proper place and time. |
| I/O Assembly | The I/O assembly has interface circuits to read the front panel devices, including softkeys, knob, system control keys, and keypad. The assembly also has HP-IB interface logic, clock circuit which produces the required microprocessor clocks, power on reset circuit which resets the microprocessor, additional CPU dynamic RAM memory, other logic which starts up the CPU to a known condition, and a battery which powers the non-volatile RAM on the CPU assembly. |
| Horizontal Control Assembly | A user inputs various timebase and trigger selections to the HP 54120B. The CPU communicates these selections and acquisition control signals to the horizontal control assembly over the SIB. The horizontal control assembly translates these CPU instructions into various trigger and timebase signals for the horizontal and vertical assemblies located in the four channel test set. These signals control the sampling and data acquisition process. An acquisition cycle is defined as the sequence of events that must occur in order to acquire a single data point per enabled channel. It will normally be the case that several acquisition cycles will be required to adequately display a waveform. |

| | |
|--|--|
| Horizontal Assembly (located in test set) | The horizontal assembly has the trigger and timebase hybrids. After a trigger occurs and delay has reached terminal count, the horizontal assembly enables the sample pulse generator. The sample pulse generator momentarily turns the samplers on. Block diagram and theory is in the test set manual. |
| Vertical Assembly (located in test set) | The vertical assembly momentarily samples incoming signals during a very narrow time window, 17 ps. It then amplifies and converts the sample to a bipolar pulse. A bipolar pulse is easier for the ADC assembly's track and hold circuitry to follow the pulse's peak amplitude. Block diagram and theory is in the test set manual. |
| ADC Assembly | The ADC assembly has track and hold circuitry which tracks the bipolar pulse's amplitude and holds the peak value. It also contains an analog to digital converter which converts incoming analog signals into a digital word. This digital word is read by the CPU and is either displayed on the CRT or used in waveform math functions. |

Acquisition Cycle The acquisition theory of operation is presented in a program flowchart. The flowchart applies directly to the infinite persistence mode, which is the simplest flowchart. Variable persistence and average modes have a few added steps to the flowchart. The microprocessor (CPU) controls an acquisition cycle with software instructions. The flowchart is presented from the CPU's point of view. The following steps are software instructions, with added indented comments. The comments will tie the software and hardware theories together.

- Start:** Program timebase delay
Program A/D input control switches.
The user selects which channels he wants on. The CPU will write to the proper switch enable lines 1-4 (SW1-4) which channels are on and which are off. There are four samplers on the vertical assembly and only one A to D converter on the ADC assembly. All four samplers fire at the same time and the track and hold circuitry will hold the analog values of each channel. Logic on the ADC assembly will search the SW1-4 lines looking for which channels are on. The A to D converter will process, one at a time, only the on channels. The analog signals are converted to digital words which the CPU can display on the CRT. Data from the off channels is not used.
Wait for timebase to settle.
The CPU is waiting for the fine delay DAC (U28) on the horizontal control assembly to settle. The wait time is 50 μ s.
Go to Enter1
- Loop:** Program A/D input control switches
As earlier, this step reprograms the SW1-4 switches on the ADC assembly.
- Enter1:** Reset GO bit
This is the low go reset (LGORESET) on the horizontal control assembly.
Enable trigger, samplers on.
This step enables various lines to latches U1 and U2 on the horizontal control assembly. The trigger enable line will go low. The sampler high on/low off line (ON/LOFF) will go high at the end of coarse delay. This allows the samplers to sample incoming signals.
Wait for GO bit
The horizontal control assembly uses the GO bit to signal the CPU to process sampled data. The CPU will wait on the GO bit signal before it does any other tasks. If the GO bit is held in a disabled mode, the CPU could hang up in a wait loop. Pressing any front-panel key will exit this wait loop.

Reset GO bit

After the CPU sees the GO bit go high, it resets the GO bit low so the GO bit can signal the CPU when the next sample is taken.

Skip sample

The longest coarse delay word represents 458.752 μ s of delay. Longer delays are accomplished by using a software counter. Coarse delay will count down from 458.752 μ s to zero. The trigger will fire, and a sample will be taken. Software will check to see if enough delay time has passed. If more delay is needed, then the sample is discarded and the coarse delay counters will start over again.

Disable Trigger.

If the trigger is not disabled, then the timebase would continue to count down and enable the trigger every 458.752 μ s. This would cause a new set of data points to be acquired by the samplers and the old set of data points would be discarded. By disabling the trigger on the horizontal control assembly, the timebase will be stopped and data points will not be discarded before the CPU has time to process them.

Read A/D.

The CPU will read the output of the A to D converter for the first channel that is on. Then the A to D converter will process the signal from the next channel that is on. The Track and Hold ICs have a capacitor which holds the sampled data value. The acquisition cycle is interrupt driven with the acquisition interrupt (GO bit) having the highest priority.

Program timebase delay for next acquisition.

This is a repeat of the timebase set-up in the Start routine discussed earlier. While the CPU is processing sampled data it allows enough time for the fine delay DAC to settle within the 50 μ s time frame.

If channel 1 is on, then Wait for A to D to finish a conversion.

The CPU is monitoring the status line (STS) from the ADC assembly. Status tells the CPU that an A to D conversion is finished, and it is time to read the A to D's digital output word.

Read A to D converter.

After the CPU reads the A to D converter's output, the low chip select analog to digital converter (LCSAD) will signal the A to D to do a conversion on the next channel which is on.

Plot data if appropriate.

The CPU does not always plot digitized data. It depends on what functions the user selected. The data may be used in waveform math and only the results would be plotted on the CRT. Data may also be acquired specifically to be sent over the HP-IB.

If channel 2 is on, then Wait for A to D to finish a conversion.

The steps for channels 2-4 are identical to the steps for channel 1.

Read A to D converter.

Plot data if appropriate.

If channel 3 is on, then Wait for A to D to finish a conversion.

Read A to D converter.

Plot data if appropriate.

If channel 4 is on, then Wait for A to D to finish a conversion.

Read A to D converter.

Plot data if appropriate.

If the trace is at the end of a sweep, then plot any functions which are on.

It takes the CPU a long time to finish plotting functions. The acquisition hardware may have a block of dead time waiting for the CPU to finish plotting functions.

Go to Loop

Variable Persistence For variable persistence mode there is an added step before the GO to loop step. This step checks if it is time to erase any of the old data points. The CPU may spend as much time erasing old data points as acquiring new data points.

Average Mode In the average mode software feedthrough compensation is done. With the samplers turned off, the output of the samplers is digitized through the A to D converters. This first value is the result of sampler feedthrough. Then the samplers are turned on and their outputs are digitized again. This second value is the sum of sampler feedthrough and an actual data point. The first value is subtracted from the second, and the result is the actual digitized point.

ADC Assembly

The following block level theory of operation refers to the analog to digital converter (ADC) assembly block diagram in figure 6B-2.

- Track and Hold** The track and low hold (T/LH) signal from the horizontal control assembly enables the track and hold circuitry to detect the first half cycle of the bipolar pulse's amplitude and hold its peak analog value. The bipolar pulse comes from the test set.
- Analog Switch Enable** The microprocessor (CPU) enables one or more of the four vertical channels by enabling the proper SW1-4 lines. The combinational logic circuit searches for which channels are on by looking at which of the SW1-4 lines were enabled by the CPU.
- Combinational Logic** When enabled by T/LH, the combinational logic circuit searches for the first channel that is turned on. After the first on channel is found, the combinational logic circuit enables the A to D to convert that channel's track and hold output to a 12-bit digital word. After the A to D conversion is finished, the CPU reads the A to D's output. The combinational logic circuit then continues to search for the next channel that is on. This process continues until reset by the T/LH signal, at which time the sequence is started over again.
- Analog Switch** The analog switch sends the track and hold outputs, one at a time as directed by the combinational logic circuit, to the 12-bit analog to digital converter (A to D).
- Status** The CPU waits until status indicates that the A to D is done with a conversion before reading the A to D's digital lines.
- A to D** The A to D converts analog signals to a 12 bit digital word. This digital word is sent through bidirectional bus drivers U37 and U38. The CPU transfers these digital words over the system interface bus (SIB) to the display assembly.
- Board ID** The CPU knows the location of each card cage assembly by asking each board for its unique ID number during the initial power-up sequence. Each assembly accessed by the CPU over the SIB has a unique board ID number.
- Offset Dac Enable** The offset DAC (digital to analog converter) enable decodes address lines A4-6 into four lines called low chip select offset DAC lines 1-4 (LCSOD1-4). The CPU accesses each offset DAC by enabling one of these four lines.
- Offset DACs** There is an offset DAC for each of the four channels. The offset DAC converts 14-bit digital (DAD0-13) words to an analog voltage. The analog voltage is then converted to a current with a range of ± 50 mA. Current drive is used to help reduce cable noise pickup while the offset current is sent through the umbilical cable to the vertical assembly.

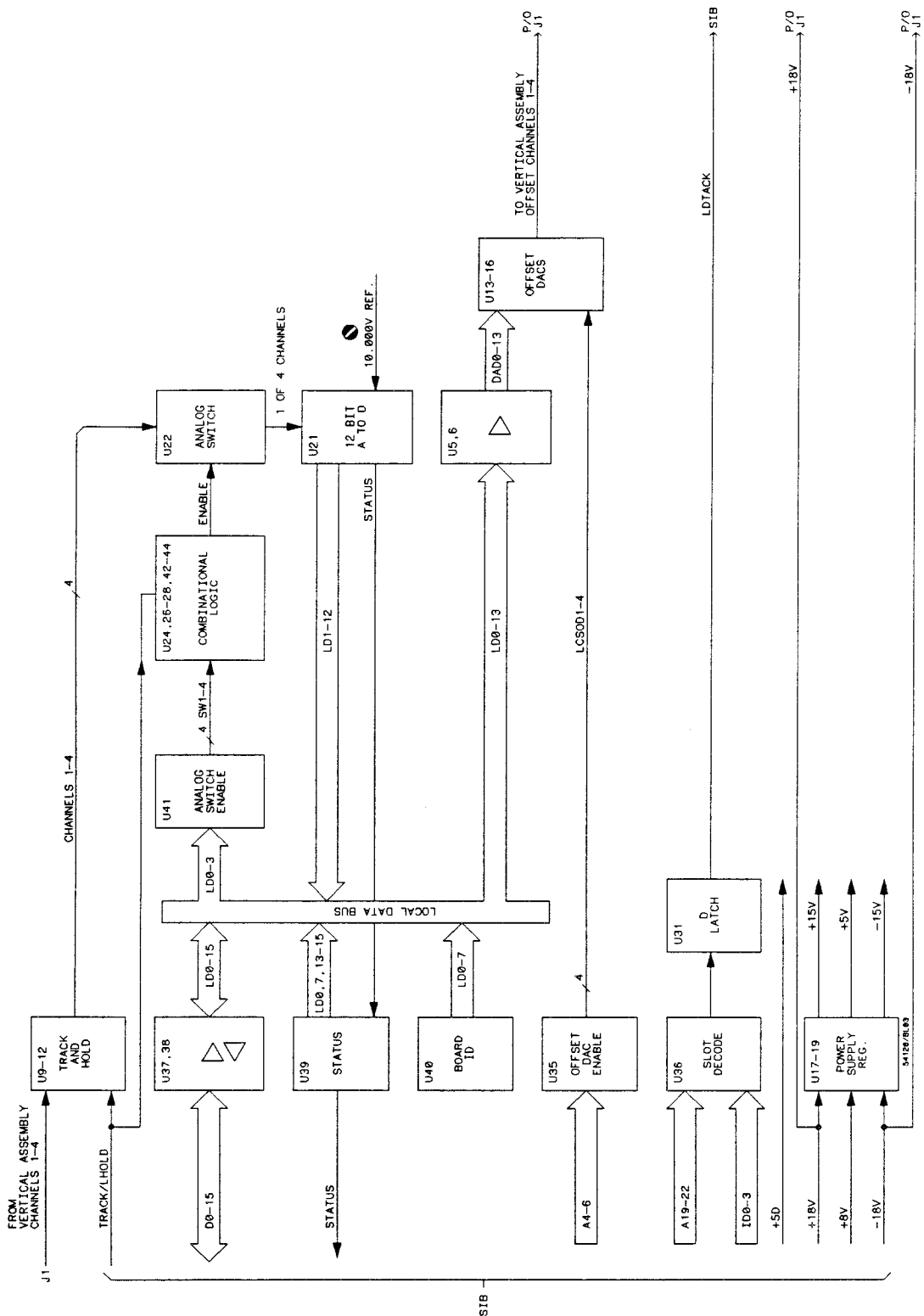


Figure 6B-2. ADC Assembly Block Diagram

Slot Decode The CPU accesses this board by sending out the board's slot ID code over address lines A19-22. U36 is a four bit comparator which compares slot address lines A19-22 with slot ID codes ID0-3. When the two codes are equal, U36 pin 6 enables other circuitry.

D Latch The D Latch signals the CPU that it has received data with the LDTACK (low data acknowledge) line.

| Mnemonics | Definition |
|------------------|--|
| A19-22 | Address lines 19-22 |
| CCLK1 | C Clock 1 |
| CCLK2 | C Clock 2 |
| LCSAD | Low Chip Select Analog to Digital converter |
| DAD0-13 | Digital to Analog Data lines 0-13 |
| D0-15 | Data lines 0-15 |
| DTRC | Delay To Read Convert |
| H/LL | High for high bandwidth enable, Low for low bandwidth enable |
| H/LT | Hold/Low Track |
| LCSOD1-4 | Low Chip Select Offset DAC's 1-4 |
| LD0-15 | Local Data lines 0-15 |
| LDTACK | Low Data Acknowledge |
| LNCH | Low Next Channel |
| R/LC | High Read/Low Convert |
| STS | Status |
| SW1-4 | Analog Switch lines 1-4 |

Horizontal Control Assembly

The following block level theory of operation refers to the horizontal control assembly block diagram in figure 6B-3.

| | |
|---------------------------------|---|
| Fine Delay DAC | U28 is a 12-bit DAC using LD2-13 to produce a level representing fine delay from 0 to 3.99975 ns. U31 uses LD0 and 1 as sub LSBs to give the DAC more resolution, 1/4 ps steps. This gives the trace a more uniform appearance. |
| Trigger Level DAC | The trigger level DAC is a 12-bit DAC which generates trigger level as selected by the front-panel. Trigger level is used by the trigger hybrid on the horizontal assembly in the four channel test set. |
| Freerun Clock Generator | U30 divides a 2 MHz clock to give a frequency range of 15.3 Hz to 500 kHz, selectable by the front-panel controls. The freerun clock signal drives the TDR generator and trigger hybrid located in the four channel test set. The freerun clock frequency directly affects the output frequency of the TDR generator. |
| Latches | U1 and U2 latch various trigger status signals to the horizontal assembly. These signals are: high frequency reject, trigger enable, TDR on or off, trigger hysteresis, and trigger slope. U11 latches four of the five LSBs of the coarse delay word going to the horizontal assembly. These are timebase bits 1-4 (TB1-4) and correspond to bits 0-3 of the coarse delay word. |
| Status | Status is the only block which transfers data back to the CPU. The GO bit tells the CPU to process sampled data on the ADC assembly. |
| Coarse Delay Counters | U10, 12, and U13 use the 12 most significant bits (MSB) of the 17-bit coarse delay word (LD4-15). When the counters have counted down to zero, a low terminal count signal (LTC2) is generated for the horizontal assembly in the four channel test set. The remaining 5 bits of the coarse delay word are used on the horizontal assembly in the four channel test set. The total length of time for the coarse delay counters is 4 ns to 458.752 μ s. Longer delay times are achieved with software counters. |
| 4 ns Bit | The fifth LSB of the coarse delay word going to the horizontal assembly is a sub LSB of the coarse delay word. It is TB0 SET and RESET and corresponds to bit 15 of the fine delay word. It is called the 4 ns bit because it is the fourth ns of the coarse delay time interval. |
| Track And Hold Generator | This circuit generates the track and low hold signal for the ADC assembly. Track means to track the output of vertical assembly. Hold means to hold the peak analog value until the A to D converter has time to do a conversion. |
| GO Bit Generator | It generates the GO bit which tells the CPU to process sampled data. When the GO bit is high, analog information is being held by the track and hold circuitry on the ADC assembly. This analog information is waiting to be converted into digital information by the A to D converter on the ADC assembly. When the GO bit goes true (low) it generates an interrupt which tells the CPU a sample has been taken (interrupt 7). |

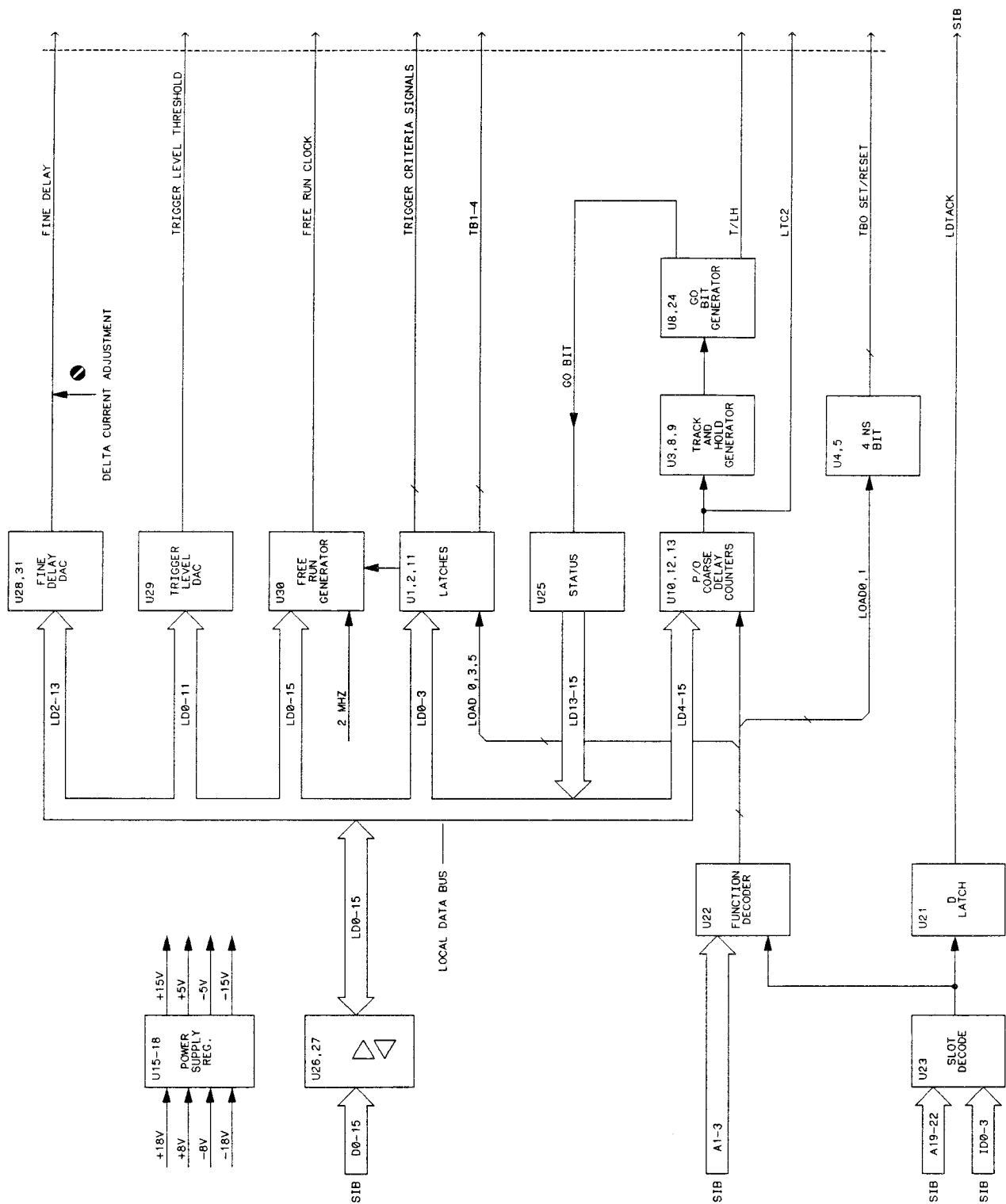


Figure 6B-3. Horizontal Control Assembly Block Diagram

Board ID The microprocessor (CPU) knows the location of each card cage assembly by asking each board for its unique ID number during the initial power-up sequence. Each assembly accessed by the CPU over the SIB has a unique board ID number. The horizontal control assembly generates board ID by pull-up resistors on the LD0-3 data lines, which will be all logic high levels.

Slot Decode The CPU accesses this assembly by sending out the board's slot ID code over address lines A19-22. U23 is a 4-bit comparator which compares slot address lines A19-22 with slot ID codes ID0-3. When the two codes are equal, U23 pin 6 enables other circuitry.

D Latch The D Latch signals the CPU it has received data with the low data acknowledge (LDTACK) line.

| Mnemonics | Definition |
|------------------|---|
| A19-22 | Address lines 19-22 |
| D0-15 | Data lines 0-15 |
| GO | Tells the CPU to process sampled data |
| H/LT | Hold/Low Track |
| HF REJECT | Trigger High Frequency Reject |
| ID0-3 | Board ID lines 0-3 |
| LD0-15 | Local Data Lines 0-15 |
| LLDS | Low Lower Data Strobe |
| LDTACK | Low Data Acknowledge |
| LGO | Low GO |
| LGORESET | Low GO Reset |
| LIRQ7 | Low Interrupt Request Line 7 |
| LPWRONRST | Low Power On Reset |
| LSB | Least Significant Bit |
| LTC2 | Low Terminal Count line 2 |
| MSB | Most Significant Bit |
| Neg/LPOS | Trigger slope select high for Negative/low for Positive |
| OFF/LON | Turns TDR generator Off and On |
| R/LW | Read/Low Write |
| SELECT | Board Select |
| LENABLE/RESET | Trigger Low Enable/Reset |
| T/LH | Track/Low Hold |
| Sampler ON/OFF | Turns Sampler ON and Off |
| SIB | System Interface Bus |

I/O Assembly

The following block level theory applies to figure 6B-4. The I/O Assembly serves two major purposes. First, it provides instrument interface to the keyboard and HP-IB by two ribbon cables. Second, it provides several system functions, all of which are described below. In addition the I/O contains passive pull-up resistors for the data, address, and control lines for the System Interface Bus, (SIB).

Slot Decode The CPU accesses this board by sending out the board's slot ID code over address lines A19-A22. U45 is a 4-bit comparator which compares slot address lines A19-22 with slot ID codes ID0-3. When the two codes are equal, U45 pin 6 will output a pulse which enables other circuitry.

LDTACK Generator U35 generates LDTACK, which is sent back to the CPU indicating data was received. This signal also resets the bus error timer.

Bus Error Timer Under normal operation U18 should be reset by LDTACK before a time constant set by R19 and C40 times out. If U18 is not reset, it will generate LBUSERR. This keeps the CPU from getting hung up in an instruction cycle. This could happen if any addressed board does not generate LDTACK or if the CPU tries to access a nonexistent board.

Board ID One side of U42 is hardwired to represent the board ID number. When the CPU asks for board type, U42 places a board ID number on the local data bus.

HP-IB U1 interprets HP-IB commands and controls the direction of data flow from an external controller to the local data bus. One side of U1, LD0-7, connects to the local data bus. The other side of U1 connects to two bidirectional data transceivers, U4 for data and U5 for control commands. Because HP-IB addressing is accomplished by software, no address lines are carried on the ribbon cable.

Function Decoder Function decoder U10 decodes address lines A12-A14 to enable, keyboard controller, RPG counter, HP-IB controller, board type, and power supply status.

Keyboard Controller Keyboard controller U21 sees a key closure and interrupts the CPU by the IRQ4 line. U21 detects which key was pressed by scanning column lines with pulses and sensing rows for a return path. When U21 is enabled, it converts key closure scan data to parallel data and places this data on the local data bus.

Dynamic Ram The I/O assembly provides 256k words of additional CPU memory used for waveform storage and other purposes. The memory is an array of sixteen 64k by 4-bit dynamic RAMs. Dynamic RAM is addressed in rows and columns with low row address strobe (LRAS1-4) and low column address strobes (LCAS1-8). Dynamic memory must be refreshed at regular intervals to maintain memory. This is accomplished with refresh counters U19-31. From the CPU's perspective the dynamic RAM is a slot by itself, irrespective of the slot for the I/O assembly. The other assemblies are identified by their slot ID code. U51 is a 4-bit comparator which compares address lines A19-22 with code 10 decimal which is hardwired on the other comparator input. The CPU sees the dynamic RAM at slot 10 no matter which slot the I/O board is in.

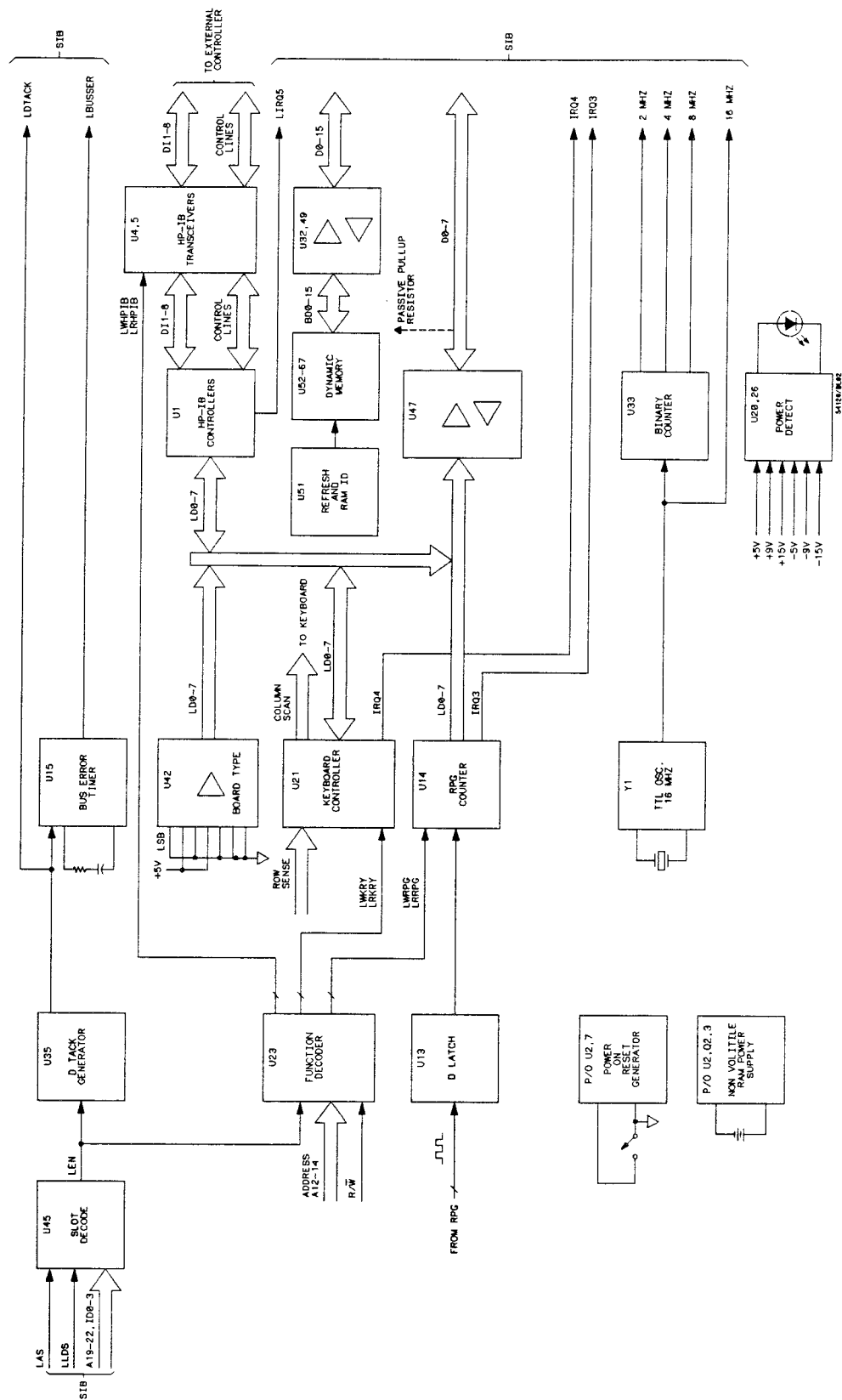


Figure 6B-4. I/O Assembly Block Diagram

| | |
|--------------------------------------|--|
| RPG Counter | The RPG outputs two out-of-phase pulses. Direction of rotation is determined by the difference in phase angle between both pulses. The pulse frequency is a function of rotation speed and this tells the microprocessor (CPU) what size of incremental steps to take. Part of U13 detects RPG activity and interrupts the CPU by the IRQ3 line. |
| TTL Oscillator | The TTL oscillator is a crystal controlled 16 MHz oscillator. A binary counter divides this into 8 MHz, 4 MHz and 2 MHz. All four signals are placed on the system interface bus for use by other assemblies. |
| Power-on Reset | The power-on reset circuit provides a glitch-free pulse shortly after power up and power down. This sets many devices to a known state and prevents the CPU from taking damaging action during power up. This also provides a means to reset the system with a push button, without powering down the instrument. |
| Power Detect | The power detect circuit samples all six supply voltages. If one or more fails, the LED on top of the I/O assembly will not illuminate. |
| Non-volatile Ram Power Supply | A battery provides the necessary power for RAM on the CPU assembly to retain basic setup information and system configuration for several years. The circuit also provides for smooth transfer of power from the battery to the power supplies after initial power up. |

| Mnemonics | Definition |
|------------------|-------------------------------------|
| DI1-8 | HP-IB Data lines 1-8 |
| D0-7 | SIB Data lines 0-7 |
| DS | Data Strobe |
| IDO-3 | Board ID lines 0-3 |
| LIRQ1-7 | Low Interrupt Request lines 1-7 |
| LA1-3 | Local Address lines 1-3 |
| LAS | Low Address Strobe |
| LCAS1-8 | Low Column Address Strobe lines 1-8 |
| LDTACK | Low Data Acknowledge |
| LD0-7 | Local Data lines 0-7 |
| LEN | Low Enable |
| LLDS | Low Lower Data Strobe |
| LRAS1-4 | Low Row Address Strobe lines 1-4 |
| LRHPIB | Low Read HP-IB |
| LRKEY | Low Read Keyboard |
| LRPWR | Low Read Power |
| LRRPG | Low Read RPG |
| LSB | Least Significant Bit |
| LSTROBE | Low Strobe |
| LUDS | Low Upper Data Strobe |
| LWHPIB | Low Write HP-IB |
| LWKEY | Low Write Keyboard |
| LWRPG | Low Write RPG |
| R/LW | Read Low Write |
| RPG | Rotary Pulse Generator |
| SIB | System Interface Bus |

Microprocessor Assembly

| | |
|-----------------------------------|--|
| | <p>The following theory applies to figure 6B-5. The microprocessor (CPU) has two major functions, data acquisition and I/O interfacing. It starts an acquisition cycle by resetting the GO bit to a logic low level. The CPU then waits for the GO bit to go high again. The GO bit going high tells the CPU to process sampled data. I/O interfacing involves updating display information, interpreting key closure data, RPG data, and HP-IB commands. In remote mode the CPU takes commands from an external controller.</p> |
| CTC | <p>The counter timer chip (CTC) contains three counters. The CPU programs and reads each counter over LD0-7 lines. Each counter has an output which is used as an interrupt to the CPU. All three counter outputs are ORed through U35 and U42. The result is ORed through U40 with LIRQ6 from the SIB and applied to the system interrupt latch.</p> |
| System Interrupt Latch | <p>The system interrupt latch allows the CPU to mask off any or all interrupt lines. The CPU sends data to U1 on LD0-7 lines. For normal operation all outputs of U1 are normally a zero, and all incoming SIB interrupt lines are normally a one. When an interrupt occurs on the SIB that interrupt line will be a zero, the corresponding output of U17 or U18 will also be a zero. The CPU can mask off any interrupt lines by simply writing a one to U17 or U18 through U1. This will guarantee that corresponding output levels of U17 or U18 will also be a one regardless of what the SIB interrupt lines are doing.</p> |
| Interrupt Priority Encoder | <p>This circuit encodes all seven incoming interrupt lines into three lines for the CPU. If more than one interrupt occurs at the same time, U34 will prioritize them so the interrupt with the highest priority will be processed first. When an interrupt occurs, the system is vectored to a predetermined software location.</p> |
| Bus Arbitration | <p>This board contains circuitry so it will operate in a multiprocessor system. Since only one CPU is used, the bus request and bus grant signals are tied to the proper logic levels to ensure this board will have control over the SIB when required.</p> |
| Bus Buffers | <p>They enhance the drive capabilities of the CPU. When enabled, they connect the CPU with the correct bus, these are: U48 and U49 for SIB data bus U45, U46 and U47 for SIB address bus U4 and U21 for local data bus U5, U6, U22 and U23 for local address bus</p> |
| Decoders | <p>U36 decodes PA16-18 to enable ROM pairs 0-7. U19 decodes PA14-16 to enable RAM pairs 0 and 1, interrupt latch, and counter timer chip.</p> |
| CPU | <p>This chip is a Motorola 68000 microprocessor running at 8 MHz. Main characteristics are, 16-bit data bus, 23-bit address bus, and 3 interrupt lines. At initial power up condition, power on reset (POR) insures the CPU will start-up in a known condition. The CPU will then run several routines, some of which are: determine which board type is in which slot, system self-diagnostics, and setup display information. The CPU will now respond to system interrupts, HP-IB, keyboard, or RPG. To the CPU all boards connected to the SIB look like memory locations. When A23 is a logic high level, the CPU is accessing system memory over the SIB. When A23 is a zero, then the CPU is accessing local processor board memory locations. After the CPU sends data over the SIB, LDTACK returns from the addressed board and signals the CPU the information was received. LDTACK also goes to the I/O board and resets a buserror timer. If the buserror timer is not reset, BUSERR is sent to the CPU. The CPU will display a SOFTWARE ERROR message on the CRT.</p> |

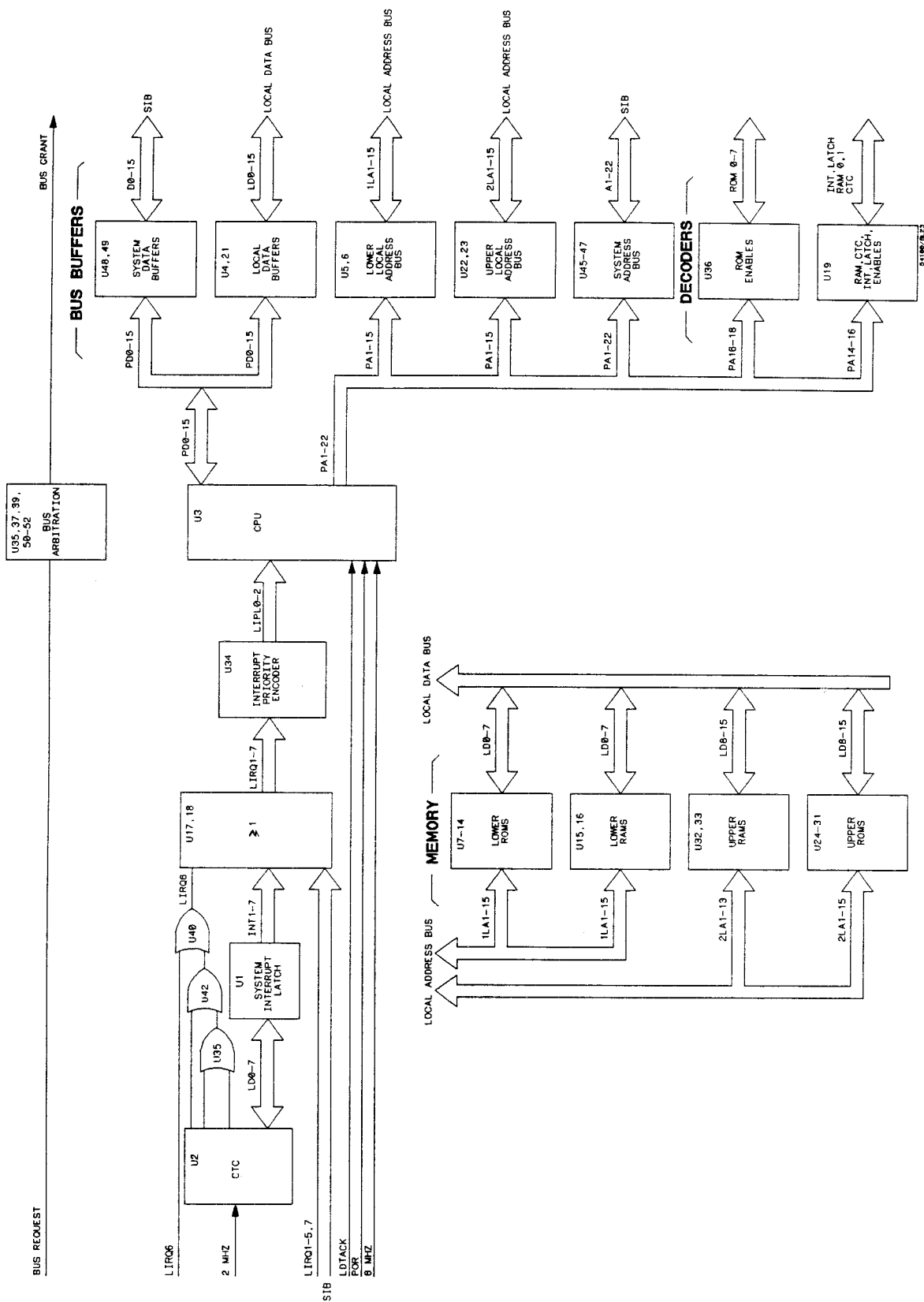


Figure 6B-5. Microprocessor Assembly Block Diagram

Memory The ROMs and RAMs have 8-bit data lines. The 16-bit words are divided into a lower portion LD0-7, and an upper portion LD8-15. All the ROMs or RAMs are read in pairs. Software instructions for the CPU are contained in ROM memory. There is space for eight ROM pairs, but not all of the space is used. Non-volatile battery backed-up RAM memory contains stack registers, status registers, scratch pad memory, and soft-cal information.

| Mnemonics | Definition |
|------------------|-----------------------------------|
| CPU | Central Processing Unit |
| CTC | Counter Timer Chip |
| LD0-15 | Local Data lines 0-15 |
| LDTACK | Low Data Acknowledge |
| LIRQ1-7 | Low Interrupt Request lines 1-7 |
| PA1-22 | Microprocessor Address lines 1-22 |
| PD0-15 | Microprocessor Data lines 0-15 |
| POR | Power On Reset |
| SIB | System Interface Bus |
| 1LA1-15 | Lower Local Address lines 1-15 |
| 2LA1-15 | Upper Local Address lines 1-15 |

Color Display Assembly

This theory refers to figure 6B-6. The board is the interface between the host microprocessor and color monitor. It has graphics memory, timing generator, character generator, prioritizing circuitry, color map, and color output DACs.

| | |
|-------------------------|---|
| Function Decoder | It decodes HA13-15 to enable various board functions, CRTC for the CRT controller, ID for board type, COLOR MAP for the color map and output DACs, priority for RAM. |
| D Latch | This circuit outputs LDTACK over the SIB indicating data was received from the CPU. |
| Slot Decode | The CPU accesses this board by sending out the board's slot ID code over address lines A19-22. U141 is a four bit comparator which compares slot address lines A19-22 with slot ID codes ID0-3. When the two codes are equal, U141 pin 6 enables other circuitry. |
| CRT Controller | The CRT controller controls several board functions, timing signals for the color monitor, blanking, horizontal drive, vertical drive, and character control functions. |
| Character RAM | Characters are stored in RAM as a 16-bit word, eight bits for an ASCII word and eight bits for character attributes. |

| Bit Number | Function | Bit Number | Function |
|------------|-----------------|------------|--------------|
| TD0-6 | ASCII character | TD10 | Underline |
| TD7 | Not used | TD11-14 | Color |
| TD8 | Inverse video | TD15 | Priority bit |
| TD9 | Blink | | |

| | |
|----------------------------------|---|
| Character ROM | It functions as a character generator by decoding ASCII data, TD0-7, from character RAMs and sending it through character shift registers to the encode circuit. |
| Character Shift Registers | They are parallel loaded with character data and output character video in serial format. |
| Attribute Logic | It converts TD8-15 to attributes, four bits for color and four bits for other attributes. To define these bits, refer to the table under Character RAM heading discussed earlier. |
| Dual Port Arbiter | The dual port arbiter outputs addresses from either the host CPU or from an outside controller and places graphics on the CRT. |
| Display Address Counters | These are 4-bit counters which generate graphic address lines GA0-13. |

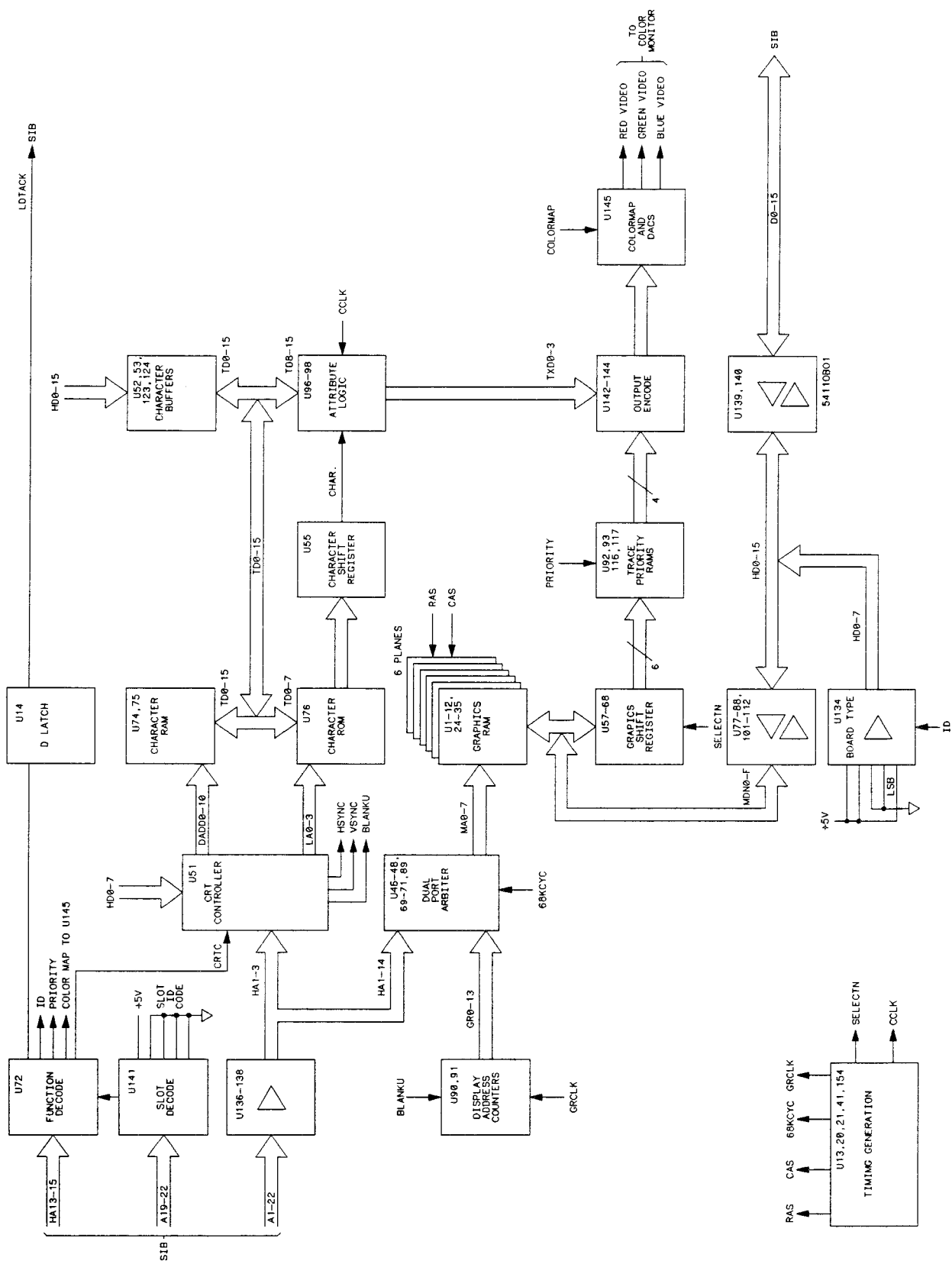


Figure 6B-6. Color Display Assembly Block Diagram

Graphics RAM There are six planes of dynamic memory where graphics data is stored.

| Plane | Information | Plane | Information |
|-------|---------------|-------|-------------|
| 0 | Graticules | 3 | Channel 2 |
| 1 | Stored Traces | 4 | Channel 3 |
| 2 | Channel 1 | 5 | Channel 4 |

Graphics Shift Registers This circuit is parallel loaded with graphics data and it serially outputs graphics video.

Trace Priority Encode This is a high speed RAM whose function is to map outputs from the graphics planes into unique address locations for the color map. It also provides arbitration when more than one plane tries to illuminate the same pixel location. Plane 0 has the lowest priority while the other places have equal priority.

Output Encode This circuit uses either graphics data or character and attribute data to generate addresses for the color map.

Color Map And Output DAC The color map consists of three color RAMs which convert the encoded addresses to a digital value. There is one output DAC for each color RAM. The output DACs convert this digital value to red, green, or blue levels for the color monitor.

Board ID When board type is requested by the CPU, this board will respond with 25 over the LD0-7 lines. LD0, 3 and 4 will be pulled high through U134, LD1 and LD2 will be pulled low through U134. LD0 is the least significant bit so adding LD0, 3 and 4 equals 25.

Timing Generation Timing generation controls timing functions for the display board.

| Mnemonics | Definition |
|-----------|--|
| A1-22 | SIB Address lines 1-22 |
| CAS 0-5 | Column Address Strobe lines 0-5 |
| CCLK | Character Clock |
| D0-15 | SIB Data lines 0-15 |
| DADD0-13 | Display Address lines 0-13 |
| DP0-5 | Display Planes 0-5 |
| GA0-13 | Graphics Address lines 0-13 |
| GRCLK | Graphics Clock |
| HA1-22 | Local Address lines 1-22 |
| HD0-15 | Local Data lines 0-15 |
| HIP21 | High Priority bit 21 (Disables Graphics) |
| HSYNC | Horizontal Sync |
| LDS | Lower Data Strobe |
| LDTACK | Low Data Acknowledge |
| MA0-7 | Memory Address lines 0-7 |
| MD0-15 | Memory Data lines 0-15 |
| RAS 0-5 | Row Address Strobe lines 0-5 |
| SIB | System Interface Bus |
| TD0-15 | Text and Attribute lines to character ROM |
| TXD0-3 | Text and Attribute lines to encode circuitry |
| UDS | Upper Data Strobe |
| VSUNC | Vertical Sync |

Power Supply Assemblies

This theory refers to figure 6B-7.

Primary Supply

The primary supply rectifies and filters the input ac voltage. When the voltage select switch is in the 230 V position, the ac is bridge rectified and filtered to yield approximately 300 V dc and 120 V dc. The 120 V dc is generated by an isolating switching regulator, and is used to power the color monitor. The 300V dc is used for the digital and analog supplies. The input voltage is doubled in the 115 V position to yield the same dc voltages. The primary board has surge protection circuitry that protects against ac line voltage transients and current surges. Over-voltage crowbar devices trip the circuit breaker for sustained input over-voltage conditions. The pulse width modulator (PWM) circuitry is powered by a bleeder resistor on one of the bulk storage capacitors. The main EMI (electromagnetic interference) filter is located in a dc current path to reduce component size and to increase the filter's effectiveness.

Digital Supply

The digital power supply is a dc to dc converter which converts 300 V dc to +5 V and -5.2 V dc. The Pulse Width Modulator (PWM) is used to achieve voltage and current regulation by changing the PWM's turn-on time. It has an operating frequency of 68 kHz. The Power Stage performs the actual conversion of 300 V dc to +5 V and -5.2 V dc. Digital and primary ground planes are kept isolated through transformer T2. The Optical Isolators are used to isolate the primary and digital ground planes. Voltage and current feedback control is sent through U2 to control the duty cycle of the PWM. Power supply shutdown is sent by U3. The Loop Control and Supervisory circuitry detects when excessive output voltage occurs. It sets a latch in the PWM which can only be reset by cycling the circuit breaker off for 60 seconds, or an instantaneous reset by cycling the front panel power switch. It also senses the current and activates foldback current limiting for excessive current loading.

Analog Supply

The analog power supply is a dc-to-dc converter which converts 300 V dc to ± 18 Vdc and ± 8 Vdc. The Pulse Width Modulator (PWM) is used to achieve voltage and current regulation by changing the PWM's turn on time. It has an operating frequency of 68 kHz. The Power Stage performs the actual conversion of 300 V dc to ± 18 Vdc and ± 8 Vdc. There is a fan drive output that increases fan speed with ambient temperature. Analog and primary ground planes are kept isolated through transformer T2. The Optical Isolators are used to isolate the primary and analog ground planes. Voltage and current feedback control is sent through U2, to control the duty cycle of the PWM. Power supply shutdown is sent through U3. The Loop Control and Supervisory circuitry detects when excessive over-voltage occurs. It sets a latch in the PWM which can only be reset instantaneously by cycling the front panel power switch to standby and then to on, or by turning the circuit breaker to the off position for 60 seconds. +18 V is regulated and the other outputs are semi-regulated outputs which follow the +18 V. Each output is current-limited. The -8 V output has foldback current limiting.

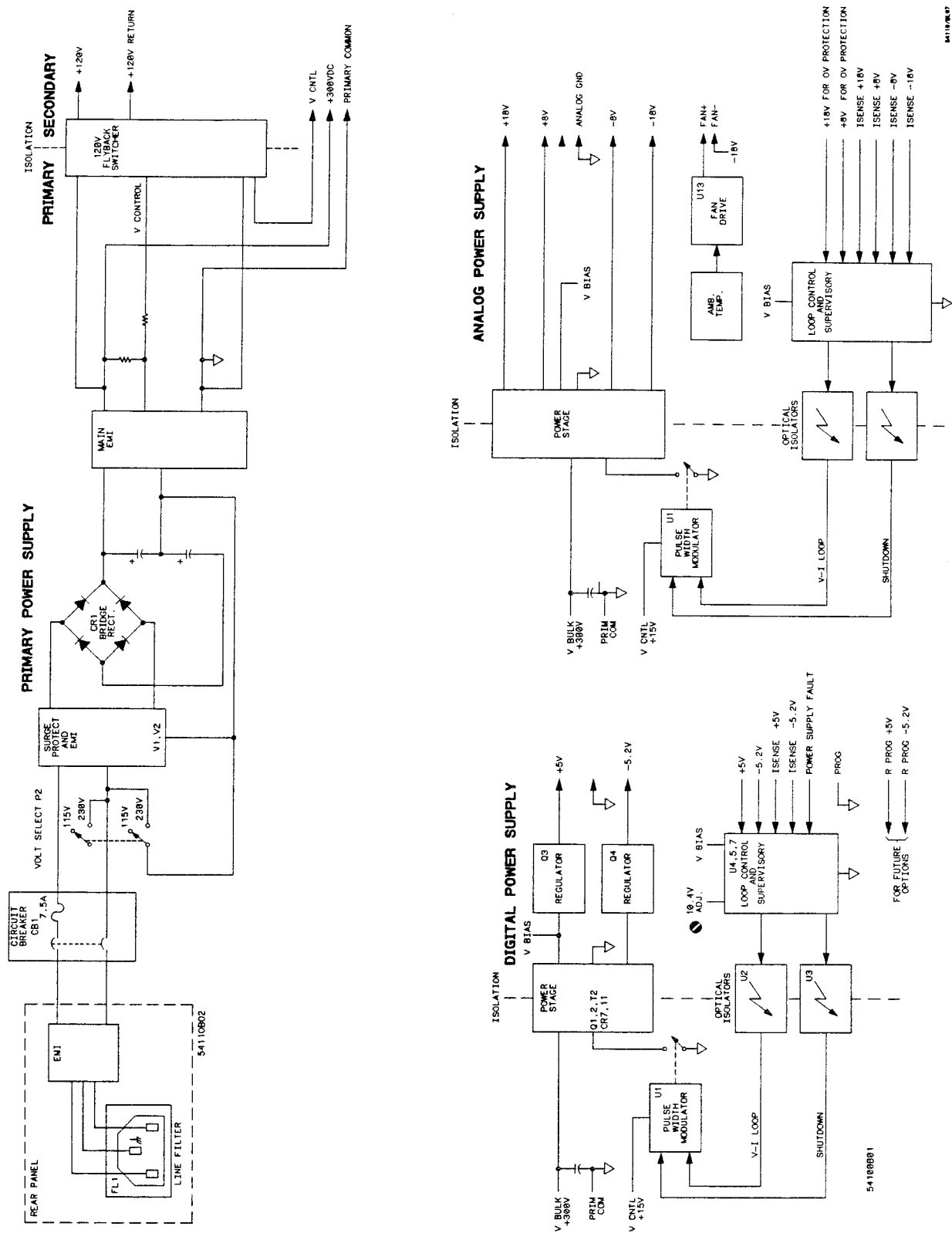


Figure 6B-7. Power Supply Assembly Block Diagrams

Table Of Contents

Service Menus

| | |
|---------------------------------|------|
| Introduction | 6C-1 |
| Service Menus | 6C-1 |
| Cal Menu | 6C-1 |
| Test Menu | 6C-1 |
| CRT Setup | 6C-1 |
| Color Cal Menu | 6C-1 |
| HP-IB Menu | 6C-1 |
| One-key Powerup | 6C-1 |
| Two-key Powerup | 6C-2 |
| Cal Menu | 6C-2 |
| Channel Vertical Cal | 6C-2 |
| Channel Skew Cals | 6C-2 |
| Channel Atten Test | 6C-2 |
| Test Menu | 6C-2 |
| Repeat Loop | 6C-3 |
| Run From Loop | 6C-3 |
| Extended Tests | 6C-3 |
| Start/Stop Test | 6C-3 |
| Display Errors | 6C-3 |
| Display Configuration | 6C-3 |
| CRT Setup Menu | 6C-4 |
| Confidence Test | 6C-4 |
| Pattern Key | 6C-4 |
| Light Output | 6C-5 |
| Color Purity | 6C-5 |

Introduction

This section describes the service menus and keys that are available for calibration, troubleshooting, and CRT display alignment. A basic understanding of these will be helpful in troubleshooting failures. However, Self-Test and Troubleshooting is covered specifically in Section 6D.

Service Menus

The service menus are part of the Utility menu, in the second level of the menu softkeys. Pressing the **Utility** key will display five other function keys: Cal Menu, Test Menu, CRT Setup, Color Cal Menu, HP-IB Menu.

CAL Menu

The Cal Menu is used to calibrate the instrument. The calibration factors are stored in non-volatile memory. Use of this menu is covered in the "Front Panel Operation Reference". Basic functions of the Cal menus are covered in this section.

Test Menu

The Test Menu provides several functions used to set up and run internal diagnostics test and view the results. Use of these functions is covered briefly in this section and comprehensively in the Self-Tests/Troubleshooting, section 6D.

CRT Setup

The CRT Setup Menu provides several functions that provide confidence testing as well as test patterns for adjusting the Color CRT Module. These functions are discussed in this section.

Color Cal Menu

The Color Cal Menu provides functions used to set the characteristics of the colors displayed. These characteristics include hue, saturation, and luminosity. This menu is covered in detail in the "Front Panel Operation Reference".

HP-IB Menu

The HP-IB Menu provides keys that are used to set the HP-IB attributes. These attributes are address number, Talk/Listen, and EOI. This menu is discussed in detail in the "Front Panel Operation Reference".

One-key Power Up

A one-key power up is performed to return the instrument to a known (default) front panel condition. This is done as follows:

1. Set the front panel POWER switch to STBY.
2. Press and hold any front panel key.
3. Turn front panel POWER switch to ON.
4. Release key when display shows "Powerup Self Test Passed!" or "Failed".

Two-key Power Up

A two-key power up is a basic reset of the entire operating system of the HP 54120B. All volatile and non-volatile RAM is cleared. As a result, all calibration factors are purged, front panel setups are erased, and the instrument must be recalibrated.

Caution

Using the two-key powerup will leave the instrument in an uncalibrated state. Effort needed for recalibration should be considered before using this mode to reset the instrument.

1. Set the front panel POWER switch to STBY.
2. Press and hold the top and bottom function keys.
3. Turn front panel POWER switch to ON.
4. Release keys when display shows "Powerup Self Test Passed!" or "Failed".

Cal Menu

Channel Vertical Cal

Channel Vertical Cal sets software calibration factors to correct for sampler gain and offset errors. The calibration is run by pressing the appropriate menu and function keys. All front panel inputs must be disconnected from the instrument. Refer to the specifications under general information in the test set service manual for a recommended cal interval.

Channel Skew Cals

The channel skew calibration is a user calibration which minimizes the delays between channels and also the external trigger input. If this calibration is performed in a calibration facility, use cables and signals similar to what the user will use with the oscilloscope.

Channel Atten Cals

This key only appears when the HP 54122A Four Channel Test Set is connected to the HP 54120B. The calibration measures the actual attenuation of the step attenuators and performs a software compensation. After a two-key power up, this calibration should be performed to ensure the correct values are stored. A very accurate dc source is required.

Test Menu

Five sub-menus are available when the Test Menu is selected. The menus allow the user to access and run internal diagnostics and view the results. In addition, the position of each card cage printed circuit board can be read and displayed, and the firmware revision date is displayed. Use of the test menus is covered in depth in section 6D, Troubleshooting.

Note

The top key toggles between REPEAT LOOP and RUN FROM LOOP. These keys in conjunction with Loop Number = [0-43] and the Start/Stop Test key will execute internal self-test diagnostic routines. All input signals must be disconnected from the instrument for these tests.

Repeat Loop

Selecting this mode will continuously execute the Loop number entered at RUN FROM LOOP. Pressing **Start Test** will start execution and the loop will continuously run until the **Stop Test** key is pressed. Pressing **Display Errors** will show how many times the loop was executed and the number of times the loop failed.

There are a number of loops that will blank or over-write the Stop Test key display on the CRT. However, the test can still be terminated by pressing the third function key from the top.

Run From Loop

Selecting this mode will start execution from the loop entered and will proceed to execute all higher numbered loops. Upon reaching the last test, the cycle will be repeated.

If any test should fail, the instrument will change from RUN FROM LOOP to REPEAT LOOP and will repeatedly execute the loop that failed until the **Stop Test** key is pressed.

Extended Tests

When this key is chosen there are 13 internal instrument tests that may be selected by entering the test number with the entry devices. These tests are numbered 0 through 12. All input signals must be disconnected from the instrument for these tests. Many of the extended tests are useful only at the factory. Those that are of use to field service personnel are covered in section 6D, troubleshooting.

Start/Stop Test

This key is used to initiate any test where a test number is entered by one of the entry devices. Once the test number is entered, pressing **Start Test** initiates the test and the key toggles to Stop Test. Pressing **Stop Test** stops the test in progress and the key toggles back to Start Test.

There are a number of tests that will blank or over-write the Stop Test key display on the CRT. However, the test can still be terminated by pressing the third function key from the top.

Display Errors

Pressing the **Display Errors** key will display the number of any loops which failed. The tests which test for loop failures are: Powerup self test, EXTENDED tests, REPEAT and RUN FROM LOOP tests, and HP-IB commanded self test. This display shows the current loop or last loop executed, the number of times the loop was executed, and the number of times that it failed. The bottom portion of the display shows all loops that failed starting with the first loop failure. These are cumulative failures and they are erased only on power up or I/O assembly reset.

The four STATUS X = XXXXX lines in the Display Errors field are primarily for factory use. Any field usable information in this part of the display is covered in section 6D, troubleshooting. To return to the Test Menu, press **Exit Display** key.

Display Configuration

Most of the assemblies used in the mainframe have circuitry that allows them to be interrogated directly by the microprocessor. The exception being the microprocessor assembly. The mainframe card cage has 9 slots, but only four assemblies are in the card cage. When the **Display Configuration** key is pressed the resulting display shows the location of the card cage assemblies, except the microprocessor. The display assembly is shown as being in slot 14, this is not part of the card cage but is on the instrument's bottom side. The firmware revision date is also displayed. To return to the Test Menu, press **Exit Display** key.

CRT Setup Menu

When CRT Setup Menu is selected, four keys are displayed that allow access to CRT setup displays. The keys available are, from top to bottom, Confidence Test, Pattern Off, Light Output Off, Color Purity Off, and at the bottom, Exit CRT Setup Menu.

Even though some of the patterns overwrite the key display, the functions can be selected. The bottom key can be pressed at any time to exit the CRT Setup Menu.

Confidence Test

When this function is selected, the confidence test pattern is displayed. The pattern consists of three parts. At the top is a complete character set, in the center is a group of seven color blocks, and at the bottom a seven block grey-scale.

The top four lines of the character set display include the complete character set. The bottom line displays three sets of numerals. The first set is displayed in inverse video, the second set, and the third set is normal video and underlined.

The seven color blocks displayed at the center are, from left to right; beige, grey, red, yellow, green, amber, and cyan.

Note

Since color perception is subjective, any slight variation in colors from what is described here should be disregarded.

At the bottom of the CRT a seven block grey-scale is displayed, with increasing luminosity from left to right. This grey-scale display is used if Color CRT Module adjustments are necessary.

Pattern

These patterns are used when Color CRT Module adjustments are necessary. When CRT Setup Menu is selected, this key is initially Pattern Off.

Pressing **Pattern Off** once will display a white cross-hatch pattern over the entire CRT and the Pattern Off key changes to Pattern White. Inside the cross-hatch pattern there are dots at the center, corners, and at the 12, 3, 6 and 9 o'clock positions. Additionally, there are test matrices in the center and corners.

Pressing **Pattern White** key changes the pattern color to red and the key label changes to "Pattern Red". Repeatedly pressing this key will change the color of the pattern to green then blue. The name of the Pattern key is the color displayed.

Pressing **Pattern Blue** key changes the display to the white cross-hatch pattern on the top half of the CRT and white with a dark cross-hatch on the bottom. The key then changes to **Pattern HV Reg**. This test is used primarily by the factory, however, it may indicate the need for service if there are severe high voltage problems.

Pressing **Pattern HV Reg** changes the display to a solid white screen with dark cross-hatch lines. The key changes to **Pattern I White**. Successive pressing of this key changes the color to red, green and then blue, the name of the **Pattern** key is again the color of the display.

Pressing **Pattern I Blue** changes the display to a white cross-hatch pattern with the inside flashing between solid white and cross-hatch. The key changes to **Pattern Bounce**. This test is primarily used by the factory, however, it may indicate the need for service if there are severe high voltage problems.

Pressing **Pattern Bounce** exits this set of tests and returns the CRT Setup Menu.

Light Output

These displays are used by the factory.

Pressing **Light Output White** displays a horizontal band of white half the height of the display. The key display is not overwritten. Repeatedly pressing this key will change the color of this band to red, green, blue and then a grey-scale. Each time the key is pressed it also changes to the appropriate description.

Pressing **Light Output Grey-Scale** exits this set of tests and returns the CRT Setup Menu.

Color Purity

Pressing **Color Purity Off** displays a full white raster. Repeatedly pressing this key changes the color of the raster to red, green and then blue. At each color display the name of the key changes to the appropriate description. These displays are used when Color CRT Module adjustments are necessary.

Pressing **Color Purity Blue** exits this set of tests and returns the CRT Setup Menu.

Table of Contents

Troubleshooting

| | |
|--|-------|
| Introduction | 6D-1 |
| Safety Considerations | 6D-1 |
| Recommended Test Equipment | 6D-1 |
| Logic Family Used | 6D-1 |
| Diagnostic Overview | 6D-2 |
| One Key-down Powerup | 6D-2 |
| Two Key-down Powerup | 6D-2 |
| I/O Assembly Hard Reset | 6D-6 |
| Keyboard Troubleshooting | 6D-6 |
| Core Subsystem Troubleshooting | 6D-9 |
| Power Supply Troubleshooting | 6D-9 |
| Color Monitor Troubleshooting | 6D-16 |
| Color CRT Module Troubleshooting | 6D-18 |
| Firmware Troubleshooting | 6D-19 |
| Additional Troubleshooting | 6D-20 |

Introduction

This section contains troubleshooting information for fault location to the PC assembly level for the HP 54120B. Reading sections 6B, theory of operation, and 6C, service menu keys, will help in understanding this section.

Safety Considerations

The following warnings and cautions must be followed for your protection and to avoid damage to the equipment.

Warning

This instrument is equipped with a standby switch on the front panel that **DOES NOT** de-energize the power supply. To avoid shock hazards capable of causing injury or death, the main power switch on the rear panel must be used to de-energize the instrument or the power cable must be disconnected when the instrument must be de-energized.

Warning

Maintenance described in this section is performed with power supplied to the instrument and with protective covers removed. Maintenance should be performed only by trained service personnel who are aware of the hazards involved (for example, fire and electrical shock). Where maintenance can be performed without power applied, the power should be removed. Read the Safety Summary in the front of this manual.

Caution

Do not remove or replace any of the circuit board assemblies in this instrument unless instrument power is removed. The assemblies contain components which may be damaged if they are removed or replaced when instrument power is applied.

Recommended Test Equipment

Equipment recommended for service is listed in table 1-1. Any equipment that satisfies the critical specifications stated in the table may be substituted.

Logic Family Used

The logic level used on the HP 54120B Mainframe is TTL. TTL ranges from approximately 0 V to 5 V.

Diagnostic Overview

Start all diagnostics by first verifying the failure mode. Then follow the main troubleshooting flowchart, figure 6D-1, to determine if the failure is in the mainframe or data acquisition system. The flowchart covers the mainframe system troubleshooting (CPU, I/O, power supplies, keyboards and display system). Sometimes this section will refer to particular paragraphs in the four channel test set service manual. For data acquisition failures refer to the four channel test set service manual for these troubleshooting procedures.

One Key-down Power Up

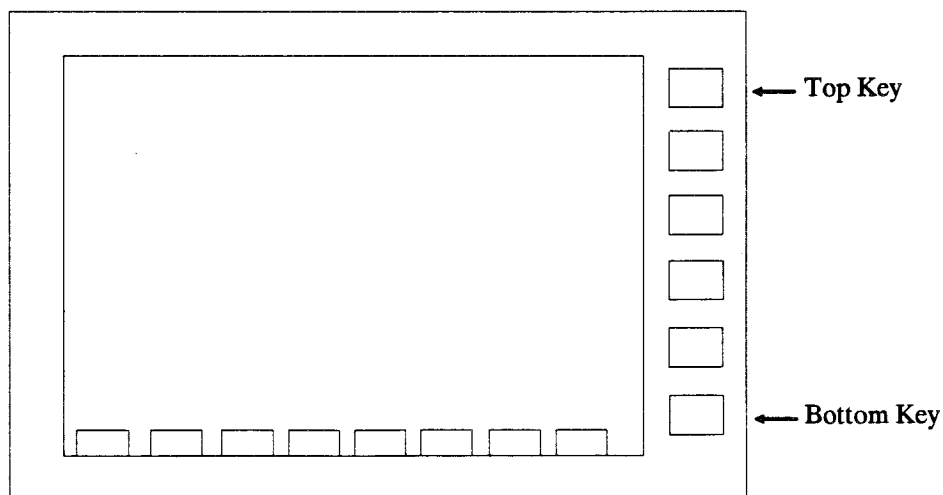
A one key-down power up places the instrument in a default condition. This default condition is identical to sending an HP-IB "RESET" over the bus. This allows users a known starting point to begin their test procedures from. Hold down any key while cycling the oscilloscope's power off and on. Continue to hold the key down until graticules are displayed on the screen.

Two Key-down Power Up

A two key-down power up sets up the instrument identical to a one key-down power up. It also clears all the RAM memory locations, resets all digital storage devices, clears vertical software calibration factors, and clears the channel to channel skew factors (clears channel attenuation cal factors in HP 54122T).

1. Turn oscilloscope's power switch to STBY.
2. Hold down the top and bottom function keys on the screen's rightside.
3. Turn oscilloscope's power switch to ON and continue holding function keys down until graticule display is on screen.
4. Ignore "Front Panel Cals Lost" warnings on top of screen, CALs will be performed later.

Keys to Hold down for two key-down powerup



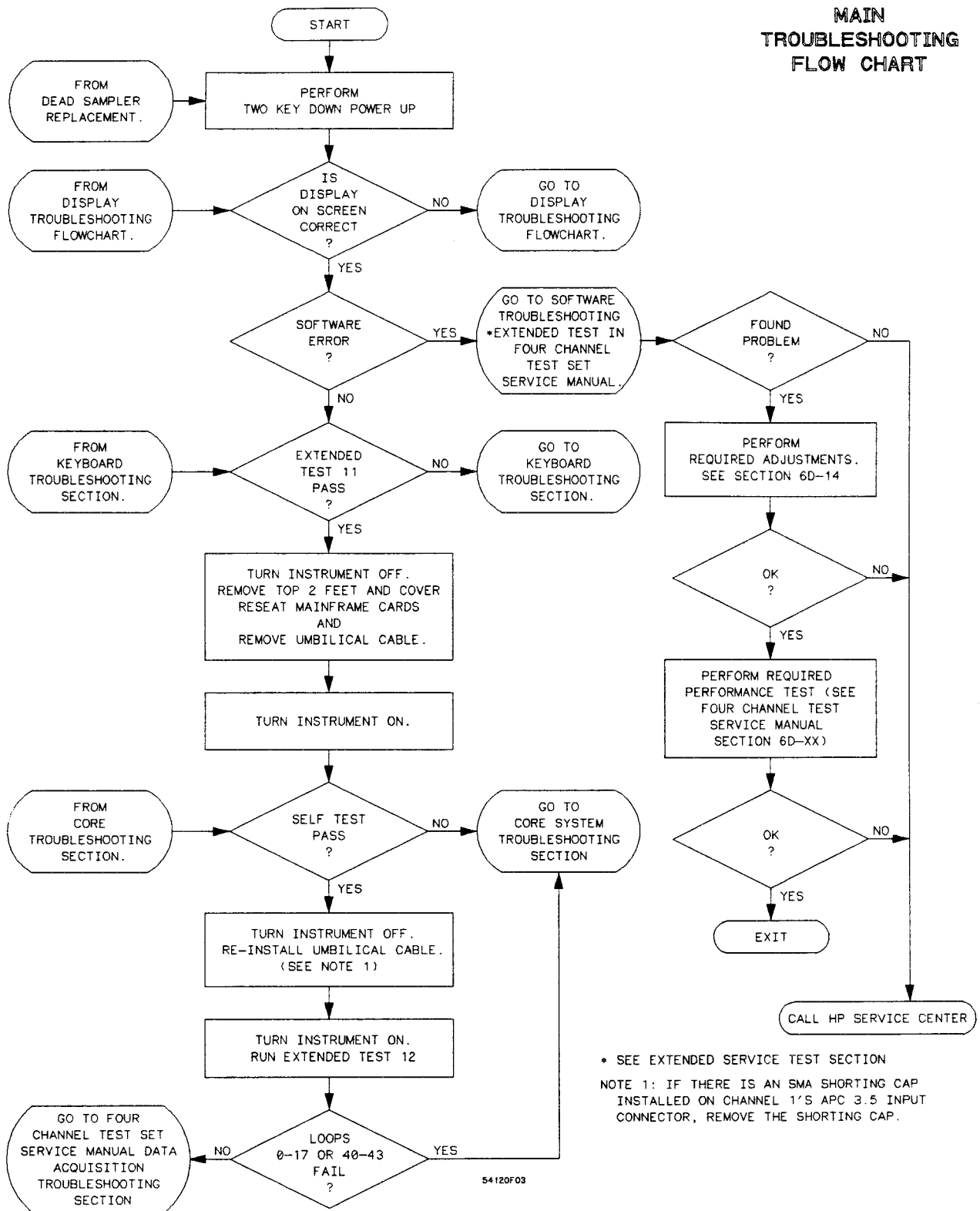


Figure 6D-1. Main Troubleshooting Flowchart

DISPLAY TROUBLESHOOTING FLOWCHART

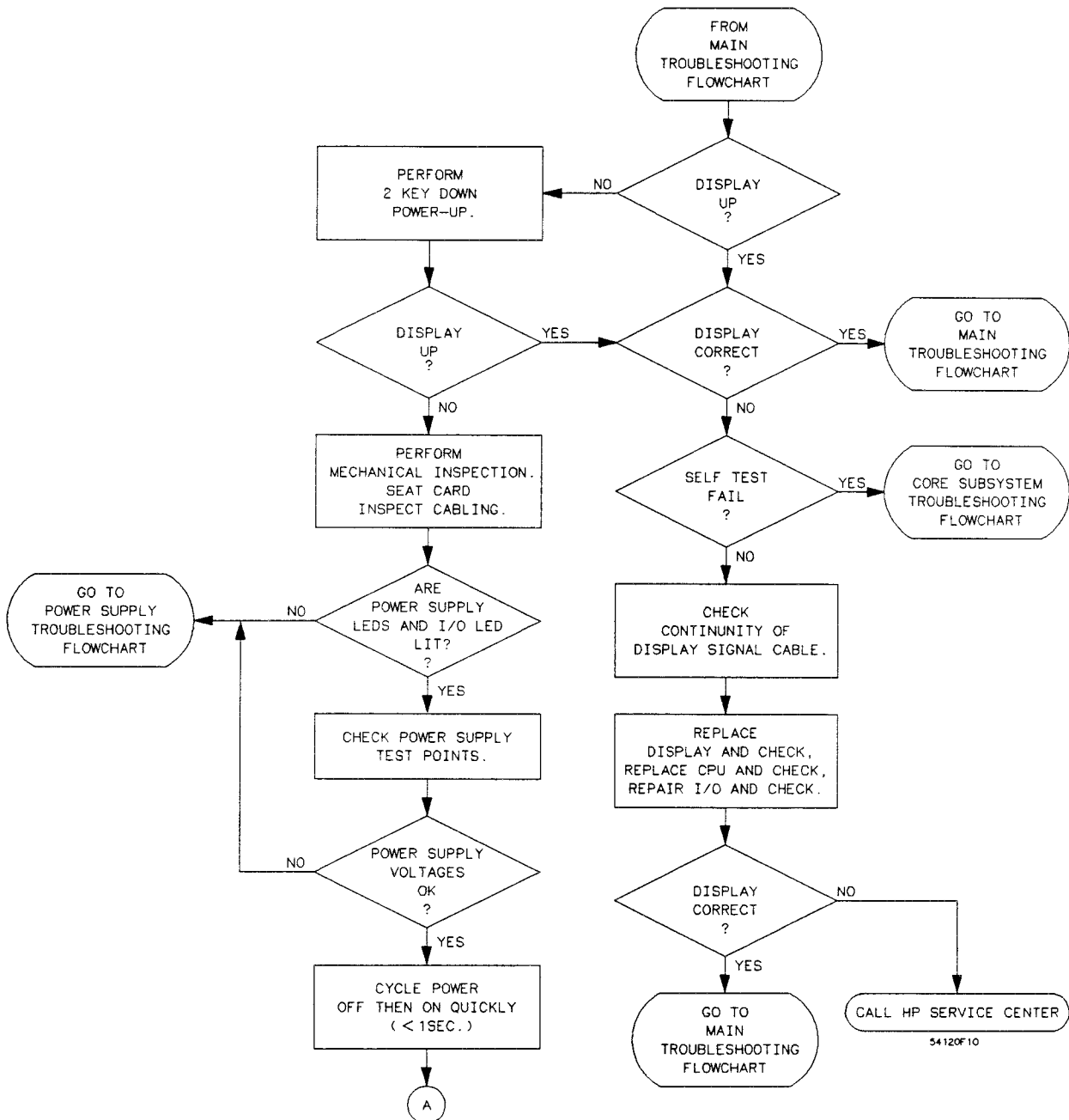


Figure 6D-2. Display Troubleshooting Flowchart Part 1

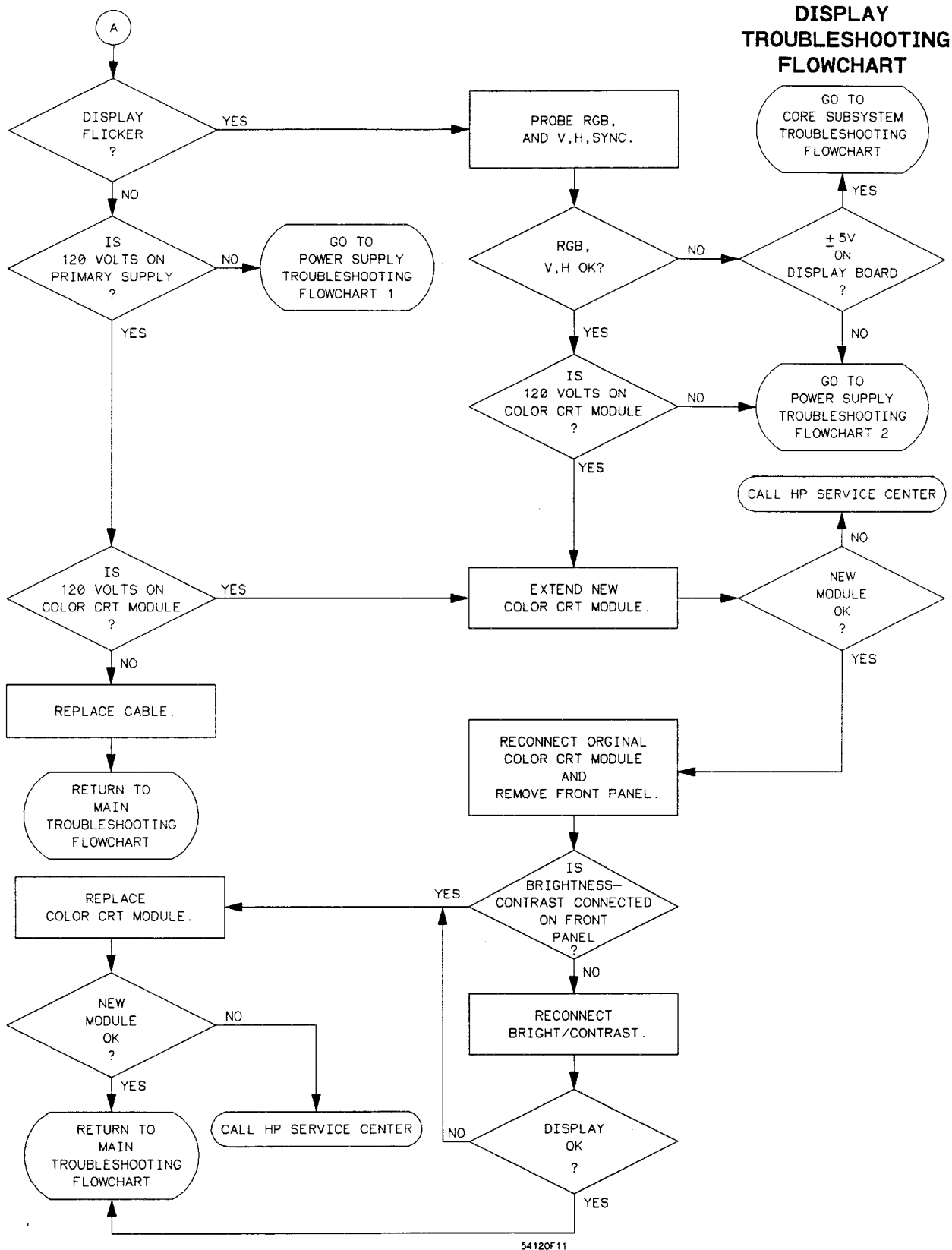


Figure 6D-3. Display Troubleshooting Flowchart Part 2

I/O Assembly Hard Reset

This reset is similar to powering the instrument off and on, except the power supplies are not lowered to 0 V. This reset is useful as a convenient method for resetting the instrument with the top cover removed. It can also be a good troubleshooting aid when there may be a failure with the instrument's normal power up routine.

Anytime the instrument has a power up problem it may help isolate the problem by trying the I/O assembly hard reset. Especially if the instrument has intermittent power up problems.

Keyboard Troubleshooting

Troubleshooting the keyboard uses flow diagram figure 6D-6 to isolate the faulty assembly to the I/O assembly, control keyboard, RPG, function keyboard, menu keyboard, or three interconnecting ribbon cables. Table 6D-2 describes what type signals are on the ribbon cables and figure 6D-5 is the cable's pin descriptions. Table 6D-1 describes which cable row and scan lines are used when the front panel keys are pressed. The softkey name assignments change with the different menu selections. Figure 6D-4 illustrates a numbering scheme for these softkeys.

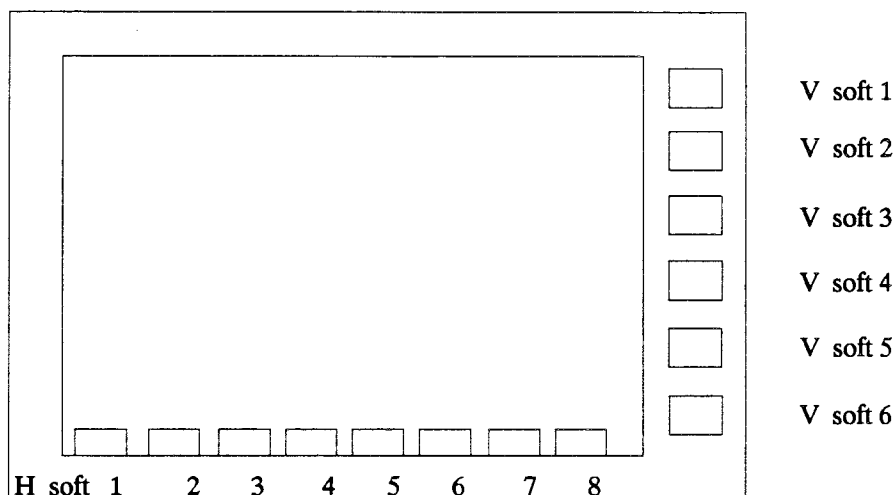


Figure 6D-4. Softkey Number Assignments

Table 6D-1. Row and Column Key Assignments

| | SC0 | SC1 | SC2 | SC3 | SC4 | SC5 | SC6 | SC7 |
|-----|----------|----------|---------------------------|-----|-----|-------------|-----------|-----|
| RL0 | H soft 1 | H soft 7 | Sec/Volt | 0 | 8 | Clear | Autoscale | ↑ → |
| RL1 | H soft 2 | H soft 8 | msec/mV | 1 | 9 | Run | | ← ↓ |
| RL2 | H soft 3 | V soft 6 | $\mu\text{s}/\mu\text{V}$ | 2 | | Stop/Single | | |
| RL3 | H soft 4 | V soft 5 | ns | 3 | | Save | | |
| RL4 | H soft 5 | V soft 4 | ps | 4 | | Recall | | |
| RL5 | H soft 6 | V soft 3 | | 5 | | Local | | |
| RL6 | | V soft 2 | | 6 | | | | |
| RL7 | | V soft 1 | | 7 | | | | |

Table 6D-2. Keyboard Ribbon Cable Signal Description

| Pin Description | Cable Pin No. | I/O Bd Pin No. | Signal |
|-----------------|---------------|----------------|--|
| SC0 | 6 | U12 pin 15 | 195 Hz, 60 mV to 2.8 V, 87% duty cycle, each slightly shifted in phase ↓ Single shot when present ↓ |
| SC1 | 5 | U12 pin 14 | |
| SC2 | 8 | U12 pin 13 | |
| SC3 | 7 | U12 pin 12 | |
| SC4 | 10 | U12 pin 11 | |
| SC5 | 9 | U12 pin 10 | |
| SC6 | 12 | U12 pin 9 | |
| SC7 | 11 | U12 pin 7 | |
| RL0 | 24 | U21 pin 38 | Single shot when present ↓ |
| RL1 | 26 | U21 pin 39 | |
| RL2 | 28 | U21 pin 1 | |
| RL3 | 30 | U21 pin 2 | |
| RL4 | 23 | U21 pin 5 | |
| RL5 | 25 | U21 pin 6 | |
| RL6 | 27 | U21 pin 7 | |
| RL7 | 29 | U21 pin 8 | + 5 V 0 V 0 V |
| RPG | 17 | U34 pin 2 | |
| RPG | 18 | U13 pin 12 | |
| Not Used | 13 | U40 pin 3 | |
| Not Used | 16 | U39 pin 6 | |
| Not Used | 14 | U28 pin 11 | |
| + 5 V | 1-4 | U20 pin 13 | |
| Not Used | 33, 34 | | |
| DGND | 15, 21, 22 | | |
| DGND | 31, 32 | | |
| Not Used | 19 | | |
| Not Used | 20 | | |

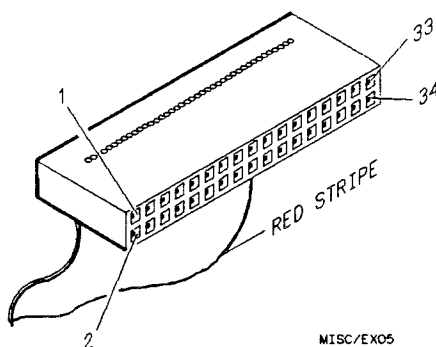
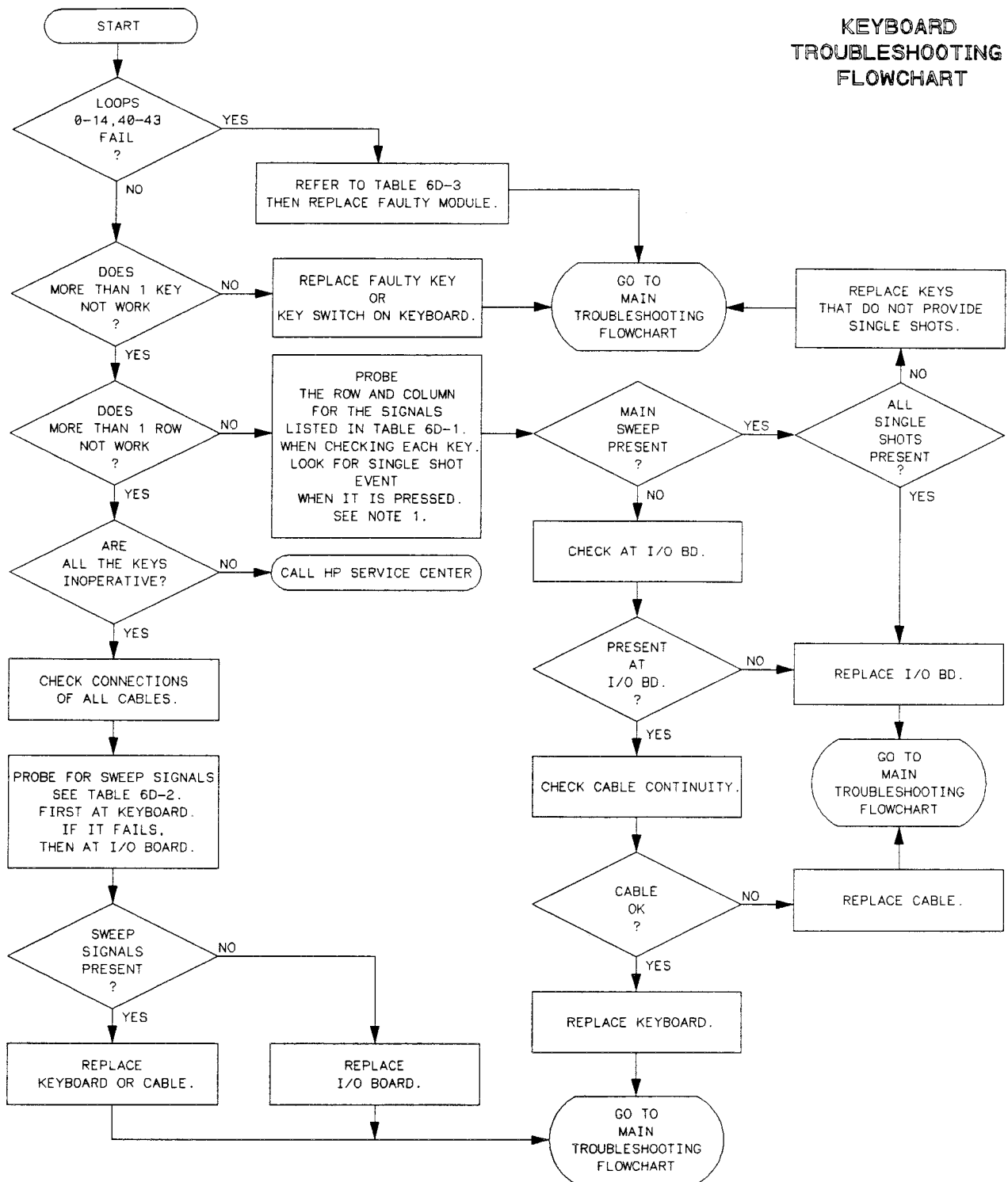


Figure 6D-5. Keyboard Cable Pin Numbers



54120F 12

Figure 6D-6. Keyboard Troubleshooting Flowchart

Core Subsystem Troubleshooting

There are two core subsystem troubleshooting methods. If the loop test information is on the screen, use table 6D-3. If the display or keyboard systems are locked up, use figure 6D-7.

It is preferable to get the HP 54120B to pass all the Core Tests before going on to fix more complex loops. Occasionally, bent motherboard pins or defects in other system elements will cause these loops to fail. Make a system of the microprocessor assembly, I/O assembly and one other assembly. It is then possible to determine which socket or assembly may be causing an interaction that causes one of the core loops to fail. Using this technique, seat each assembly into the motherboard one at a time. Be sure to turn the power off before raising or seating an assembly into the motherboard.

If only the microprocessor and I/O assemblies are seated, the system will go into a repeating multicolored routine with about a two second cycle. This is useful in certain troubleshooting situations but no loop error information will be available.

Table 6D-3. Core Subsystem Diagnostic Routines

| Test Loop | Probable Failing Assembly |
|-----------|---------------------------|
| 0-4 | Microprocessor Assembly |
| 5-9 | Display Assembly |
| 10-15 | I/O Assembly |
| 40 | Microprocessor Assembly |
| 41, 42 | Display assembly |
| 43 | I/O Assembly |

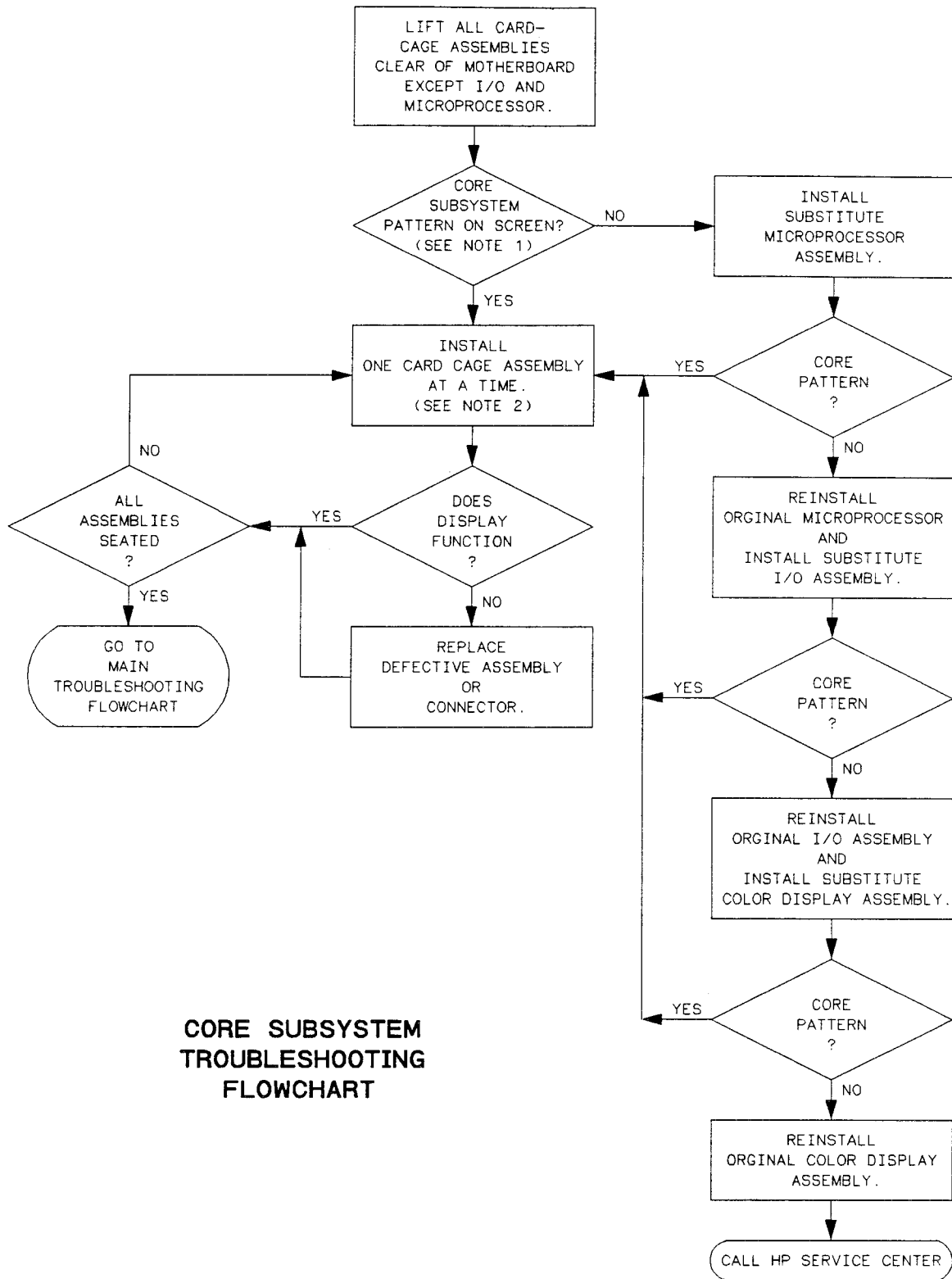
Power Supply Troubleshooting

When a power supply problem is suspected, it is first important to make sure that no unusual load is keeping the supply in a current limited condition. Table 6D-4 indicates which supplies are used on each assembly. Start the power supply troubleshooting with figure 6D-8.

Table 6D-4. Power Supply Distribution

| | +120 V | +18 V | +8 V | +5 V | -5 V | -8 V | -18 V |
|--------------------|--------|-------|------|------|------|------|-------|
| Microprocessor | | | | * | | | |
| Input/Output † | | * | * | * | * | * | * |
| Horizontal Control | | * | * | * | | * | * |
| ADC Assembly | | * | * | * | | * | * |
| Color Display | | | | * | | | |
| Color CRT Module | * | | | | | | |
| To Test Set | | | | | | | |
| From ADC | | * | | | | | * |
| From Horizontal | | * | * | | | * | * |

† Only the +5 V is used for power. The other supplies connect for power test only and are high impedance points; the likelihood of loading these supplies is low.



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Figure 6D-7. Core Subsystem Troubleshooting Flowchart

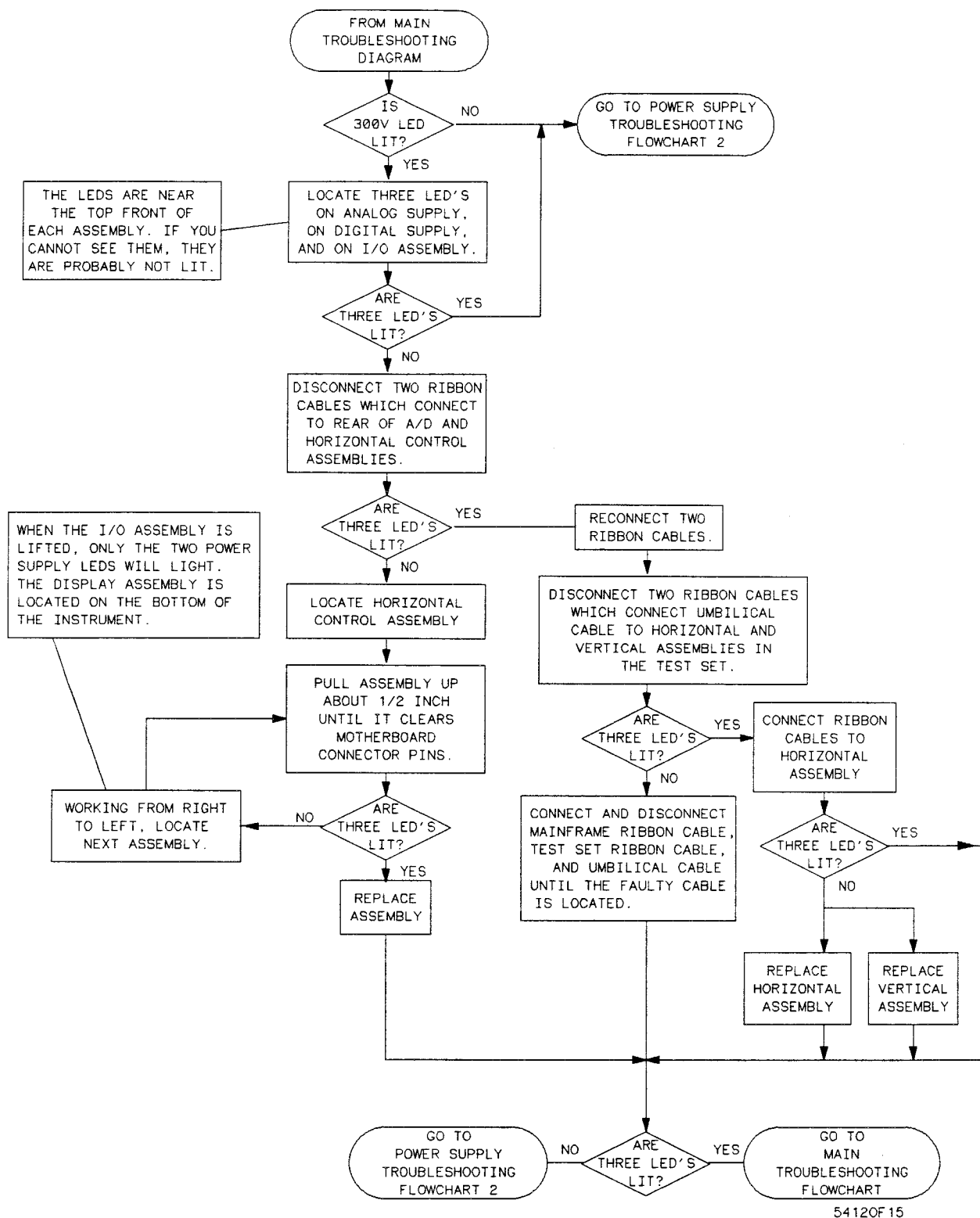
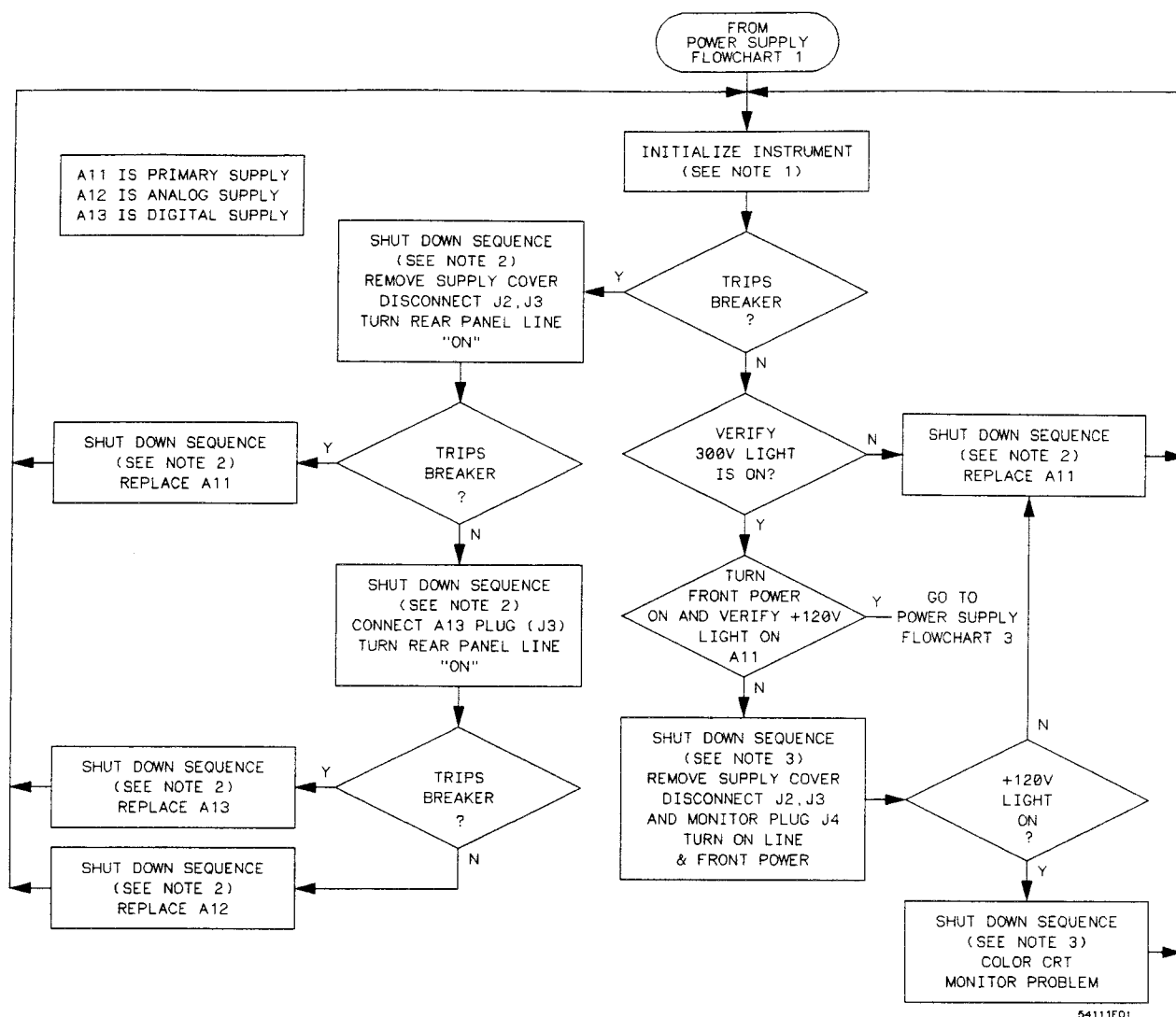


Figure 6D-8. Power Supply Troubleshooting Flowchart 1

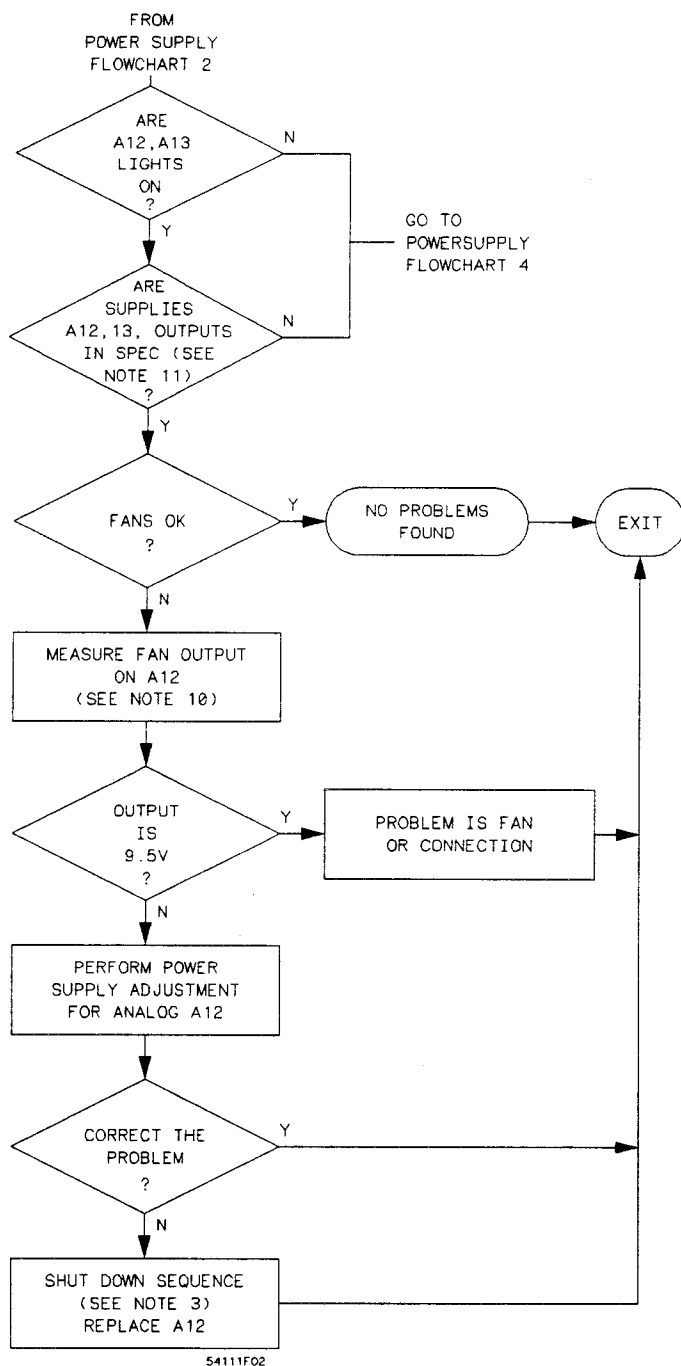


Notes for Flowchart 2

- 1) A. Turn front panel power switch to standby
B. Rear panel line switch should be OFF "0"
C. Connect AC power source
D. Turn rear panel line switch to ON "1"
- 2) A. Turn rear panel line switch to OFF "0"
B. Always unplug AC power source
C. CAUTION!!! Wait until + 300 V light is completely off (about 3 minutes) before proceeding; shock hazard exists and you can cause damage to the instrument
- 3) A. Turn rear panel switch to standby
B. Turn rear panel line switch to OFF "0"
C. Always unplug AC power source
D. CAUTION!!! Wait until + 300 V light is completely off (about 3 minutes) before proceeding; shock hazard exists and you can cause damage to the instrument

Warning
Extreme caution must be taken when removing power supply cover

Figure 6D-9. Power Supply Troubleshooting Flowchart 2



A11 is Primary Supply
A12 is Analog Supply
A13 is Digital Supply

Notes For Flowchart 3

- 3) A. Turn front panel switch to standby
- B. Turn rear panel line switch to OFF "0"
- C. Always unplug AC power source
- D. **CAUTION!!!** Wait until + 300 V ligh is completely off (about 3 minutes) before proceeding; shock hazard exists and you can cause damage to the instrument!!!

10) Connect the voltmeter (+) lead to the "FAN" test point and the (-) lead to the -18 V test point. The reading should be 9.5 V. This voltage will increase with increasing ambient temperature. See the power supply adjustment procedure for the analog supply.

11) For power supply test points and specifications see table below.

| Digital Supply Test Points | | Voltage |
|----------------------------|----------|---------------------|
| (+) Lead | (-) Lead | |
| +5 V | GND | +5.10 V \pm 0.1 V |
| -5 V | GND | -5.30 V \pm 0.1 V |
| +14B | GND | +5 V |
| Analog Supply Test Points | | Voltage |
| (+) Lead | (-) Lead | |
| +18 V | GND | +18.5 V \pm 0.3 V |
| +8 V | GND | +8.9 V \pm 1 V |
| -8 V | GND | -8.5 V \pm 1 V |
| -18 V | GND | -18.5 V \pm 0.3 V |
| FAN | -18 V | +9.5 V \pm 0.3 V |
| +26B | GND | +5 V |

Figure 6D-10. Power Supply Troubleshooting Flowchart 3

Notes For Flowchart 4

Caution

- 3) Turn front panel switch to standby
Turn rear panel line switch to off "0"
Always unplug ac power source
-

Wait until +300 V light is completely off (about three minutes) before proceeding; shock hazard exists and you can cause damage to the instrument.

- 4) The nominal output for +14B is 21V. However, when the supply is operating in the current limit mode, it can be as low as +5 V. The nominal output for +26B is 26 V. It can also be as low as +5 V when in current limit.
- 5) Measure ± 5 V on the digital power supply. If both outputs are \leq half the normal output, then use the yes path. Otherwise, use the no path.
- 6) When the supply or supplies are running in the current mode this may mean that an external load is pulling down the supply output(s). An external load could be a board in the card cage or the color display assembly (not the color crt module). the only way to isolate the color display assembly is to completely remove it from the mainframe. The fans can also put the analog board into the current mode. You can disconnect the fans by removing the bottom cover and disconnecting the fan cable.

To isolate a current problem, first disconnect the test set, then remove one load at a time until the problem is found. Problems could include bent pins on the motherboard or a bad component on a PC assembly. Refer to table 6D-4 for power distribution to the various assemblies.

- 7) Measure ± 18 V and ± 8 V on the analog supply. If both outputs are \leq half the normal output, then use the yes path. Otherwise use the no path.
- 8) The test points to measure +14.6 V are at the back of the board close to the top. Connect the voltmeter common lead to the "COM" test on the board.

Caution

Use caution when measuring this voltage. It is not isolated from the line (mains) input and the primary supply is exposed with the power supply cover removed.

- 9) By removing the connectors at J2 and J3 you are checking if either the analog or digital supply is loading VCNTL.
-

Caution

The top pin on connectors J2 and J3 is VBULK which is +300 V. The pins below are VCNTL, then ground.

To measure VCNTL, turn the power off and make sure the +300 V lamp (near top of board) is off. Connect the voltmeter (+) lead to VCNTL (second pin from top) and the (-) lead to ground (bottom pin). Apply power and observe the meter reading. With one supply connected the reading should be about +25 V and with neither connected about +42 V. Turn off power and ensure +300 V LED is off before removing the voltmeter leads.

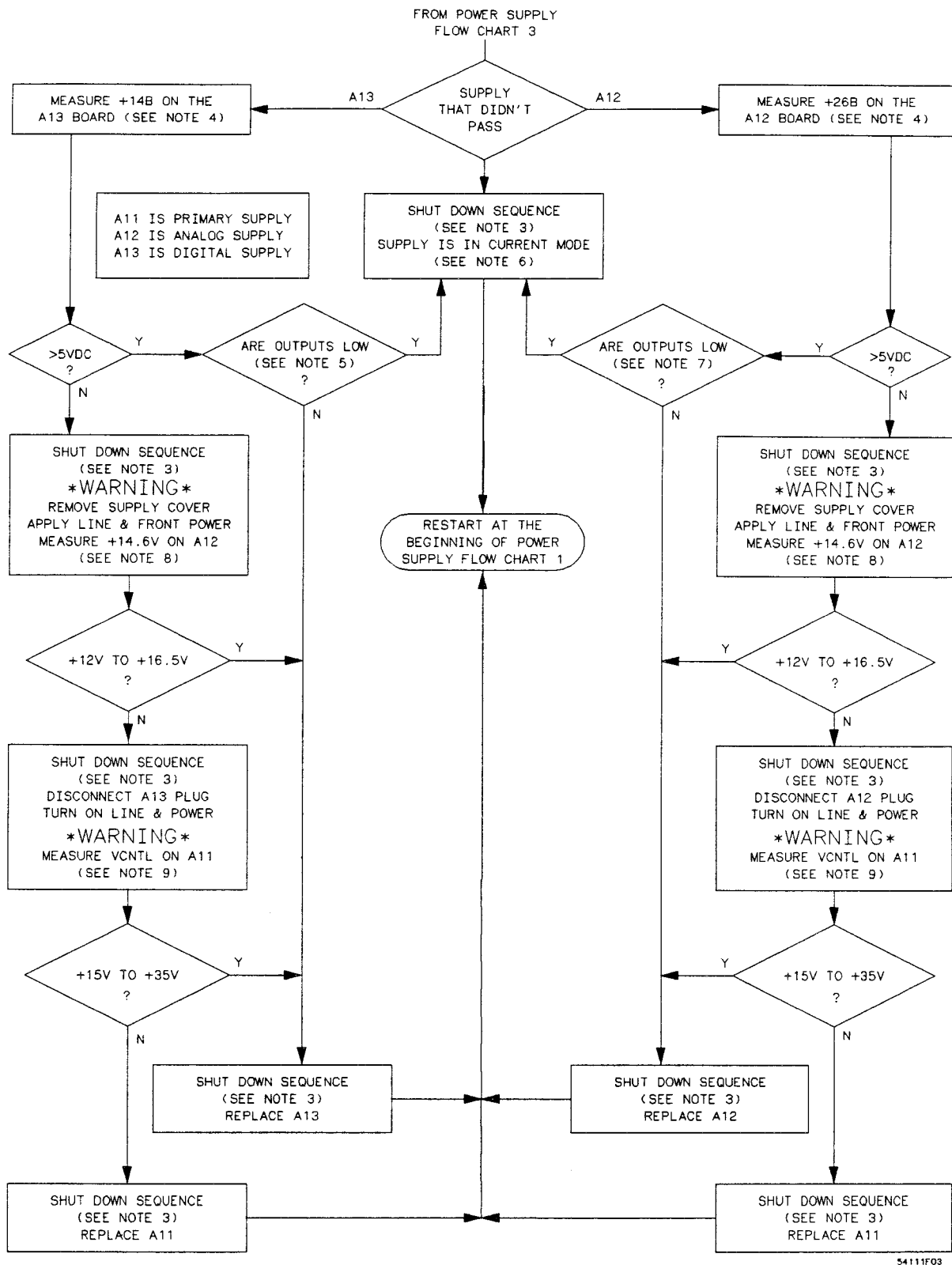


Figure 6D-11. Power Supply Troubleshooting Flowchart 4

Color Monitor Troubleshooting

This test determines if the color monitor is faulty by checking horizontal sync pulses (HSYNC), vertical sync pulses (VSYNC), and color pulses (RGB) at the color monitor's input connector.

1. Turn mainframe's power switch to STBY.
2. Remove the mainframe's top and bottom covers.
3. Turn the mainframe's power switch to ON.
Check the +120 V at the module power connector. Refer to figure 6D-12. The correct voltage should be between +118 V and +122 V. If the +120 V supply is incorrect, refer to the power supply troubleshooting procedure.

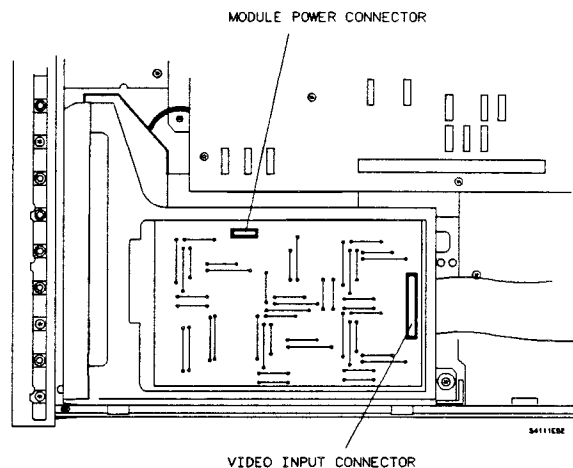


Figure 6D-12. Color CRT Module Input Connections

4. Move the clear plastic shield on the bottom of color CRT module by pushing it rearward until it clears the front frame. Hinge the clear plastic shield away from the board.
5. Connect 10:1 divider probes to monitor oscilloscope. Connect channel 1 to vertical sync test point, pin 3 of video input connector. Connect channel 2 to horizontal sync test point, pin 7 of video input connector. The vertical and horizontal sync pulses are TTL levels and should resemble figure 6D-13.

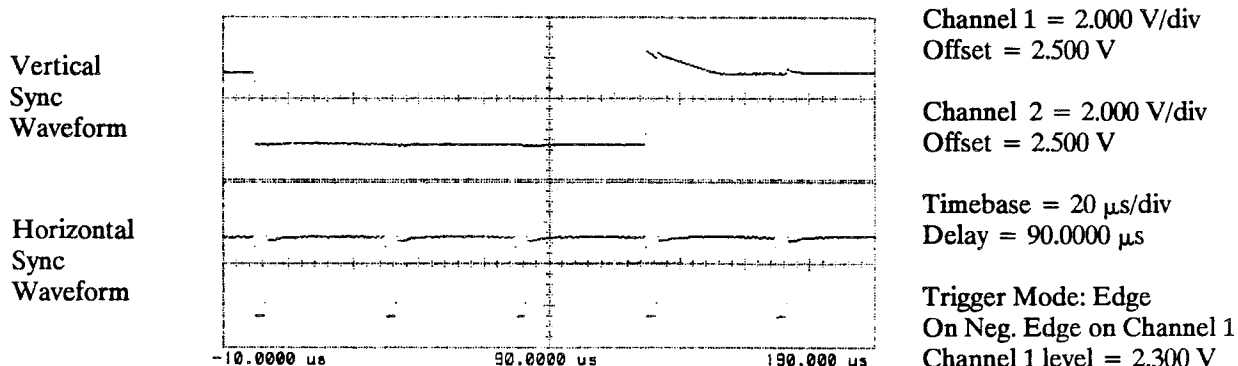


Figure 6D-13. Vertical and Horizontal Sync. Waveforms

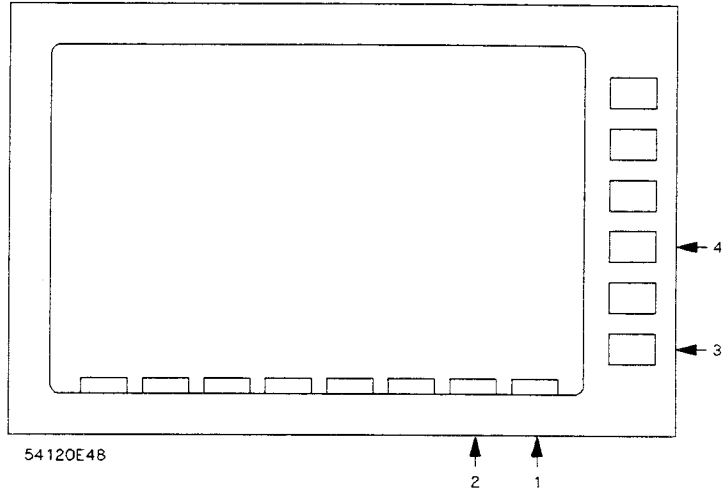
6. Before checking the video waveforms, try to get a known display on screen. If the display is operating, press the **More**, **Utility**, **CRT Setup** menu, and **Color Purity** keys. This will place a white raster on screen which means all video signals will be at maximum levels. If there is no display, try to get the same signals by pressing the following softkeys.

In Bottom Row Press:

1. Key at extreme right
2. Key second from right

In Vertical Column Press:

3. Key at bottom
4. Key third from bottom



7. Probe the following points. The video signals have a 0 V baseline and will vary in amplitude from 0 V to approximately 600 mV, depending on the characteristics of the colors displayed.

| Video Signal | Video Input Connector |
|--------------|-----------------------|
| red | 21 |
| green | 29 |
| blue | 37 |

8. The video signals can be loaded down by the color CRT module's input circuits. If the video signals were bad in step 8, disconnect the cable from the video input connector and recheck the signals on the color display assembly.

| Video Signal | J2 on Display Assembly |
|--------------|------------------------|
| red | 14 |
| green | 18 |
| blue | 22 |
| Sync Signals | On Display Assembly |
| Vert. sync | V.Sync TP |
| Horz. sync | H.Sync TP |

9. If the video signals are now good, replace the color CRT module.

Color CRT Module Troubleshooting



It is time consuming to remove a suspected faulty color CRT module from the instrument. This test connects a good color CRT module outside the instrument without having to remove the suspected faulty monitor. This requires the use of parts from the HP 54100 family product support kit.

Chassis ground on the color CRT module will be disconnected from the chassis ground of the instrument. This will leave the color CRT module chassis ground floating. Therefore, use an alligator clip lead to connect the monitor's chassis ground to the instrument's chassis ground.

1. Turn mainframe's power switch to STBY and remove power cable.
2. Remove mainframe's top and bottom covers.
3. Disconnect color CRT module power cable from primary power supply.
4. Connect a replacement power cable (54110-61601) from the product support kit to the primary power supply.
5. On instrument's bottom side, disconnect the wide ribbon cable from the suspected faulty color CRT module and extend it away from the instrument.
6. Place the known good color CRT module next to the instrument.
7. Connect the wide ribbon cable to the working color CRT module.
8. On the working color CRT module's bottom PC board is a connector labeled B-4, connect the power cable (from step 4) to this connector.
9. On the working color CRT module's bottom PC board is a connector labeled B-2, connect a display control cable from the product support kit to this connector.
10. Connect the CRT brightness control from the product support kit to the other end of the display control cable.
11. Reconnect the power cord and turn the instrument on.
12. If the display is now operational, the suspected faulty color CRT module in the instrument is bad.

Firmware Troubleshooting

Some failures cause the keyboards to lock up and prevent you from entering the troubleshooting menus. This procedure isolates which assembly is causing the problem. After the problem is repaired, return to the flow diagram.

1. Perform two key-down powerup routine.
2. Turn mainframe's power switch to STBY and remove the horizontal and A/D assemblies from the mainframe. Remove the ribbon cables from the assemblies.
3. Turn mainframe on. If there is a graphics pattern (core troubleshooting pattern) repeated displayed, go to step 4; otherwise go to step 10.
4. Turn mainframe's power switch to STBY and install the horizontal control assembly in the mainframe. Do not connect the ribbon cable.
5. Turn the mainframe's power switch to ON. If the core troubleshooting pattern is displayed on screen and the keyboards and display are still functional, go to step 6; otherwise replace the horizontal control assembly and return to flow diagram.
6. Turn the instrument's power switch to STBY and install the A/D assembly in the mainframe. Do not connect the ribbon cable.
7. Turn mainframe on. If the keyboards and display are still functional, go to step 8; otherwise replace the A/D assembly and return to flow diagrams.
8. Turn the mainframe's power switch to STBY and connect the ribbon cable to the horizontal control assembly only.
9. Turn mainframe on. If the keyboards and display are still functional, go to step 9; otherwise continue with step 8's instructions. Disconnect umbilical cable from test set. If display and keyboards are still functional, replace the horizontal assembly in the test set and return to the flow diagram. Disconnect umbilical cable from the mainframe. If the display and keyboards are still functional replace the umbilical cable and return to the flow diagram; otherwise replace the ribbon cable.
10. Turn the mainframe's power switch to STBY and connect the ribbon cable to the A/D assembly only.
11. Turn mainframe on. If the keyboards and display are still functional, go to step 9; otherwise continue with step 9's instructions. Disconnect umbilical cable from test set. If display and keyboards are still functional, replace the vertical assembly in the test set and return to the flow diagram. Disconnect umbilical cable from the mainframe. If the display and keyboards are still functional replace the umbilical cable and return to the flow diagram; otherwise replace the ribbon cable.

12. Replace the following assemblies in order and check the core troubleshooting pattern each time: CPU assembly, display assembly, I/O.

13. Return to the flow diagram.

Additional Troubleshooting

Data acquisition and internal diagnostic troubleshooting is included in the four channel test set service manual.

Table of Contents

General Information

| | |
|---|------|
| Safety and Handling Precautions | A1-1 |
| Incoming Inspection | A1-1 |
| Equipment Required But Not Supplied | A1-2 |

Accessory Kit Devices

| | |
|---|------|
| Introduction | A2-1 |
| 7.5 cm Beadless Airline | A2-1 |
| 15 cm Beadless Airline | A2-3 |
| Model 909D 50 Ω Terminator | A2-3 |
| Coaxial Attenuators | A2-4 |
| Coaxial Short | A2-5 |
| Test Port Return Cables | A2-5 |
| Adapter (m-m) | A2-7 |
| Semi-Rigid L Connector | A2-7 |
| Power Splitter | A2-7 |

Making Accurate Measurements

| | |
|---|------|
| Introduction | A3-1 |
| Operating Conditions and Procedures | A3-1 |
| Device Specifications | A3-2 |
| SMA Inspect | A3-3 |
| Alignment | A3-3 |
| Mismatch | A3-3 |

Making Good Connections

| | |
|--|------|
| Introduction | A4-1 |
| Handling Precision 3.5 mm Connectors | A4-1 |
| Visual Inspection and Cleaning | A4-2 |
| Mechanical Inspection | A4-4 |
| Center Conductor | A4-4 |
| Outer Conductor | A4-4 |
| Connecting the Devices | A4-8 |
| Counter-Rotation Technique | A4-8 |

Safety and Handling Precautions

Precautions that apply generally to Hewlett-Packard equipment, including the HP 54007A Accessory Kit, are explained in the Safety Considerations page. The devices in the kit, however, are not mechanically, electrically, or chemically hazardous, so no special safety precautions are necessary.

Extreme care must be taken in handling and storing these devices to protect them from mechanical damage. This is especially true in making connections, in order to avoid damaging the connectors and to avoid damaging the HP 54120 system by electrostatic discharge (ESD). A detailed discussion of connection procedures appears later in this manual.

The devices in the HP 54007A Accessory Kit have very precise mechanical tolerances, some on the order of one ten-thousandth of an inch (a few microns). Therefore, rough handling of any kind must be avoided. Do not permit any of the devices to fall on any hard surface or come in contact with dirt, oils, or abrasives. The connectors must be clean and undamaged to ensure an accurate calibration.

The foam-lined storage case in which you receive the accessory kit is the best place to store the devices. Never store any of the devices loose, in a desk drawer, or place them contact-end down on a table top. The lid of the storage case is detachable and allows convenient storage, even in a shallow desk drawer.

Incoming Inspection

The foam-lined storage case provides enough protection for the accessory kit during shipping. If the case arrives in good condition, the devices are probably in good condition. If the case or devices appear to have been damaged, set aside the accessory kit and all packaging materials, contact the nearest Hewlett-Packard sales/support office.

Hewlett-Packard will arrange for repair or replacement of incomplete or damaged shipments without waiting for a settlement from the transportation company.

Equipment Required But Not Supplied

If you will be using SMA connectors in your calibrations or test setups, a precision connector gauge for measuring the contact pin locations of SMA connectors, as well as for connecting 3.5 mm precision connectors, is recommended. Please read the caution about SMA connectors (see Chapter 3 of this appendix, "Device Specifications"). Precision connector gauges for SMA connectors are available from Maury Microwave Corporation.

A few tools are required to make safe and repeatable connections with either the precision 3.5 mm connectors or SMA connectors.

- Torque wrench (optional) capable of 8 lb-in (90 N-cm) to install precision 3.5 mm devices to each other and the front panel connectors (HP part number 8710-1765).
- Torque wrench (optional) preset to 5 lb-in for mating SMA connectors to precision 3.5 mm connectors (HP part number 8710-1582).

All precision 3.5 mm connectors must be visually inspected before use and cleaned (or replaced) as needed. The following equipment is required for cleaning:

- An illuminated, 4-power magnifying glass for visual inspection of the connectors. The exact power of the glass is not critical, but the type of illumination is. Ordinary room lighting, or oblique lighting from a desk lamp casts shadows that can easily mask the small defects you are trying to see. Therefore, make sure that the magnifying glass has built-in lighting and provides axial, shadowless illumination. Illuminating magnifying glasses are available from most equipment suppliers. Hewlett-Packard does not sell or recommend any particular model.
- Compressed air in a pressurized can, HP part number 92193Y, can be used to blow dust and lint from the connectors. Any source of clean, dry, low-pressure air can be used if it has an effective oil-vapor filter and condensation trap placed just before the air outlet hose.

When using compressed air from a pressurized can, hold the can upright. If the can is tilted or inverted, the liquid propellant sprays out with the air. The propellant evaporates instantly on the connector surface and causes the connector to become too cold for the calibration to continue. If this happens, you must wait until thermal equilibrium is re-established within the allowable temperature range before continuing the calibration. Permanent connector damage from the propellant is unlikely.

- Liquid Freon (trichlorotrifluoroethane), HP part number 8500-1914, CD 7, is the only cleaning solvent recommended by Hewlett-Packard for cleaning 3.5 mm connectors. Several types of liquid Freon exist, so make sure that the kind you use contains only trichlorotrifluoroethane. Some other types contain harmful compounds which can damage precision connectors. A liquid is preferred over spray because the liquid can be applied sparingly and selectively. If a spray must be used, spray the cleaning swab only, not the connector.

Do not use any solvents other than liquid Freon. They can leave residues that react destructively with the metal plating on the connectors, or erode essential plastic dielectric supports. Along with your supply of solvent, keep a microscope slide or a similar piece of clear glass to check the solvent periodically for contamination.

- Plastic foam swabs, HP part number 9300-0468 CD 1, are used along with liquid Freon to clean the connector surfaces. These swabs resemble common swabs, but have lint-free plastic foam tips.

Introduction

This chapter describes and explains the uses of the components of the HP 54007A Accessory Kit. All precautions apply to the uses covered in this chapter.

7.5 cm Beadless Airline

A 7.5 cm beadless airline has been included in the HP 54007A Accessory Kit for use in discontinuity separation and isolation. This device, although not a perfect termination, can improve and reduce reflections, increase the round-trip time of reflections, or isolate perturbations in the circuit.

The airline is a known 50 Ω load and is a good reference. Due to this fact, the primary uses are as follows:

1. The primary use of the 7.5 cm beadless airline is to separate perturbations. If you place a known load between perturbations you can separate known perturbations from those in the device-under-test and evaluate each individually.
2. The airline can be used as a precision 50 Ω load during reflection calibrations. Place the airline at the reference plane and increase the timebase until the end of the airline is offscreen (to the right). This yields a 50 Ω reference dependent only on the mechanical dimensions of the airline.
3. By placing the airline on the four channel test set, the device-under-test can be separated from the incident edge. This is convenient for viewing data that is close to the incident edge, plus you can see the 50 Ω reference more clearly in relation to the device-under-test.

Connecting the 7.5 cm beadless airline is a very sensitive procedure. More care must be taken than for normal connections. First verify that the center conductor is properly oriented when installed; the male end of the center conductor should be at the end of the outer conductor with the connector nut.

Caution



Wear a grounded wrist strap and discharge static electricity by grasping the outer shell of the test port briefly before you begin making the connection. When connecting the airline, you are touching exposed center conductors that are connected to the internal circuits of the HP 54120 series.

The airline is small, and the center and outer conductors are almost the same length, so connecting the center conductor at the same time as the outer conductor is difficult. But, it is also difficult to slide the outer conductor over the center conductor without risking damage to the inner surface of the outer conductor. Therefore, check the center conductors to see if they have mated after the outer conductors have been loosely connected. Pressing gently on the end of the center conductor with a plastic rod will usually mate the conductors.

Connect the airline as follows:

1. Retract the connector nut on the airline fully. Put the center conductor into the airline and verify that the female end of the center conductor emerges from the female end of the outer conductor. This end will be connected to the test set.
2. Hold the airline and center conductor, bring both the airline and center conductor to the test port connector. Carefully align and mate the center conductors. Then make a preliminary connection by fastening the test set connector nut finger tight. In handling the center conductor, use lint-free gloves or finger cots.
3. When the preliminary connection has been made, verify that the center conductors have mated by pressing gently on the end of the center conductor with a plastic rod.
4. Connect the termination device to the opposite end of the airline. Carefully align and mate the center conductor of the device with the center conductor of the airline. Then make a preliminary connection of the terminating device and the airline by fastening connector nut finger tight.

Now make the final connections:

5. Start at the test port with the counter-rotation technique (see Figures A4-8 and A4-9) to eliminate air wedges from this connection. After counter-rotation, retighten the connection finger tight and use a torque wrench to make the final connection. Support the airline when making connections to avoid applying lateral or vertical (bending) force.
6. Tighten the connection of the termination device or adapter on the airline with the counter-rotation technique. You will have to hold the airline firmly to prevent loosening the test port connection. After counter-rotation, retighten the connection finger tight and use the 3.5 mm connector torque wrench to make the final connection.

Disconnect the airline by reversing the above procedure.

15 cm Beadless Airline

The 15 cm airline is not included in the HP 54007A Accessory Kit. This device will enhance testing lines and reading reflections by extending the time before they are returned and displayed. The time extension is significant. It will allow you to take measurements without the fear of a known perturbation in the circuit. The 15 cm beadless airline gives greater separation between a known perturbation and perturbations of the device-under-test.

Connection procedures are the same as for the 7.5 cm airline.

The HP 54007A storage box has been designed to accommodate the 15 cm beadless airline.

Model 909D 50 Ω Terminator

The HP 909D is a precision, low-reflection load for terminating 50 Ω coaxial systems in their characteristic impedance. When trying to normalize out gross perturbations the precision 50 Ω becomes more important. The HP 909D is used to improve the quality of precision reflection measurements and normalize the HP 54120 system to precision specifications.

The HP 909D comes with the rugged APC-3.5 connector for measurement repeatability even after hundreds of connections.

The performance is specified to 26.5 GHz. Based on limited tests the expected SWR at 34 GHz is in the range of 1.3, and the HP 909D will operate to 39 GHz before higher mode resonances have any significant effect.

Impedance stability with both time and temperature, a key parameter for precision terminations, is achieved by using tantalum nitride on sapphire thin film technology.

Maintenance

The HP 909D is used for precise measurements so it must be kept in top operating condition. Hewlett-Packard recommends that the connector be inspected periodically and cleaned if necessary. It is also recommended that the HP 909D be verified annually or after 1000 connections.

Specifications

Frequency Range: dc to 26.5 GHz

Impedance: 50 Ω

SWR: 1.02, dc-3 GHz 1.036, 3-6 GHz 1.12, 6-26.5 GHz (At 26.5 GHz the typical SWR is 1.1. Statistically, 90% of the terminators produced will meet this performance).

Power Rating: 2 W ave. @ 20° C derated to 1 W ave. at 75° C 100 W peak (10 μ s max. pulse width) @ 20° C

Connector: APC-3.5 male; Opt.. 011, APC-3.5 female.

Dimensions: 23 mm x 4 mm diameter (0.91 in x 0.16 in diameter).

Environment

In a non-operating environment the terminator should be stored in a clean, dry place. The following environmental limitations apply to both storage and shipment (unless stated otherwise in the Data Sheet).

- Temperature: -55° C to +75° C
- Humidity: 95% relative @ +40° C
- Altitude: 15,300 metres (50,000 ft)

The operating environment of the instrument should be within the following limitations (unless stated otherwise in the Data Sheet).

- Temperature: 0° C to +55° C
- Humidity: 95% relative at +40° C
- Altitude: 4500 meters (15,000 ft)

Caution



Storage or operation of the instrument in an environment other than that specified may cause damage to the instrument and may void the warranty.

Coaxial Attenuators

The HP 33340C coaxial fixed attenuator offers broad frequency coverage, low SWR and small size. The attenuator is available in nominal attenuation values of 3, 6, 10, 20, 30 and 40 dB. It is fully tested to meet specifications at all frequencies and over most of the frequency band. It will typically perform much better than specified.

The HP 33340C attenuator is included in this kit in the 6 dB and 40 dB values.

Applications

One of the main applications is to reduce the power to critical microwave circuits and avoid possible damage. Another application is to "pad" badly matched devices, such as mixers in order to minimize SWR. Use of the HP 33340C will not only protect your instrument, it also increases the input signal range.

Specifications

Frequency range: dc - 26.5 GHz

| | | |
|------------------------------|--------|--------|
| Attenuation Accuracy: | 6 dB | 40 dB |
| dc-18.0 GHz | 0.6 dB | 1.0 dB |
| dc-26.5 GHz | 0.6 dB | 1.3 dB |

| | | |
|---------------|------|-------|
| SWR: | 6 dB | 40 dB |
| dc-8 GHz | 1.10 | 1.10 |
| 8-12.4 GHz | 1.15 | 1.15 |
| 12.4-26.5 GHz | 1.27 | 1.25 |

| | | | |
|---------------------------|------|-------|-------|
| Attenuation Range: | 6 dB | 40 dB | 20 dB |
| | 2.0 | 100 | 10 |

Temperature, stability: 0.0002 dB/dB/@C

Maximum input power: 2W ave @ 20° C derated to 1 W ave at 75°C, 100 W peak

Power sensitivity: 0.001 dB/w

Connectors: APC-3.5 (m-f)

Weight: 8.5 g (0.3 oz)

Environmental

- Temperature, non-operating: -55° C to +85° C
- Temperature, operating: -40° C to +75° C
- Altitude, non-operating: 50,000 feet Altitude, operating: 15,000 feet Humidity: cycling 5 days, 40° C at 95% RH with condensation
- Vibration: 7 G's 5-2000 Hz Shock: 500 G's, 1.8 ms in six directions. EMC: radiated interference is within Mil Std. 461 method RE02, VDE 0871 and CISPR Publication 11.

Coaxial Short

The coaxial short is a precision, low-inductance device that will give an accurate representation of frequency information of reflected energy. It can provide a precision reference point for TDNA calibration as a time reference. It can be used to determine a baseline reference (voltage) for absolute ground.

The short is used in calibration of dielectric and velocity constants because it has a precision time offset of 21.17 ps and can be either deducted out of measurements, or more commonly, the offset is 1% and has no bearing on the measurement.

Both male and female shorts have the same electrical length.

Test Port Return Cables

The 17 inch test port return cables are used in performance verifications (see HP 54120 system service manuals.). They are included in the HP 54007A Accessory kit for low loss network measurements. And they are flexible for hard-to-access areas. The lengths are matched so that the reflection path length equals the transmission path length and both measurements can be made in the same timebase setting. The flexible cables are not precision impedance devices.

The cables included in the accessory kit have female-to-female and male-to-female end connectors. The male and female ends of the two cables allow direct connection for calibrating the transmission path. This implies that the device under test should be equipped with male and female connectors. Refer to paragraph in this chapter titled "Adapter (m-m)".

Characteristics

Impedance: 50 Ω

Capacitance: 26 pF/ft (85.3 pF/metre)

Time delay: 1.2 ns/ft (3.9 ns/metre)

Velocity of Propagation: 85% of C

Dielectric Constant: 1.4

Jacket Withstand: 1.0 kV

Dielectric Withstand: 1.0 kV

Center Conductor: 15 AWG solid

Minimum Bend Radius: 25 mm (1 inch)

To prolong the life of these cables, minimize repeated bending to a tight radius. Do not exceed the 25 mm radius specification.

| | |
|-----------------------|--------------------|
| VSWR | 2-4 GHz 1.15 |
| | 4-8 GHz 1.25 |
| | 8-18 GHz 1.30 |
| | 18-26.5 GHz 1.35 |
| Insertion Loss | 0-4 GHz 0.36 dB |
| | 4-8 GHz 0.50 dB |
| | 8-12 GHz 0.60 dB |
| | 12-16 GHz 0.72 dB |
| | 16-18 GHz 0.80 dB |
| | 18-26.5 GHz 1.0 dB |



VSWR and Insertion loss are typically 10% better than characterized.

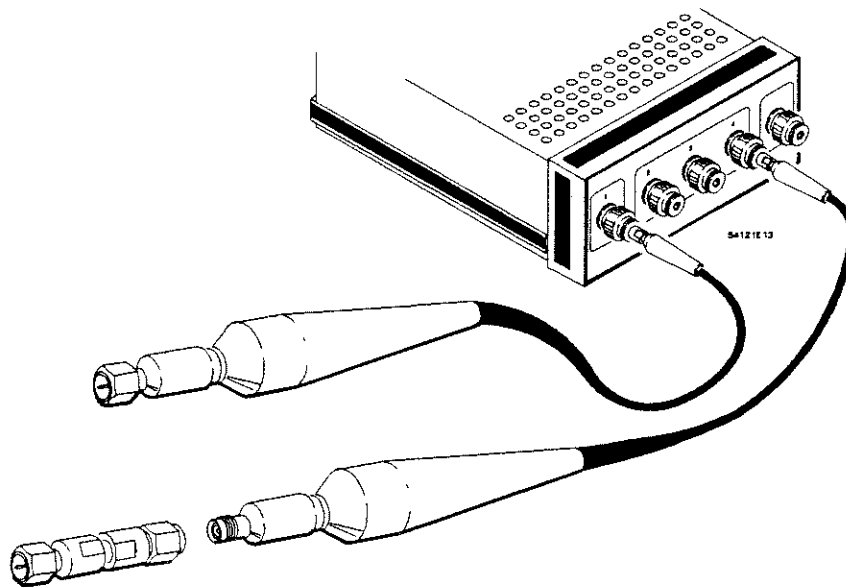


Figure A2-1. Test Port Return Cables

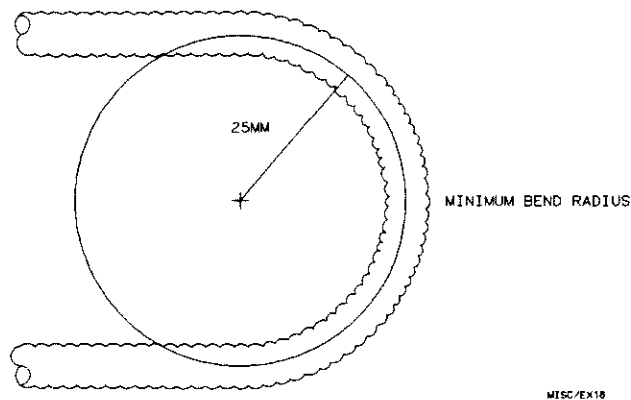


Figure A2-2. Minimum Bend Radius

Adapter (m-m)

The m-m adapter is a precision APC-3.5 device used to change connector sex. Many situations will arise when both ends to be connected are female. Placing a m-m adapter will not change the circuit characteristics other than the electrical length. The electrical length is approximately 137 ps and the mechanical length is 41 mm. These dimensions are approximate and should be verified before any critical measurements are made.

If, when using the test port return cables, the input has two female connections, this adapter can be connected to the device-under-test. This hook-up will add 137 ps to your measurement.

Semi-Rigid L Connectors

The semi-rigid "L" connectors are used to create network connections and access different channels or functions simultaneously. This allows you to view the trigger signal, attenuate the TDR signal, or connect and configure any way you desire.

Power Splitter

This section contains operating and service information for the HP 11667B power splitter. It explains how the operator checks this device and describes the one performance test required to test tracking between the output arms.

Description

The HP 11667B is a two-resistor power splitter used in oscilloscope measurement systems that have one output arm for triggering the HP 54120 system. The power splitter is useful for making attenuated TDR measurements.

Safety Considerations

Do not apply more than +27 dBm RF CW power to the HP 11667B, or the power splitter may be damaged.

Specifications

These are performance standards or limits against which the instrument may be tested.

Frequency Range: dc to 26.5 GHz

Maximum Input Power: +27 dBm (0.5W)

dc to 18.0 GHz

dc to 26.5 GHz

Input SWR: 1.22

1.29

Equivalent Output SWR: 1.22
(leveling or ratio measurement)

1.22

Output Tracking: 0.25 dB
(between output arms)

0.40 dB

Connectors: Precision 3.5 mm (f) on all ports

Dimensions: 47 mm X 40 mm X 10 mm (1.85 in x 0.39 in)

Shipping Weight: 0.14 kg (4.94 oz)

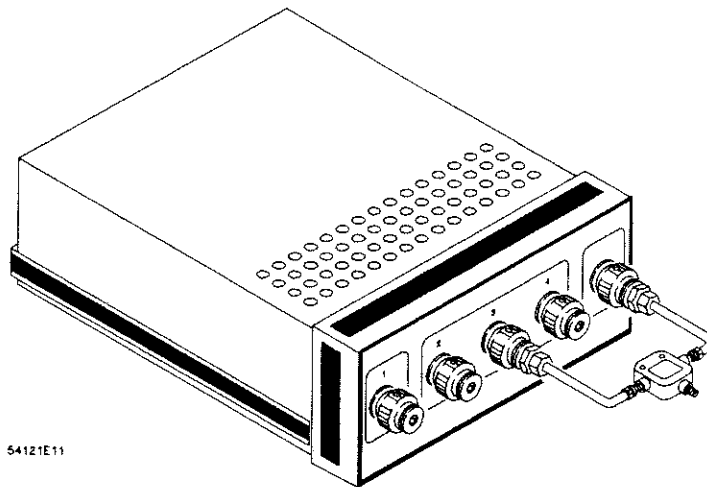


Figure 2A-3. Viewing the Trigger Signal

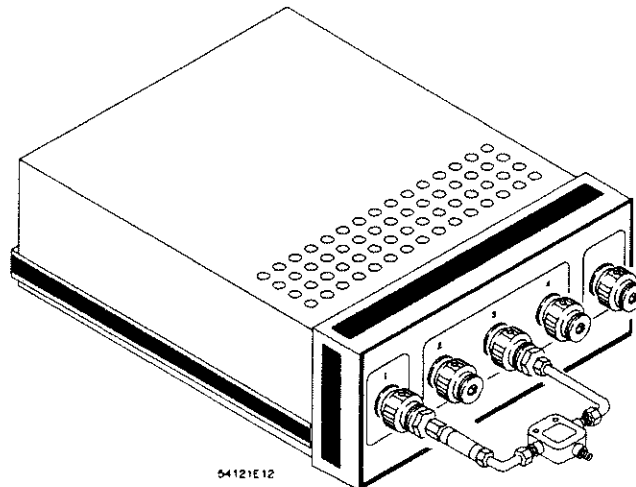


Figure 2A-4. Attenuating the TDR Signal

Supplemental Characteristics

These are not specifications, but typical characteristics included as additional information for the user.

| Frequency (GHz) | dc to 18.0 | dc to 26.5 |
|---|------------|------------|
| Phase Tracking (between output arms) | 1.5° | 2.5° |
| Output Tracking | 0.25 dB | 0.40 dB |

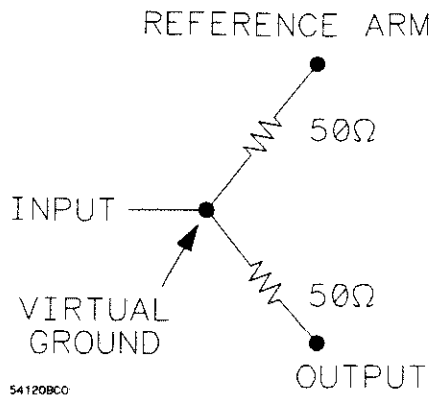


Figure A2-5. HP 11667B Power Splitter Schematic

Connections

Follow all handling precautions discussed in chapter A4 and maintain all device specifications while handling, connecting, or disconnecting the power splitter.

Operating Environment

- Temperature, 0° C to 55° C (32° F to 131° F)
- Humidity, Up to 95% relative
- Altitude, Up to 4,572 metres (15,000 feet)

Storage and Shipment

- Temperature, -40° C to +75° C (-40° F to +167° F)
- Humidity, Up to 95% relative
- Altitude, Up to 7,620 metres (25,000 feet)

Protect the HP 11667B from temperature extremes that could introduce internal condensation.

Features

1. Input port for incoming signal.
2. 3. Output ports used as exit ports. Output signal is 6 dB down in power from input signal. Either port may be used as test or reference port since power is equal in both ports.

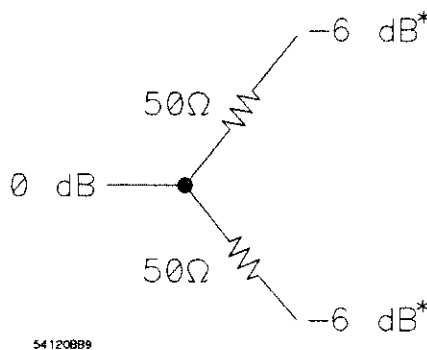


Figure A2-6. HP 11667B Power Splitter Insertion Loss

Introduction

This chapter acquaints you with the operating conditions and procedures necessary to use the devices properly. Familiarize yourself with this information before trying any measurements.

Hewlett-Packard guarantees that the performance of your calibration devices will equal or exceed the listed specifications. Certain operating procedures must be followed if these specifications are to be met and maintained, due to the precision of the devices and to the performance capabilities of the HP 54120 system.

The performance of the TDNA calibration devices described in Device Specifications are the performance values guaranteed by Hewlett-Packard. Characteristics are typical, or nominal, values.

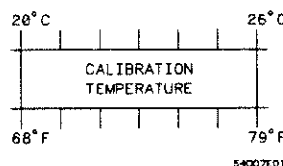
Operating Conditions and Procedures

Temperature

Temperature, wear of the precision 3.5 mm connectors, and operator skill can all significantly affect the accuracy and repeatability of microwave measurements.

Temperature of the calibration devices is critical because the dimensions of the devices (electrical characteristics) change with temperature. Figure A3-1 illustrates the allowable environmental conditions for using the HP 54007A kit. These conditions must be met if accurate measurements are to be obtained.

Note that the operating temperature during calibration and actual device measurements must be 20-26° C (68-79°F). During device measurements, the operating temperature must be within $\pm 1^\circ\text{C}$ ($\pm 1.8^\circ\text{F}$) of the temperature during calibration. Thus, if the calibration was done at 22° C (71.6° F) the operating temperature must be 21-23° C (69.8-73.4° F). If the work area is subject to temperature fluctuations, you might want to record the temperature at which the calibration is made, to assure repeatability and accuracy.



Operating temperature during actual measurements must be within $\pm 1^\circ\text{C}$ ($\pm 1.8^\circ\text{F}$) of the calibration temperature.

Storage temperature: Min -40° C (-40° F) Max +65° C (+149° F)

Relative humidity: 20-80% (30° C maximum wet bulb) during operation, 5-95% during storage; non-condensing at all times.

Figure A3-1. Allowable Temperature, Humidity, Pressure

Barometric pressure (expressed as altitude): < 4500 metres (15,000 ft) during operation, < 15,000 during storage.

The temperature of the calibration devices and all connectors must be stable before use. Devices kept with the oscilloscope are usually at a stable temperature and can be used immediately. Devices that have been moved from one location to another should be allowed to reach the same temperature as the oscilloscope.

Heat Source

Your fingers are also a heat source. Normal body temperature is 37° C (98.6° F). You should avoid unnecessary handling of the devices during use. Some devices have a plastic jacket over the connector body to provide thermal insulation during handling. Barometric pressure and relative humidity also affect device performance, although less than temperature. Air exists between the inner and outer conductors of these devices (air-dielectric devices), and the dielectric constant of air depends on pressure and humidity. Refer to Figure A3-2.

Wear

Connector wear will eventually degrade performance. The calibration devices, which are typically used only a few times each day, should have a very long life. However, because the connectors often undergo many connections a day, they wear rapidly. Therefore, it is essential that all connectors on the HP 54120 system be inspected regularly, both visually (with a magnifying glass) and mechanically (with a connector gage), and replaced as necessary. Procedures for visual and mechanical inspection are given in the next section of this manual. For four channel test sets used in high-volume work, it is best to place an adapter on both the input and the output ports. It is easier and cheaper to replace a worn adapter than a worn four channel test set connector.

Skill

Operator skill in making good connections is essential. The mechanical tolerances of the precision 3.5 mm connectors used in the HP 54007A kit are two or three times better than the tolerances in regular 3.5 mm connectors. Slight errors in operator technique that would go unnoticed with regular connectors often appear with precision connectors in the calibration kit. Incorrect operator technique can often result in lack of repeatability. Carefully study and practice the connection procedures that are explained later in this manual until your calibration measurements are consistently repeatable.

Device Specifications

Electrical specifications depend upon several mechanical conditions. A 3.5 mm connector is a precision connector dedicated to very specific tolerances. SMA connectors are not precision mechanical devices. They are not designed for repeated connections and disconnections and are very susceptible to mechanical wear. They are often found, upon assembly, to be out of specification. This makes them potentially destructive to any precision 3.5 mm connectors with which they might be mated.



Caution

Use extreme caution when mating SMA connectors with 3.5 mm precision connectors. Prevent accidental damage due to worn or out-of-specification SMA connectors. Such connectors can destroy a precision 3.5 mm connector, even on the first connection.

Hewlett-Packard recommends that you keep three points clearly in mind when you mate SMA and precision 3.5 mm connectors:

SMA Inspect

1. Before mating an SMA connector (even a new one) with a precision 3.5 mm connector, carefully inspect the SMA connector, both visually and mechanically with a precision connector gauge designed to measure SMA connectors. A male SMA connector pin that is too long can smash or break the delicate fingers on the precision 3.5 mm female connector. Gauging SMA connectors is the most important step you can take to prevent damaging your equipment.

Alignment

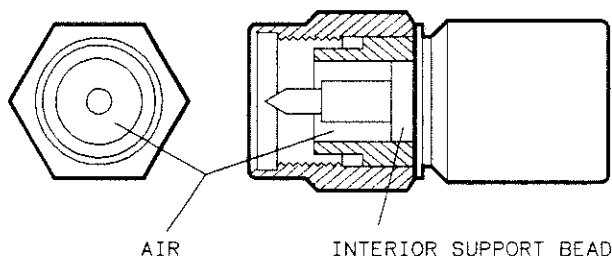
2. Be careful with alignment. Push the two connectors together with the male contact pin precisely concentric with the female. Do not overtighten or rotate either center conductor. Turn only the outer nut of the male connector and use a torque wrench (5 lb.in., 60 N-cm) for the final connection. Note that this torque is less than that when mating precision 3.5 mm connectors with each other. A torque wrench suitable for SMA connectors preset to 5 lb.in. is available (HP part number 8710-1582, CD 0).

Install an adapter on the four channel test set if many connections and disconnections will be made. Then, if accidental damage does occur, the adapter is all that needs to be replaced. It is easier and cheaper to replace a damaged adapter than an entire four channel test set connector. SMA connectors can then be mated with precision 3.5 mm connectors without difficulty or fear of expensive and time-consuming repairs.

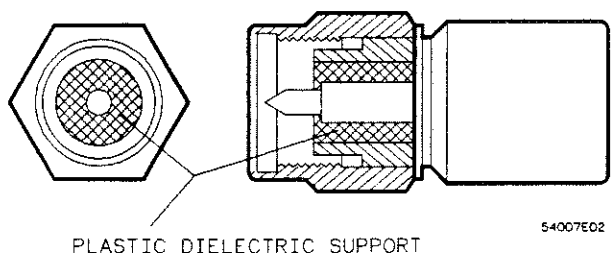
Mismatch

3. Significant structural and dimensional differences exist between these two types of connectors. Precision 3.5 mm connectors, also known as APC-3.5 connectors, are air-dielectric devices. Only air exists between the center and outer conductors. The male or female center conductor is supported by a plastic "bead" within the connector. In SMA connectors, a plastic dielectric supports the entire length of the center conductor. In addition, the diameter of both the center and outer conductors of an SMA differ from that of a precision 3.5 mm connector.

Precision 3.5 mm
Connector



SMA Connector



When an SMA connector is mated with a precision 3.5 mm connector, the connection exhibits a continuity mismatch (SWR), typically about 1.10 at 20 GHz. This mismatch is less than when two SMA connectors are mated, but still higher than when precision 3.5 mm connectors are mated. Keep this fact in mind when making measurements on SMA and precision 3.5 mm coupled junctions.

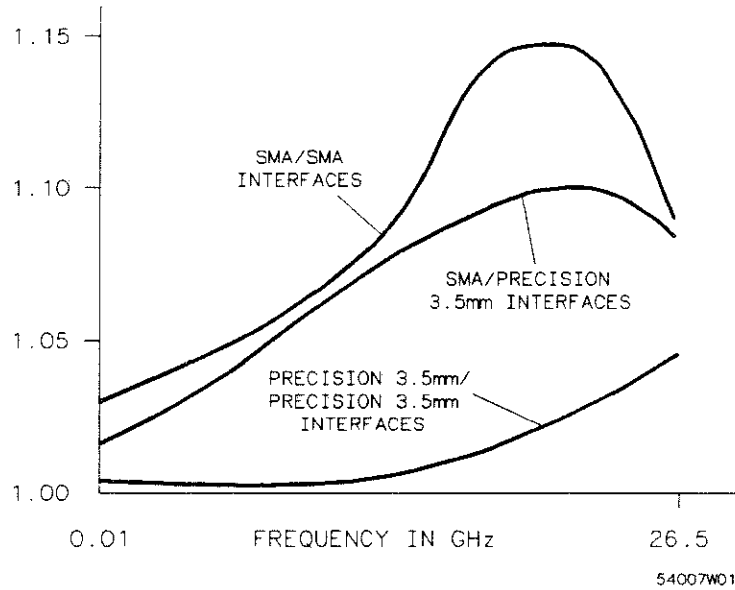


Figure 3A-2. Typical SWR of SMA and APC 3.5 Connectors

Introduction

This chapter explains the operating procedures which must be followed to obtain an accurate TDNA calibration.

Accuracy requires that 3.5 mm precision connectors be used. However, SMA connectors can be used if special care is taken when mating the two, and all connectors are undamaged and clean. Before each use, the mechanical dimensions of all connectors must be checked with a connector gauge to make sure that the center conductors are positioned correctly. All connections must be made for consistent and repeatable mechanical (and therefore electrical) contact between the connector mating surfaces.

Carefully study and practice all procedures in this chapter until you can successfully perform them repeatedly. Accuracy and repeatability are critical for good microwave measurements. Note that the device connection procedures differ in several important ways from traditional procedures used in the microwave industry. Hewlett-Packard procedures have been developed through careful experimentation.

Handling Precision 3.5 mm Connectors

Precision 3.5 mm connectors must be handled carefully if accurate calibrations and measurements are to be obtained.

- Store the devices in the foam-lined storage case when not in use.
- Avoid bumping or scratching any part of the mating surfaces.
- Be careful to align the center connectors. Check the alignment carefully before tightening the connector nuts.
- Use a torque wrench for all final connections in order to avoid overtightening.
- Support the devices being used in order to avoid vertical or lateral force on any connectors. This precaution is critical when using the airline, 6 cm "L", or cables.

When Disconnecting Devices:

- Do not rock or bend any connections.
- Pull the connector straight out without unscrewing or twisting.

- Before storage, screw the connector nut all the way out to help protect the surfaces, and use the plastic caps provided. These plastic caps can be taken off easily by unscrewing, rather than pulling.

Caution

Do not use a damaged or defective connector. It will damage any good connector to which it is attached. Throw the connector away or have it repaired.

A connector is bad if it fails either the visual or mechanical examinations or when an experienced operator cannot make repeatable connections. The time and expense involved in replacing four channel test set connectors warrants considerable caution when any connector might be less than perfect.

If any doubts exist about a connector, call your Hewlett-Packard representative. HP field offices offer limited professional advice and have access to the factory for information.

Visual Inspection and Cleaning

Always begin a calibration with a careful visual inspection of the connectors, including the test set connectors to make sure they are clean and undamaged.

Caution

Make sure that you and your equipment are grounded before touching any center conductor so you won't cause static electricity and create a potential for electrostatic discharge. When using or cleaning connectors on the test set, be aware that you are touching exposed center connectors that are connected directly to the internal circuits of the oscilloscope. Touching the center conductor, especially with a wiping or brushing motion, can cause an electrostatic discharge (ESD) and severely damage these sensitive circuits.

Visual Inspection

Use an illuminated, 4-power magnifying glass for visual inspection.

1. Before you begin, make sure you and any equipment you are using are grounded to prevent electrostatic discharge.
2. Examine the connectors first for obvious problems, such as deformed threads, contamination, or corrosion.
3. Next concentrate on the mating surfaces of each connector. Look for scratches, rounded shoulders, misalignment, or any other signs of wear or damage.
4. Make sure that the surfaces are clean, free of dust and solvent residues.

Dirt or damage visible with a 4-power magnifying glass can cause degraded electrical performance and possible connector damage. All connectors should be repaired or discarded immediately.

Cleaning

Cleaning the connectors is seldom necessary. Dust or dirt on the connector surfaces can be brushed or wiped away gently with a plastic foam swab or low-pressure, clean, compressed air. Be sure that you and all of your cleaning equipment are grounded to avoid electrostatic discharge.

If necessary, liquid Freon (trichlorotrifluoroethane), HP part number 8500-1914 CD 7, is the only cleaning solvent recommended by Hewlett-Packard for cleaning 3.5 mm connectors. Several types of liquid Freon exist, so make sure that the kind you use contains only trichlorotrifluoroethane. Some other types contain harmful compounds which can damage precision 3.5 mm connectors. Using the solvent in liquid is preferred because the liquid can be applied sparingly and selectively. If spray must be used, spray the cleaning swab only, not the connector. Use a microscope slide, or similar piece of clear glass to check the solvent periodically for contamination. Refer to figure A4-1.

Caution



Do not, under any circumstances, use abrasives (not even pencil eraser) or any solvent other than trichlorotrifluoroethane. Residue can be left behind that can damage the metal connector surfaces and the plastic conductor supports.

When you are satisfied that all the connectors are clean and undamaged, you can proceed to the mechanical inspection of connector dimensions.

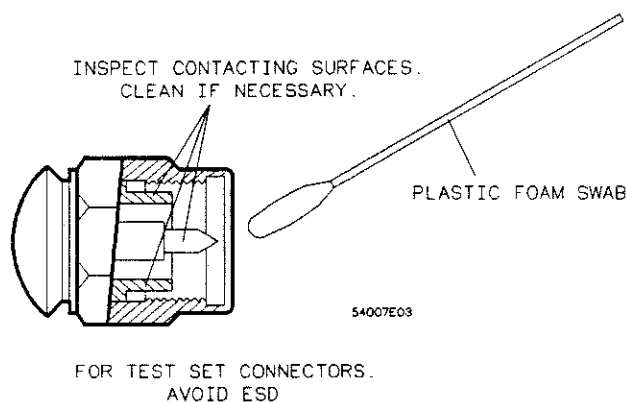


Figure 4A-1. Visual Inspection of APC 3.5 Connectors

Mechanical Inspection

Mechanical inspection of the connectors is the next step. This inspection consists of using the appropriate male or female precision 3.5 mm connector gauge to check the mechanical dimensions of all connectors, including those on the test set. The purpose of doing this is to make sure that perfect mating will occur between the connector surfaces. Perfect mating assures a good electrical match and is very important mechanically to avoid damaging the connectors themselves, especially on the oscilloscope.

Center Conductor

The critical dimension to be measured is the recession of the center conductor. This dimension is shown as MP and FP in Figure A4-2 and A4-3. No protrusion of the center conductor's shoulder is allowable on any connector. The maximum allowable recession of the center conductor shoulder is 0.003 in. (0.08 mm) on all connectors, except those on the four channel test sets.

On the four channel test set connectors, not only is no protrusion allowable, the shoulder of the center conductor must be recessed at least 0.0002 in. (0.005 mm). The maximum allowable recession of the center conductor shoulder on the four channel test set connectors is 0.0021 in. (0.056 mm).

Outer Conductor

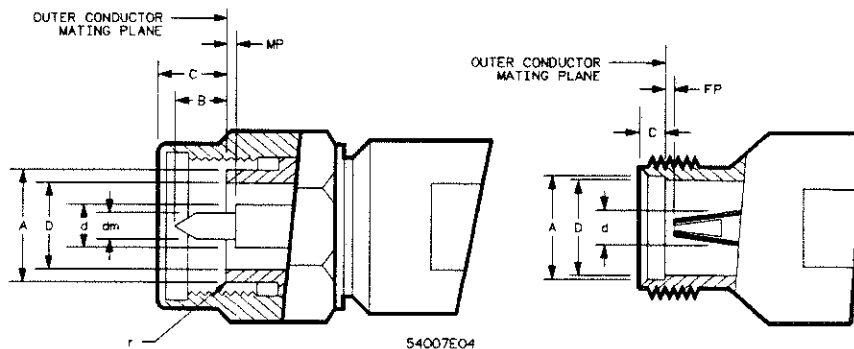
If any contact protrudes beyond the outer conductor mating plane, the contact is out of tolerance and must be replaced. If the center conductor is not recessed at least 0.0002 in. (0.005 mm), it is out of tolerance and must be replaced. In both cases the out-of-tolerance connector will permanently damage any connector attached to it. Destructive electrical interference will also result due to buckling of the female contact fingers. This is often noticeable as a power hole several dB deep occurring at about 22 GHz.

If any contact is recessed too far behind the outer conductor mating plane (0.0021 in. 0.056 mm, except in test sets), poor electrical contact will result, causing high electrical reflections. Careful gauging of all connectors will help prevent this condition.

Before using the connector gauge to measure the connectors, visually inspect the end of the gauge and the calibration block in the same way that you inspected the connectors. Dirty or damaged gauge facings can cause dirty or damaged connectors. Two connector gauges are available from Hewlett-Packard, one for each connector type, male and female. Refer to figure A4-4. A single gauge calibration block is used to zero both gauges; one end protrudes for zeroing the male connector gauge. The part number for both gauges, as well as the calibration block is 85052-80010.

Figures A4-5 to A4-7 show how to use the connector gauges. Zero the gauge with the calibration block. Refer to figure A4-5. It is recommended that you zero both gauges first, then measure each of the terminations and/or adapters that will be used. Then, as the last step, measure the test set connectors.

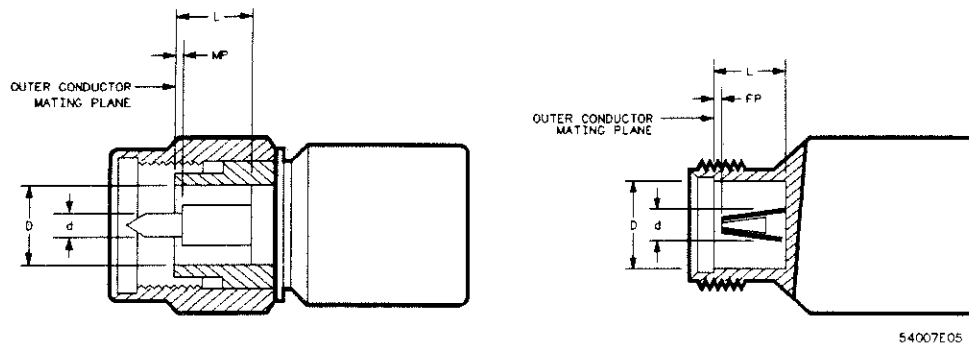
Figures A4-6 and A4-6 show how to measure precision 3.5 mm connectors. Note that a plus (+) reading on the gauge indicates recession of the center conductor and a minus (-) reading indicates protrusion. Since no protrusion of either connector is allowable, readings for connectors within the allowable range will be on the plus (+) scale of the gauge. Also note that the allowable tolerance range for the test set connectors is different from the range for other connectors. Both ranges are shown in Figures A4-6 and A4-7. Before measuring test set connectors, be sure that the power to the test set is off and that you and your equipment are grounded to prevent electrostatic discharge.



- D** = inside diameter of the outer conductor
d = diameter of male/female center connector
A = outside diameter of outer conductor at the mating plane
r = corner relief for male connector
B = protrusion of the male contact pin tip beyond the outer conductor mating plane
C = recession of the outer conductor mating plane behind outer face of connector
MP = recession of male contact pin shoulder behind outer conductor mating plane
FP = recession of face of female connector behind outer conductor mating plane
Dm = diameter of tip of male contact pin

| Male Connectors | Female Connectors | Male Connectors | Female Connectors |
|---|---|--|--|
| $D = 0.1378 \pm 0.0005 \text{ in}$ $3.500 \pm 0.013 \text{ mm}$ | $D = 0.1378 \pm 0.0005 \text{ in}$ $3.500 \pm 0.013 \text{ mm}$ | $B = 0.085^{+0.005}_{-0.015} \text{ in}$ $2.16^{+0.13}_{-0.38} \text{ mm}$ | N/A |
| $d = 0.0598 \pm 0.0003 \text{ in}$ $1.519 \pm 0.008 \text{ mm}$ | $d = 0.0598 \pm 0.0003 \text{ in}$ $1.519 \pm 0.008 \text{ mm}$ | $C = 0.120 \pm 0.015 \text{ in}$ $3.05 \pm 0.38 \text{ mm}$ | $C = 0.176 \pm 0.002 \text{ in}$ $1.93 \pm 0.05 \text{ mm}$ |
| $A = 0.1803^{+0.000}_{-0.002} \text{ in}$ $4.580^{+0.00}_{-0.05} \text{ mm}$ | $A = 0.1807^{+0.002}_{-0.000} \text{ in}$ $4.590^{+0.05}_{-0.00} \text{ mm}$ | $MP = 0.000^{+0.003}_{-0.000} \text{ in}$ $^{+0.08}_{-0.00} \text{ mm}$ | $FP = 0.000^{+0.003}_{-0.000} \text{ in}$ $^{+0.08}_{-0.00} \text{ mm}$ |
| $r = 0.003 \text{ in}$ 0.08 mm | $r = 0.003 \text{ in}$ 0.08 mm | $dm = 0.037^{+0.000}_{-0.001} \text{ in}$ $0.94^{+0.00}_{-0.03} \text{ mm}$ | N/A |

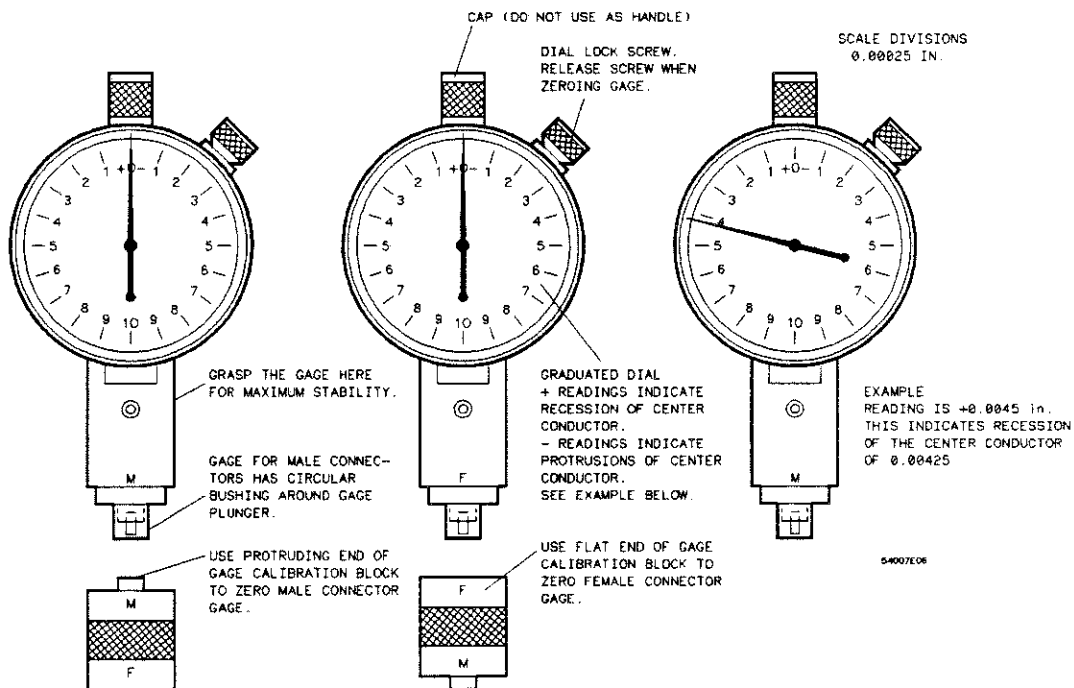
Figure A4-2. Mechanical Dimensions of Connector Faces



54007E05

- D = inside diameter of outer conductor = 0.1378 ± 0.0003 in
 3.500 ± 0.008 mm
- d = diameter of center conductor = 0.0598 ± 0.0002 in
 1.519 ± 0.005 mm
- MP = recession of center conductor shoulder = $0.000 + 0.000 / -0.003$ in
 FP = $0.00 + 0.00 / -0.08$ mm
- L = length of outer conductor = 0.197 ± 0.001 in
 0.00 ± 0.000 mm
- C = concentricity of contact is governed by mating connector: typically, 0.003 FIM (TIR)

Figure 4A-3. Mechanical Dimensions of the Short Circuit



54007E06

Figure A4-4. Precision 3.5 mm Connector Gages

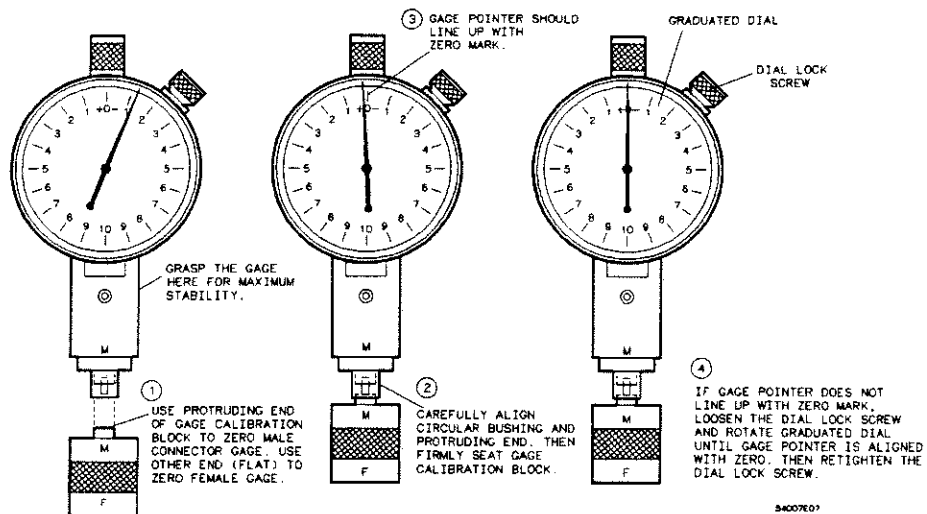


Figure A4-5. Zeroing Precision 3.5 mm Connector Gages

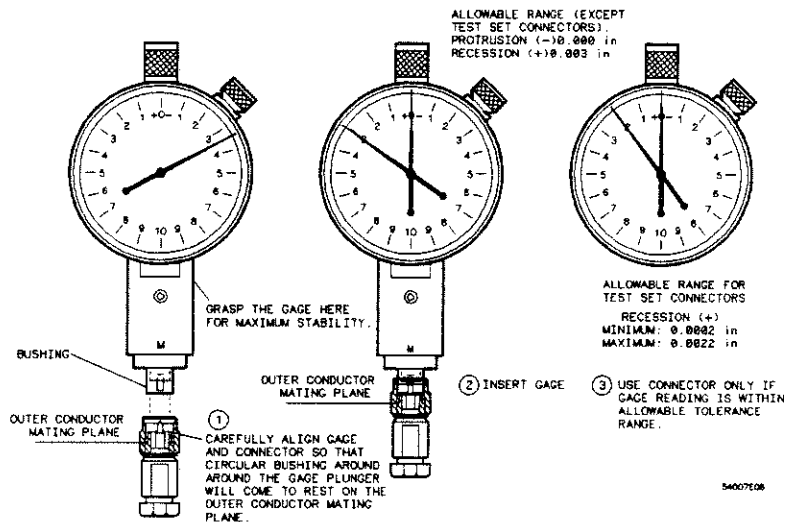


Figure A4-6. Measuring Precision 3.5 mm Male Connectors

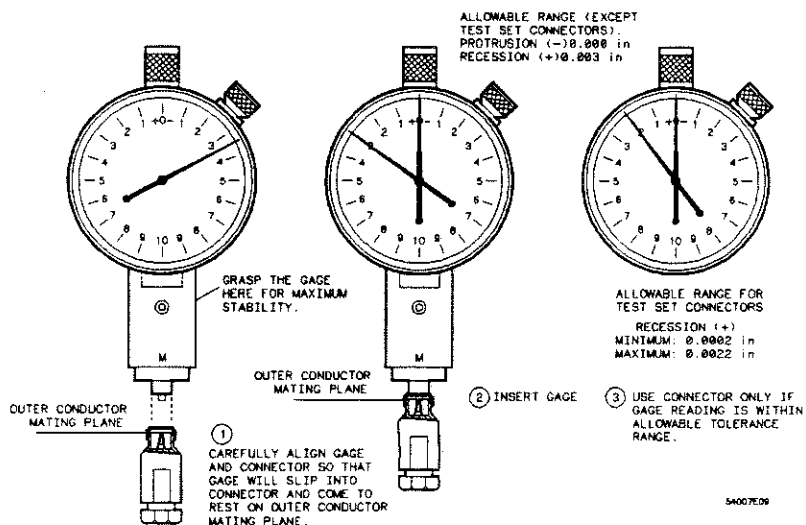


Figure A4-7. Measuring Precision 3.5 mm Female Connectors

Connecting the Devices

Figures A4-8 and A4-9 illustrate the Hewlett-Packard recommended procedures for making connections with the calibration devices. Notice that these recommended procedures differ from traditional procedures used in the microwave industry, especially the counter-rotation technique and procedure for connecting the airline.

The counter-rotation technique, recommended here, involves a slight rotation of the termination or adapter just before the final tightening of the connector nut. This eliminates the very small air wedge between the outer conductors that frequently occurs when the body is held stationary during tightening, as it is in the traditional procedure. The HP 54120 system will detect the reflections caused by such small wedges.

The counter-rotation technique does not harm the connectors. The gold plating on the outer conductor surface will become burnished in time. This is normal, and as long as the surface remains smooth, the connector is still good. After much use the gold plating may eventually wear through and expose the beryllium-copper substratum. This too is normal, and if it is smooth the connector is still good, although the beryllium-copper surface may oxidize if the connector is used infrequently.

If the burnished surface is rough, scratched, rippled, or has other irregularities, too much tightening force is being used. If the roughness is severe, the connector is ruined and should not be used.

Caution

Damage can result if SMA connectors are overtightened to precision 3.5 mm connectors. Use a torque wrench designed for SMA connectors, set to a 5 in lb (60 N/cm). A torque wrench suitable for SMA connectors is available, HP part number 8710-1582.

Counter-Rotation Technique

The recommended Hewlett-Packard counter-rotation technique is for precision 3.5 mm connectors. Before making any connections to the test set, ground yourself with a grounded wrist strap. Also, it is good practice to grasp the outer shell of the test port before you make any connections to the test set in order to discharge any static electricity on your body. This is the most effective single safeguard to prevent ESD damage to your instruments.

Connect 3.5 mm devices by the following procedure. Refer to figures A4-8 and A4-9.

1. If the device has a retractable connector nut, fully retract the nut before mating the connectors. Carefully align the male and female contact pins and slide the connectors straight together until the center and the two outer conductors meet. Be careful not to twist or bend the contact pins. You should feel a slight resistance as the connectors mate.

2. Make the preliminary connection by attaching the connector nut of the male connector to the female. The male connector is held stationary as the female connector is tightened and draws the male pin into the female connector. Refer to figure 4A-8. Any other method used may cause the male pin to damage the female connector. Support the body of the device and turn the connector nut until the mating surfaces make light contact. Do not overtighten. All you want is a connection of the outer conductors with gentle contact at all points of both mating surfaces.

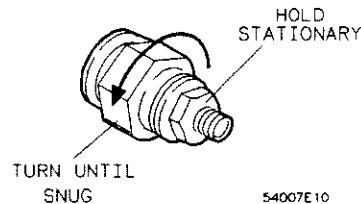


Figure A4-8. Connecting Devices

3. When you are satisfied with this preliminary connection, use the following counter-rotation technique to eliminate air wedges between the mating planes. Refer to figure A4-9. If the calibration device is male, hold the connector nut firmly. Very slowly rotate the body of the device about 10-20° counterclockwise. Note that this slight rotation or backwiping is sufficient. Greater rotation does not improve electrical performance and increases wear on the connector surfaces. If the calibration device is female (the connector nut is on the test set), very slowly rotate both the connector nut and the body of the device clockwise 10-20° (counterclockwise rotation will loosen the connection).

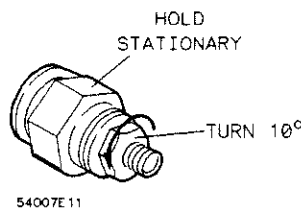


Figure 4A-9. Counter Rotation Technique

Light, smooth frictional resistance felt during the counter-rotation indicates you have made the preliminary connection correctly and that the counter-rotation technique has been successful. Roughness felt during counter-rotation indicates either that the connectors are damaged or that there is roughness in the connector nut/thread contact. Inspect both connectors again before proceeding, to make sure that the roughness is due to roughness in the connector nut interface rather than on the connector mating planes.

4. Tighten the connector nut finger tight, allowing the device to turn with the nut if it tends to do so. A small rotation of the body of the device at this point is acceptable and tends to occur naturally.

5. Use a torque wrench to make the final connection. Use of the torque wrench assures the final connection will be tight enough for optimum electrical performance, but not so tight as to distort or damage the connectors. Refer to pages A1-2.

To disconnect, follow this procedure:

1. Loosen the connector nut on the male connector with the torque wrench. Leave the connection finger tight.
2. While supporting the calibration device, gently unfasten the connectors and pull the calibration device straight out of the test port connector. Do not twist either the center conductor or the outer conductor housing or exert lateral or vertical (bending) force on the connection.

Note that some precision 3.5 mm female connector fingers are very tight and can pull the center pin of their mates out past specifications as they are disconnected. If such a male pin is inserted into a female connector it can cause considerable damage by pushing the female center conductor back too far. Be aware of this possibility and check all connectors before mating them again.

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1416 BUENOS AIRES
Tel: 541-58-1981, 541-59-2767
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AUSTRALIA

Customer Information Centre
Tel: (008) 033821

Adelaide, South Australia Office

Hewlett-Packard Australia Ltd.
PARKSIDE, S.A. 5063
153 Greenhill Road
ADELAIDE (Parkside) Sales
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Fax: (61/8) 373-1398

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P.O. Box 257,
JAMISON, A.C.T. 2614
Tel: 61-62-51-6999
Telex: 62650
Cable: HEWPARD Canberra

Melbourne, Victoria Office

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Hewlett-Packard GmbH
Verkaufsbuero Graz
Grottenhofstrasse 94
A-8052 **GRAZ**
Tel: 43-316-291-5660
Telex: 312375
Hewlett-Packard GmbH
Liebigasse 1
P.O. Box 72
A-1222 **VIENNA**
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Hewlett-Packard Belgium S.A./N.V.
Blvd de la Woluwe, 100
Woluwedael
1200 BRUSSELS
Tel: (32/2) 761.31.11
Fax: (32/2) 763.06.13

BENIN

S.I.T.E.L.
Immeuble le General
Av. General de Gaulle
P.O. Box 161
ABIDJAN 01
Ivory Coast
Tel: 32 12 27
Telex: 22149

BERMUDA

Applied Computer Technologies
Atlantic House Building
P.O. Box HM 2091
Par-La-Ville Road
HAMILTON 5
Tel: 295-1616
Telex: 380 3589/ACT BA

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Arrellano Ltda
Av. 20 de Octubre #2125
Casilla 1383
LA PAZ
Tel: 368541
Siser Ltda. (Sistemas de
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Gabriel Gozalez 221
Casilla 4084
LA PAZ
Tel: (591/2) 340962/
363365/343245
Fax: 35-9268

BRAZIL

Hewlett-Packard do Brasil S.A.
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Telex: 21905 HPBR BR
Cable: HEWPACK Rio de Janeiro

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P.O. Box 1297,
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NEGARA BRUNI DARUSSALAM
Tel: 673-2-2000-70/26711

BURKINA FASSO

S.I.T.E.L.
Immeuble le General
Avenue General de Gaulle
P.O. Box 161
ABIDJAN 01
Ivory Coast
Tel: 32 12 27
Telex: 22149

CAMEROON

R.T.I.
175 Rue Biomet
75015 PARIS
France
Tel: (1) 45 31 0906
Telex: 203376
Fax: (1) 45 31 09 18

CANADA

Alberta
Hewlett-Packard (Canada) Ltd.
3030 3rd Avenue N.E.
CALGARY, Alberta T2A 6T7
Tel: (1/403) 235-3100
Fax: (1/403) 272-2299
Hewlett-Packard (Canada) Ltd.
11120-178th Street
EDMONTON, Alberta T5S 1P2
Tel: (1/403) 486-6666
Fax: (1/403) 489-8764

SALES OFFICES

Arranged alphabetically by country (cont'd)

CANADA (Cont'd)

British Columbia

Hewlett-Packard (Canada) Ltd.
10691 Shellbridge Way
RICHMOND,
British Columbia V6X 2W8
Tel: (1/604) 270-2277
Fax: (1/604) 270-0859

Manitoba

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1825 Inkster Blvd.
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Hewlett-Packard (Canada) Ltd.
814 Main Street
MONCTON, New Brunswick E1C 1E6
Tel: (506) 855-2841

Nova Scotia

Hewlett-Packard (Canada) Ltd.
201 Brownlow Avenue
DARTMOUTH, Nova Scotia B3B 1W2
Tel: (1/902) 468-7820
Fax: (1/902) 468-2817

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475 Hood Rd., Unit #2
MARKHAM, L3R 8H1
Tel: (416) 479-1770

Ontario

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Tel: (1/519) 686-9181
Fax: (1/519) 686-9145

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Fax: (1/416) 673-7253

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OTTAWA, Ontario K2B 8K1
Tel: (1/613) 820-6483
Fax: (1/613) 820-0377

Hewlett-Packard (Canada) Ltd.
3790 Victoria Park Ave.
WILLOWDALE, Ontario M2H 3H7
Tel: (1/416) 499-2550

Quebec

Hewlett-Packard (Canada) Ltd.
17500 Trans Canada Highway
South Service Road
KIRKLAND, Quebec H9J 2X8
Tel: (1/514) 697-4232
Fax: (1/514) 697-6941

Saskatchewan

Hewlett-Packard (Canada) Ltd.
#1, 2175 Airport Rd.
SASKATOON, Saskatchewan S7L 7E1
Tel: (306) 242-3702

CHILE

Ricardo Borzutsky
Avanzados Sistemas de
Conocimientos S. A.
Austria 2041
SANTIAGO
America del Sur
Tel: (562) 223-5946/6148

CHINA, People's Republic of

China Hewlett-Packard Co., Ltd.
22/F Bond Centre, West Tower
89 Queensway, Central

HONG KONG

Tel: (852/5) 8487777
Fax: (852/5) 868 4997

China Hewlett-Packard Co., Ltd.
P.O. Box 9610, Beijing
38 Bei San Huan X1 Road
Shuang Yu Shu, Hai Dian District
BEIJING
Tel: 256-6888
Fax: 256-3207

China Hewlett-Packard Co., Ltd.
23/F Shanghai Union Building
100 Yan An Road
SHANGHAI
Tel: 203-240
Fax: 202-149

COLOMBIA

Instrumentación
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BOGOTA 1, D.E.
Tel: 212-1466
Telex: 44400 INST CO
Cable: AARIS Bogota

CONGO

Sema-Metra
16-18 Rue Barbes
92126 Montrouge Cedex
FRANCE
Tel: (1) 657/300
Telex: 200601 Semetra
Fax: (1) 46 56 96 53

COSTA RICA

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Avenida 2, Calle 5
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Apartado 10159
SAN JOSÉ
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Telex: 3032367 GALGUR CR

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Fax: 21-6905

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SAN JOSE
Tel: 23-72-44
Telex: 2379
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P.O. Box 65074
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ATHENS
Greece
Tel: 647 79 426, 647 79 427
Telex: 224903

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Valentine House
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Telex: 5845 tlrx cy

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NICOSIA
Cyprus
Tel: 44 10 64
Telex: 3085
Fax: 46 46 35

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Hewlett-Packard A/S
Kongevejen 25
3460 **BIRKERØD**
Tel: (45/42) 816640
Fax: (45/42) 815810

Hewlett-Packard A/S
Rølgødsvej 32
DK-8240 **RISSKOV**, Aarhus
Tel: 45-06-17-6000
Telex: 37409 hpas dk

DOMINICAN REPUBLIC

Microprog S.A.
Juan Tomás Mejía y Cotes No. 60
Arroyo Hondo
SANTO DOMINGO
Tel: 565-6268
Telex: 4510 ARENTA DR (RCA)

ECUADOR

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y Belgica
Casilla 6423 CCI
QUITO
Tel: 9-011-593-2-450975
Telex: 39322548 CYEDE ED

EGYPT

International Engineering Associates
6 El Gamea Street
Agouza

CAIRO
Tel: 71-21-681 348 0904
Telex: 93830 IEA UN
Cable: INTEGASSO

EL SALVADOR

IPESA de El Salvador S.A.
29 Avenida Norte 1223
SAN SALVADOR
Tel: 9-011-503-266-858
Telex: 301 20539 IPESA SAL

ETHIOPIA

R.T.I.
175 rue Blomet
75016 **PARIS**
France
Tel: (1) 45 31 09 06
Telex: 203376
Fax: (1) 45 31 09 18

FINLAND

Hewlett-Packard Finland
Field Oy
Niittylanpolku 10
00620 **HELSINKI**
Tel: (90) 757-1011
Telex: 122022 Field SF

Hewlett-Packard Oy
Piispankallontie 17
02200 **ESPOO**
Tel: (358/0) 88721
Fax: (358/0) 887 2277

Hewlett-Packard Oy
Väinökatu 9 C
40100 **JYVÄSKYLÄ**
Tel: (358/41) 21 85 11

Hewlett-Packard Oy
Valtatie 57
90500 **OULU**
Tel: (358/81) 340 144

FRANCE

Hewlett-Packard France
Z.I. Mercure B
Rue Berthelot
13763 Les Milles Cedex
AIX-EN-PROVENCE
Tel: 33-42-59-41-02
Telex: 410770F

Hewlett-Packard France
ZA Kergaradec
Rue Fernand Forest
29239 **GOUEESNOU** (Brest)
Tel: (98) 41-87-90

Hewlett-Packard France
Chemin des Mouilles
Boite Ecuelle 162
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Tel: (33) 72-29-32-93
Telex: 310617F

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Z.I. Mercure B
Rue Berthelot
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Aix-en-Provence
Tel: (33/42) 59-41-02
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Fax: 594872

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Parc Club des Tanneries
Batiment B4
4, Rue de la Faisanderie
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Tel: (88) 76-15-00
Telex: 890141F

Hewlett-Packard France
Parc d'activités Cadéra
Quartier Jean-Mermoz
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33700 **MÉRIGNAC** (Bordeaux)
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Telex: 550105F

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Tel: (76) 90-38-40

Hewlett-Packard France
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Tel: 40-30-38-38
Telex: 711085F

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Tel: 38-43-93-56
Telex: 783 497F

Hewlett-Packard France
Zone Industrielle de Courtaboeuf
1, av. du Canada
91947 **LES ULIS** Cedex (Orsay)
Tel: 69-82-60-60
Telex: 600048F

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Telex: 42/203376

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Telex: 740912F

Hewlett-Packard France
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Centre d'Affaires Paris Nord II
F-93420 Villepinte
B.P. 60020
F-95971 **ROISSY**
CHARLES DE GAULLE Cédex
Tel: (33/48) 91-68-00
Telex: 232366
Fax: 632183

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P.A.T. Lavatine
3, rue Jacques Monod
BP 185
76136 **MONT-ST-AIGNAN** (Rouen)
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Telex: 770035F

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BP 167 - Voie n°7
31328 **LABEGE** Cedex (Toulouse)
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Telex: 531639F

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Route des Dolines
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Parc d'activité des Prés
1, Rue Papin Cedex
59658 **VILLENEUVE D'ASCQ**
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Telex: 160124F

FRENCH WEST INDIES (Antilles)

R.T.I.
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75015 PARIS
FRANCE
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Telex: 203376
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75015 PARIS
France
Tel: (1) 45 31 09 06
Telex: 203376
Fax: (1) 45 31 09 18

GERMAN FEDERAL REPUBLIC

Hewlett-Packard GmbH
Vertriebszentrale Deutschland
Hewlett-Packard-Strasse
Postfach 1641
D-6380 BAD HOMBURG v.d.H
Tel: (06172) 400-0
Telex: 410 844 hpbhg

Hewlett-Packard GmbH
Geschäftsstelle
Keithstrasse 2-4
D-1000 BERLIN 30
Tel: (030) 21 99 04-0
Telex: 018 3405 hpbln d

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Verbindungsstelle Bonn
Friedrich-Ebert-Allee 26
5300 BONN
Tel: (0228) 234001
Telex: 8869421

Hewlett-Packard GmbH
Vertriebszentrum Südwest
Schickardstrasse 2
D-7030 BOBLINGEN
Postfach 1427
Tel: (49/7031) 645
Fax: (49/7031) 645-429

Hewlett-Packard GmbH
Zentralbereich Mktg
Herrenberger Strasse 130
D-7030 BOBLINGEN
Tel: (49/7031) 14-0
Fax: (49/7031) 14-2999

Hewlett-Packard GmbH
Geschäftsstelle
Schleefstr. 28a
D-4600 DORTMUND-41
Tel: (0231) 45001
Telex: 822858 hepdod

Hewlett-Packard GmbH
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Bernar Strasse 117
6000 FRANKFURT/MAIN 60
Tel: (069) 500001-0
Telex: 413249 hpffm

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Vertriebszentrum Nord
Kapstadtring 5
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Telex: 021 63 032 hphh d

Hewlett-Packard GmbH
Geschäftsstelle
Heidering 37-39
D-3000 HANNOVER 61
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Fax: (49/511) 5706-126

Hewlett-Packard GmbH
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Rosslauer Weg 2-4
D-6800 MANNHEIM
Tel: 49-0621-70-05-0
Telex: 0462105 hpmhm

Hewlett-Packard GmbH
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D-7910 NEU ULM
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Telex: 0712816 HP ULM-D

Hewlett-Packard GmbH
Geschäftsstelle
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D-8500 NÜRNBERG 10
Tel: (0911) 5205-0
Telex: 0623 860 hpnbg

Hewlett-Packard GmbH
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Berliner Strasse 111
D-4030 RATINGEN
Postfach 31 12
Tel: (02102) 494-0
Telex: 589 070 hprad

Hewlett-Packard GmbH
Vertriebszentrum Muchen
Eschenstrasse 5
D-8028 TAUFKIRCHEN
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Telex: 0524985 hpmch

Hewlett-Packard GmbH
Geschäftsstelle
Ermisallee
7517 WALDBRONN 2
Postfach 1251
Tel: (07243) 602-0
Telex: 782 838 hepk

GREAT BRITAIN See United Kingdom

GREECE

Hewlett-Packard Hellas
32, Kiffissias Avenue
15125 Amaroussion
ATHENS
Greece
Tel: 6828811
Telex: 216588 hpat gr
Fax: 6832978

GUATEMALA

IPESA DE GUATEMALA
Avenida Reforma 3-48, Zona 9
GUATEMALA CITY
Tel: 316627, 317853, 6647 1/5
9-011-502-2-316627
Telex: 3055765 IPESA GU

GUINEA

R.T.I.
175, Rue Blomet
75015 PARIS
France
Tel: (1) 45 31 09 06
Telex: 203376
Fax: (1) 45 31 09 18

HONG KONG

Hewlett-Packard Asia, Ltd.
22/F, West Tower Bond Centre
89 Queensway Central
HONG KONG
Tel: (852/5) 848-7777
Fax: (852/5) 868-4997
Cable: HEWPACK HONG KONG

ICELAND

Hewlett-Packard Iceland
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Tel: 354-1-67-1000
Telex: 37409
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Hewlett-Packard India
Meridian Commercial Complex
6th Floor
8 Windsor Place
Janpath
NEW DELHI 110 001
Tel: 91-11384911
Telex: 31-4935 HPNDIN

INDONESIA

BERCA Indonesia P.T.
P.O. Box 496/Jkt.
Jl. Abdul Muis 62
JAKARTA
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Telex: 46748 BERSAL IA
Cable: BERSAL JAKARTA

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P.O. Box 2497/Jkt
Antara Bldg., 12th Floor
Jl. Medan Merdeka Selatan 17
JAKARTA-PUSAT
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Telex: 46748 BERSAL IA

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Cable: BERSAL-SURABAYA

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Hewlett-Packard Trading S.A.
Service Operation
Al Mansoor City 609/10/7
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Telex: 212-455 HEPA/IRAQ IK

IRELAND

Hewlett-Packard Ireland Ltd.
Temple House, Temple Road
Blackrock, Co. DUBLIN
Tel: (353/1) 883399
Telex: 30439

Hewlett-Packard Ltd.
75 Belfast Rd, Carrickfergus
Belfast BT38 8PH
NORTHERN IRELAND
Tel: 09603-67333
Telex: 747626

ISRAEL

Eidan Electronic Instrument Ltd.
P.O. Box 1270
JERUSALEM 91000
16, Ohaiav St.
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Tel: 533 221, 553 242
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Computation and Measurement
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11 Masad Street
67060
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Tel: 388 388
Telex: 33569 Motil IL

ITALY

Hewlett-Packard Italiana Spa
Via G. di Vittorio 10
20094 CORSICO (MI)
Tel: 02/4408351
Fax: 02/4409964

Hewlett-Packard Italiana Spa
Via Nuova Rivoltana 95
20090 LIMITO (MI)
Tel: 02/75761
Fax: 02/7576230

Hewlett-Packard Italiana Spa
Via Emilia 51/C
40011 ANZOLA
DELL'EMILIA (BO)
Tel: 051/731061

Hewlett-Packard Italiana Spa
Via M. Ricci 17 - Palombina Nuova
60100 ANCONA
Tel: 071/883782

Hewlett-Packard Italiana Spa
Traversa 99C Giulio Petroni 19
70124 BARI
Tel: 080/410744
Fax: 080/417891

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Via Principe Nicola 43G/C
95126 CATANIA
Tel: 095/371087
Fax: 095/388569

Hewlett-Packard Italiana Spa
Via G. Di Vittorio 9
20063 CERNUSCO S/N (MI)
Tel: 02/923691
Fax: 02/9237746

Hewlett-Packard Italiana Spa
Via Sacco e Vanzetti 1/A
50145 FIRENZE
Tel: 055/318533
Fax: 055/373965

Hewlett-Packard Italiana Spa
Viale Brigata Bisagno 2
16129 GENOVA
Tel: 010/541141
Fax: 010/591733

Hewlett-Packard Italiana Spa
Via Orazio 16
80122 NAPOLI
Tel: 081/7611444
Fax: 081/680164

Hewlett-Packard Italiana Spa
Via Pellizzo 15
35128 PADOVA
Tel: 049/8070166
Fax: 049/773097

Hewlett-Packard Italiana Spa
Via Del Tintoretto 200
00144 ROMA
Tel: 06/54831
Fax: 06/5408710

SALES OFFICES

Arranged alphabetically by country (cont'd)

ITALY (Cont'd)

Hewlett-Packard Italiana Spa
Corso Svizzera 185
10149 **TORINO**
Tel: 011/744044
Fax: 011/7710815

IVORY COAST

Ste Ivoirienne des Techniques
de l'Informatique
Immeuble C.N.A. - 5e etage
Avenue General de Gaulle
P.O. Box 161
ABIDJAN 01
Tel: 32 12 27
Telex: 22149

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Angle Avenue J. Anoma et Bd.
République
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Fax: 35 37 90

JAPAN

Yokogawa-Hewlett-Packard Ltd.
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Chuo-Dori Bldg.
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Tel: (81/188) 36-5021

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152-1, Onna
ATSUGI, Kanagawa, 243
Tel: (81/462) 25-0031
Fax: (81/462) 25-0064

Yokogawa-Hewlett-Packard Ltd.
3-1 Motochiba-Cho
CHIBA, 280
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Fax: (81/472) 21-0382

Yokogawa-Hewlett-Packard Ltd.
Dai-3 Hakata-Kaisei Bldg.
1-3-6 Hakata-eki Minami
Hakata-Ku, **FUKUOKA 812**
Tel: (81/92) 472-8731

Yokogawa-Hewlett-Packard Ltd.
Nihon-Dantai-Seimei-
Koriyama Bldg.
21-10 Toramaru-Cho,
Koriyama **FUKUSHIMA, 963**
Tel: (81/249) 39-7111

Yokogawa-Hewlett-Packard Ltd.
Yasuda-Seimei Hiroshima Bldg.
6-11, Hon-dori, Naka-ku
HIROSHIMA, 730
Tel: (81/82) 241-0611
Fax: (81/82) 241-0619

Yokogawa-Hewlett-Packard Ltd.
Issei Bldg.
2-3-17 Takezono, Tsukuba
IBARAGI, 305

Yokogawa-Hewlett-Packard Ltd.
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1-4-73, Sanno-maru
Mito, **IBARAKI 310**
Tel: (81/292) 25-7470

Yokogawa-Hewlett-Packard Ltd.
Towa Building 2-2-3
Kaigan-dori, Chuo-ku
KOBE, 650
Tel: (81/78) 392-4791
Fax: (81/78) 392-4839

Yokogawa-Hewlett-Packard Ltd.
Kumagaya Asahi 82 Bldg.
3-4 Tsukuba
KUMAGAYA, Saitama 360
Tel: (81/485) 24-6563
Fax: (81/485) 24-9050

Yokogawa-Hewlett-Packard Ltd.
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614 Higashi-Shiokoji-cho
Karasuma-Nishi-Iru, Shiokoji-Dori
Shimogyo-Ku, **KYOTO, 600**
Tel: (81/75) 343-0921
Fax: (81/75) 343-4356

Yokogawa-Hewlett-Packard Ltd.
Mito Mitsui Bldg.
1-4-73, Sanno-Maru
MITO, Ibaraki 310
Tel: (81/292) 25-7470
Fax: (81/292) 31-6589

Yokogawa-Hewlett-Packard Ltd.
Nagano-Tokyo Kaijo Bldg.
1081, Minamimagata-Machi
Nagano-Shi, **NAGANO, 380**
Tel: (81/262) 24-8012
Fax: (81/262) 24-8016

Yokogawa-Hewlett-Packard Ltd.
Nagoya Kokusai Center Building
1-47-1, Nagano, Nakamura-ku
NAGOYA, AICHI 450
Tel: (81/52) 571-5171
Fax: (81/52) 565-0896

Yokogawa-Hewlett-Packard Ltd.
Sai-Kyo-Ren Building
1-2 Dote-cho
OOMIYA-SHI SAITAMA 330
Tel: (0486) 45-8031

Yokogawa-Hewlett-Packard Ltd.
Chuo Bldg., 5-4-20 Nishi-Nakajima
4-20 Nishinakajima, 5 Chome,
Yodogawa-ku
OSAKA, 532
Tel: (81/6) 304-6021
Fax: (81/6) 304-0216

Yokogawa-Hewlett-Packard Ltd.
1-27-15, Yabe
SAGAMIHARA Kanagawa, 229
Tel: (81/427) 59-1311

Yokogawa-Hewlett-Packard Ltd.
Hamamatsu Motoshiro-Cho Daichi
Seimei Bldg 219-21, Motoshiro-Cho
Hamamatsu-shi
SHIZUOKA, 430
Tel: (81/534) 56-1771
Fax: (81/534) 552371

Yokogawa-Hewlett-Packard Ltd.
Shinjuku Daiichi Seimei Bldg.
Nishi Shinjuku 2-7-1,
Shinjuku-ku, **TOKYO 163**
Tel: (81/3) 348-4611
Fax: (81/3) 348-7969

Yokogawa-Hewlett-Packard Ltd.
9-1, Takakura-cho
Hachioji-shi, **TOKYO, 192**
Tel: 81-426-42-1231

Yokogawa-Hewlett-Packard Ltd.
Tokyo-Nissam-Minato Bldg.
1-6-34 Konan, Minato-Ku
TOKYO 108
Tel: (81/3) 458-5411

Yokogawa-Hewlett-Packard Ltd.
29-21 Takaido-Higashi, 3-chome
Suginami-ku **TOKYO 168**
Tel: (03) 331-6111
Telex: 232-2024 YHPTOK

Yokogawa-Hokushin Electric Corp.
(YEW)
Shinjuku-NS Bldg. 10F
9-32 Nakacho 2 Chome
Shinjuku-ku
TOKYO, 163
Tel: (03) 349-1859
Telex: J27584

Yokogawa-Hewlett-Packard Ltd.
Toyoda-Tokyo-Kaijo Bldg.
1-179 Miyuki-Hon-Cho
TOYODA 473
Tel: (81/565) 27-5611

Yokogawa-Hewlett-Packard Ltd.
Chiyodaseimei-Utsunomiya Bldg.
2-3-1, Ohdori, **UTSUNOMIYA, Tochigi-**
Shi 320
Tel: (81/286) 33-1153
Fax: (81/286) 33-1175

Yokogawa-Hewlett-Packard Ltd.
No. 2 Yasuda Bldg.
2-32-12, Tsuruyo-cho
Kanagawa-ku, **YOKOHAMA 221**
Tel: (81/45) 312-1252
Fax: (81/45) 311-8328

KENYA

ADCOM Ltd., Inc., Kenya
P.O. Box 30070
NAIROBI
Tel: 331955
Telex: 22639

KOREA

Samsung Hewlett-Packard Co. Ltd.
Dongbang Yeosu Building
36-1 Yeosu Do-Dong
Youngdeungpo-Ku
SEOUL, 150
Tel: (82/2) 784-4666, 784-2666
Fax: (82/2) 784-7084
Telex: 25166 SAMSAN K

KUWAIT

Al-Khaldiya Trading & Contracting
P.O. Box 830
SAFAT 13009
Tel: 242 49 10, 241 17 26
Telex: 22481 AREEG KT
Cable: VISCOUNT

LEBANON

Computer Information Systems S.A.L.
Chammas Building
P.O. Box 11-6274
DORA BEIRUT
Tel: 89 31 13, 58 18 35
Telex: 42309 chacis le
Fax: 58 18 34

LUXEMBOURG

Hewlett-Packard Belgium S.A./N.V.
Blvd de la Woluwe, 100
Woluwedel
B-1200 **BRUSSELS**
Tel: (32/2) 761-3111
Telex: 23-494 paloben bru

MADAGASCAR

R.T.I.
175, Rue Blomet
75015 Paris
FRANCE
Tel: (1) 45 31 09 06
Tlx: 203376
Fax: (1) 45 31 09 18

MALAWI

Syston (Private) Ltd.
Manhattan Court
61 Second Street
P.O. Box 3458
HARARE
Zimbabwe
Tel: 739881/739885
Telex: 4122
Fax: 70 20 08

MALAYSIA

Hewlett-Packard Sales (Malaysia)
Sdn. Bhd.
9th Floor
Chung Khia Bank Building
46, Jalan Raja Laut
50350 **KUALA LUMPUR, MALAYSIA**
Tel: (60/3) 298-6555
Fax: (60/3) 291-5495
Protel Engineering
P.O. Box 1917
Lot 6624, Section 64
23/4 Pending Road
Kuching, **SARAWAK**
Tel: 36299
Telex: 70904 PROMAL MA
Cable: PROTELENG

MALTA

R.T.I.
175, Rue Blomet
75015 **PARIS**
France
Tel: (1) 45 31 09 06
Telex: 203376
Fax: (1) 45 31 09 18

MAURITANIA

R.T.I.
175, Rue Blomet
75015 **PARIS**
France
Tel: (1) 45 31 09 06
Tlx: 203376
Fax: (1) 45 31 09 18

MAURITIUS

R.T.I.
175, Rue Blomet
75015 **PARIS**
France
Tel: (1) 45 31 09 06
Telex: 203376
Fax: (1) 45 31 09 18

MEXICO

Hewlett-Packard de Mexico,
S.A. de C.V.
Rio Nio No. 4049 Desp. 12
Fracc. Cordoba
JUAREZ, Mexico
Tel: 161-3-15-62

Hewlett-Packard de Mexico,
S.A. de C.V.
Condominio Kadereyta
Circuito del Mezon No. 186 Desp. 6
Col. Del Prado - 76030
QRO, Mexico
Tel: 463-6-02-71

Hewlett-Packard de Mexico,
S.A. de C.V.
Monti Morelos No. 299
Fraccionamiento Loma Bonita 45060
GUADALAJARA, Jalisco
Col. Del Prado - 31 46 00
Telex: 0684 186 ECOMEX

Hewlett-Packard de Mexico,
S.A. de C.V.
Monte Pelvoux No. 111
Lomas de Chapultepec
11000 **MEXICO, D.F.**
Tel: (52/5) 596 79 33
Fax: (52/5) 596 42 08 (Ext 3231)

Hewlett-Packard de Mexico,
S.A. de C.V.
Czda. del Valle
409 Ote. 4th Piso
Colonia del Valle
Municipio de Garcia
66220 **NUEVO LEON**
Tel: 83-78-42-40
Telex: 362410 HPMY

Hewlett-Packard Co.
Latin America Region
Customer Support Center
7208 N.W. 31st St.
MIAMI, FL 33122
United States
Tel: (305) 599-0465
Telex: 441603 HPMIAMI
Fax: 599-0277

Hewlett-Packard de Mexico,
S.A. de C.V.
Blvd. Independencia No. 2000 Ote.
Ote Zerpiso
Co 1 Estrella
27010 **TORREON, COA.**
Tel: (52/171) 8 22 01

MOROCCO

Sicotel
Complexe des Habous
Tour C, avenue des Far
CASABLANCA 01
Tel: 31 22 70
Telex: 27604

R.T.I.
175, Rue Blomet
75015 **PARIS**
France
Tel: (1) 45 31 09 06
Tlx: 203376
Fax: (1) 45 31 09 18

Socofren Maroc
164, Boulevard D' Anfa
CASABLANCA
Tel: 36 08 84, 36 01 77
Telex: 23940

NETHERLANDS

Hewlett-Packard Nederland
Startbaan 16
1187 XR **AMSTELVEEN**
Tel: (31/20) 5476911
Telex: 13 216 HEPA NL
Fax: (31/20) 471825



Hewlett-Packard Nederland B.V.
Bongerd 2
NL 2900AA **CAPELLE A/D IJSEL**
Tel: 31-20-51-6444
Telex: 21261 HEPAC NL

Hewlett-Packard Nederland B.V.
Pastoor Petersstraat 134-136
P.O. Box 2342
NL 5600 CH **EINDHOVEN**
Tel: 31-40-32-6911
Telex: 51484 hepae nl
Fax: (31/40) 446546

NEW ZEALAND

Hewlett-Packard (N.Z.) Ltd.
5 Owens Road
P.O. Box 26-189
Epsom, **AUCKLAND**
Tel: (64/9) 605-651
Fax: (64/9) 600-507

Hewlett-Packard (N.Z.) Ltd.
186-190 Willis Street
P.O. Box 9443
WELLINGTON
Tel: (64/4) 820-400
Fax: (64/4) 843-380

NIGER

S.I.T.E.L.
Immeuble le General
Avenue General de Gaulle
PO Box 161
ABIDJAN 01
Ivory Coast
Tel: 32 12 27
Telex: 22149

NIGERIA

Management Information Systems Ltd.
3 Gerrard Road, Ikoyi
LAGOS
Tel: 68 08 87
Telex: 23582
Fax: 68 54 87

NORTHERN IRELAND

See United Kingdom

NORWAY

Hewlett-Packard Norway A/S
Oesterndalen 16-18
P.O. Box 34
N-1345 **ØESTERAAS**
Tel: (47/2) 24-6090
Telex: 76621 HPNAS N

Hewlett-Packard Norway A/S
Boemerget. 42
Box 2470
N-5037 **SOLHEIMSVIK**
Tel: (5/29) 10 72

OMAN

Suhail & Saud Bahwan
P.O. Box 169

MUSCAT/SULTANATE OF OMAN

Tel: 79 37 41
Telex: 3585 mb
Fax: 79 61 58

Imtac LLC
P.O. Box 9196

MINA AL FAHAL/SULTANATE OF OMAN

Tel: 70-77-27, 70-77-23
Telex: 3865 Tawoos ON

PAKISTAN

Mushko & Company Ltd.
House No. 16, Street No. 16
Sector F-6/3
ISLAMABAD
Tel: 824545
Telex: 54001 Muski PK
Cable: FEMUS Islamabad

Mushko & Company Ltd.
Oosman Chambers
Abdullah Haroon Road
KARACHI 0302
Tel: 524131, 524132
Telex: 2894 MUSKO PK
Cable: COOPERATOR Karachi

PANAMA

Electronico Balboa, S.A.
Calle Samuel Lewis, Ed. Alfa
Apartado 4929

PANAMA CITY

Tel: 9-011-507-636613
Telex: 368 3483 ELECTRON PG

PERU

Cia Electro Médica S.A. (ERMED)
Los Flamencos 145, Ofc. 301/2
San Isidro
Casilla 1030
LIMA 1 Peru
Tel: 9-011-511-4-414325, 41-3705
Telex: 39425257 PE PB SIS

PHILIPPINES

The Online Advanced Systems Corp.
2nd Floor, Electra House
115-117 Esteban Street
P.O. Box 1510
Legaspi Village, Makati
Metro **MANILA**
Tel: 815-38-10 (up to 16)
Telex: 63274 ONLINE PN

PORTUGAL

Mundinter Intercambio
Mundial de Commercio
Avenida Antonio 2761
LISBON
Tel: 53 21 31, 53 21 37
Telex: 16691

CPC Instrumentacao
Torre de Santo Antonio
rue Gregorio Lopes, Lote
Restelo
1400 **LISBON**
Tel: 617343/44/45/46
Telex: 27432/26054
Fax: 617345

C.P.C.S.I.
Rua de Costa Cabral 575
4200 **PORTO**
Tel: 493122
Telex: 26054, 27432
Fax: 48 87 21

PUERTO RICO

Hewlett-Packard Puerto Rico
Box 4048
Aguadilla, PR 00605
Tel: (809) 891-5235

Hewlett-Packard Puerto Rico
101 Munoz Rivera Avenue
Esu. Calle Ochoa
HATO REY, 00918
Tel: (809) 754-7800

QATAR

Qatar Datamation Systems
P.O. Box 350
DOHA
Tel: 41 32 82
Tlx: 4833
Fax: 42 63 78

REUNION ISLAND

R.T.I.
175, Rue Blomet
75015 **PARIS**
France
Tel: (33/1) 453 10906
Telex: 42/203376

RWANDA

R.T.I.
175, Rue Blomet
75015 **PARIS**
France
Tel: (33/1) 453 10906
Telex: 42/203376
Fax: (1) 45 31 09 18

SAUDI ARABIA

Modern Electronics Establishment
P.O. Box 281
Thuobah
AL-KHOBAR 31952
Tel: 895-1760, 895-1764
Telex: 671 106 HPMEEK SJ
Cable: ELECTA AL-KHOBAR

Modern Electronics Establishment
P.O. Box 1228
Redec Plaza, 6th Floor
JEDDAH
Tel: 644 96 28
Telex: 4027 12 FARNAS SJ
Cable: ELECTA JEDDAH

Modern Electronics Establishment
P.O. Box 22015
RIYADH 11495
Tel: 4763030
Telex: 402040 MEERYD SJ

SCOTLAND

See United Kingdom

SENEGAL

2SC
10, rue Tolbiac
B.P. 3716
DAKAR R.P.
(Please contact R.T.I. France.)
Tel: (221) 222248
Telex: 906/671

R.T.I.
175, Rue Blomet
75015 **PARIS**
France
Tel: 453 10906
Telex: 203376
Fax: (1) 45 31 09 18

SINGAPORE

Hewlett-Packard Singapore Ltd.
1150 Depot Road
SINGAPORE, 0410
Tel: (65) 273 7388
Fax: (65) 278 8990

SOUTH AFRICA

Hi Performance Systems (Pty.) Ltd.
P.O. Box 120, Howard Place
CAPE TOWN 7450
Tel: (27/21) 53-7954
Fax: (27/21) 53-5119

Hi Performance Systems (Pty.) Ltd.

Private Bag Wendywood
SANDTON 2144
Tel: (27/11) 802-5111
Fax: (27/11) 802-6332

SPAIN

Hewlett-Packard Española, S.A.
Avda. Diagonal, 605
08028-**BARCELONA**
Tel: (34/3) 401 91 00
Telex: 52603 hpbee

Bilbao (Vizcaya) Sales
Hewlett-Packard Español, S.A.
Avda. Zugazarte, 8
48930 - Las Arenas - **VIZCAYA**

Hewlett-Packard Española, S.A.
Crta. N-VI, Km. 16, 500
Las Rozas
E-MADRID
Tel: (34/1) 6370011
Telex: 23515 HPE

Hewlett-Packard Española, S.A.
Avda. S. Francisco Javier, S/N
Planta 10. Edificio Sevilla 2
E-SEVILLA 5, SPAIN
Tel: (34/54/64) 4454
Telex: 72933

Hewlett-Packard Española, S.A.
Isabel La Catolica, 8
46004 **VALENCIA**
Tel: (34/6) 351 59 44
Telex: 63435
Fax: (34/6) 351 59 44

Hewlett-Packard Española, S.A.
Avda. de Zugazarte, 8
48930 - Las Arenas
VIZCAYA
Tel: (34/4) 464 32 55
Telex: 33032

SUDAN

Mediterranean Engineering &
Trading Co., Ltd.
P.O. Box 1025
KHARTOUM
Tel: (249) 41184
Telex: 24052

R.T.I.
175, Rue Blomet
75015 **PARIS**
France
Tel: (1) 45 31 09 06
Tlx: 203376
Fax: (1) 45 31 09 18

SWEDEN

Hewlett-Packard Sverige AB
Östra Tullgatan 3
20011 **MALMÖ**
Box 6132
Tel: (46/40) 702 70
Telex: (854) 17886 (via Spånga office)
Fax: (46/40) 97 74 18

Hewlett-Packard Sverige AB
Elementvagen 16
S-7022 7 **ÖREBRO**
Tel: (49/19) 10 48 80
Telex: (854) 17886 (via Spånga office)

Hewlett-Packard Sverige AB
Skallholtsgratan 9, Kista
P.O. Box 19
S-16493 **KISTA**
Tel: 46/8/750-200
Telex: (854) 17886
Telefax: (08) 7527781

Hewlett-Packard Sverige AB
Box 266
Topasgatan 1A
S-42123 **VÄSTRA-FRÖLUNDA**
(Gothenburg)
Tel: (031) 891000
Telex: (854) 17886 (via Spånga office)

SWITZERLAND

Hewlett-Packard (Schweiz) AG
Clarastrasse 12
CH-4058 **BASEL**
Tel: (41/61) 681 59 20
Fax: (41/61) 681 98 59

Hewlett-Packard (Schweiz) AG
7, rue du Bois-du-Lan
Case postale 365-1366
CH-1217 **MEYRIN 1**
Tel: (41/22) 7804111
Telex: 27333 HPAG CH

Hewlett-Packard (Schweiz) AG
Allmend
CH-8967 **WIDEN**
Tel: (41/57) 321 111
Telex: 53933 HPAG CH
Fax: (41/57) 321 475

SYRIA

Middle East Electronics
P.O. Box 2308
Abu Rumaneh
DAMASCUS
Tel: 33 45 92
Telex: 411 771 Meesy

TAIWAN

Hewlett-Packard Taiwan Ltd.
Taipei Office
8th Floor, Hewlett-Packard Building
337 Fu Hsing North Road
TAIPEI
Tel: (02) 712-0404
Telex: 24439 HEWPACK
Cable: HEWPACK Taipei

Hewlett-Packard Taiwan Ltd.
THM Office
2, Huan Nan Road
CHUNG LI, Taoyuan
Tel: (034) 929-666

SALES OFFICES

Arranged alphabetically by country (cont'd)

TAIWAN (Cont'd)

Hewlett-Packard Taiwan Ltd.
Taichung Office
5FL, 67, Sec. 3,
Wen-Hsin Road,
TAICHUNG
Tel: (04) 254-1201

Hewlett-Packard Taiwan Ltd.
Kaohsiung Office
11/F, 456, Chung Hsiao 1st Road
KAOHSIUNG
Tel: (07) 2412318

TANZANIA

Adcom Ltd, Inc. Kenya
P.O. Box 30070

NAIROBI

Kenya
Tel: 33 19 55
Telex: 22639

THAILAND

Unimesa Co. Ltd.
2540 Sukumvit Avenue
Bangna
BANGKOK 10260
Tel: 662-398-6953
Telex: 84439 Simonco TH
Cable: UNIMESA Bangkok

TOGO

S.I.T.E.L.
Immeuble le General
Avenue General de Gaulle
P.O. Box 161
ABIDJAN 01
Ivory Coast
Tel: 32 12 27
Telex: 22149

Societe Africaine De Promotion
Immeuble Sageb
Rue d'Atakpame
P.O. Box 4150
LOME
Tel: 21-62-88
Telex: 5357

TRINIDAD & TOBAGO

Caribbean Telecoms Ltd.
Corner McAllister Street &
Eastern Main Road, Laventille
P.O. Box 732
PORT-OF-SPAIN
Tel: 624-4213
Telex: 22561 CARTEL WG
Cable: CARTEL, PORT OF SPAIN

Computer and Controls Ltd.
P.O. Box 51
1 Taylor Street
PORT-OF-SPAIN
Tel: (809) 622-7719/622-7985
Telex: 38722798 COMCON WG
LOGO AGENCY 1264

TUNISIA

Precision Electronique
5, rue de Chypre
Mutuelleville
1002 **TUNIS BELVEDERE**
Tunisia
Tel: 78 50 37
Tlx: 13238

TURKEY

E.M.A.
Mediha Eldem Sokak No. 41/6
Yenisehir
ANKARA
Tel: 131 4695, 131 9175
Telex: 46912n emsetr
Cable: EMATRADE ANKARA

Hewlett-Packard Bilgisayar Ve Olcum
Sistemleri A.S. (Headquarter)
Mesrutiyet Mah. 19 Mayıs Cad.
Nova-Baran Plaza Kat: 11-12
SISLI / ISTANBUL
Tel: 175 29 70
Telex: 39150
Fax: 175 29 92

Hewlett-Packard Bilgisayar Ve Olcum
Sistemleri A.S.
Paris Caddesi No 3
Diare 9
06670 ANKARA
Tel: 125 83 13
Telex: 46180
Fax: 125 47 45

UGANDA

Adcom Ltd, Inc. Kenya
P.O. Box 30070
NAIROBI
Kenya
Tel: 33 19 55
Telex: 22639

UNITED ARAB EMIRATES

Emitac Ltd.
P.O. Box 1641
SHARJAH
Tel: 591181
Telex: 48710 EMITAC EM
Cable: EMITAC SHARJAH

Emitac Ltd.
P.O. Box 2711
ABU DHABI
Tel: 820419-20
Cable: EMITACH ABUDHABI

Emitac Ltd.
P.O. Box 8391
DUBAI
Tel: 377591

Emitac Ltd.
P.O. Box 473
RAS AL KHAIMAH
Tel: 28133, 21270

UNITED KINGDOM

ENGLAND

Hewlett-Packard Ltd.
Customer Information Centre
King St. Lane
Winnersh, Wokingham
GB-BERKSHIRE RG11 5AR
Tel: (44/734) 784774
Telex: 847178
Fax: 777285

Hewlett-Packard Ltd.
Miller House
The Ring, **BRACKNELL**
Berkshire RG12 1XN
Tel: (44/344) 424-898
Fax: (44/344) 860015, Ext 56023

Hewlett-Packard Ltd.
Customer Sales & Support
Building 1, Filton Road
Stoke Gifford
BRISTOL, BS12 6QZ
Tel: (44/272) 236000

Hewlett-Packard Ltd.
Oakfield House, Oakfield Grove
Clifton **BRISTOL**, Avon BS8 2BN
Tel: 44-272-736 806
Telex: 444302

Hewlett-Packard Ltd.
9 Bridewell Place
LONDON EC4V 6BS
Tel: (44/583) 6565
Fax: (44/583) 6565, Ext 4713

Hewlett-Packard Ltd.
Heathside Park Rd.
Cheadle Heath, Stockport
GB-MANCHESTER SK3 0RB
Tel: (44/61) 428-0828
Telex: 668068
Fax: 4955009

Hewlett-Packard Ltd.
Harman House
No. 1 George St.
Uxbridge,
GB-MIDDLESEX UB8 1YH
Tel: (44/895) 72020
Telex: 893135
Fax: 73684

Hewlett-Packard Ltd.
Pontefract Road
NORMANTON,
West Yorkshire WF6 1RN
Tel: (44/924) 895-566
Fax: (44/924) 896-691
Telex: 557355

Hewlett-Packard Ltd.
The Quadrangle
106-118 Station Road
REDHILL, Surrey RH1 1PS
Tel: 44-737-686-55
Telex: 947234

Hewlett-Packard Ltd.
Avon House
435 Stratford Road
Shirley, **SOLIHULL**, West Midlands
B90 4BL
Tel: 44-21-745-8800
Telex: 339105

Hewlett-Packard Ltd.
Heathside Park Road
Cheadle Heath, Stockport
Cheshire SK3 0RB
Tel: (44/61) 428-0828
Fax: (44/61) 495-5009
Telex: 668068

Hewlett-Packard Ltd.
Harman House
No. 1 George Street
UXBRIDGE, Middlesex UB8 1YH
Tel: (44/895) 72020
Fax: (44/895) 73684

Hewlett-Packard Ltd.
King Street Lane
Winnersh, **WOKINGHAM**
Berkshire RG11 5AR
Tel: (44/734) 784774
Fax: (44/734) 777285 Ext 52285

NORTHERN IRELAND

Hewlett-Packard (Ireland) Ltd.
Carrickfergus Industrial Centre
75 Belfast Road, Carrickfergus
CO. ANTRIM BT38 8PM
Tel: 09603 67333

Unit 5
Bridgewood House
Newforge Lane
Malone Road
BELFAST BT95 NW
Tel: (353/232) 664-851
Fax: (353/232) 665-619

SCOTLAND

Hewlett-Packard Ltd.
1/3 Springburn Place
College Milton North
EAST KILBRIDE, G74 5NU
Tel: 035-52-49261
Fax: 03552-35929
Telex: 779615

Hewlett-Packard Ltd.
SOUTH QUEENSFERRY
West Lothian, EH30 9TG
Tel: 031-331-1188
Fax: 031-331-7412

UNITED STATES

Hewlett-Packard Co.
Customer Information Center
Tel: (800) 752-0900
Hours: 6:00 AM to 5:00 PM
Pacific Time

Alabama

Hewlett-Packard Co.
2100 Riverchase Center
Building 100 - Suite 118
BIRMINGHAM, AL 35244
Tel: (205) 988-0547
Fax: (205) 988-5308

Hewlett-Packard Co.
620 Discovery Dr.
HUNTSVILLE, AL 35806
Tel: (205) 830-2000
Fax: (205) 830-1427

Alaska

Hewlett-Packard Co.
4000 Old Seward Highway
Suite 101
ANCHORAGE, AK 99503
Tel: (907) 563-8855
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JACKSONVILLE, FL 32216
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Fax: (904) 636-9955

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ORLANDO, FL 32809
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Fax: (407) 826-9309

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Building 5
PENSACOLA, FL 32503
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Fax: (904) 476-4116

Hewlett-Packard Co.
5550 Idelwild, #150
TAMPA, FL 33634
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Fax: (813) 889-4445

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Hewlett-Packard Co.
2015 South Park Place
ATLANTA, GA 30339
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Fax: (404) 980-7669

Hewlett-Packard Co.
3607 Parkway Lane
Suite 300
NORCROSS, GA 30092
Tel: (404) 448-1894
Fax: (404) 246-5206

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Hewlett-Packard Co.
Pacific Tower
1001 Bishop St.
Suite 2400
HONOLULU, HI 96813
Tel: (808) 526-1555
Fax: (808) 536-7873

Idaho

Hewlett-Packard Co.
11309 Chinden Blvd.
BOISE, ID 83714
Tel: (208) 323-2700
Fax: (208) 323-2528

Illinois

Hewlett-Packard Co.
2205 E. Empire St.
BLOOMINGTON, IL 61704
Tel: (309) 662-9411
Fax: (309) 662-0351

Hewlett-Packard Co.
525 W. Monroe St., Suite 1308
CHICAGO, IL 60606
Tel: (312) 930-0010
Fax: (312) 930-0986

Hewlett-Packard Co.
1200 East Diehl Road
NAPERVILLE, IL 60566
Tel: (312) 357-8800
Fax: (312) 357-9896

Hewlett-Packard Co.
5201 Tollview Drive
ROLLING MEADOWS, IL 60008
Tel: (312) 255-9800
Fax: (312) 259-5878

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Hewlett-Packard Co.
11911 N. Meridian St.
CARMEL, IN 46032
Tel: (317) 844-4100
Fax: (317) 843-1291

Hewlett-Packard Co.
111 E. Ludwig Road
Suite 108
FT. WAYNE, IN 46825
Tel: (219) 482-4283
Fax: (219) 482-9907

Iowa

Hewlett-Packard Co.
4050 River Center Court
CEDAR RAPIDS, IA 52402
Tel: (319) 393-0606
Fax: (319) 378-1024

Hewlett-Packard Co.
4201 Corporate Dr.
WEST DES MOINES, IA 50265
Tel: (515) 224-1435
Fax: (515) 224-1870

Kansas

Hewlett-Packard Co.
3607 Rock Business Park
3450 N. Rock Rd.
Suite 300
WICHITA, KS 67226
Tel: (316) 636-4040
Fax: (316) 636-4504

Kentucky

Hewlett-Packard Co.
305 N. Hurstbourne Lane,
Suite 100
LOUISVILLE, KY 40222
Tel: (502) 426-0100
Fax: (502) 426-0322

Louisiana

Hewlett-Packard Co.
160 James Drive East
ST. ROSE, LA 70087
Tel: (504) 467-4100
Fax: (504) 467-4100 x 291

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Hewlett-Packard Co.
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BALTIMORE, MD 21227
Tel: (301) 644-5800
Fax: (301) 362-7650

Hewlett-Packard Co.
2 Choke Cherry Road
ROCKVILLE, MD 20850
Tel: (301) 948-6370
Fax: (301) 948-5986

Massachusetts

Hewlett-Packard Co.
1775 Minuteman Road
ANDOVER, MA 01810
Tel: (508) 682-1500
Fax: (508) 794-2619

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29 Burlington Mall Rd.
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Fax: (617) 221-5240

Michigan

Hewlett-Packard Co.
3033 Orchard Vista S.E.
GRAND RAPIDS, MI 49546
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Fax: (616) 956-9022

Hewlett-Packard Co.
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NOVI, MI 48050
Tel: (313) 349-9200
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TROY, MI 48064
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Minnesota

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Mississippi

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Fax: (601) 957-2515

Missouri

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Fax: (314) 344-5273

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KANSAS CITY, MO 64133
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Fax: (816) 737-4690

Montana

Hewlett-Packard Co.
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Tel: (314) 344-5100
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Nebraska

Hewlett-Packard
11626 Nicholas St.
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Fax: (201) 682-4031

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Hewlett-Packard Co.
1362-C Trinity Dr.
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New York

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Tel: (518) 458-1550
Fax: (518) 458-1550 x 0393

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Hewlett-Packard Co.
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Tel: (315) 451-1820
Fax: (315) 451-1820 x 255

Hewlett-Packard Co.
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34th Street & 7th Avenue
MANHATTAN NY 10119
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Fax: (914) 935-6497

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68 Middlebush Rd.
WAPPINGERS FALLS, NY 12590
Tel: (914) 298-9125
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North Carolina

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Fax: (919) 668-1797
Mailing Address
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Greensboro, NC 27426

Ohio

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Tel: (216) 644-2270
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Hewlett-Packard Co.
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Suite 101
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2800 Electric Road Suite 100
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Fax: (703) 989-8049

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Hewlett-Packard Co.
15815 S.E. 37th Street
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Fax: (206) 643-8748

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SPOKANE, WA 99212-2657
Tel: (509) 922-7000
Fax: (509) 927-4236

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CHARLESTON, WV 25304
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Fax: (304) 925-1910

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275 N. Corporate Dr.
BROOKFIELD, WI 53005
Tel: (414) 792-8800
Fax: (414) 792-0218

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Pablo Ferrando S.A.C. e I.
Avenida Italia 2877
Casilla de Correo 370
MONTEVIDEO
Tel: 59-82-802-586
Telex: 398802586

Olympia de Uruguay S.A.
Maquinas de Oficina
Avda. del Libertador 1997
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MONTEVIDEO
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Telex: 6342 OROU UY

VENEZUELA

Analytical Supplies, CA
Quinta #103 Impermes
Av El Centro
Los Chorrros
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CARACAS
Tel: 364904, 2394047
Telex: 26274 CABIC

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Avenida 3 Y con Calle 75
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Apartado 2646
Tel: 586175669
Telex: 62464 HPMAR

YUGOSLAVIA

Do Hermes
General Zdanova 4
YU-11000 BEOGRAD
Tel: (011) 342 641
Telex: 11433

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Celovska 73
YU-61000 LJUBLJANA
Tel: (061) 553 170
Telex: 31583

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Computer & Industrial Engineering
25 Ave. de la Justice Gombe
Boite Postale 10976
KINSHASA
Tel: 32 063, 32 633, 28 251
Telex: 21552
Fax: 22 850

ZAMBIA

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LUSAKA
Tel: 21 55 80
Telex: 40128

ZIMBABWE

Field Consolidated (Private) Ltd.
Syston Division
Manhattan Court
61 Second Street
P.O. Box 3458
HARARE
Tel: 73 98 81
Telex: 26241
Fax: 70 20 08

Please send directory corrections to:

Test & Measurement Catalog
Hewlett-Packard Company
3200 Hillview Avenue
Palo Alto, CA 94304
Tel: (415) 857-4706
Fax: (415) 857-3880

September 1989



MANUAL CHANGES

MANUAL IDENTIFICATION

Model Number: HP 54120B

Date Printed: July 1989

Part Number: 54120-90908

This supplement contains important information for correcting errors in the manual and for adapting the manual to instruments containing improvements that were 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 table.

| Serial Prefix or Number | Make Manual Changes | Serial Prefix or Number | Make Manual Changes |
|-------------------------|---------------------|-------------------------|---------------------|
| 2944A | 1 | | |
| 3008A | 1, 2 | | |
| 3012A | 1, 2, 3 | | |
| 3035A | 1, 2, 4 | | |
| 3051A | 1, 2, 4, 5 | | |
| | | | |

◆ NEW ITEM

◆ Errata

This errata inclusion provides a drawing for the Replaceable Parts section to help locate cables in the mainframe. The Table of Contents page is also updated.

Replace page Contents-5 with the page in this document.

Add page 5-11 to the end of the Replaceable Parts section.

Change 1

The following changes were made to the Replaceable Parts pages. The changes are documented on the new pages that are a part of change 5.

A14 changed to HP part number 2090-0226 Color CRT Module.

MP13, right side cover 5061-9523, was removed from the Replaceable Parts list.

MP12, MP14, MP15, and MP16, changed in quantity from 1 to 2.

Change 2

The following changes were made to the Replaceable Parts pages. The changes are documented on the new pages that are a part of change 5.

A2 changed to HP part number 54111-66527, CD = 7

*A2 changed to HP part number 54111-69527, CD = 3

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.

March 29, 1991

Printed in U.S.A.

1 of 13



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Change 3

The part number of the A11 assembly was changed as indicated below. However, the A11 assembly was changed again to a new part number in change 4. Therefore, you will find the change 4 part numbers for the A11 assembly in the replaceable parts list.

A11 changed to HP part number 54110-66515, CD = 2

*A11 changed to HP part number 54110-69515, CD = 8

Change 4

The following changes were made to the Replaceable Parts pages. The changes are documented on the new pages that are a part of change 5.

A11 changed to HP part number 54110-66516, primary power supply assembly.

Change 5

Replace: Title page, Printing History pages iii and iv, Replaceable Parts pages 5-8 and 5-9.

This prefix change covers changes to PC assemblies that are transparent at the assembly replacement level of maintenance.

Service Manual

HP 54120B

Digitizing Oscilloscope Mainframe

Serial Numbers

This manual applies directly to instruments
prefixed with serial number:

3051A

With changes described within, this manual also
applies to instruments with serial prefixes:

3035A
3012A
3008A
2944A
2926A
2909A

For Additional Information about serial numbers see
Instruments Covered by This Manual
in Section 1.

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Herstellerbescheinigung

Hiermit wird bescheinigt, dass das Gerät/System HP 54120B in Übereinstimmung mit den Bestimmungen von Postverfügung 1046/84 funkentstört ist.

Der Deutschen Bundespost wurde das Inverkehrbringen dieses Gerätes/Systems angezeigt und die Berechtigung zur Überprüfung der Serie auf Einhaltung der Bestimmungen eingeräumt.

Zusatzinformation für Mess- und Testgeräte

Werden Mess- und Testgeräte mit ungeschirmten Kabeln und/oder in offenen Messaufbauten verwendet, so ist vom Betreiber sicherzustellen, dass die Funkentstörbestimmungen unter Betriebsbedingungen an seiner Grundstücksgrenze eingehalten werden.

Manufacturer's Declaration

This is to certify that this product HP 54120B meets the radio frequency interference requirements of directive 1046/84. The German Bundespost has been notified that this equipment was put into circulation and was granted the right to check the product type for compliance with these requirements.

Additional Information for Test and Measurement Equipment

Note: If test and measurement equipment is operated with unshielded cables and/or used for measurements on open set-ups, the user must insure that under these operating conditions, the radio frequency interference limits are met at the border of his premises.

Printing History

New editions are complete revisions of the manual. Update packages, which are issued between editions, contain additional and replacement pages to be merged into the manual by the customer. The dates on the title page change only when a new edition is published.

A software and/or firmware code may be printed before the date; this indicates the version level of the software and/or firmware of this product at the time of the manual or update was issued. Many product updates and fixes do not require manual changes and, conversely, manual corrections may be done without accompanying product changes. Therefore, do not expect a one to one correspondence between product updates and manual updates.

| | | |
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| Contents-1, 5-11 | March 1991 |

List of Illustrations

- 1-3 Figure 1-1. HP 54120B Dimensions

- 2-2 Figure 2-1. Rear Panel of Mainframe and Test Set

- 4-10 Figure 4-1. CRT Adjustment Sequence
- 4-11 Figure 4-2. PIN AMP Adjustment
- 4-11 Figure 4-3. PIN PHASE Adjustment
- 4-13 Figure 4-4. Purity Magnet Centering
- 4-13 Figure 4-5. Purity Magnet Adjustment Raster
- 4-14 Figure 4-6. Landing and Purity Adjustment Guide
- 4-15 Figure 4-7. Static Convergence
- 4-16 Figure 4-8. Y BOW Adjustment
- 4-16 Figure 4-9. Y BOW CROSS Adjustment
- 4-16 Figure 4-10. V.STAT TOP Adjustment
- 4-17 Figure 4-11. V.STAT BOTTOM Adjustment
- 4-17 Figure 4-12. H.AMP Adjustment
- 4-17 Figure 4-13. H.TILT Adjustment

- 5-4 Figure 5-1. Top View
- 5-5 Figure 5-2. Bottom View
- 5-6 Figure 5-3. Front Panel
- 5-6 Figure 5-4. Rear Panel
- 5-7 Figure 5-5. Left Side View
- 5-7 Figure 5-6. Right Side View
- 5-11 Figure 5-7. Mainframe Cable Locations

- 6A-2 Figure 6A-1. Major Assembly Locations
- 6A-4 Figure 6A-2. Primary Power Supply Mounting Screws
- 6A-7 Figure 6A-3. CRT Bezel Removal Pressure Locations
- 6A-8 Figure 6A-4. Front Panel Mounting Screws
- 6A-10 Figure 6A-5. Color CRT Module Mounting Screws
- 6A-13 Figure 6A-6. Fan Housing Mounting Screws
- 6A-15 Figure 6A-7. Color Display Assembly Mounting Screws
- 6A-15 Figure 6A-8. Motherboard Mounting Screws

- 6B-2 Figure 6B-1. System Block Diagram
- 6B-7 Figure 6B-2. ADC Assembly Block Diagram
- 6B-10 Figure 6B-3. Horizontal Control Assembly Block Diagram
- 6B-13 Figure 6B-4. I/O Assembly Block Diagram
- 6B-16 Figure 6B-5. Microprocessor Assembly Block Diagram
- 6B-19 Figure 6B-6. Color Display Assembly Block Diagram
- 6B-22 Figure 6B-7. Power Supply Assembly Block Diagrams

- 6D-3 Figure 6D-1. Main Troubleshooting Flowchart
- 6D-4 Figure 6D-2. Display Troubleshooting Flowchart Part 1
- 6D-5 Figure 6D-3. Display Troubleshooting Flowchart Part 2
- 6D-6 Figure 6D-4. Softkey Number Assignments
- 6D-7 Figure 6D-5. Keyboard Cable Pin Numbers
- 6D-8 Figure 6D-6. Keyboard Troubleshooting Flowchart

| | |
|-------|---|
| 6D-10 | Figure 6D-7. Core Subsystem Troubleshooting Flowchart |
| 6D-11 | Figure 6D-8. Power Supply Troubleshooting Flowchart 1 |
| 6D-12 | Figure 6D-9. Power Supply Troubleshooting Flowchart 2 |
| 6D-13 | Figure 6D-10. Power Supply Troubleshooting Flowchart 3 |
| 6D-15 | Figure 6D-11. Power Supply Troubleshooting Flowchart 4 |
| 6D-16 | Figure 6D-12. Color CRT Module Input Connections |
| 6D-16 | Figure 6D-13. Vertical and Horizontal Sync. Waveforms |
| A2-6 | Figure A2-1. Test Port Return Cables |
| A2-6 | Figure A2-2. Minimum Bend Radius |
| A2-8 | Figure A2-3. Viewing the Trigger Signal |
| A2-8 | Figure A2-4. Attenuating the TDR Signal |
| A2-9 | Figure A2-5. HP 11667B Power Splitter Schematic |
| A2-9 | Figure A2-7. HP 11667B Power Splitter |
| A3-1 | Figure A3-1. Allowable Temperature, Humidity, Pressure |
| A3-4 | Figure A3-2. Typical SWR of SMA and APC 3.5 Connectors |
| A4-3 | Figure A4-1. Visual Inspection of APC 3.5 Connectors |
| A4-5 | Figure A4-2. Mechanical Dimensions of Connector Faces |
| A4-6 | Figure A4-3. Mechanical Dimensions of the Short Circuit |
| A4-6 | Figure A4-4. Precision 3.5 mm Connector Gauges |
| A4-7 | Figure A4-5. Zeroing Precision 3.5 mm Connector Gauges |
| A4-7 | Figure A4-6. Measuring Precision 3.5 mm Male Connectors |
| A4-7 | Figure A4-7. Measuring Precision 3.5 mm Female Connectors |
| A4-9 | Figure A4-8. Connecting Devices |
| A4-9 | Figure A4-9. Counter Rotation Technique |

List of Tables

| | |
|------|--|
| 1-4 | Table 1-1. Recommended Equipment List |
| 2-4 | Table 2-1. Power Cord Configurations |
| 5-2 | Table 5-1. List of Manufacturers' Codes |
| 5-3 | Table 5-2. Reference Designators and Abbreviations |
| 5-8 | Table 5-3. Replaceable Parts List |
| 6D-6 | Table 6D-1. Row and Column Key Assignments |
| 6D-7 | Table 6D-2. Keyboard Ribbon Cable Signal Description |
| 6D-9 | Table 6D-3. Core Subsystem Diagnostic Routines |
| 6D-9 | Table 6D-4. Power Supply Distribution |

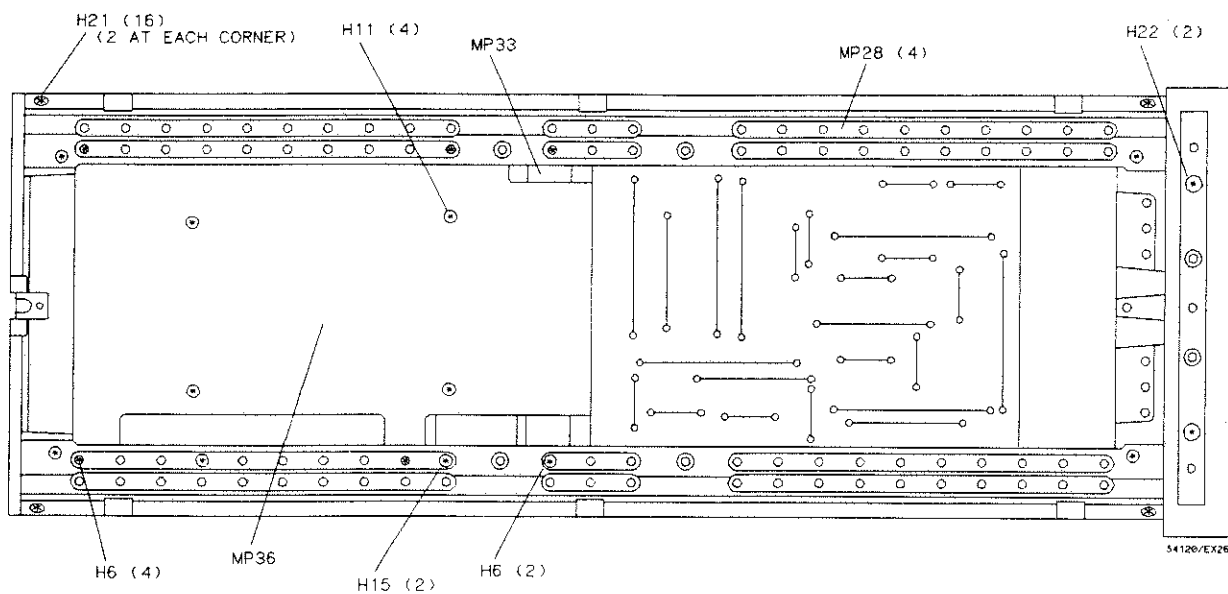


Figure 5-5. Left Side View

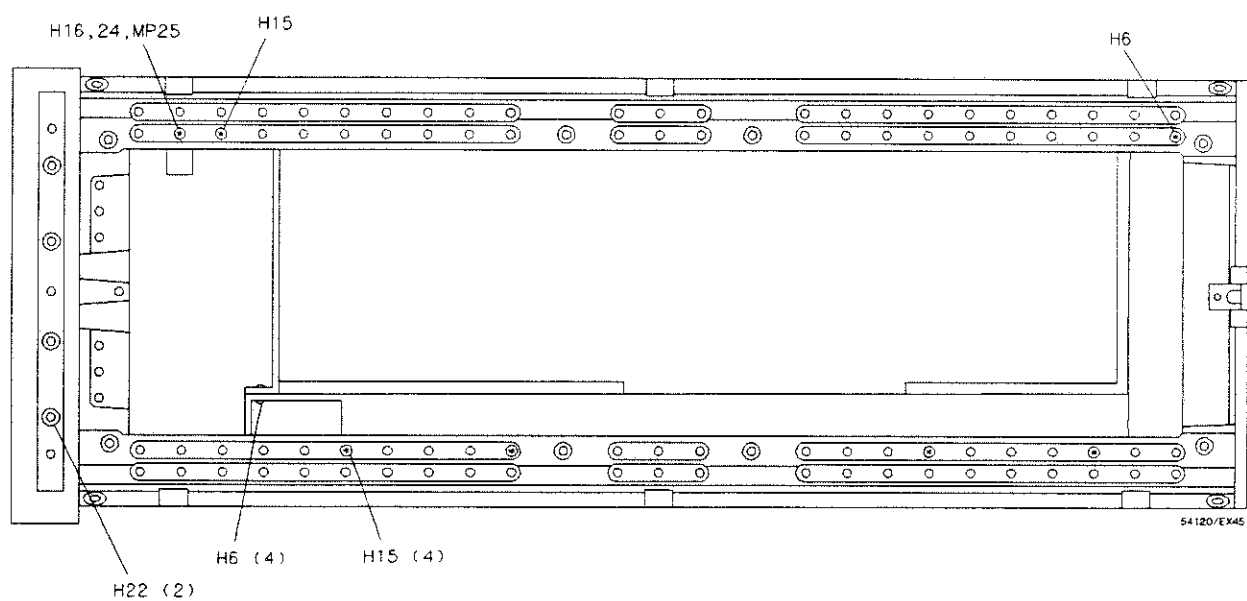


Figure 5-6. Right Side View

Table 5-3. Replaceable Parts List

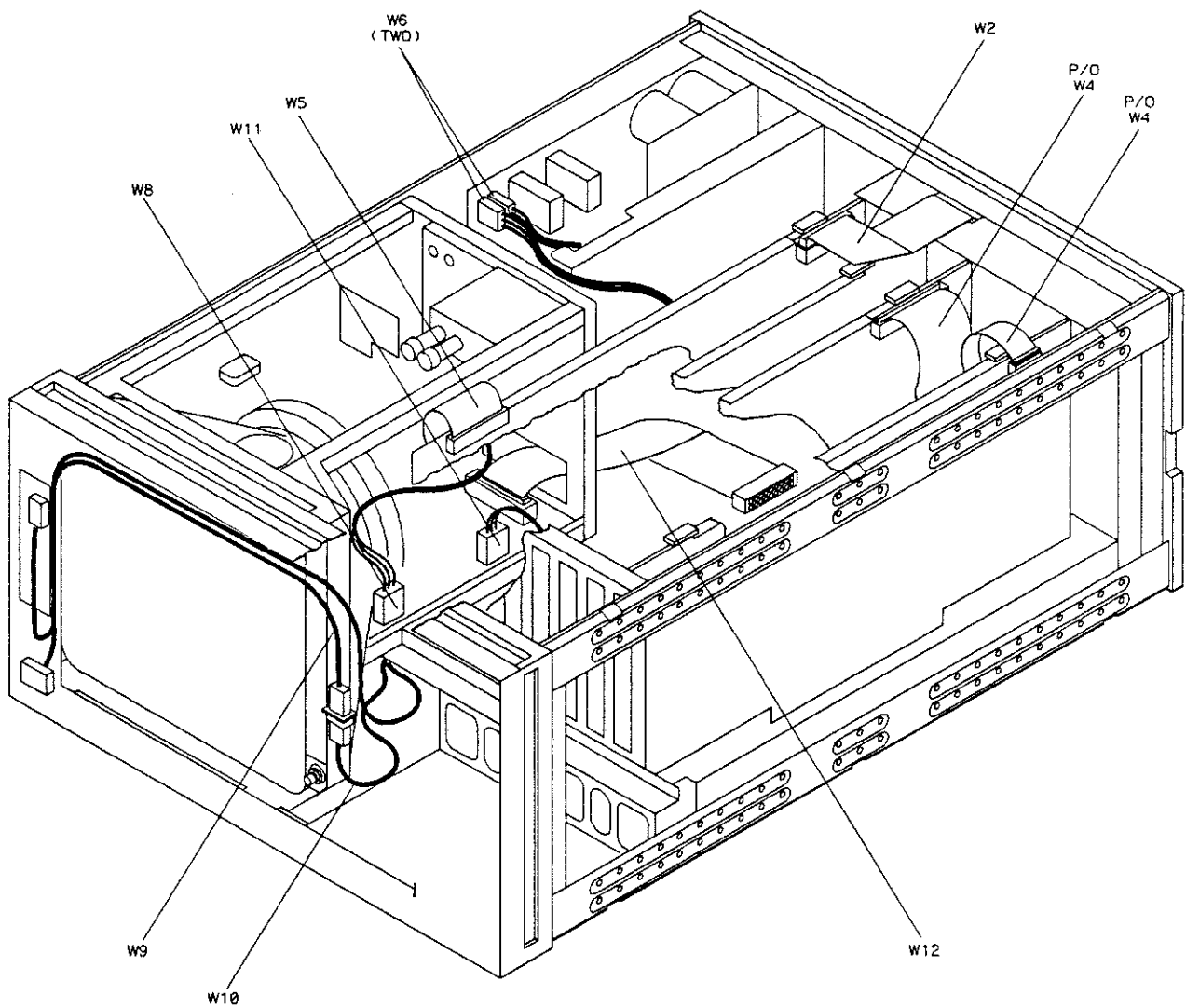
| Reference Designator | HP Part Number | CD | Qty | Description | Mfr Code | Mfr Part Number |
|-----------------------------|----------------|----|-----|---|----------|-----------------|
| *EXCHANGE ASSEMBLIES | | | | | | |
| *A1 | 54111-69506 | 8 | 0 | I/O ASSEMBLY | 28480 | 54111-69506 |
| *A2 | 54111-69527 | 3 | 0 | MICROPROCESSOR ASSEMBLY | 28480 | 54111-69527 |
| *A3 | 54122-69501 | 6 | 0 | HORIZONTAL CONTROL ASSEMBLY | 28480 | 54122-69501 |
| *A4 | 54120-69502 | 5 | 0 | ADC ASSEMBLY | 28480 | 54120-69502 |
| *A6 | 54110-69514 | 7 | 0 | COLOR DISPLAY ASSEMBLY | 28480 | 54110-69514 |
| *A11 | 54110-69516 | 3 | 0 | PRIMARY POWER SUPPLY ASSEMBLY | 28480 | 54110-69516 |
| *A12 | 54110-69510 | 3 | 0 | ANALOG POWER SUPPLY ASSEMBLY | 28480 | 54110-69510 |
| *A13 | 54110-69506 | 7 | 0 | DIGITAL POWER SUPPLY ASSEMBLY | 28480 | 54110-69506 |
| A1 | 54111-66506 | 2 | 1 | I/O ASSEMBLY | 28480 | 54111-66506 |
| A2 | 54111-66527 | 7 | 1 | MICROPROCESSOR ASSEMBLY | 28480 | 54111-66527 |
| A3 | 54122-66501 | 0 | 1 | HORIZONTAL CONTROL ASSEMBLY | 28480 | 54122-66501 |
| A4 | 54120-66502 | 9 | 1 | ADC ASSEMBLY | 28480 | 54120-66502 |
| A5 | 54110-66511 | 8 | 1 | MOTHER BOARD ASSEMBLY | 28480 | 54110-66511 |
| A6 | 54110-66514 | 1 | 1 | COLOR DISPLAY ASSEMBLY | 28480 | 54110-66514 |
| A7 | 54110-66509 | 4 | 1 | CRT CONTROL ASSEMBLY | 28480 | 54110-66509 |
| A8 | 54100-66520 | 7 | 1 | MENU KEYBOARD | 28480 | 54100-66520 |
| A9 | 54110-66502 | 7 | 1 | FUNCTION KEYBOARD | 28480 | 54110-66502 |
| A10 | 54100-66505 | 8 | 1 | CONTROL KEYBOARD | 28480 | 54100-66505 |
| A11 | 54110-66516 | 9 | 1 | PRIMARY POWER SUPPLY ASSEMBLY | 28480 | 54110-66516 |
| A12 | 54110-66510 | 7 | 1 | ANALOG POWER SUPPLY ASSEMBLY | 28480 | 54110-66510 |
| A13 | 54110-66506 | 1 | 1 | DIGITAL POWER SUPPLY ASSEMBLY | 28480 | 54110-66506 |
| A14 | 2090-0226 | 5 | 1 | COLOR CRT MODULE | 28480 | 2090-0226 |
| A15 | 01980-61062 | 5 | 1 | RPG ASSEMBLY | 28480 | 01980-61062 |
| B1 | 3160-0521 | 3 | 1 | FAN-TUBEAXIAL | 28480 | 3160-0521 |
| E1 | 8160-0577 | 4 | 1 | RFI GROUND STRIP | 28480 | 8160-0577 |
| H1 | 0515-1384 | 8 | 2 | SCREW-MACH M5 X 0.8 10MM-LG | 28480 | 0515-1384 |
| H2 | 0515-1444 | 1 | 4 | SCREW-MACH M3.5 X 0.6 25.4MM-LG PAN-HD | 28480 | 0515-1444 |
| H3 | 0515-1319 | 9 | 8 | SCREW-MACH M3 X 0.5 20MM-LG PAN-HD | 28480 | 0515-1319 |
| H4 | 1251-2942 | 7 | 2 | SCREW LOCK KIT-SUBMIN D CONN | 28480 | 1251-2942 |
| H5 | 1251-1245 | 7 | 3 | COVER SCREW | 28480 | 1251-2945 |
| H6 | 0515-0372 | 2 | 49 | SCREW-MACHINE ASSEMBLY M3 X 0.5 8MM-LG | 28480 | 0515-0372 |
| H7 | NOT ASSIGNED | | | | | |
| H8 | 0515-1253 | 0 | 3 | RETAINER RING FOR COVER SCREW2 | 8480 | 0515-1253 |
| H9 | 0515-1444 | 1 | 4 | FOOT SCREW | 28480 | 0515-1444 |
| H10 | 0515-1410 | 1 | 7 | SCREW-MACHINE ASSEMBLY M3 X 0.5 20MM-LG | 28480 | 0515-1410 |
| H11 | 0515-1025 | 4 | 4 | SCREW-MACHINE ASSEMBLY M3 X 0.5 26MM-LG | 28480 | 0515-1025 |
| H12 | 5061-6138 | 2 | 4 | NUT-INSERT M4 X 0.7 X 4.6 OD | 28480 | 5061-6138 |
| H13 | 2190-0763 | 7 | 2 | WASHER-FL MTLC NO. 6 .14-IN-ID .5-IN-OD | 28480 | 2190-0763 |
| H14 | 3050-1238 | 8 | 2 | WASHER-FL NM 9/64 .149-IN-ID .478-IN-OD | 86928 | 3050-1238 |
| H15 | 0515-0433 | 6 | 15 | SCREW-MACHINE ASSEMBLY M4 X 0.7 8MM-LG | 28480 | 0515-0433 |

Table 5-3. Replaceable Parts List

| Reference Designator | HP Part Number | CD | Qty | Description | Mfr Code | Mfr Part Number |
|----------------------|----------------|----|-----|--|----------|-----------------|
| H16 | NOT ASSIGNED | | | | | |
| H17 | 0515-0641 | 8 | 2 | SCREW-THD-RLG M4 X 0.7 10MM-LG PAN-HD | 28480 | 0515-0641 |
| H18 | 0515-0435 | 8 | 4 | SCREW-MACHINE ASSEMBLY M4 X 0.7 14MM-LG | 28480 | 0515-0435 |
| H19 | NOT ASSIGNED | | | | | |
| H20 | 0515-1228 | 9 | 4 | SCREW-MACH M4 X 0.7 6MM-LG 90-DEG-FLH-HD | 28480 | 0515-1228 |
| H21 | 0515-1403 | 2 | 16 | SCREW-SPCL M4 X 0.7 6MM-LG 90-DEG-FLH-HD | 28480 | 0515-1403 |
| H22 | 0515-1269 | 8 | 16 | SCREW-MACH M4 X 0.7 10MM-LG | 28480 | 0515-1269 |
| H23 | 0535-0031 | 2 | 9 | NUT-HEX W/LKWR M3 X 0.5 2.4MM-THK | 28480 | 0535-0031 |
| H24 | NOT ASSIGNED | | | | | |
| H25 | 2950-0043 | 8 | 1 | NUT-HEX-DBL-CHAM 3/82THD .094-IN-THK | 28480 | 2950-0043 |
| H26 | 0380-1686 | 6 | 2 | STANDOFF-HEX 6.5-MM-LG M3 X 0.5-THD | 28480 | 0380-1686 |
| H27 | 2190-0016 | 3 | 1 | WASHER-LK INTL T 3/8 IN .377-IN-ID | 28480 | 2190-0016 |
| H28 | 3050-1176 | 3 | 1 | WASHER-FL NM 3/8 IN .39-IN-ID .562-IN-OD | 86928 | 3050-1176 |
| H29 | 0515-0664 | 5 | 5 | SCREW M3 12MN-L6 PAN-HP T10 | 28480 | 0515-0664 |
| MP1 | 01650-47401 | 7 | 1 | RPG KNOB | 28480 | 01650-47401 |
| MP2 | 5061-9448 | 3 | 1 | BOTTOM COVER | 28480 | 5061-9448 |
| MP3 | 5040-7201 | 8 | 2 | BOTTOM FEET | 28480 | 5040-7201 |
| MP4 | 5040-7222 | 3 | 2 | BOTTOM NON SKID FEET | 28480 | 5040-7222 |
| MP5 | 1460-1345 | 5 | 2 | TILT STAND SST | 28480 | 1460-1345 |
| MP6 | 8160-0590 | 1 | 2 | GROUND RFI STRIP | 28480 | 8160-0590 |
| MP7 | 54110-04103 | 4 | 1 | TOP COVER | 28480 | 54110-04103 |
| MP8 | 0890-0029 | 0 | 1 | TUBING-HS .187-IN-D/.093-IN-RCVD | 28480 | 0890-0029 |
| MP9 | 5001-0441 | 2 | 2 | TRIM STRIP SIDE | 28480 | 5001-0441 |
| MP10 | 5040-7202 | 9 | 1 | TOP TRIM STRIP | 28480 | 5040-7202 |
| MP11 | 54110-40502 | 3 | 4 | REAR FOOT | 28480 | 54110-40502 |
| MP12 | 5060-9948 | 6 | 2 | SIDE COVERS—PERFORATED | 28480 | 5060-9948 |
| MP13 | NOT ASSIGNED | | | | | |
| MP14 | 5060-9805 | 4 | 2 | STRAP HANDLE | 28480 | 5060-9805 |
| MP15 | 5041-6819 | 4 | 2 | FRONT CAP FOR STRAP HANDLE | 28480 | 5041-6819 |
| MP16 | 5041-6820 | 7 | 2 | REAR CAP FOR STRAP HANDLE | 28480 | 5041-6820 |
| MP17 | NOT ASSIGNED | | | | | |
| MP18 | 5021-5807 | 6 | 1 | FRONT FRAME | 28480 | 5021-5807 |
| MP19 | 54120-00206 | 2 | 1 | FRONT PANEL | 28480 | 54120-00206 |
| MP20 | 54111-00203 | 8 | 1 | FRONT SUB PANEL | 28480 | 54111-00203 |
| MP21 | 54110-40501 | 2 | 1 | DISPLAY BEZEL | 28480 | 54110-40501 |
| MP22 | 16500-00603 | 3 | 1 | FAN SCREEN | 28480 | 16500-00603 |
| MP23 | 0403-0092 | 6 | 1 | BUMPER FOOT-PRS-IN | 28480 | 0403-0092 |
| MP24 | 1400-1362 | 0 | 2 | CLAMP-CABLE .35-DIA .51-WD NYL | 28480 | 1400-1362 |
| MP25 | 1400-0611 | 0 | 2 | CLAMP-FL-CA 1-WD | 06915 | 1400-0611 |
| MP26 | 54111-01203 | 0 | 1 | FRONT CARD CAGE BRACKET | 28480 | 54111-01203 |
| MP27 | 54111-00101 | 5 | 1 | MAIN DECK | 28480 | 54111-00101 |
| MP28 | 5021-5838 | 3 | 4 | SIDE STRUT | 28480 | 5021-5838 |
| MP29 | NOT ASSIGNED | | | | | |
| MP30 | 54110-01201 | 7 | 1 | TOP CRT BRACKET | 28480 | 54110-01201 |

Table 5-3. Replaceable Parts List

| Reference Designator | HP Part Number | CD | Qty | Description | Mfr Code | Mfr Part Number |
|----------------------|----------------|----|-----|--|----------|-----------------|
| MP31 | 54110-01202 | 8 | 1 | BOTTOM CRT BRACKET | 28480 | 54110-01202 |
| MP32 | 54110-01210 | 8 | 1 | BRACKET-COLOR CRT MOD. REAR-ON MODULE | 28480 | 54110-01210 |
| MP33 | 54110-04702 | 9 | 1 | BRACKET-COLOR CRT MOD. REAR-ON FRAME | 28480 | 54110-04702 |
| MP34 | 1400-0679 | 0 | 4 | CLIP-CABLE 'U' SHP, PNL MTG TYPE | 28480 | 1400-0679 |
| MP35 | 54111-04104 | 6 | 1 | POWER SUPPLY COVER-TOP | 28480 | 54111-04104 |
| MP36 | 54110-04106 | 7 | 1 | POWER SUPPLY COVER-SIDE | 28480 | 54110-04106 |
| MP37 | 5021-5808 | 7 | 1 | REAR FRAME | 28480 | 5021-5808 |
| MP38 | 54110-94302 | 4 | 1 | WARNING LABEL | 28480 | 54110-94302 |
| MP39 | 54120-00201 | 7 | 1 | REAR PANEL | 28480 | 54120-00201 |
| MP40 | 54111-05201 | 6 | 1 | AIR PLENUM | 28480 | 54111-05201 |
| MP41 | 7120-4835 | 0 | 1 | LABEL-INFORMATION .75-IN-WD 2-IN-LG PPR | 28480 | 7120-4835 |
| MP42 | 3160-0092 | 3 | 1 | FAN GUARD | 28480 | 3160-0092 |
| MP44 | 54120-04103 | 6 | 1 | FAN COVER | 28480 | 54120-04103 |
| MP45 | 54120-04702 | 1 | 1 | FAN SPACER | 28480 | 54120-04702 |
| S1 | 3101-2911 | 5 | 1 | ROCKER SWITCH (STANDBY) | 28480 | 3101-2911 |
| W1 | 8120-1521 | 6 | 1 | POWER CABLE | 28480 | 8120-1521 |
| W2 | 54100-61602 | 6 | 1 | HPIB CABLE | 28480 | 54100-61602 |
| W3 | 54120-61618 | 8 | 1 | UMBILICAL CABLE 2 METRE | 28480 | 54120-61618 |
| W4 | 54120-61612 | 2 | 1 | MAINFRAME CABLE ASSEMBLY | 28480 | 54120-61612 |
| W5 | 54100-61601 | 5 | 1 | RIBBONCABLE-I/O TO FRONT PANEL | 28480 | 54100-61601 |
| W6 | 54100-61612 | 8 | 2 | CABLE AC BD CO ANAL & DIG BD | 28480 | 54100-61612 |
| W7 | NOT ASSIGNED | | | | | |
| W8 | 54110-61601 | 7 | 1 | 3 WIRE CABLE - COLOR DISPLAY MODULE POWE | 28480 | 54110-61601 |
| W9 | 54111-61610 | 9 | 1 | POWER SWITCH CABLE 2 WIRE-FRONT PANEL ST | 28480 | 54110-61610 |
| W10 | 54111-61611 | 0 | 1 | 2 WIRE CABLE-REAR CABLE STBY SWITCH | 28480 | 54111-61611 |
| W11 | 54110-61611 | 9 | 1 | DISPLAY CONTROL CABLE | 28480 | 54110-61611 |
| W12 | 54110-61607 | 3 | 1 | RIBBON CABLE DISP ASSY TO COLOR MODULE | 28480 | 54110-61607 |



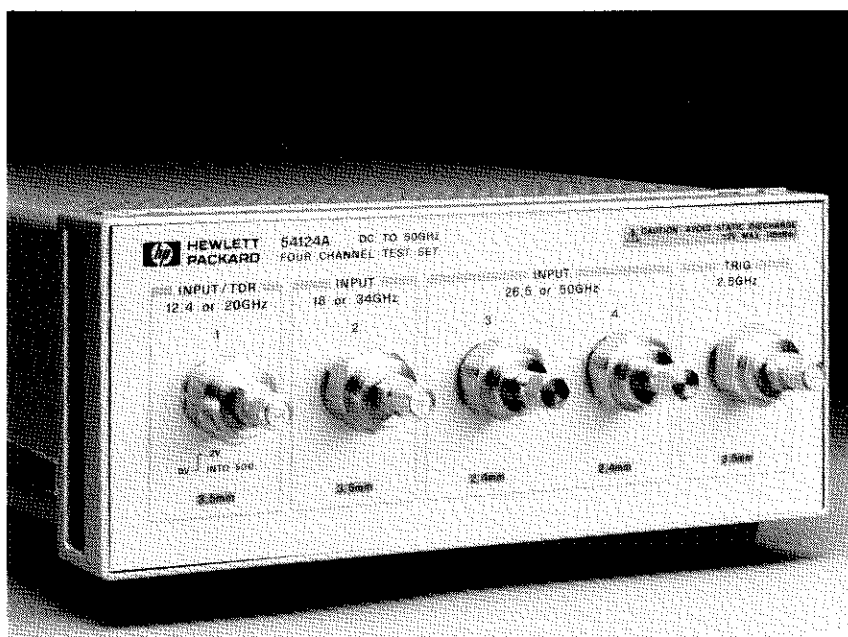
54120E50

Figure 5-7. Mainframe Cable Locations

HP 54124A

Four Channel Test Set

Service Manual



 **HEWLETT
PACKARD**

HP 54124A Four Channel Test Set



SERVICE MANUAL

HP 54124A

Four Channel Test Set

SERIAL NUMBERS

This manual applies directly to instruments
prefixed with serial number:

3008A

For additional information about serial numbers see
instruments covered by this manual
in Section 1.

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Herstellerbescheinigung

Hiermit wird bescheinigt, dass das Gerät/System HP 54124A in Übereinstimmung mit den Bestimmungen von Postverfügung 1046/84 funkentstört ist.

Der Deutschen Bundespost wurde das Inverkehrbringen dieses Gerätes/Systems angezeigt und die Berechtigung zur Überprüfung der Serie auf Einhaltung der Bestimmungen eingeräumt.

Zusatzinformation für Mess- und Testgeräte

Werden Mess- und Testgeräte mit ungeschirmten Kabeln und/oder in offenen Messaufbauten verwendet, so ist vom Betreiber sicherzustellen, dass die Funkentstörbestimmungen unter Betriebsbedingungen an seiner Grundstücksgrenze eingehalten werden.

Manufacturer's declaration

This is to certify that this product HP 54124A meets the radio frequency interference requirements of directive 1046/84. The German Bundespost has been notified that this equipment was put into circulation and was granted the right to check the product type for compliance with these requirements.

Additional Information for Test and Measurement Equipment

Note: If test and measurement equipment is operated with unshielded cables and/or used for measurements on open set-ups, the user must insure that under these operating conditions, the radio frequency interference limits are met at the border of his premises.

CERTIFICATION

Hewlett-Packard Company certifies that this product met its published specifications at the time of shipment from the factory. Hewlett-Packard further certifies that its calibration measurements are traceable to the United States National Bureau of Standards, to the extent allowed by the Bureau's calibration facility, and to the calibration facilities of other International Standards Organization members.

WARRANTY

This Hewlett-Packard product is warranted against defects in material and workmanship for a period of one year from date of shipment. During the warranty period, Hewlett-Packard Company will, at its option, either repair or replace products which prove to be defective.

For warranty service or repair, this product must be returned to a service facility designated by HP. Buyer shall prepay shipping charges to HP and HP shall pay shipping charges to return the product to Buyer. However, Buyer shall pay all shipping charges, duties, and taxes for products returned to HP from another country.

HP warrants that its software and firmware designated by HP for use with an instrument will execute its programming instructions when properly installed on that instrument. HP does not warrant that the operation of the instrument or software, or firmware will be uninterrupted or error free.

LIMITATION OF WARRANTY

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by Buyer, buyer-supplied software or interfacing, unauthorized modification or misuse, operation outside the environmental specifications for the product, or improper site preparation or maintenance.

NO OTHER WARRANTY IS EXPRESSED OR IMPLIED. HP SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

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THE REMEDIES PROVIDED HEREIN ARE BUYER'S SOLE AND EXCLUSIVE REMEDIES. HP SHALL NOT BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER BASED ON CONTRACT, TORT, OR ANY OTHER LEGAL THEORY.

ASSISTANCE

Product maintenance agreements and other customer assistance agreements are available for Hewlett-Packard products.

For any assistance, contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.

CWA388

Safety Considerations

General Operation

This is a Safety Class I instrument (provided with terminal for protective earthing). BEFORE APPLYING POWER verify that the power transformer primary is matched to the available line voltage, the correct fuse is installed, and Safety Precautions are taken (see the following warnings). In addition, note the instrument's external markings which are described under "Safety Symbols."

General Warnings and Cautions

- BEFORE SWITCHING ON THE INSTRUMENT, the protective earth terminal of the instrument must be connected to the protective conductor of the (mains) powercord. The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. The protective action must not be negated by the use of an extension cord (power cable) without a protective conductor (grounding). Grounding one conductor of a two-conductor outlet is not sufficient protection.
- Servicing instructions are for use by service-trained personnel. To avoid dangerous electric shock, do not perform any servicing unless qualified to do so.
- If this instrument is to be energized via an auto-transformer (for voltage reduction) make sure the common terminal is connected to the earth terminal of the power source.
- Any interruption of the protective (grounding) conductor (inside or outside the instrument) or disconnecting the protective earth terminal will cause a potential shock hazard that could result in personal injury.
- Whenever it is likely that the protection has been impaired, the instrument must be made inoperative and be secured against any unintended operation.
- Only fuses with the required rated current, voltage, and specified type (normal blow, time delay, etc.) should be used. Do not use repaired fuses or short circuited fuseholders. To do so could cause a shock or fire hazard.
- Do not operate the instrument in the presence of flammable gasses or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.
- Do not install substitute parts or perform any unauthorized modification to the instrument.
- Adjustments described in the manual are performed with power supplied to the instrument while protective covers are removed. Energy available at many points may, if contacted, result in personal injury.
- Any adjustment, maintenance, and repair of the opened instrument under voltage should be avoided as much as possible, and when inevitable, should be carried out only by a skilled person who is aware of the hazard involved.
- Capacitors inside the instrument may still be charged even if the instrument has been disconnected from its source of supply.

Safety Symbols



Instruction manual symbol. The product will be marked with this symbol when it is necessary for the user to refer to the instruction manual in order to protect against damage to the product.



Indicates Hazardous Voltages



Earth terminal (sometimes used in manual to indicate circuit common connected to grounded chassis).

Warning



The WARNING sign denotes a hazard. It calls attention to a procedure, practice, or the like, which, if not correctly performed or adhered to, could result in personal injury. Do not proceed beyond a WARNING sign until the indicated conditions are fully understood and met.

Caution



The CAUTION sign denotes a hazard. It calls attention to an operating procedure, practice, or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product. Do not proceed beyond a CAUTION sign until the indicated conditions are fully understood or met.

Printing History

New editions are complete revisions of the manual. Update packages, which are issued between editions, contain additional and replacement pages to be merged into the manual by the customer. The dates on the title page change only when a new edition is published.

A software and/or firmware code may be printed before the date; this indicates the version level of the software and/or firmware of this product at the time of the manual or update was issued. Many product updates and fixes do not require manual changes and, conversely, manual corrections may be done without accompanying product changes. Therefore, do not expect a one to one correspondence between product updates and manual updates.

Edition 1

April 1990

54124-90901

List of Effective Pages

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| Pages | Effective Date |
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Contents

| | |
|------------------|--|
| Section 1 | General Information |
| | Introduction 1-1 |
| | Description 1-1 |
| | Safety Considerations 1-1 |
| | Instruments Covered by This Manual 1-1 |
| | Options 1-2 |
| | Accessories Supplied 1-2 |
| | Accessories Available 1-2 |
| | Systemizing 1-2 |
| | Specifications 1-3 |
| | Operating Characteristics 1-6 |
| | General Characteristics 1-11 |
| | Recommended Test Equipment 1-13 |

| | |
|------------------|--|
| Section 2 | Installation |
| | Introduction 2-1 |
| | Power Requirements 2-1 |
| | Four Channel Test Set Connection 2-1 |
| | Operating Environment 2-2 |
| | Cleaning 2-2 |
| | Storage and Shipment 2-2 |
| | Tagging for Service 2-2 |
| | Packaging 2-2 |

| | |
|------------------|---|
| Section 3 | Performance Tests |
| | Introduction 3-1 |
| | Recommended Equipment 3-1 |
| | Test Record 3-1 |
| | Performance Test Cycle 3-1 |
| | Special Procedures 3-1 |
| | Bandwidth Test 3-3 |
| | dc Voltage Measurement Accuracy and RMS Noise Test 3-10 |
| | rms Noise Test 3-14 |
| | Time Interval Accuracy Test 3-15 |
| | Short Delta T 3-17 |
| | Long Delta T 3-18 |
| | Trigger Sensitivity and Jitter Tests 3-19 |
| | Jitter Test 3-22 |
| | TDR Systems Test 3-23 |
| | Input Reflection Test 3-29 |
| | Performance Test Record 3-32 |

Section 4

Adjustments

| | |
|---|------|
| Introduction | 4-1 |
| Recommended Test Equipment | 4-1 |
| Adjustment Sequence | 4-1 |
| Special Procedures | 4-2 |
| Range Adjustment | 4-3 |
| Step Recovery Diode (SRD) Adjustments | 4-4 |
| Frequency Adjustments | 4-7 |
| END and 4 ns CAL Adjustments | 4-9 |
| Sampler Bias Adjustments | 4-12 |
| Offset Gain Adjustments | 4-16 |
| TDR Step Adjustments | 4-18 |
| Feedthrough Compensation Adjustments | 4-24 |
| Trigger Adjustments | 4-27 |
| Channel Skew Calibration | 4-29 |

Section 5

Replaceable Parts

| | |
|--------------------------------|-----|
| Introduction | 5-1 |
| Abbreviations | 5-1 |
| Replaceable Parts List | 5-1 |
| Exchange Assemblies | 5-1 |
| Ordering Information | 5-2 |
| Direct Mail Order System | 5-2 |

Section 6A

Disassembly

| | |
|--|-------|
| Introduction | 6A-1 |
| Safety Considerations | 6A-1 |
| Tools Required | 6A-1 |
| Fan | 6A-2 |
| Rear Panel | 6A-3 |
| Test Set Cable Assembly | 6A-4 |
| Trigger Power Cable | 6A-5 |
| Main Deck Assembly | 6A-6 |
| Vertical Assembly | 6A-7 |
| Sampler, Pulse Filter, and Pulse Conditioner | 6A-8 |
| TDR (Step Generator) | 6A-10 |
| Trigger Hybrid | 6A-12 |
| Horizontal Assembly | 6A-13 |
| Temperature Sense Thermistor | 6A-14 |
| TDR Delay Line | 6A-15 |
| APC 3.5 Center Conductor Replacement | 6A-16 |
| Front Panel Connectors | 6A-17 |
| Front Panel | 6A-18 |

Section 6B

Theory

| | |
|------------------------------|------|
| Introduction | 6B-1 |
| Simplified Signal Flow | 6B-1 |
| Vertical Assembly | 6B-4 |
| Horizontal Assembly | 6B-6 |

Section 6C

Troubleshooting

| | |
|---|-------|
| Introduction | 6C-1 |
| Safety Considerations | 6C-1 |
| Recommended Test Equipment | 6C-1 |
| Logic Families Used | 6C-2 |
| Diagnostic Overview | 6C-2 |
| Data Acquisition Troubleshooting | 6C-2 |
| Preliminary Investigation | 6C-2 |
| Internal Diagnostic Loop Test | 6C-2 |
| Extended Service Test | 6C-3 |
| Analyzing Failures | 6C-3 |
| After Repairs Are Made | 6C-15 |
| Temperature Failures | 6C-20 |
| Internal Diagnostic Loop Tests | 6C-20 |
| Test Loop Considerations | 6C-21 |
| Loop 20 Data Acquisition | 6C-24 |
| Loop 21 Trigger Off/Freerun Off | 6C-27 |
| Loop 22 Trigger Level (1) | 6C-28 |
| Loop 23 Pos/Neg Slope | 6C-29 |
| Loop 24 Trigger Level (2) | 6C-31 |
| Loop 25 Coarse Delay Time | 6C-33 |
| Loop 26 Rate Generator | 6C-36 |
| Loop 27 Hysteresis Band Off | 6C-39 |
| Loop 28 A/D Conversion | 6C-40 |
| Loop 29 Feedthrough | 6C-43 |
| Loop 30 Data Acquisition (2) | 6C-44 |
| Loops 31-34 Channels 1-4 Check | 6C-45 |
| Loops 35-38 Channels 1-4 Sampler Gain | 6C-46 |
| Loop 39 TDR | 6C-47 |
| Extended Service Tests | 6C-48 |
| Sampler Test | 6C-50 |
| Umbilical Cable Test | 6C-51 |
| Fine Delay Test | 6C-54 |
| Sampler Input Test | 6C-58 |
| Sampler Swap Test | 6C-58 |
| Vertical Test | 6C-58 |
| A/D Test | 6C-62 |
| Pulse Filter Test | 6C-64 |
| TDR Test | 6C-67 |
| TDR System Test | 6C-68 |
| Trigger Test | 6C-70 |
| Probing Trigger Test | 6C-71 |
| Timebase/Trigger Test | 6C-72 |
| Horizontal Test | 6C-72 |

List of Illustrations

| | | |
|-------|--|-------|
| 1-1 | HP 54124A Dimensions | 1-11 |
| 2-1 | Rear Panel of Mainframe and Test Set | 2-1 |
| 3-1 | Bandwidth Test Equipment Setup A | 3-3 |
| 3-2 | Bandwidth Test Equipment Setup B | 3-5 |
| 3-3 | Bandwidth Test Equipment Setup C | 3-6 |
| 3-4 | Bandwidth Test Equipment Setup D | 3-7 |
| 3-5 | Incident Step Using Two Different 50 Ω Terminations ... | 3-23 |
| 3-6 | –3% Test, Reflection Appears Before the Termination .. | 3-27 |
| 4-1 | Trace Discontinuity at Eighth Graticule | 4-10 |
| 4-2 | Expanded Trace Discontinuity | 4-11 |
| 4-3 | Correct End Adjustment, No Discontinuity | 4-11 |
| 4-4 | Low Bandwidth Adjustment with Markers | 4-13 |
| 4-5 | High Bandwidth Adjustment with Markers | 4-14 |
| 4-6 | Setting Start and Stop Markers on Pulse | 4-21 |
| 4-7 | Adjusting TDR Pulse to Stop Marker | 4-21 |
| 4-8 | TOP Adjustment | 4-23 |
| 4-9 | Overshoot Fine Adjustment | 4-23 |
| 4-10 | Feedthrough Not Compensated | 4-25 |
| 4-11 | Adjusting RC1 | 4-26 |
| 4-12 | Horizontal Assembly (A1) Adjustments | 4-30 |
| 4-13 | Vertical Assembly (A2) Adjustments | 4-30 |
| 5-1 | Assembled View of Test Set | 5-4 |
| 5-2 | APC 3.5 Connector Exploded View | 5-4 |
| 5-3 | Top View | 5-5 |
| 5-4 | Bottom View | 5-6 |
| 5-5 | Main Deck without Vertical Assembly | 5-7 |
| 5-6 | Main Deck without Horizontal Assembly | 5-8 |
| 6A-1 | Fan Removal | 6A-2 |
| 6A-2 | Rear Panel Removal | 6A-3 |
| 6A-3 | Test Set Cable Assembly Removal | 6A-4 |
| 6A-4 | Trigger Power Cable Removal | 6A-5 |
| 6A-5 | Main Deck Assembly Removal | 6A-6 |
| 6A-6 | Vertical Assembly Removal | 6A-7 |
| 6A-7 | Sampler and Pulse Filter Assembly Locations | 6A-9 |
| 6A-8 | Sampler and TDR Assembly Locations | 6A-11 |
| 6A-9 | Trigger Hybrid Removal | 6A-12 |
| 6A-10 | Horizontal Assembly Removal | 6A-13 |
| 6A-11 | Temperature Sense Thermistor Removal | 6A-14 |
| 6A-12 | TDR Delay Line Removal | 6A-15 |
| 6A-13 | APC 3.5 Center Conductor Removal | 6A-16 |
| 6A-14 | Front Panel Connector Removal | 6A-17 |
| 6A-15 | Front Panel Removal | 6A-18 |
| 6B-1 | Simplified Signal Flow | 6B-2 |
| 6B-2 | Vertical Assembly Block Diagram | 6B-5 |
| 6B-3 | Horizontal Assembly Block Diagram | 6B-7 |

| | | |
|-------|--|-------|
| 6C-1 | HP 54120 System Functional Block Diagram | 6C-4 |
| 6C-2 | Simplified Signal Interconnect Diagram | 6C-5 |
| 6C-3 | Data Acquisition Troubleshooting Flowchart 1 | 6C-7 |
| 6C-4 | Data Acquisition Troubleshooting Flowchart 2 | 6C-8 |
| 6C-5 | Loop Test Troubleshooting Flowchart | 6C-9 |
| 6C-6 | Sampler Troubleshooting Flowchart | 6C-10 |
| 6C-7 | Single Channel Troubleshooting Flowchart | 6C-11 |
| 6C-8 | TDR Troubleshooting Flowchart | 6C-12 |
| 6C-9 | Pulse Filter Troubleshooting Flowchart | 6C-13 |
| 6C-10 | Trigger Troubleshooting Flowchart | 6C-14 |
| 6C-11 | Horizontal Assembly Component Locator | 6C-18 |
| 6C-12 | Vertical Assembly Component Locator | 6C-19 |
| 6C-13 | Test Loop 20 Troubleshooting Waveforms | 6C-25 |
| 6C-14 | Test Loop 20 Troubleshooting Waveforms | 6C-25 |
| 6C-15 | Test Loop 20 Troubleshooting Waveforms | 6C-25 |
| . | . | . |
| 6C-35 | Test Loop 28 Troubleshooting Waveforms | 6C-42 |
| 6C-36 | Test Loop 28 Troubleshooting Waveforms | 6C-42 |
| 6C-37 | Umbilical Cable and Ribbon Cable Pin Locations | 6C-52 |
| 6C-38 | Package Pin Locations | 6C-54 |
| 6C-39 | Extended Service Test Troubleshooting Waveforms | 6C-55 |
| 6C-40 | Extended Service Test Troubleshooting Waveforms | 6C-56 |
| . | . | . |
| 6C-76 | Extended Service Test Troubleshooting Waveforms | 6C-75 |
| 6C-77 | Extended Service Test Troubleshooting Waveforms | 6C-75 |

List of Tables

| | | |
|-------|---|-------|
| 1-1 | Recommended Equipment List | 1-13 |
| 3-1 | Performance Test Record | 3-32 |
| 5-1 | Reference Designators and Abbreviations | 5-3 |
| 5-2 | Replaceable Parts List | 5-9 |
| 6C-1 | Assemblies Tested by Loop Tests | 6C-6 |
| 6C-2 | Adjustments That Can Cause Loop Failures | 6C-6 |
| 6C-3 | Adjustments to Check after Assembly Repairs | 6C-15 |
| 6C-4 | Performance Tests to Check after Adjustments | 6C-15 |
| 6C-5 | Performance Tests to Check after Repairs | 6C-16 |
| 6C-6 | Adjustment's Effect on the Displayed Performance | 6C-16 |
| 6C-7 | Loops Affected by Hardware Failures | 6C-17 |
| 6C-8 | Adjustments That Can Cause Loop Failures | 6C-22 |
| 6C-9 | Assemblies Tested by Loop Tests | 6C-22 |
| 6C-10 | Loop Descriptions | 6C-23 |
| 6C-12 | Fine Delay Test Signals | 6C-54 |
| 6C-13 | Trigger Level Settings vs Measured Results | 6C-54 |

Table Of Contents

General Information

| | |
|--|------|
| Introduction | 1-1 |
| Description | 1-1 |
| Safety Considerations | 1-1 |
| Instruments Covered by This Manual | 1-1 |
| Options | 1-2 |
| Accessories Supplied | 1-2 |
| Accessories Available | 1-2 |
| Systemizing | 1-2 |
| Specifications | 1-3 |
| Operating Characteristics | 1-6 |
| General Characteristics | 1-11 |
| Recommended Test Equipment | 1-13 |

Introduction

This service manual contains information necessary to test, adjust and service the Hewlett-Packard 54124A Four Channel Test Set.

This manual is divided into 8 sections as follows:

- 1 – General Information
- 2 – Installation
- 3 – Performance Tests
- 4 – Adjustments
- 5 – Replaceable Parts
- 6A – Disassembly
- 6B – Theory
- 6C – Troubleshooting

Information on operating and interfacing with the HP 54124A is contained in the *Front-Panel Reference* supplied with the instrument.

This section includes a description of the HP 54124A, its specifications, operating characteristics, general characteristics, safety considerations, instruments covered by this manual, options, accessories supplied, and recommended test equipment.

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

Description

The HP 54124A is a Four Channel Test Set, two of the channels are 50 GHz . The HP 54124A contains four input channels, a trigger input, and a TDR step generator. The HP 54124A is designed to operate with the HP 54120B Digitizing Oscilloscope Mainframe.

Safety Considerations

The appropriate sections contain safety information relevant to the service procedure it describes. Both the HP 54124A and this manual should be reviewed for safety markings and instructions before work is begun. Refer to the pages following the title page. They include a safety summary and safety considerations.

Instruments Covered by This Manual

The HP 54124A's serial number is on the rear panel. Hewlett-Packard uses a two-part serial number consisting of a four-digit prefix and a five-digit suffix separated by a letter (0000A00000). The prefix is the same for all identical oscilloscopes and changes only when a modification is made that affects parts compatibility. The suffix differs for each oscilloscope. This manual applies directly to instruments with the serial prefix shown on the title page.

Options

The following options are available for the HP 54124A.

- Option 090 – Delete RF Accessory Kit
- Option 908 – Rack mount kit
- Option 910 – Additional copies of Front-Panel, Programming, and Service manuals

Accessories Supplied

The following accessories are supplied with the HP 54124A:

- This Service manual
- RF Accessory kit, HP part number 54121-68701
- Connectors savers, APC 3.5 (f-f), HP part number 5061-5311 – Quantity 3
- Connectors savers, 2.4 mm (f-f), HP 11900B – Quantity 2
- Coaxial shorts, HP part number 0960-0055 – Quantity 3
- Coaxial shipping cap, 2.4 mm, HP part number 54124-24101 – Quantity 2

| List of RF Accessory kit devices | Qty | HP Part Number |
|----------------------------------|-----|----------------|
| APC 3.5 (f-m) 20 dB attenuators | 5 | 33340C/020 |
| 50 Ω load SMA (f) | 1 | 1\ 250-2151 |
| Coaxial Short SMA (f) | 1 | 1250-2152 |
| 50 Ω load SMA (m) | 1 | 1250-2153 |
| SMA (m) to BNC (f) adapters | 2 | 1250-1200 |
| SMA (m-m) 36 inch coaxial cables | 3 | 8120-4948 |

Accessories Available

The following accessories are available for the HP 54124:

- Accessory kit HP 54007A
- 6 GHz Probe kit HP 54006A
- 22 ns Delay Line HP 54008A
- 0.5 to 18 GHz Trigger HP 54118A

Systemizing

The HP 54120B Digitizing Oscilloscope Mainframe and the HP 54124A Four Channel Test Set are calibrated together as a system called the HP 54124T. This system will meet all published specifications when shipped from the factory. If the system is split up, (a different HP 54124A Four Channel Test Set is used with the HP 54120B Mainframe), the system will meet all specifications except for the dc accuracy specifications for single voltage and dual voltage markers. The single voltage marker specification will change from $\pm 0.4\%$ of full scale ± 2 mV to $\pm 2.0\%$ of full scale ± 2 mV. The dual voltage marker specification will change from $\pm 0.8\%$ of full scale to $\pm 5\%$ of full scale. To obtain the original factory specifications, perform the sampler bias and offset adjustments in section 4, "Adjustment."

Specifications

The following specifications for the HP 54124A are the performance standards against which the instrument is tested.

Channels (Vertical)¹

High Bandwidth²

| | |
|-------|---------------------------|
| –3 dB | dc to 50 GHz channels 3-4 |
| | dc to 34 GHz channel 2 |
| | dc to 20 GHz channel 1 |

Low Bandwidth

| | |
|-------|-----------------------------|
| –3 dB | dc to 26.5 GHz channels 3-4 |
| | dc to 18 GHz channel 2 |
| | dc to 12.4 GHz channel 1 |

High Bandwidth Transition Time (10% to 90% calculated from $T_r = 0.35/BW$)

| | |
|-----------|--------------|
| ≤ 7.0 ps | channels 3-4 |
| ≤ 10.3 ps | channels 2 |
| ≤ 17.5 ps | channel 1 |

Low Bandwidth Transition Time (10% to 90% calculated from $T_r = 0.35/BW$)

| | |
|-----------|--------------|
| ≤ 13.2 ps | channels 3-4 |
| ≤ 19.4 ps | channels 2 |
| ≤ 28.2 ps | channel 1 |

| | |
|---------------|--------------------------------|
| Maximum Noise | High Bandwidth mode ≤ 2 mV rms |
| | Low Bandwidth mode ≤ 1 mV rms |

Scale Factor (full scale is 8 divisions)

| | |
|---------|-----------|
| Minimum | 1 mV/div |
| Maximum | 80 mV/div |

dc Accuracy single voltage marker³

Average mode $\pm 0.4\%$ of full-scale or marker reading (whichever is greater) ± 2 mV
High bandwidth persistence mode $\pm 0.4\%$ of full-scale or marker reading
(whichever is greater) ± 2 mV $\pm 5.0\%$ of ⁴ (reading – channel offset)
Low bandwidth persistence mode $\pm 0.4\%$ of full-scale or marker reading (whichever is greater) ± 2 mV $\pm 3.0\%$ of ⁴ (reading – channel offset)

dc Difference Voltage Accuracy with two voltage markers on the same channel³

Average mode $\pm 0.8\%$ of full-scale or delta marker reading (whichever is greater)
High bandwidth persistence mode $\pm 0.8\%$ of full-scale or delta marker reading
(whichever is greater) $\pm 5.0\%$ of ⁴ (delta marker reading)
Low bandwidth persistence mode $\pm 0.8\%$ of full-scale or delta marker reading
(whichever is greater) $\pm 3.0\%$ of ⁴ (delta marker reading)

1. When operated within $\pm 5^\circ\text{C}$ ($\pm 9^\circ\text{F}$) of the temperature of the last front-panel calibration.
2. The input samplers are biased differently for increased bandwidth in the high bandwidth mode.
3. When driven from a $0\ \Omega$ source.
4. Performing a vertical software calibration immediately before making a measurement eliminates the final term in the persistence mode dc accuracy specifications.

Programmable dc Offset¹ ± 500 mV

Inputs

| | |
|--------------------|--|
| Number | Four |
| Dynamic Range | ± 320 mV relative to channel offset |
| Maximum Input V | ± 2 V dc + ac peak (16 dBm) |
| Impedance | 50 Ω (Nominal) |
| Percent Reflection | $\leq 5\%$ for 30 ps risetime channels 1-2 $\leq 5\%$ for 20 ps risetime channels 3-4 |
| Connectors | 3.5 mm (m) channels 1-2 2.4 mm (m) channels 3-4 |

TDR System **Risetime²** combined oscilloscope and TDR performance
 ≤ 45 ps³

Flatness² combined oscilloscope and TDR performance
 $\leq \pm 1\%$ after 1 ns from edge
 $\leq +5\%$, -3% to 1 ns from edge)

Levels combined oscilloscope and TDR performance

| | |
|------|-------------------|
| Low | 0 V ± 2 mV |
| High | 200 mV ± 2 mV |

Timebase **Scale Factor** full-scale is 10 divisions
(Horizontal) Minimum 10 ps/div
 Maximum 1 s/div

Delay time offset relative to trigger

| | |
|---------|---|
| Minimum | 16 ns |
| Maximum | 1000 screen diameters or 10 seconds, whichever is smaller |

Time Interval Accuracy dual marker measurement ≤ 10 ps $\pm 0.1\%$ of reading

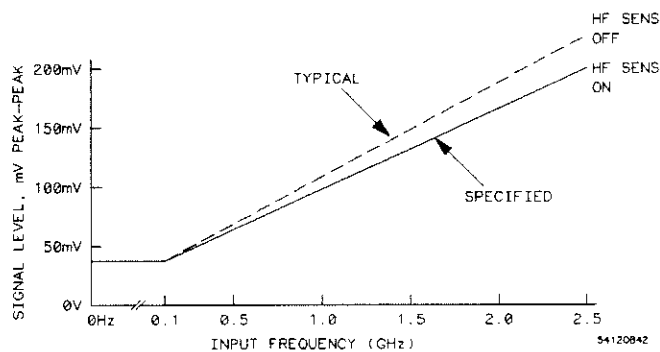
Time Interval Resolution 0.25 ps⁴ or 0.02 divisions, whichever is greater.

1. An effective offset of ± 820 mV can be achieved by using the ± 500 mV of channel offset and adding ± 320 mV of offset with the waveform math offset scaling function.
2. Measured in the low bandwidth and averaged display modes.
3. The risetime of the generator is less than 35 ps, as calculated by
 $(T_{r \text{ system}})^2 = (T_{r \text{ generator}})^2 + T_{r \text{ oscilloscope}}^2$
4. At 10 ps/division, data points are plotted at 0.2 ps intervals to match the display pixel resolution.

Trigger External Input Only

Sensitivity

dc to 100 MHz 40 mV peak-to-peak; increasing linearly from 40 mV at 100 MHz to 200 mV peak-to-peak at 2.5 GHz



Graph Illustrating Trigger Sensitivity Specification

Pulse Width 200 ps for pulses > 200 mV

Trigger Level Range ± 1 V

Jitter trigger and timebase combined (one standard deviation)

< 2.5 ps + $5E-5$ x delay setting. Tested using 2 GHz synthesized source at 200 mV peak-to-peak with high frequency sensitivity on and high frequency reject off.

Trigger Input

Maximum Input V ± 2 V dc + ac peak (16 dBm)

Impedance 50 Ω (Nominal)

Percent Reflection $\leq 10\%$ for 100 ps risetime

Connector 3.5 mm (m)

Operating Characteristics

The following operating characteristics for the HP 54124A are not specifications, but are typical characteristics included as additional information only.

Channels (Vertical)

Scale Factors: Adjustable from 1 mV/div to 80 mV/div in a 1-2-5-10-20-50-80 sequence from the RPG control or the increment/decrement keys. Also adjustable over the range in 1 mV increments from the numeric keypad.

Attenuation Factors: Factors may be entered to scale the oscilloscope for external attenuators connected to the channel inputs.

Noise: Averaging reduces noise by $1/\sqrt{n}$ where n is the number of averages, until a system limitation of approximately $32 \mu\text{V}$ is reached. Typical rms noise is:

| Display Mode | | High bandwidth | Low bandwidth |
|--------------|-------------|-------------------|-------------------|
| Channels 1-2 | avg = 1 | 1 mV | 500 μV |
| | avg = 256 | 64 μV | 35 μV |
| | persistence | 800 μV | 400 μV |
| Channels 3-4 | avg = 1 | 1.2 mV | 625 μV |
| | avg = 256 | 80 μV | 44 μV |
| | persistence | 1 mV | 500 μV |

Channel-to-channel Isolation: 60 dB

Timebase (Horizontal)

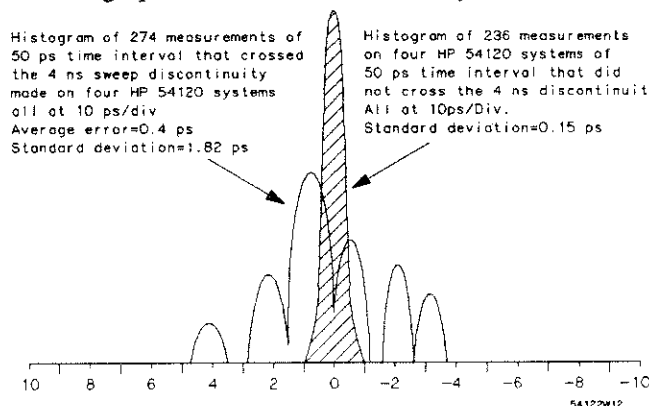
Delay Between Channels: The difference in delay between channels can be nulled out in 1 ps increments to compensate for differences in input cables or probe length. This skew can compensate for up to 100 ns of skew.

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

Triggered Mode: Causes the oscilloscope to trigger synchronously to the trigger input signal.

Free Run Mode: Causes the oscilloscope to generate its own triggers at a user specified rate (between 15.3 Hz and 500 kHz). Used with the Channel 1 step generator for TDR and transmission measurements. The channel 1 step may also be used to trigger a device under test for viewing information prior to the trigger.

Typical Accuracy: The timebase consists of a series of 4 ns blocks. Small discontinuities across these blocks is a major contribution to the 10 ps accuracy specification. The graph below is the result of many measurements on 8 instruments.



Trigger **Attenuation Factors:** Factors may be entered to scale the oscilloscope for external attenuators connected to the trigger input.

Edge Trigger: Triggers on the positive or negative edge of the trigger source.

HF Reject: Limits trigger bandwidth to approximately 100 MHz.

Display **Data Display Resolution:** 501 points horizontally by 256 points vertically.

Data Display Formats

Full screen: All channel displays are superimposed and are eight divisions high.

Split screen: With four graphs, channels are displayed separately and are two divisions high; or with two graphs, channels 1 and 3 are superimposed and channels 2 and 4 are superimposed and are four divisions high.

Display Modes

Persistence: The time that each data point is retained on the display can be varied from 300 ms to 10 seconds, or it can be displayed infinitely.

Averaging: The number of averages can be specified as powers of 2, up to 2048. On each acquisition, $1/n$ times the new data is added to $(n-1) \div n$ of the previous value at each time coordinate. Averaging operates continuously, except over HP-IB where it terminates at the specified number of averages.

Graticules: The user may choose full grid, axes with tic marks, frame with tic marks, or no graticule.

Bandwidth: When in the average or persistence display modes, the user may select between a high bandwidth and a low bandwidth. The low bandwidth mode reduces noise. See channel characteristics for bandwidths and noise levels.

Display Colors: Users may choose a default color selection or select their own colors from the front panel or over HP-IB. Different colors are used for display background, channels, functions, background text, highlighted text, advisories, markers, overlapping waveforms, and memories.

Programmability Instrument settings and operating modes, including automatic measurements, may be remotely programmed by HP-IB (IEEE-488). HP-IB programming complies with IEEE 488.2 standards. The HP 54124T system can be programmed to take data only at specified time points, or to return only measurement results, (i.e., tr, tf, frequency, etc.,) to speed up data acquisition.

Data Output Transfer Rate: 115 Kbytes/s

Typical Measurement Times: 200 ms to 700 ms

Data Record Lengths:

| Timebase Setting/Histogram Type | Number of points/record |
|---|-----------------------------|
| 10 ps/div \leq time/div 20 ps/div | 100, or 400 |
| 20 ps/div \leq time/div 50 ps/div | 100, 400, or 800 |
| 50 ps/div \leq time/div 200 ps/div | 100, 500, or 1000 |
| 200 ps/div \leq time/div \leq 1 s/div | 128, 256, 500, 512, or 1024 |
| Voltage Histogram | 256 |
| Time Histogram | 501 |

Histograms

Time and voltage histograms may be taken with a user-specified number of samples (between 100 and 655,000,000) within a user-specified voltage window (time histogram) or time window (voltage histogram). To accelerate throughput when taking voltage histograms, take samples only in the user-specified time window.

Distribution markers: Two markers, labeled Upper and Lower Distribution Limits, indicate the cumulative occurrences of samples from the edge of the display to a given time (time histogram) or voltage (voltage histogram).

Mean and Standard Deviation: Calculates the mean and standard deviation of a distribution on screen, or between the distribution limits, assuming a Gaussian distribution.

Measurement Aids

Markers: Dual voltage or time markers can be used for a variety of time and voltage measurements. Voltage markers can be assigned to channels, memories, or functions.

Automatic Level Set: Voltage markers may be preset to 10%-90%, 20%-80%, 50%-50%, or to user specified levels.

Automatic Edge Find: The time markers can be assigned automatically to any displayed edge of either polarity on any channel. The voltage markers establish the reference, on the edge, for the time markers in this mode.

Automatic Pulse Parameter Measurements: The HP 54124T system automatically takes ten pulse parameter measurements, (as defined by IEEE standard 194-1977, IEEE Standard Pulse Terms and Definitions). The standard measurement thresholds are 10%, 50%, and 90%. The measurement modes are frequency, period, positive pulse width, negative pulse width, duty cycle, risetime, falltime, preshoot, overshoot, and rms voltage, peak-to-peak voltage.

Waveform Math: Any two of seven waveform math operations may be assigned to two displayable math functions. The available operations are Plus, Minus, Invert, Versus, Max, Min, and Only. Max and Min, which define an envelope about the waveform, are only available in the persistence mode. The vertical channels, or any of the waveform memories can be used as operands for the waveform math. Function sensitivity and offset may be adjusted independently of the channel display settings.

Waveform Save: Four waveforms may be stored and displayed in four non-volatile waveform memories. Waveform memories are typically used in the average display mode. Screen displays may be stored in two volatile pixel memories. Pixel memories are typically used in the persistence display mode.

TDR System

Normalized information is a characteristic not a specification. The information is presented here for comparison purposes only. Normalization characteristics are achieved only with the use of the normalization calibrations and firmware routine.

Risetime: adjustable, allowable values based on timebase setting.

Minimum - 10 ps or $0.08 \times \text{time/div}$, whichever is greater

Maximum - $5 \times \text{time/div}$

Flatness: $\leq \pm 1\%$

Levels:

Low $0 \text{ V} \pm 2 \text{ mV}$

High $200 \text{ mV} \pm 2 \text{ mV}$

Networks Reflection measurements

Source: Measurements are made using the Channel 1 step source or a user-supplied external source.

Calibration: A reference plane is defined by calibrating the reflection channel with a short placed at the point where the device under test will be connected. The short calibration is followed with a 50 Ω calibration. These calibrations are used to derive the normalization filter.

Cursor: Reads the percent reflection, impedance, time, and distance from the reference plane to the cursor. See note 1 below.

Percent Reflection: Automatically calculates the maximum and minimum percent reflection of the waveform shown on screen.

Normalization Filter: Applies a firmware digital filter to the measured data and stores the resulting waveform in memory 1. The risetime of the filter may be varied to allow the user to simulate the edge speeds which would be seen by the device under actual operation. Normalization also removes errors caused by discontinuities prior to the reference plane.

Note 1: Percent reflection measurements should be used to quantify reactive peaks and valleys of the TDR display. Impedance measurements are valid only for resistive, horizontal flat line TDR displays. Because the accuracy depends on the measurement being made, percent reflection and impedance accuracies are not specified. Percent reflection and impedance measurements are ratios of voltage measurements whose accuracies are specified.

$$\text{Percent Reflection (Rho)} = (V_{\text{cursor}} - V_{\text{top}}) \div (V_{\text{top}} - V_{\text{base}})$$

$$\text{Impedance (Z)} = 50 \Omega \times [(1 + \text{Rho}) \div (1 - \text{Ro})]$$

where V_{cursor} = voltage at the cursor

V_{top} = high level of calibration reflected step and is determined during the reflection calibration.

V_{base} = low level of calibration reflected step and is determined during the reflection calibration.

Distance measurements are subject to the accuracy of the velocity factor or dielectric constant entered by the user. Since the HP 54124T system has no control over the accuracy of these numbers, distance accuracy is not specified. Distance is derived from time interval measurements whose accuracies are specified.

$$\text{Distance (d)} = 1/2 \times (\Delta t \text{ divided by the velocity constant})$$

Where Δt = time from the reference plane to the cursor.

$$\text{Dielectric Constant} = (3 \times 10^8 \text{ m/s})^2 (\text{Velocity Constant})^2$$

Where the user enters either a relative Dielectric Constant or a velocity constant. The TDR's ability to resolve the distance between two discontinuities is limited to 1/2 the system risetime. Without normalization, this is approximately 1/2 of 45 ps or 7 mm in air. For the distance resolution in your media, divide 7 mm by the the square root of the effective dielectric constant of your media. With normalization, the system risetime can be 10 ps yielding 1.5 mm of resolution in air. The maximum length the TDR can measure is subject to media loss. For a lossless vacuum, and with a 15.3 Hz TDR repetition rate, the HP 54124T system can measure 4,900 km. Actual maximum lengths will generally be limited by the losses of the media under test.

Transmission measurements

Source: Measurements are made using the channel 1 step source or a user-supplied external source.

Calibration: A calibration with a straight-through path or through a users standard device determines reference amplitude levels, reference time, and distances of the signal path. These reference levels are used for gain and propagation delay measurements.

Cursor: Reads the referenced to the calibration edge and gain referenced to the transmission calibration results. See Note 2 below.

Propagation Delay and Gain: Automatically calculates the difference in time and distance between the calibration signal path and the test signal path. Also calculates the ratio of the test signal amplitude to the calibration signal amplitude. See Note 2 below.

Normalization Filter: Applies a firmware digital filter to the measured data and puts the resulting waveform in memory 2. The risetime of the filter may be varied to allow the user to simulate the edge speeds which would be seen by the device under actual operation. See TDR system levels specifications, on page 1-4, for the allowable risetime values.

Note 2:

$\Delta t = \text{Time of the cursor (50\%)} - \text{Time of reference edge (50\%)}$

$\text{Gain} = (V_{\text{top}} - V_{\text{base}}) \text{ signal} \div (V_{\text{top}} - V_{\text{base}}) \text{ reference}$

$\text{Prop Dly} = \text{Time of test edge (50\%)} - \text{Time of reference edge (50\%)}$

$\text{Distance (d)} = \text{Prop Dly} \div \text{Velocity Constant}$

where $V_{\text{top}} = \text{High level of waveform}$

$V_{\text{base}} = \text{Low level of waveform}$

Setup Aids

Auto-Scale: Pressing the Auto-Scale key automatically adjusts the vertical and horizontal scale factors and the trigger level for a display appropriate to the signals applied to the inputs. Auto-Scale requires a signal with a duty cycle greater than 2%, a frequency greater than 50 Hz, and an input level of 5 mV for low bandwidth mode or 20 mV for high bandwidth mode. Auto-Scale is operative for relatively stable input signals, and the signal applied to the external trigger input must meet the minimum trigger specifications.

Save/Recall: Up to ten front-panel setups may be saved in non-volatile memory.

Preset Reflection Channel: Sets up the instrument for making TDR measurements.

Documentation Aids

Waveforms, scaling information, and measurement results can be transferred directly to HP-GL compatible digital plotters and HP-IB raster graphics printers, including the HP 2225A ThinkJet printer and the HP 3630A printer.

Vertical Software Calibration: A front-panel vertical software calibration performs a linearization of the sampling system of the HP 54120 Series Digitizing Oscilloscopes. With the push of a button, the 5 second calibration assures that you obtain the highest vertical system performance possible.

The vertical software calibration improves the persistence mode dc accuracy specification of the instrument. Performing a vertical software calibration immediately before making a measurement eliminates the final term in the persistence mode dc accuracy specification.

The vertical software calibration should be performed after a 15 minute warm-up period to ensure accurate calibration.

Digitizer Converter: 12-bit successive approximation A/D converter.

Resolution: The useable full-scale range of the A/D is 640 mV. One LSB of the A/D converter equals $250\ \mu\text{V}$. This gives one part in 2560, or slightly more than 11 bits of resolution. Averaging can extend the resolution to $32\ \mu\text{V}$. This increased resolution of around 14 bits can be seen at more sensitive ranges or over the HP-IB.

Digitizing Rate: The signal is sampled and digitized at a rate dictated by the trigger rate, repetition rate, timebase range, display mode, and number of channels turned on. If data acquisition is not limited by trigger rate, the actual sampling and digitizing rate will vary within the following range:

- a. Maximum of 10,000 samples per second at 10 ns/div or faster with one channel on while the HP 54124T system is in infinite persistence display mode.
- b. Minimum of 1,000 samples per second at timebase ranges of $46\ \mu\text{s}/\text{div}$ or slower, regardless of number of channels turned on or the display mode.

A typical sample rate is 4,500 samples per second.

General Characteristics

The following general characteristics are not specifications, but typical characteristics included as additional information only.

Environmental Conditions

Temperature Operating: $+15^{\circ}\text{C}$ to $+35^{\circ}\text{C}$ ($+59^{\circ}\text{F}$ to $+95^{\circ}\text{F}$).

Temperature Non-operating: -40°C to $+70^{\circ}\text{C}$ (-40°F to $+158^{\circ}\text{F}$).

Humidity Operating: Up to 90% relative humidity at $+35^{\circ}\text{C}$ (95°F).

Humidity Non-operating: Up to 95% relative humidity at $+65^{\circ}\text{C}$ ($+149^{\circ}\text{F}$).

Altitude Operating: Up to 4600 meters (15,000 ft).

Altitude Non-operating: Up to 15,300 meters (50,000 ft).

Vibration Operating: Random vibrations 5-500 Hz, 10 minutes per axis, $\sim 0.3\ \text{g}$ (rms).

Vibration Non-operating: Random vibration 5-500 Hz, 10 minutes per axis, $= 2.41\ \text{g}$ (rms); and swept sine resonant search, 5-500 Hz, 0.75 g (0-peak), 5 minute resonant dwell at 4 resonances per axis.

Power Requirements

Power requirements listed are for the combined HP 54124T system. The HP 54124A Four Channel Test Set obtains its power over the provided interface cable from the HP 54120B Digitizing Oscilloscope Mainframe.

Weight Dimensions

HP 54124A Net: Approximately 3.2 kg (7 lb).

Dimensions are for general information only. If dimensions are required for building a special enclosure, contact your local HP sales office. Dimensions are in millimeters and inches in parentheses. Refer to figure 1-1.

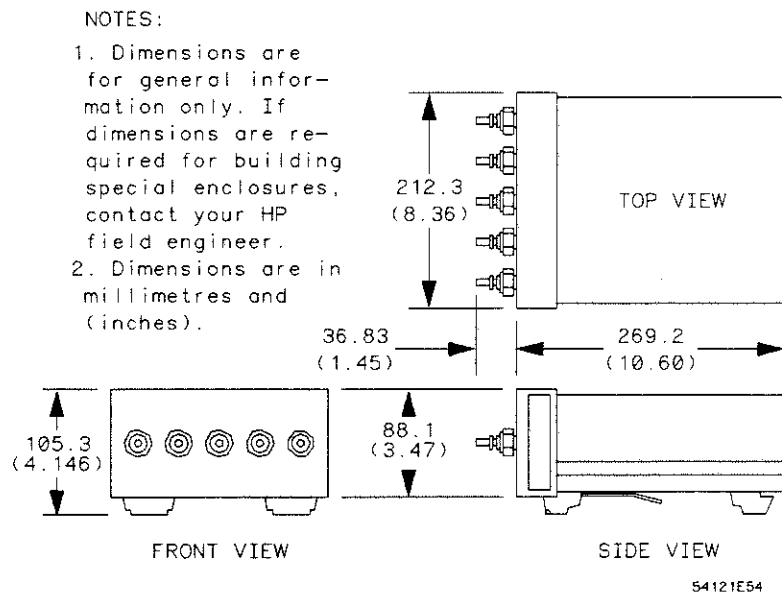


Figure 1-1. HP 54124A Dimensions

Recommended Test Equipment

The test equipment recommended for maintaining the HP 54124A is listed in table 1-1. The three sections requiring test equipment are: Performance Tests (section 3), Adjustments (section 4), and Troubleshooting (section 6C)

Table 1-1. Recommended Equipment List

| Instrument | Critical Specifications | Model | Use ¹ |
|---|---|------------------------|------------------|
| Synthesized sweeper ² | 20 GHz, +12 dBm, -6 dBm, Stability 0.25 ppm/yr, -25 dBc Harmonics | HP 8341A/B/003 | P,A |
| Power splitter | APC 3.5 connectors | HP 11667B | P,A |
| DMM | 100 μ V resolution | HP 3478A | P,A |
| Power meter | 50 GHz | HP 437B | P |
| Power sensor | 50 GHz, 300 mW maximum power | HP 8487A | P |
| Microwave Amplifier | 2-20 GHz, 15 dB gain | HP 8349B | P |
| Millimeter Wave Source Modules | 26.5 GHz to 40 GHz 33 GHz to 50 GHz | HP 83554A HP 83555A | P P |
| Trigger | dc to 18 GHz | HP 54118A | P |
| 50 Ω load | APC 3.5 (m) | HP 909D | P,A |
| 50 Ω load | APC 3.5 (f) | HP 909D/011 | P |
| Calculator | Log base 10 function | HP 11C | P |
| 6 dB pad | 2.4 mm (m-f) | HP 8490D/006 | P |
| 6 dB pad | APC 3.5 (m-f) | HP 8493C/006 | P |
| 10 dB pad | APC 3.5 connectors | HP 33340C/010 | P |
| 20 dB pad [*] | APC 3.5 connectors | HP 33340C/020 | P,A,T |
| RF amplifier | 20 dB Gain at 10 MHz to 1.3 GHz | HP 8447D/E/F | P |
| Frequency synthesizer | 100 kHz to 10 MHz, Frequency stability 0.05 ppm/yr 200 mV output level, sine and square wave outputs dc mode 1/2 V output, 100 μ V resolution | HP 3325B/001 | P,A,T |
| Oscilloscope | 300 MHz bandwidth, general purpose | HP 54100A | T |
| Delay line | 22 ns | HP 54008A | A, P |
| 1. P is for Performance Tests, A is for Adjustments, and T is for Troubleshooting | | | |
| 2. For adjustments and systemizing, only 250 MHz, +12 dBm, synthesized sine wave generator is required. | | | |

Table 1-1. Recommended Equipment List (continued)

| Accessories | Critical Specifications | Part Number | Use ¹ |
|---|---|----------------|------------------|
| Adapter | BNC (m-m) | HP 1250-0216 | A |
| Adapter | BNC (f) to SMA (m), 2 needed | HP 1250-1200 | P,A |
| Adapter | APC 3.5 (m-m) | HP 1250-1864 | P |
| Adapter | APC 3.5 (f-f) | HP 1250-1865 | P |
| Adapter | APC 3.5 (m-f), 6 needed | HP 1250-1866 | P,A |
| Adapter | N (m) to APC 3.5 (m) | HP 1250-1743 | P |
| Adapter | N (m) to APC 3.5 (f) | HP 1250-1744 | P,A |
| Adapter | N (m) to SMA (f) | HP 1250-1250 | P |
| Adapter | UR-28 to 2.4 mm (m) | HP Q281B | P |
| Adapter | UR-22 to 2.4 mm (m) | HP R281B | P |
| Adapter | 2.4 mm (m-f) | HP 11900C | P |
| Adapter | 2.4 mm (f-f) | HP 11900B | P |
| Adapter | 2.4 mm (f) to APC 3.5 (f) | HP 11901B | P |
| Adapter | 2.4 mm (m) to APC 3.5 (f) | HP 11901C | P,A,T |
| BNC Tee | 1 (m) end, 2 (f) ends | HP 1250-0781 | P,A,T |
| Coaxial cable | APC 3.5 (m-f) | HP 8120-4942 | P,A |
| Coaxial cable | APC 3.5 (m-m), 3 needed | HP 8120-4948 | P,A,T |
| Coaxial cable | BNC connectors, length 48 inches, 2 needed | HP 10503A | P,A,T |
| Coaxial short | APC 3.5 (f) | HP 1250-2127 | P |
| Coaxial short | APC 3.5 (m) | HP 1250-2128 | P |
| Adapter | Banana to BNC (f) | HP 1250-2277 | P,A |
| Cable | Semi-rigid U shaped | HP 54121-61601 | P,A |
| Cable | Semi-rigid S shaped | HP 54121-61602 | P,A |
| Cliplead | Alligator to alligator | N/A | A |
| Screwdriver | Jewelers, 0.01 inches thick, 0.04 inches long | N/A | A |
| Alignment tool | Non-metallic | HP 8710-1355 | A |
| Torque wrench | 5 in/lb | HP 8710-1582 | P,A,T |
| Torque wrench | 8 in/lb | HP 8710-1765 | P,A,T |
| 1. P is for Performance Tests, A is for Adjustments, and T is for Troubleshooting | | | |

Installation

Table Of Contents

Installation

| | |
|--|-----|
| Introduction | 2-1 |
| Power Requirements | 2-1 |
| Four Channel Test Set Connection | 2-1 |
| Operating Environment | 2-2 |
| Cleaning | 2-2 |
| Storage and Shipment | 2-2 |
| Tagging for Service | 2-2 |
| Packaging | 2-2 |

Introduction

This section contains installation instructions, operating environments, cleaning, storage, and shipment.

Power Requirements

The HP 54124A receives its power from the HP 54120B Mainframe through the umbilical cable.

Four Channel Test Set Connection

Connect the Umbilical Cable to the Interface Cable Ports on the mainframe and four channel test set. See figure 2-1.

Caution



Do not connect an HP 54124A test set to an HP 54120A mainframe, unless the HP 54120A mainframe has been updated to an HP 54120B configuration and the mainframe has a firmware datecode of January 15, 1990 or later. To check the datecode, press the **Utility** key, press the **Test Menu** key, then press the **Display Configuration** key. The datecode is displayed at the bottom of the screen.

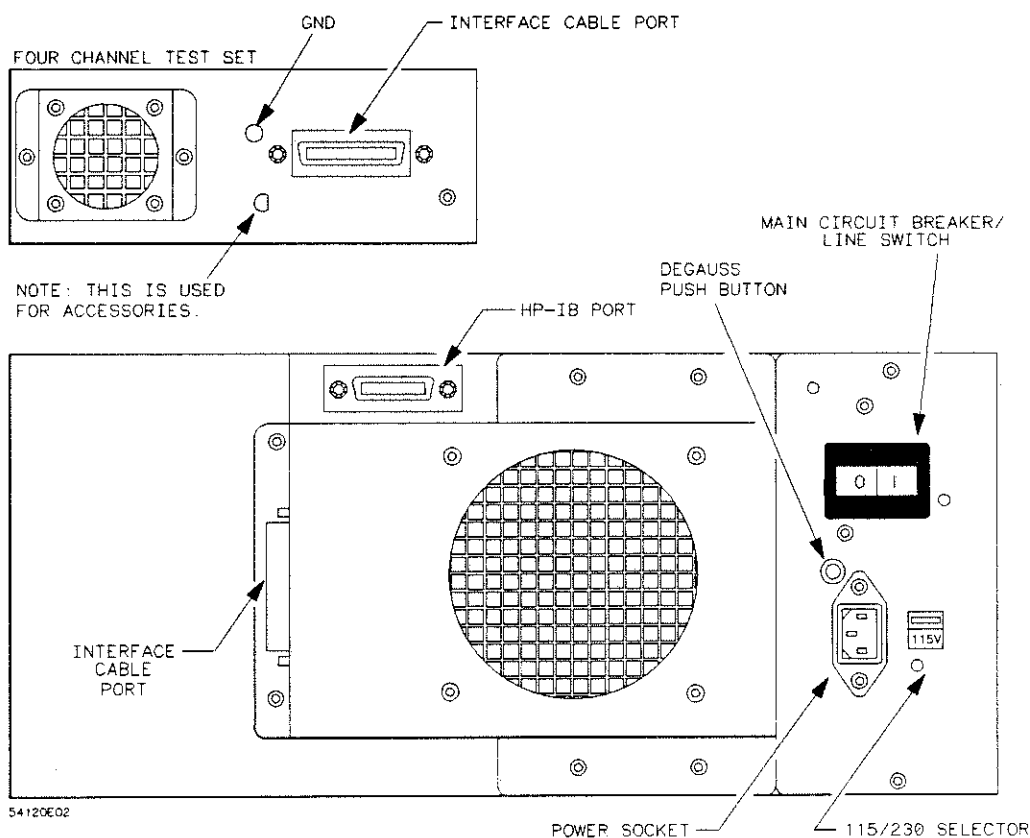


Figure 2-1. Rear Panel of Mainframe and Test Set

Operating Environment

The operating environment is noted in the "General Characteristics" in section 1 under. Note the non-condensing humidity limitation. Because condensation within the instrument can cause poor operation or malfunction, it should be avoided. The HP 54124A will operate to all specifications with the temperature and humidity range stated in the "General Characteristics" in section 1 under general characteristics, except where noted in the specifications.

Cleaning

When cleaning the HP 54124A, CAUTION must be exercised about which cleaning agents are used. USE MILD SOAP AND WATER. If a harsh soap or solvent is used, the water-base paint finish WILL BE DAMAGED.

Storage and Shipment

The instrument may be stored or shipped in environments with the following limits:

Temperature: -40°C to $+70^{\circ}\text{C}$ (-40°F to $+158^{\circ}\text{F}$)

Humidity: Up to 95% at $+65^{\circ}\text{C}$ ($+149^{\circ}\text{F}$)

Altitude: Up to 15,300 meters (50,000 feet)

Tagging for Service

The instrument should also be protected from temperature extremes which cause condensation within the instrument. Condensation within the instrument may cause a malfunction.

If the instrument is being returned to Hewlett-Packard for servicing, attach a tag indicating the type of servicing required, the return address, model number, and full serial number. In any correspondence refer to the instrument by model number and full serial number.

Packaging

Original packaging, such as containers and material identical to those used in factory packaging, is available from Hewlett-Packard. If other packaging is to be used the following general instructions for repackaging with commercially available materials should be followed:

- a. Wrap the instrument in heavy paper or plastic. Install SMA shorts on the test set's inputs 3.5 mm inputs, and shipping caps on the 2.4 mm inputs.
- b. Use a strong shipping container. A double wall carton made of 2.4 MPa (350 psi) test material is adequate.
- c. Use a layer of shock absorbing material 75 to 100 mm (3 to 4 inches) thick around all sides of the instrument to provide firm cushioning and prevent movement inside the container. Protect the front panel with cardboard.
- d. Seal the shipping container securely.
- e. Mark the shipping container FRAGILE to ensure careful handling.

Performance Tests

Table Of Contents

Performance Tests

| | |
|--|------|
| Introduction | 3-1 |
| Recommended Equipment | 3-1 |
| Test Record | 3-1 |
| Performance Test Cycle | 3-1 |
| Special Procedures | 3-1 |
| Bandwidth Test | 3-3 |
| dc Voltage Measurement Accuracy and rms Noise Test | 3-10 |
| dc Voltage Measurement Accuracy Test | 3-12 |
| rms Noise Test | 3-14 |
| Time Interval Accuracy Test | 3-15 |
| Short Delta T | 3-17 |
| Long Delta T | 3-18 |
| Trigger Sensitivity and Jitter Tests | 3-19 |
| Low Frequency Trigger Hysteresis | 3-20 |
| 100 MHz/2.5 GHz Trigger Sensitivity Test | 3-24 |
| Jitter Test | 3-22 |
| TDR Systems Test | 3-23 |
| Input Reflection Test | 3-29 |
| Performance Test Record | 3-32 |

Introduction

The procedures in this section test the instrument's electrical performance using the specifications in section 1 as performance standards. All tests can be performed without access to the interior of the instrument.

Recommended Equipment

Equipment recommended for performance tests is listed in table 1-1, section 1, "Recommended Test Equipment." You may use any equipment that satisfies the critical specifications.

Test Record

Results of performance tests may be tabulated on the Performance Test Record (table 3-1) at the end of the procedures. The Test Record lists all of the tested specifications and their acceptable limits. The results recorded at incoming inspection can be used for comparison during periodic maintenance, troubleshooting, and after repairs or adjustments.

Performance Test Cycle

This instrument requires periodic verification of performance. The instrument should be checked using the following performance tests at least every twelve months or every 2000 hours of operation. Amount of use, environmental conditions, and the user's experience concerning need for performance checks will contribute in deciding the performance test cycle.

Special Procedures

1. The front-panel has both APC 3.5 and 2.4 mm connectors. Do not connect APC 3.5 connectors to 2.4 mm connectors, or the connectors may be damaged. All connectors should be clean and undamaged to ensure accurate measurements. All APC 3.5 and 2.4 mm connectors should be mechanically and visually checked before inserting any calibration test tool into them. Damaged connectors or loose connections may cause the performance verification tests to fail. See appendix A in the HP 54120B Mainframe Service manual.
2. The system should be allowed to warm up for at least 15 minutes.
3. To avoid damage to the four channel test set connectors, use of the APC 3.5 and 2.4 mm connector savers is encouraged. These connector savers are a supplied accessory. See appendix A in the HP 54120B Mainframe Service manual for more information on mating APC 3.5 connectors with SMA connectors.
4. Avoid sharp bends in the two 17 inch coaxial cables, HP part numbers 8120-4941 and 8120-4942.
5. When mating APC 3.5 to APC 3.5 or 2.4 mm to 2.4 mm, torque the connections to 8 in/lbs. When mating APC 3.5 to SMA or SMA to SMA, torque the connections to 5 in/lbs.

6. If possible, minimize connector swapping during the procedures to avoid connector wear. All connectors on test tools and adapter should be inspected both visually and mechanically every few calibrations.
7. The performance test procedures outlined in this section make use of extra connectors. These are used to save expensive parts from repeated excessive wear caused by many reconnections. These parts are not necessary, but their use is highly advised.
8. Throughout the procedures identical connectors are used in different ways. One way is precise at both ends. This means that both ends of the APC 3.5 connector should be precise and should never be connected to SMA connectors. The other way is precise at one end. This means that one of the APC 3.5 ends may be used with SMA connectors, but the other end should never be connected to an SMA connector. Never connect 2.4 mm connectors to APC 3.5 or SMA connectors.



Allow instruments to warm up for at least 15 minutes prior to beginning performance tests.



The HP 54124A is very sensitive to static discharge. Failure to observe proper antistatic methods may result in damage to the gallium arsenide samplers. All maintenance or operation should be performed with the antistatic mat and wrist strap, which are supplied with the HP 54120B mainframe.



Electrostatic discharge can seriously damage the test set's inputs. To eliminate any electrostatic build up from a cable you're connecting to the test set, connect a female short to either end of the cable. Touch the short to the frame on the test set or the ground clip on the antistatic mat to discharge any electrostatic build up to ground. Remove the female short. Use this procedure for all cables before connecting them to the test set.



The HP 83554A and HP83555A Millimeter Wave Source Modules are capable of radiating millimeter-wave energy from the end of an unterminated waveguide. Do not look directly into the open end of any waveguide when it is connected to a source of millimeter-wave energy.

Take precautions consistent with ANSI C95.1 – 1982, a study performed by the American National Standards Institute that sets limits for human exposure to microwave and millimeter-wave energy . Copies of this publication are available from:

American National Standards Institute
1430 Broadway
New York, NY 10018

Bandwidth Test

The following procedure verifies the bandwidth of the HP 54124A. The sine wave output of a synthesized sweeper is leveled with a power meter. The sine wave's rms voltage is measured and converted to a power measurement to determine bandwidth. This is done on four frequencies on all four channels. This allows use of the HP 54120B's auto measurement modes to increase measurement accuracy.

The specification for channel 1 is -3 dB at 20 GHz. However, the generator's vertical output is not synchronized with its 10 MHz reference output at 20 GHz. You will test channel 1 at 19.98 GHz where the specification at 19.98 GHz would be -2.99 dB.

If this performance test fails, perform the vertical system adjustments in the following order: 10 V reference, step recovery diode, sampler bias, offset gain, and feedthrough compensation adjustments.

| | | | |
|-----------------------|----------------|--------------|---------------------------|
| Specifications | High bandwidth | Channels 3-4 | dc to 50 GHz at -3 dB |
| | | Channel 2 | dc to 34 GHz at -3 dB |
| | | Channel 1 | dc to 20 GHz at -3 dB |
| | Low bandwidth | Channels 3-4 | dc to 26.5 GHz at -3 dB |
| | | Channel 2 | dc to 18 GHz at -3 dB |
| | | Channel 1 | dc to 12.4 GHz at -3 dB |

Equipment Setup

HP 54120B

Display

| | |
|-----------------|----------|
| Display Mode | Averaged |
| No. of Averages | 16 |
| Screen | Single |
| Graticule | Frame |
| Bandwidth | Low |

Trigger

| | |
|---------------|-----|
| Trigger Level | 0 V |
| Slope | Pos |
| HF Sens. | Off |
| HF Reject | Off |
| Attenuation | 1 |

Channels

| | |
|-------------|-----------|
| Channels | 1-4 |
| Display | On |
| Volts/Div | 20 mV/div |
| Offset | 0V |
| Attenuation | 1 |

Timebase

| | |
|--------------|----------|
| Time/Div | 5 ns/div |
| Delay | 16 ns |
| Delay Ref at | Left |
| Sweep | Trg'd |

Network

| | |
|-------------------|---------|
| Reflect/Trans/CAL | Reflect |
| Step & Chan 1 | Off |

Equipment Connections

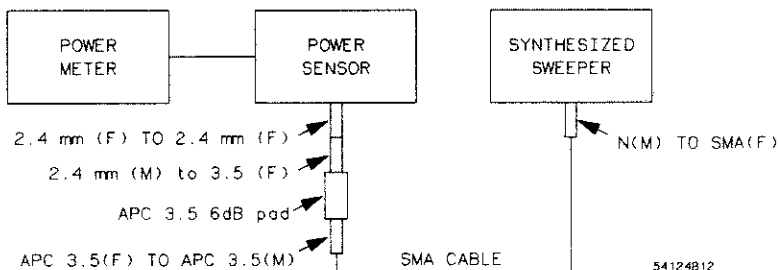


Figure 3-1. Bandwidth Test Equipment Setup A

Equipment

This is a list of recommended test equipment for this performance test. However, you may use any instrument that satisfies the critical specifications.

| Equipment | Critical Specifications | Model/ Part |
|-------------------------------|--|------------------------|
| Synthesized sweeper | 20 GHz, +6 dBm, 25 dBc subharmonics, noise < 6 dB | HP 8341A/B/003 |
| RF amplifier | 20 dB Gain at 10 MHz | HP 8447D/E/F |
| Power meter | 50 GHz | HP 437A |
| Power sensor | 50 GHz | HP 8487A |
| Microwave amplifier | 2 to 20 GHz | HP 8349B |
| Millimeter wave source module | 26.5 to 50 GHz The HP 83554A covers 26.5 to 40 GHz The HP 83555A covers 33 to 50 GHz | HP 83554A HP 84555A |
| Trigger | 18 GHz | HP 54118A |
| Calculator | Log base 10 function | HP 11C |
| 6 dB pad | APC 2.4 connections | HP 8490D/006 |
| 6 dB pad | APC 3.5 connections | HP 33340C/006 |
| Adapter | BNC (f) to SMA (m), Qty – 2 | HP 1250-1200 |
| Adapter | WR-28 to 2.4 mm (m) | HP R281B |
| Adapter | WR-22 to 2.4 mm (m) | HP r281B |
| Adapter | N (m) to APC 3.5 (m) | HP 1250-1743 |
| Adapter | APC 3.5 (f-f) | HP 1250-1865 |
| Adapter | APC 3.5 (m-f) | HP 1250-1866 |
| Adapter | 2.4 mm (f-f) | HP 11900B |
| Adapter | 2.4 mm (m-f) | HP 11900C |
| Adapter | 2.4 mm to APC 3.5 (f-f) | HP 11901B |
| Adapter | 2.4 mm to APC 3.5 (m-f) | HP 11901C |
| Adapter | N (m) to SMA (f) | HP 1250-1250 |
| Coaxial cable | APC 3.5 (m-f) | HP 8120-4942 |
| Coaxial cable | SMA, 36 inches | HP 8120-4948 |
| BNC cable | Length – 48 inches, Qty – 2 | HP 10503A |

Procedure Characterizing the sweep oscillator's output



The sweep oscillator's output will change slightly from one day to the next day. That makes this part of the calibration procedure difficult to repeat. Improperly torqued connectors or the usage of different 6 dB pads is the most likely source of errors for regaining previously obtained numbers.

| Type of Equipment | Model Number | Serial Number |
|---------------------|--------------|---------------|
| Synthesized sweeper | _____ | _____ |
| Power meter | _____ | _____ |
| Power sensor | _____ | _____ |
| 6 dB pad | _____ | _____ |

1. Calibrate and zero power the meter before connecting the sensor to the synthesized sweeper. Use the N type (m) to APC 2.4 (f) adapter supplied with the HP 8487A Power Sensor.
2. Set the frequency of the sweep oscillator to 50 MHz.
3. Set the output power of the sweep oscillator to -8 dBm.
4. Set the calibration factor (CF) of the power meter to 100%. **DO NOT** change that setting during this procedure.
5. Record the reading of the power meter in μ W in step 48 part 1.
6. Set the frequency of the sweep oscillator to 12.4 GHz, 18 GHz, and 19.98 GHz, then record the reading of the power meter in μ W in step 48 part 1.
7. Record the calibration factors (CF) of the power sensor in step 48 part 2 (assume 100% for 50 MHz).

Checking the bandwidth of the oscilloscope

8. Connect the equipment as shown in figure 3-2. Remove the APC 3.5 (f-f) adapters from the channel 1 and 2 input connectors. Attach the 11901B APC 3.5 (f) to 2.4 mm (f) to channel 1 with the 2.4 mm (f) end facing out. Leave the 2.4 mm (f-f) connector savers (shipped with the instrument) on channels 3 and 4.

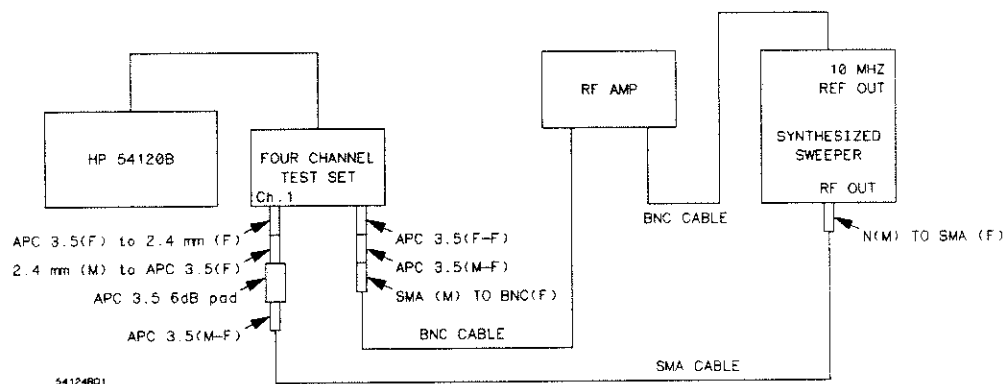


Figure 3-2. Bandwidth Test Equipment Setup B

9. Turn channel 1 on and channels 2 through 4 off. Set the vertical sensitivity to 20 mV/div on all four channels and the time base to 5 ns/div.
10. Set the frequency of the sweeper to 50 MHz at -8 dBm.
11. Press the **Clear Display** key, then wait for 16 averages to accumulate at the top left corner of the screen.
12. Press the **More** key, press the **Measure** key, then press the **Precision** key until **fine** is highlighted. Press the **More** key twice, then press the **rms Voltage** key.
13. Record the V_{rms} reading from the bottom of the screen in step 48 part 3.
14. Change the sweep speed of the oscilloscope to 15 ps/div.
15. Change the frequency of the sweeper to 12.4 GHz, then repeat steps 11 through 13.
16. Change the display bandwidth mode to **High**.
17. Change the frequency of the sweeper to 19.98 GHz, then repeat steps 11 through 13.
18. Change the display bandwidth mode to **Low**.
19. Move the input from channel 1 to channel 2. (the APC 3.5 (f) to 2.4 mm (f) adapter must be moved from channel 1 to channel 2). Repeat steps 9 through 15 for channel 2 (use 18 GHz in step 15)
20. Connect the equipment as shown in figure 3-3. Do not turn on the microwave amplifier until after the millimeter wave source module is connected.

Note 

Arrange the equipment such that the source module can be connected directly to the test set without using cables. The transmission of signals greater than 26.5 GHz through the coax cables can introduce errors.

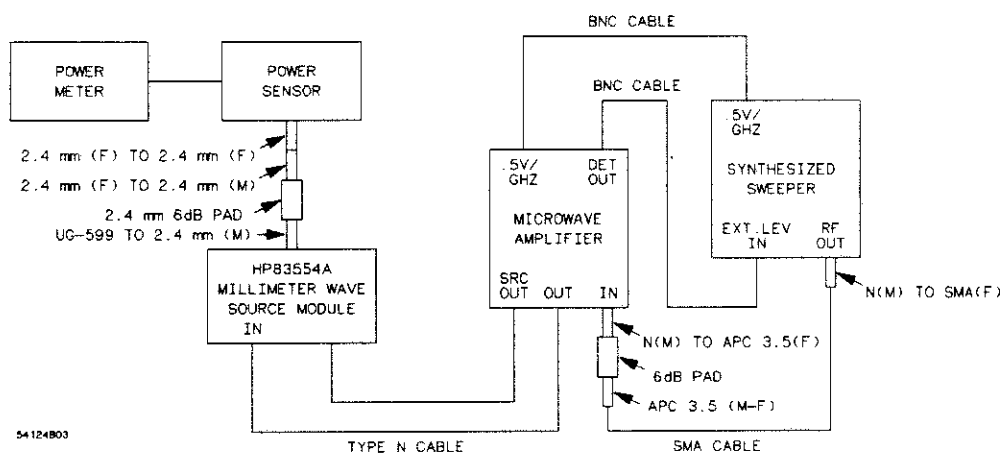


Figure 3-3. Bandwidth Test Equipment Connection C

21. Set the sweeper to 13.25 GHz (the HP 83554A Source Module doubles this frequency to 26.5 GHz). Set the sweep oscillator for external leveling. Use the step keys to set the internal attenuation of the sweep oscillator to 0 dB. Set the external-leveling reference of the sweep oscillator to about -54.4 dBV (the output of the microwave amplifier should be -8 dB).
22. Set the calibration factor of the power meter to 100%. Then record the reading in μW in step 48 part 1.
23. Record the calibration factor of the power sensor for 26.0 GHz in step 48 part 2. The power sensor is not calibrated at exactly 26.5 GHz, however, the value at 26.0 GHz is acceptable.
24. Set the sweeper to 17.0 GHz. The source module doubles the 17 GHz to 34 GHz. Do not adjust the external-leveling reference on the sweeper.
25. Record the reading of the power meter in μW in step 48 part 1. Then record the calibration factor of the power sensor for 34 GHz in step 48 part 2.
26. Connect the equipment as shown in figure 3-4. The connections are changed to channel 2. Keep the source module set to 17 GHz (doubles to 34 GHz).

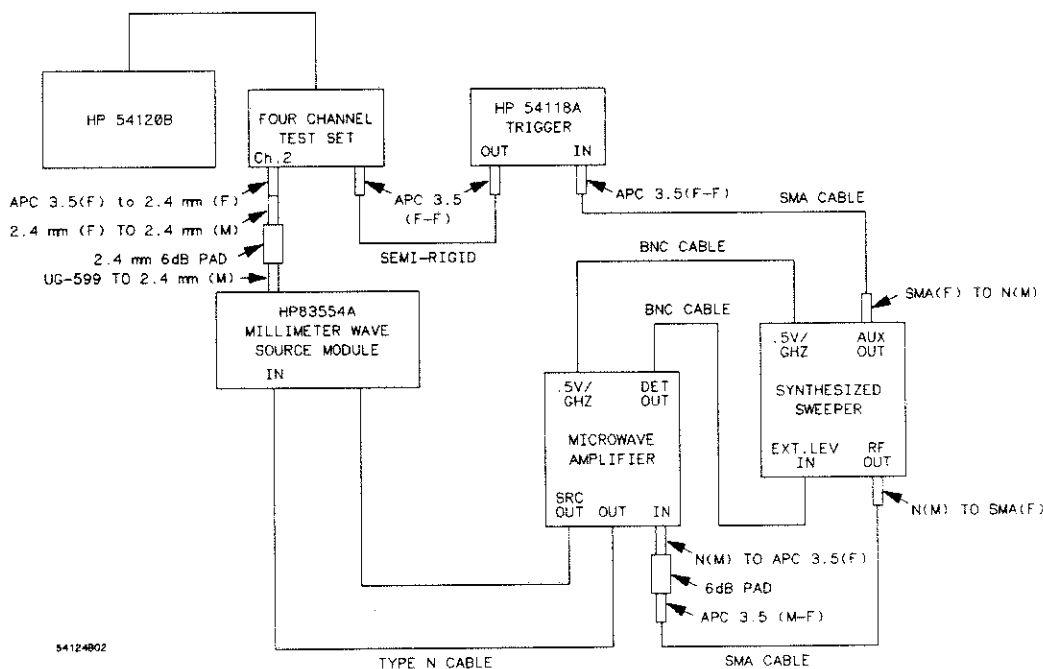


Figure 3-4. Bandwidth Test Equipment Connection D.

27. Change the display mode to persistence, display time to 300 ms, display bandwidth mode to **High**, and sweep speed to 10 ps/div.
28. Adjust the HP 54118A Trigger for a stable signal on the screen.
29. Change the display mode to averaged, then set the number of averages to 16.
30. Press the **Clear Display** key, then wait for 16 averages to accumulate at the top left corner of the screen.

31. Press the **More** key, press the **Measure** key, then press the **Precision** key until **fine** is highlighted. Press the **More** key twice, then press the **rms Voltage** key.
32. Record the V_{rms} reading from the bottom of the screen in step 48 part 3.
33. Move the source module connection to channel 3. Turn off channel 2 and turn on channel 3.
34. Set the sweeper to 13.25 GHz (doubles to 26.5 GHz).
35. Change the display bandwidth to **Low** for step 27, then repeat steps 27 through 32.
36. Move the source module connection to channel 4. Turn off channel 3 and turn on channel 4.
37. Change the display bandwidth to **Low** for step 27, then repeat steps 27 through 32.
38. Turn the RF power off on the sweeper. Turn the microwave amplifier off.
39. Replace the HP 83554A (26.5 to 40 GHz) source module with the HP 83555A (33 to 50 GHz) source module. Turn on the microwave amplifier.
40. Connect the equipment as shown in figure 3-3. Turn the sweeper power on.
41. Set the sweeper to 16.6666 GHz. The HP 83555A Source Module triples the frequency to 49.9998 GHz. Set the external-leveling reference on the sweeper to about -50.5 dBV. The output of the micro-wave amplifier should be about -7 dB.
42. Make sure that the calibration factor on the power meter is 100%.
43. Record the reading of the power meter in μW in step 48, part 1.
44. Record the calibration factor of the power sensor for 50 GHz in step 48, part 2.
45. Connect the equipment as shown in figure 3-4, except connect the equipment to channel 3.
46. Repeat steps 27 through 32 with the display bandwidth set to **High** in step 27.
47. Move the module connection to channel 4 and repeat steps 27 through 32 with the display bandwidth set to **High** in step 27.

48. Calculate the bandwidth gains of the oscilloscope with the values and the formula listed below. There is an example at the bottom of this page.

Part 1

| Frequency | Sweeper output in μW |
|-----------|---------------------------|
| 50 MHz | _____ μW |
| 12.4 GHz | _____ μW |
| 18 GHz | _____ μW |
| 19.98 GHz | _____ μW |
| 26.5 GHz | _____ μW |
| 34 GHz | _____ μW |
| 50 GHz | _____ μW |

Part 2

| Frequency | Calibration factor |
|-----------|--------------------|
| 50 MHz | _____ % |
| 12.4 GHz | _____ % |
| 18 GHz | _____ % |
| 19.98 GHz | _____ % |
| 26.5 GHz | _____ % |
| 34 GHz | _____ % |
| 50 GHz | _____ % |

Part 3

| Frequency | Channel measurement results in rms volts | | | |
|-----------|--|-----------|-----------|-----------|
| | Channel 1 | Channel 2 | Channel 3 | Channel 4 |
| 50 MHz | _____ mV | _____ mV | _____ mV | _____ mV |
| 12.4 GHz | _____ mV | | | |
| 18 GHz | | _____ mV | | |
| 19.98 GHz | _____ mV | | | |
| 26.5 GHz | | | _____ mV | _____ mV |
| 34 GHz | | _____ mV | | |
| 50 GHz | | | _____ mV | _____ mV |

Example: Power Meter Reading at low frequency of 50 MHz = $38.8 \mu W$
 Power Meter Reading at high frequency of 19.98 GHz = $27.6 \mu W$
 Vrms of HP 54120B at low frequency of 50 MHz = 43.79 mV
 Vrms of HP 54120B at high frequency of 19.98 GHz = 28.55 mV
 CF of power meter at low frequency of 50 MHz = 100%
 CF of power meter at high frequency of 19.98 GHz = 91.7%

$$\text{Gain} = 10 \log_{10} \left[\frac{\text{Power Meter reading 50 MHz}}{\text{Power Meter reading high freq}} \right] \left[\frac{\text{CF high freq}}{\text{CF 50 MHz}} \right] \left[\frac{V_{\text{RMS high freq}}}{V_{\text{RMS 50 MHz}}} \right]^2$$

$$54124B04 \quad -2.6 \text{ dB} = 10 \log_{10} \left[\frac{38.8 \mu W}{27.6 \mu W} \right] \left[\frac{91.7\%}{100\%} \right] \left[\frac{28.55 \text{ mV}}{43.79 \text{ mV}} \right]^2$$

dc Voltage Measurement Accuracy and RMS Noise Test

This test checks the offset accuracy, offset gain accuracy, sampler gain accuracy, and the rms noise level of the HP 54120B and HP 54124A. If this performance test fails, perform the vertical system adjustments in the following order: 10 V reference, step recovery diode, sampler bias, offset gain, and feedthrough compensation adjustments.

Specifications

dc voltage accuracy

Single voltage marker

Average mode: $\pm 0.4\%$ of full-scale or marker reading (whichever is greater) ± 2 mV

High bandwidth persistence mode: $\pm 0.4\%$ of full-scale or marker reading (whichever is greater) ± 2 mV $\pm 5\%$ of (reading – channel offset)

Low bandwidth persistence mode: $\pm 0.4\%$ of full-scale or marker reading (whichever is greater) ± 2 mV $\pm 3\%$ of (reading – channel offset)

Dual voltage markers (on same channel)

Average mode: $\pm 0.8\%$ of full-scale or delta marker reading (whichever is greater)

High bandwidth persistence mode: $\pm 0.8\%$ of full-scale or delta marker reading (whichever is greater) $\pm 5\%$ of delta marker reading

Low bandwidth persistence mode: $\pm 0.8\%$ of full-scale or delta marker reading (whichever is greater) $\pm 3\%$ of delta marker reading

rms noise in persistence mode (1 sigma)

High bandwidth mode: ≤ 2 mV

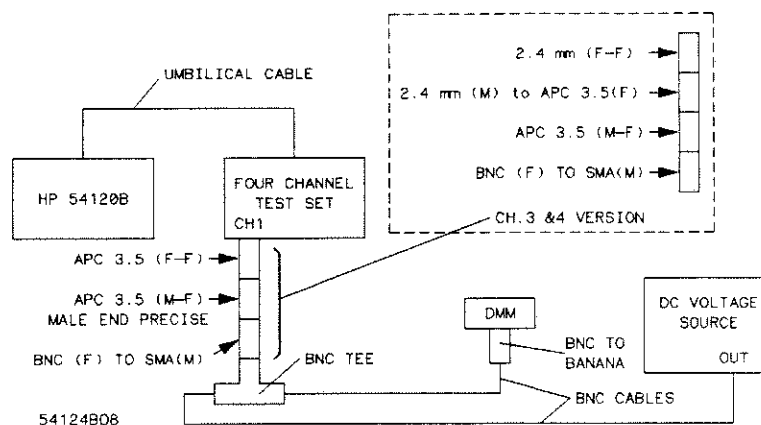
Low bandwidth mode: ≤ 1 mV

Equipment

This is a list of recommended test equipment for this performance test. However, you may use any instrument that satisfies the critical specifications.

| Equipment | Critical Specifications | Model/ Part |
|-------------------|-----------------------------|--------------|
| dc voltage source | $\pm 1/2$ volt | HP 3325A/B |
| DMM | 100 μ V resolution | HP 3478A |
| Adapter | BNC (f) to SMA (m) | HP 1250-1200 |
| Adapter | BNC to banana | HP 1250-2277 |
| Adapter | APC 3.5 (m-f) | HP 1250-1866 |
| BNC Tee | | HP 1250-0781 |
| BNC cable | Length – 48 inches, Qty – 2 | HP 10503A |

Equipment Connections



Caution

Exceeding ± 2 V on the dc power supply may damage the test set's input.

Equipment Setup

dc Voltage Source

| | |
|--------|---------|
| Mode | dc |
| Offset | 500 mV |
| Output | enabled |

HP 54120B

Display

| | |
|-----------------|----------|
| Display Mode | Averaged |
| No. of Averages | 16 |
| Screen | Single |
| Graticule | Frame |
| Bandwidth | Low |

Channels

| | |
|-------------|----------|
| Channels | 1-4 |
| Display | Off |
| Volts/Div | 5 mV/div |
| Offset | 0 V |
| Attenuation | 1 |

Timebase

| | |
|--------------|----------|
| Time/Div | 1 ms/div |
| Delay | 200 ns |
| Delay Ref at | Left |
| Sweep | Freerun |
| Freerun Rate | 10 KHz |

Trigger

| | |
|---------------|-----|
| Trigger Level | 0 V |
| Slope | Pos |
| HF Sens. | Off |
| HF Reject | Off |
| Attenuation | 1 |

Network

| | |
|-------------------|---------|
| Reflect/Trans/CAL | Reflect |
| Step & Chan 1 | Off |

Procedure dc Voltage Measurement Accuracy Test



Channel Vertical Cal is a built-in calibration feature that is performed by the user. No equipment connections or internal adjustment is necessary. A Channel Vertical Cal can be performed any time the user wishes to optimize measurement accuracy and takes only about 10 seconds. Performing a Channel Vertical Cal does not invalidate the internal adjustments. The oscilloscope should be warmed up prior to performing the calibration (about 20 to 30 minutes).

1. Perform a Channel Vertical Calibration by pressing the **Utility** key, **CAL Menu** key, then the **Channel Vertical Cal** key.
2. Press the **Save Setup** key, then the **1** key on the oscilloscope (this saves the front panel setup to memory location 1).
3. Change the vertical sensitivity on channels 1-4 to 80 mV/div, and the display mode to a persistence of 300 ms. Press the **Save Setup** key, then the **2** key on the oscilloscope.
4. Change the display bandwidth to **High**. Press the **Save Setup** key, then the **3** key on the oscilloscope.
5. If the BNC tee is connected to the four channel test set, remove the tee and leave it disconnected until you are told to connect the tee.
6. Press the **Recall Setup** key, then the **1** key (this recalls the instrument setup from memory location 1). Turn channel 1 on.
7. Turn on the Delta V markers, then overlay both markers on channel 1. Press the **Preset Levels** key until **50%-50%** is highlighted.
8. Press the **Clear Display** key, then wait for 16 averages to accumulate at the top left corner of the screen.
9. Press the **Auto Level Set** key, then note the V1 value.
V1 should be 0 V \pm 2.16 mV.
10. Press the **Display** key, then change the bandwidth to **High**.
11. Press the **Clear Display** key, then wait for 16 averages to accumulate. Press the **Delta V** menu key, then press the **Auto Level Set** key.
The V1 value should be 0 V \pm 2.16 mV.
12. Connect the BNC tee to channel 1.
13. Change the channel 1 offset to 500 mV, then change display bandwidth to **Low**.

14. Adjust the dc source until the DMM reads $500\text{ mV} \pm 100\text{ }\mu\text{V}$.
15. Press the **Clear Display** key, then wait for 16 averages to accumulate. Turn on the Delta V markers, then overlay marker 2 over the trace.
The V2 value should be $500\text{ mV} \pm 4\text{ mV}$.
16. Change the channel 1 offset to -500 mV .
17. Adjust the dc source until the DMM reads $-500\text{ mV} \pm 100\text{ }\mu\text{V}$.
18. Press the **Clear Display** key, then wait for 16 averages to accumulate. Turn on the Delta V markers, then overlay marker 1 over the trace.
The V1 value should be $-500\text{ mV} \pm 4\text{ mV}$.
The delta V value should be $1.0000\text{ V} \pm 8\text{ mV}$.
19. Recall the instrument setup from memory location 2. Turn on channel 1.
20. Press the **More** key, then press the **Wfm Math** key. Press the **Function** key until 1 is highlighted. Press the **Display** key until **On** is highlighted (verify the channel is on).
21. Press the **first Chan-Mem** key until **Chan 1** is highlighted. Press the **Operation** key until **Only** is highlighted. Press the **Display Scaling** key until **Volts/Div** is highlighted.
22. Adjust the sensitivity to 5 mV/div . Press the **Display Scaling** key until **Offset** is highlighted. Adjust the offset to 250 mV .
23. Adjust the dc source until the DMM reads $250\text{ mV} \pm 100\text{ }\mu\text{V}$.
24. Turn on the Delta V markers, then overlay both markers over function 1.
Press the **preset levels** key until **50%-50%** is highlighted.
25. Manually overlay the delta V marker 1 to the center of the trace.
The V1 value should be $250\text{ mV} \pm 3.0\text{ mV}$.
26. Press the **Wfm Math** key. Press the **Display Scaling** key until **Offset** is highlighted. Adjust the offset to -250 mV .
27. Adjust the dc source until the DMM reads $-250\text{ mV} \pm 100\text{ }\mu\text{V}$.
28. Manually overlay delta V marker 2 to the center of the trace.
The V2 value should be $-250\text{ mV} \pm 3.0\text{ mV}$.
29. Press the **Recall Setup** key, then the **3** key.
30. Repeat steps 20 through 28. In the high bandwidth mode, V1 should be $250\text{ mV} \pm 3.0\text{ mV}$ and V2 should be $-250\text{ mV} \pm 3.0\text{ mV}$.

rms Noise Test

31. Press the **Recall 2** key. Turn on channel 1. Make sure that the bandwidth is set to low.
32. Disconnect any signals connected to channel 1.
33. Change the display mode to infinite persistence, and the time base delay to 16 ns.
34. Change the channel 1 sensitivity to 2 mV/div, then the offset to 0 V.
35. Press the **Histogram** menu key, then press the **Window/Acquire/Results** key until **Window** is highlighted.
36. Press the **Voltage/Time** key until **Voltage** is highlighted.
37. Set the windows to the left and right sides of the screen.
38. Press the **Window/Acquire/Results** key until **Acquire** is highlighted. Select 10,000 samples, press the **Start Acquiring** key, then wait until the oscilloscope finishes acquiring data.
39. Press the **Window/Acquire/Results** key until **Results** is highlighted. Press the **Sigma** key. The sigma value should be ≤ 1 mV.
40. Press the **More** menu key, then the **Display** menu key. Change the bandwidth to **High**.
41. Repeat steps 32 through 40 for the high bandwidth mode. The sigma value should be ≤ 2 mV.
42. Repeat steps 5 through 41 for channels 2, 3, and 4. Channels 3 and 4 require an additional adapter. See "Equipment Connections" on page 11.

Time Interval Accuracy Test

This tests the accuracy of all time base delay counter modes. If this performance test fails, perform these adjustments in the following order: delta current, range, frequency, end, and 4 ns cal adjustments.

Specifications

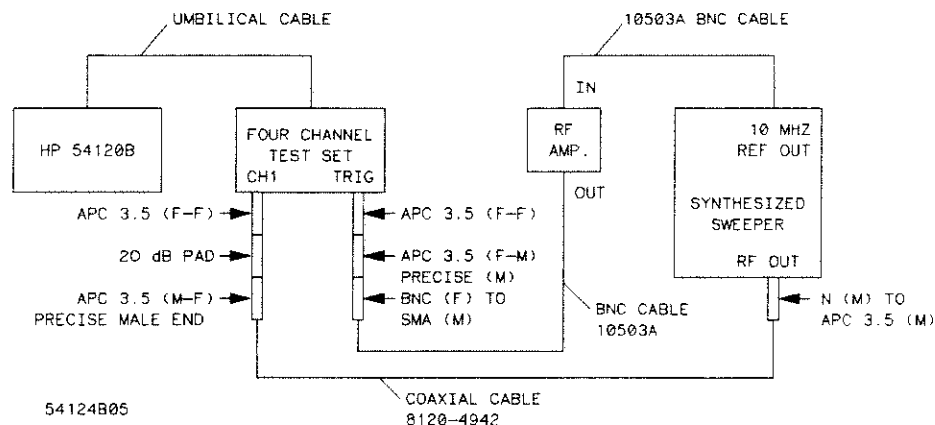
Time interval accuracy 10 ps \pm 0.1% of reading

Equipment

This is a list of recommended test equipment for this performance test. However, you can use any instrument that satisfies the critical specifications.

| Equipment | Critical Specifications | Model/ Part |
|-----------------------|---|----------------|
| Synthesized sweeper | 20 GHz, -25 dBc harmonics, output $+6$ dBm, stability 0.25 ppm/yr | HP 8341A/B/001 |
| 20 dB pad | APC 3.5 connections | HP 8493C/020 |
| RF amplifier | 20 dB Gain at 10 MHz | HP 8447D/E/F |
| Frequency synthesizer | 10 MHz square wave, 120 mV output, stability 0.05 ppm/yr | HP 3325A/B/001 |
| Adapter | BNC (f) to SMA (m), Qty – 2 | HP 1250-1200 |
| Adapter | N (m) to APC 3.5 (m) | HP 1250-1743 |
| Adapter | APC 3.5 (m-f), Qty – 2 | HP 1250-1866 |
| Coaxial cable | APC 3.5 (m-m) | HP 8120-4942 |
| BNC cable | Length – 48 inches, Qty – 2 | HP 10503A |

Equipment Connections



Equipment Setup

Synthesized Sweeper

Frequency 19.98 GHz
Amplitude +6 dBm

Frequency Synthesizer

Mode Square wave
Frequency 10 MHz
Amplitude 1.2 V

HP 54120B

Display

Display Mode Averaged
No. of Averages 64
Screen Single
Graticule Frame
Bandwidth High

Trigger

Trigger Level 0 V
Slope Pos
HF Sens. Off
HF Reject Off
Attenuation 1

Channels

Channels 1-4
Display Off
Volts/Div 20 mV/div
Offset 0 V
Attenuation 1

Network

Reflect/Trans/CAL Reflect
Step & Chan 1 Off

Time base

Time/Div 10 ps/div
Delay 16 ns
Delay Ref at Left
Sweep Trg'd

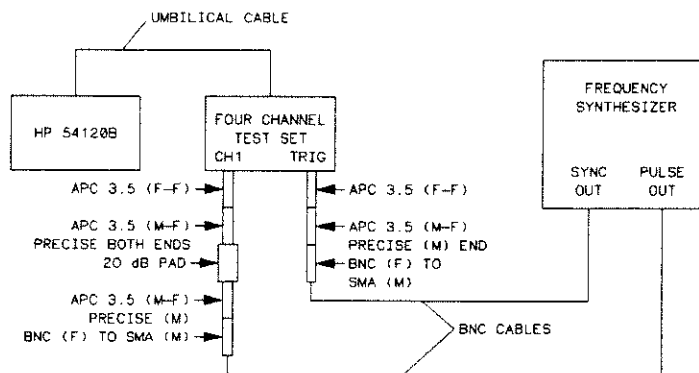
Procedure Short Delta T

1. Press the **Save Setup** key, then press the **3** key. Turn on channel 1.
2. Press the **Clear Display** key, then wait until 64 averages accumulate.
3. Press the **Measure** menu key. Press the **Precision** key until **fine** is highlighted.
4. Press the **Period** key to measure the period of the 19.98 GHz sine wave. The period should be 50.1 ps \pm 10.1 ps.
5. Repeat steps 2 through 4 for the time base delay settings of 18 ns, 19.9 ns, 19.95, 23.95 ns, 27.95 ns, and 55.95 ns.
6. Change the time base delay to 16 ns and the display bandwidth to **Low**.
7. Repeat step 2 through 4 for the following oscilloscope time base settings and sweeper frequency settings. Make sure that the measured results are within the allowable limits.

| <u>Timebase Setting</u> | <u>Sweeper Setting</u> | <u>Test Limits</u> |
|-------------------------|------------------------|----------------------|
| 50 ps/div | 10 GHz | 100 ps \pm 10.1 ps |
| 100 ps/div | 5 GHz | 200 ps \pm 10.2 ps |
| 250 ps/div | 2 GHz | 500 ps \pm 10.5 ps |
| 500 ps/div | 1 GHz | 1 ns \pm 11 ps |
| 1 ns/div | 500 MHz | 2 ns \pm 12 ps |
| 2.5 ns/div | 200 MHz | 5 ns \pm 15 ps |
| 5 ns/div | 100 MHz | 10 ns \pm 20 ps |
| 10 ns/div | 50 MHz | 20 ns \pm 30 ps |
| 25 ns/div | 20 MHz | 50 ns \pm 60 ps |

Long Delta T

8. Change the equipment setup as follows.



54120BD1

9. Press the **Recall 3**, then turn on channel 1.
10. Change the time base sweep speed to 20 ns/div and the trigger level to 500 mV.
11. Press the **Clear Display** key, then wait until 64 averages accumulate.
12. Press the **Measure** menu key. Press the **Precision** key until **fine** is highlighted.
13. Press the **Period** key, then wait for the oscilloscope to measure the period of a 10 MHz sine wave. The period should be 100 ns \pm 110.0 ps.
14. Repeat steps 10 through 13 for the following settings. Make sure that the measured values are within the allowable limits.

| <u>Timebase Setting</u> | <u>Sweeper Setting</u> | <u>Test Limits</u> |
|-------------------------|------------------------|---|
| 100 ns/div | 5 MHz | 200 ns \pm 210 ps |
| 250 ns/div | 2 MHz | 500 ns \pm 510 ps |
| 500 ns/div | 1 MHz | 1 μ s \pm 1.01 ns |
| 1 μ s/div | 500 kHz | 2 μ s \pm 2.01 ns |
| 2.5 μ s/div | 200 kHz | 5 μ s \pm 5.01 ns |
| 5 μ s/div | 100 kHz | 10 μ s \pm 10.01 ns |
| 10 μ s/div | 50 kHz | 20 μ s \pm 20.01 ns |
| 25 μ s/div | 20 kHz | 50 μ s \pm 50.01 ns (0.05001 μ s) |
| 50 μ s/div | 10 kHz | 100 μ s \pm 100.01 ns (0.10001 μ s) |

Trigger Sensitivity and Jitter Tests

The sensitivity test measures the high and low frequency trigger sensitivities by applying a 100 MHz sine wave and a 2.5 GHz sine wave. If the oscilloscope triggers at 2.5 GHz, it will also trigger on a 200 ps pulse width at 200 mV. If this performance test fails, adjust the trigger hysteresis and trigger offset adjustments in section 4, "Adjustments."

The jitter test measures the oscilloscope's internal jitter with a 2.0 GHz sine wave. The instrument's jitter is less with fast risetime input signals. If a generator is substituted, careful consideration of the generator's horizontal jitter and vertical noise is important.

Specifications

Sensitivity: dc to 100 MHz 40 mV peak-to-peak, increasing linearly to 200 mV peak-to-peak at 2.5 GHz

Jitter: Trigger and timebase combined (one standard deviation)

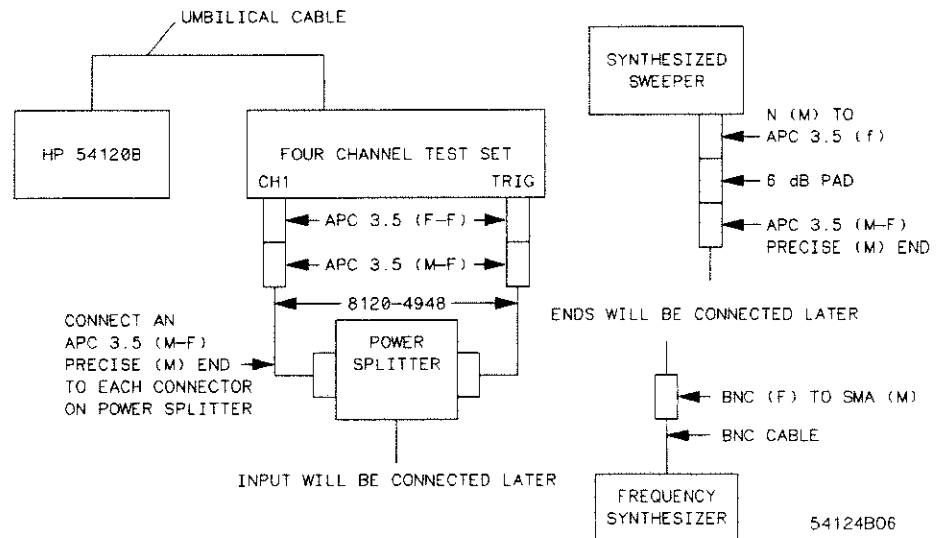
< 2.5 ps + 5×10^{-5} × delay setting. Tested using 2 GHz synthesized source at 200 mV peak-to-peak with high frequency sensitivity on and high frequency reject off.

Equipment

This is a list of recommended test equipment for this performance test. However, you may use any instrument which satisfies the critical specifications.

| Equipment | Critical Specifications | Model/ Part |
|-----------------------|------------------------------------|--------------|
| Synthesized sweeper | 20 GHz, +6 dBm | HP 8341/003 |
| Power splitter | > 10 GHz bandwidth | HP 11667B |
| Frequency synthesizer | 100 kHz sine wave, 200 mV output | HP 3325A/B |
| Delay line | 22 ns, < 6 dB attenuation at 2 GHz | HP 54008A |
| Adapter | APC 3.5 (m-m) | HP 1250-1864 |
| Adapter | APC 3.5 (m-f), Qty – 6 | HP 1250-1866 |
| Adapter | N (m) to APC 3.5 (f) | HP 1250-1744 |
| Adapter | SMA (m) to BNC (f) | HP 1250-1200 |
| Adapter | SMA (f-f) | HP 1250-1158 |
| Coaxial cable | SMA (m-m) 18 GHz, Qty – 3 | HP 8120-4948 |
| BNC cable | 48 inches long | HP 10503A |
| 6 dB pad | APC 3.5 connectors | HP 8493C/020 |

Equipment Connections



Equipment Setup

| | | | |
|------------------------------|-----------|----------------------------|---------------|
| Frequency Synthesizer | | Synthesized Sweeper | |
| Frequency | 100 KHz | Frequency | 100 MHz |
| Power output | 200 mV | Power output | 0 dBm |
| Mode | Sine wave | | |
| HP 54120B | | | |
| Display | | Trigger | |
| Display Mode | Averaged | Trigger Level | 0 V |
| No. of Averages | 4 | Slope | Pos |
| Screen | Single | HF Sens. | Off |
| Graticule | Frame | HF Reject | Off |
| Bandwidth | Low | Attenuation | 1 |
| Channels | | Timebase | |
| Channels | 1-4 | Time/Div | 1 μ s/div |
| Display | Off | Delay | 16 ns |
| Volts/Div | 20 mV/div | Delay Ref at | Left |
| Offset | 0 V | Sweep | Trg'd |
| Attenuation | 1 | | |
| Network | | | |
| Reflect/Trans/CAL | Reflect | | |
| Step & Chan 1 | Off | | |

Procedure Low Frequency Trigger Hysteresis Test

1. Connect the frequency synthesizer to the power splitter.
2. Turn on channel 1.
3. Adjust the frequency synthesizer until the signal on the screen is exactly 100 mV p-p.

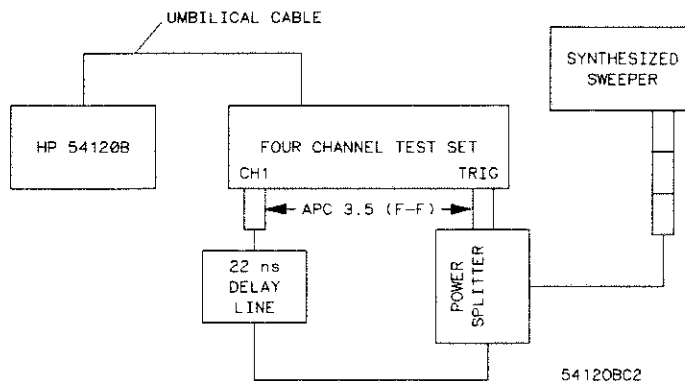
4. Slowly adjust the trigger level greater than 0 V until the oscilloscope just stops triggering. This is indicated on the screen by pressing the **Clear Display** key each time the trigger level is changed. If the oscilloscope is triggered, the waveform will be displayed on the screen. Note the trigger level, this is V_{pos} .
5. Return the trigger level to 0 V. Slowly adjust the trigger level less than 0 V until the oscilloscope just stops triggering. This is V_{neg} .
6. Calculate the hysteresis. $V_{hysteresis} = 100 \text{ mV} - (V_{pos} - V_{neg})$
The value should be $\leq 40 \text{ mV}$.

100 MHz/2.5 GHz Trigger Sensitivity Test

7. Change the time base sweep speed on the oscilloscope to 2 ns/div, then set the trigger level to 0 V. Turn HF Reject off and HF Sens. off.
8. Connect the synthesized sweeper (set to 100 MHz) to the power splitter.
9. Adjust the amplitude of the sweeper to exactly 150 mV as displayed on the screen.
10. Slowly adjust the trigger level greater than 0 V until the oscilloscope just stops triggering. This is V_{pos} .
11. Return the trigger level to 0 V. Slowly adjust the trigger level less than 0 V until the oscilloscope just stops triggering. This is V_{neg} .
12. Calculate the sensitivity. $V_{sense} = 150 \text{ mV} - (V_{pos} - V_{neg})$. The value should be $\leq 40 \text{ mV}$.
13. Turn HF Reject on and repeat steps 10 through 12. The value should be $\geq 57 \text{ mV}$ (+3 dB).
14. Change the sweep speed of the oscilloscope to 100 ps/div, sensitivity to 50 mV/div, and trigger level to 0 V. Turn HF Sens. on and HF Reject off.
15. Change the frequency of the sweeper to 2.5 GHz, then adjust the amplitude to exactly 200 mV as displayed on the screen. The oscilloscope should be triggered.
16. Slowly adjust the trigger level greater than 0 V until the oscilloscope just stops triggering. This is V_{pos} .
17. Return the trigger level to 0 V. Slowly adjust the trigger level less than 0 V until the oscilloscope just stops triggering. This is V_{neg} .
18. Calculate the sensitivity. $V_{sense} = 200 \text{ mV} - (V_{pos} - V_{neg})$. The value should be $\leq 200 \text{ mV}$.

Jitter Test

19. Change the frequency of the sweeper to 2.0 GHz. The amplitude should still be set to 200 mV p-p. Add the delay line and change the equipment setup as shown below.



20. Change the sweep speed of the oscilloscope to 500 ps/div, Delay Ref at center, and delay to 20 ns.
21. Slightly vary the frequency of the sweeper. Select the trigger point that does not expand or contract with frequency changes of the sweeper (using the infinite persistence mode may help you find the trigger edge).
22. Turn on the Delta V markers. Press the **Preset Levels** key until **50%-50%** is highlighted. Press the **Auto Level Set** key.
23. Turn the Delta T markers on, then set the start marker to the 50% point of the positive slope on the selected trigger point.
24. Change the sweep speed to 200 ps/div and the delay to the value of the start marker.
25. Adjust the delay to center the positive edge of the waveform on the screen.
Delay = _____ ns.
26. Change the sweep speed to 10 ps/div and the sensitivity to 5 mV/div.
27. Press the **Histogram** menu key. Press the **Window/Acquire/Results** key until **Window** is highlighted. Press the **Time/Voltage histogram** key until **Time** is highlighted. Set window marker 1 to -0.25 mV and window marker 2 to 0.25 mV.
28. Press the **Window/Acquire/Results** key until **Acquire** is highlighted. Enter the number of samples as 1000. Press the **Start acquiring** key, then wait until the acquire cycle is 100% complete.
29. Press the **Window/Acquire/Results** key until **Results** is highlighted. Press the **Sigma** key. The sigma value should be $< 2.5 \text{ ps} + (5 \times 10^{-5} \times \text{delay setting from step 26})$. If the instrument does not meet the jitter specification, you can adjust the trigger level for best jitter. You would then need to repeat steps 20 through 29. Example with a delay setting of 20.5 ns:

$$\leq 2.5 \text{ ps} + [(5 \times 10^{-5}) \times (20.5 \times 10^{-9})] = 2.5 \text{ ps} + 1.025 \text{ ps} \leq 3.525 \text{ ps}$$

TDR System Tests

This test verifies correct operation of the TDR system by checking the specifications of both the TDR system and the oscilloscope. The final value of the TDR step generator's amplitude is controlled by the dc resistance of the 50 Ω termination. Since all of the flatness specifications depend on the final value measured in this test, the effects of using a nonperfect 50 Ω termination are accounted for during the procedure.

The dc resistance of a nonperfect 50 Ω termination will effect the on-screen final value. Figure 3-5 shows the first 1 ns after the incident step using two different 50 Ω terminations. Notice the two traces are coincident for approximately the first 500 ps until the 50 Ω termination is encountered. The two traces finally settle with a constant level shift between them. The amount of the level shift is dependent on the dc resistance variation between the 50 Ω terminations used.

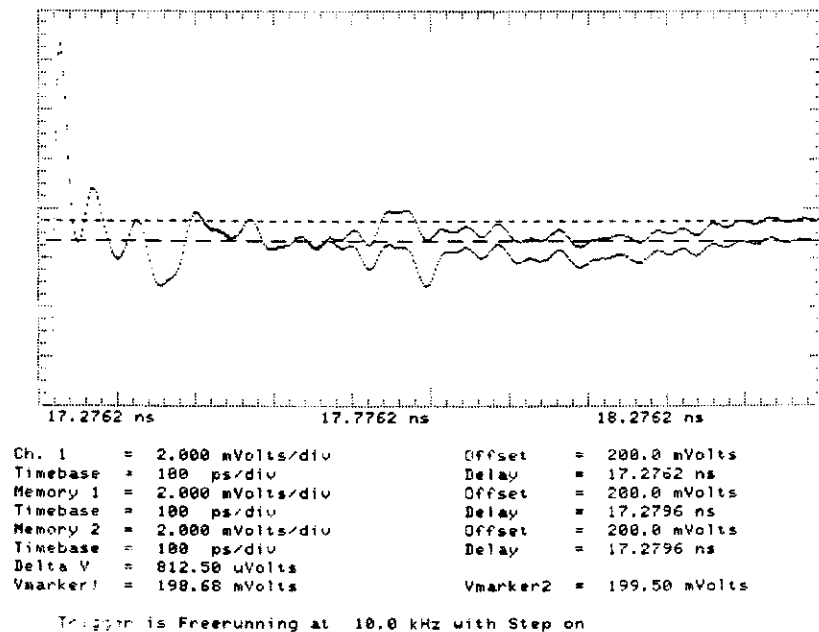


Figure 3-5. Incident Step With Two Different 50 Ω Terminations, Top Trace dc Resistance = 50.34 Ω , Bottom Trace dc Resistance = 49.91 Ω

The final value recorded in the procedure is the final value that a perfect 50 Ω termination would present. This number is calculated based on the actual dc resistance of the 50 Ω termination used.

There are two sets of flatness specifications, both are referenced to 1 ns after the incident step. One specification is before the 1 ns reference point. The other specification is after the 1 ns reference point.

For the $\pm 1\%$ tests (> 1 ns after edge) a delta V measurement is made between the actual on-screen final value and the reflections from the 50 Ω termination. This delta V measurement will be independent of the dc resistance of the 50 Ω termination. This value is divided by the final value calculated for a 50 Ω termination's final value and multiplied by 100%.

For the +5%, -3% tests (< 1 ns after edge) a different approach must be used. If the -3% reflection appears before the 50 Ω termination in time, then a delta V measurement using the on-screen final value and voltage value of that reflection will be dependent on the dc resistance of the 50 Ω termination. This is not true if the reflection appears after the 50 Ω termination in time.

Reflection appears before the termination The recorded final value is subtracted from the reflection's voltage value, then divided by the recorded final value and then multiplied by 100%.

Reflection appears after the termination The on-screen final value is subtracted from the reflection's voltage value, then divided by the recorded final value and multiplied by 100%.

The overshoot (+5% at < 1 ns after edge) calculation is identical to the -3% test (reflections before the 50 Ω termination) since the overshoot appears before the termination in time.

If this performance test fails, perform the TDR adjustments in section 4, "Adjustments".

Specifications: Combined oscilloscope and TDR risetime performance $\leq 45 \text{ ps}^1$
(measured in Low bandwidth, averaged mode)

Combined oscilloscope and TDR flatness performance
(measured in Low bandwidth, averaged mode)
After 1 ns from edge $\pm 1\%$
+5%, -3% to 1 ns from edge

Combined oscilloscope and TDR levels performance
Low - 0 V $\pm 2 \text{ mV}$
High - 200 mV $\pm 2 \text{ mV}$

Equipment This is a list of recommended test equipment for this performance test. However, you may use any instrument which satisfies the critical specifications.

| Equipment | Critical Specifications | Model/ Part |
|---------------|------------------------------|--------------|
| Termination | 50 Ω , APC 3.5 (f) | HP 909D/011 |
| DMM | 100 μV resolution | HP 3478A |
| Adapter | BNC (m-m) | HP 1250-0216 |
| Adapter | BNC (f) to banana | HP 1250-2277 |
| Adapter | BNC (f) to SMA (m) | HP 1250-1200 |
| Adapter | APC 3.5 (m-f) | HP 1250-1866 |
| Coaxial short | APC 3.5 (f) | HP 1250-2127 |

1. The risetime of the generator is less than 35 ps, as calculated by

$$(T_{r \text{ system}})^2 = (T_{r \text{ generator}})^2 + (T_{r \text{ oscilloscope}})^2$$

Equipment setup:

HP 54120B

Display

| | |
|-----------------|----------|
| Display Mode | Averaged |
| No. of Averages | 16 |
| Screen | Single |
| Graticule | Frame |
| Bandwidth | Low |

Timebase

| | |
|--------------|-----------|
| Time/Div | 50 ps/div |
| Delay | 16 ns |
| Delay Ref at | Left |
| Sweep | Freerun |
| Rate | 10 kHz |

Channels

| | |
|-----------|----------|
| Channel | 1 |
| Display | On |
| Volts/Div | 5 mV/div |
| Offset | 0 V |
| Channels | 2-4 |
| Display | Off |

Network

| | |
|-------------------|---------|
| Reflect/Trans/CAL | Reflect |
| Step & Chan 1 | On |

Note

If there is a rising edge on screen, the "TDR Step Adjustments" in section 4 must be performed before continuing with this procedure.

Procedure:

1. Assemble a fixture by connecting a banana to BNC (f) adapter to a BNC (m-m) adapter. Connect this to a BNC (f) to SMA (m) adapter. Connect this to an APC 3.5 (m-f) adapter (male end precise), then connect the fixture to the DMM. Connect an APC 3.5 (f) precise 50 Ω termination to the other end of the fixture. Record the dc resistance of the 50 Ω termination here _____ Ω
Example 50.390 Ω
2. Remove the 50 Ω termination and connect the APC 3.5 (f) short to the fixture. Record the dc resistance of the fixture here _____ Ω Example 0.050 Ω
3. Subtract the fixture resistance (step 2) from the termination resistance (step 1).
Step 1 _____ Ω - Step 2 _____ Ω = Z_L _____ Ω Example 50.340 Ω
4. Solve for E_R using this formula (E_R may be a negative number).
 $E_R = 200 [(Z_L - 50) \div (Z_L + 50)]$ (round to the nearest 0.01 mV)
Example 0.68 mV
Install a 50 Ω termination on channel 1.
5. Select the Delta V menu, then press the **V Markers** key until **On** is highlighted. Press the **Preset Levels** key until **50%-50%** is highlighted. Press the **Auto Level Set** key. V(1) should read 0 V \pm 2 mV.
Record V(1) here _____ mV Example 156.25 μ V
6. Change the sweep speed to 1 ns/div, channel 1 vertical sensitivity to 80 mV/div, and offset to 200 mV.
7. Select the Delta V menu, then press the **Preset Levels** key until **50%-50%** is highlighted. Press the **Auto Level Set** key.

8. Select Delta T menu and press **T Markers** key until **On** is highlighted. Press the **START ON EDGE** key until **POS 1** is highlighted. Press the **STOP ON EDGE** key until **POS 1** is highlighted. Press the **Precise Edge Find** key.
9. Change the stop-marker value to the start-marker value plus 1 ns.
10. Change the sweep speed to 100 ns/div, delay to the stop-marker value, and channel 1 vertical sensitivity to 2 mV/div.
11. Select the Delta V menu, then overlay marker 1 on the trace at right edge of the screen. Record V(1) the on-screen final value here _____ mV
Example 200.37 mV
12. Subtract the value of E_R (from step 4) from V(1) and record that value here _____ mV. This value should be 200 mV \pm 2 mV. Example 199.69 mV
13. Allow time for 16 averages to accumulate, then adjust marker 2 to the highest point of the signal on the screen. Divide the delta V reading by the final value obtained in step 12, then multiply the result by 100%.
(delta V reading _____ \div step 12 _____) 100% = _____
Example $(812.50 \mu\text{V} \div 199.69 \text{ mV}) 100\% = 0.41\%$
The absolute value of this number should be less than 1% (+ 1% at > 1 ns after the edge).
14. Adjust marker 2 to the lowest point of the signal on the screen.
15. Select the time base menu, then press the **TIME/DIV** key. Press the front panel increment key to select the next fastest sweep speed. If there is a point on the screen lower than the previous position of marker 2, readjust marker 2 to that lowest point. Repeat this step until a sweep speed of 1 ns/div is reached.
16. Divide the absolute value of delta V by the final value obtained in step 12, then multiply the result by 100%.
(delta V reading _____ \div step 12 _____) 100% = _____
Example $(-1.8125 \text{ mV} \div 199.69 \text{ mV}) 100\% = -0.91\%$
The absolute value of this number should be $\leq 1\%$ (-1% at > 1 ns after edge).
17. Change the time base sweep speed to 200 ps/div, delay reference to center, and delay equal to the value of the start marker.
18. Change the channel 1 sensitivity to 80 mV/div.
19. Select the Delta V menu and press the **Preset Levels** key until **50%-50%** is highlighted. Press the **Auto level set** key.
20. Select the Delta T menu. Press the **START ON EDGE** key until **POS 1** is highlighted. Press the **STOP ON EDGE** key until **POS 1** is highlighted. Press the **Precise Edge Find** key.

21. Change the time base delay reference to left, and the delay equal to start-marker value. Adjust the stop marker to value of start marker plus 0.5 ns (500 ps). Change the sweep speed to 100 ps/div and the vertical sensitivity to 2 mV/div.
22. Select the Delta V menu and adjust marker 2 to the lowest point of the signal on the screen. **DO NOT** include the rising edge of the signal. If this point is to the left of the stop marker, then subtract the final value obtained in step 12 from V(2) and record that value in step 23 (round to the nearest 0.01mV). Refer to figure 3-5. V(2) _____ mV Example 196.75 mV

If the lowest point on the screen is out of specification and is to the right of the stop marker, change the 50 Ω termination. Out-of-tolerance connectors will cause out-of-specification perturbations from slightly left of the stop marker and to the right of the stop marker and continuing off screen.

23. -3% test _____ mV Example -2.94 mV

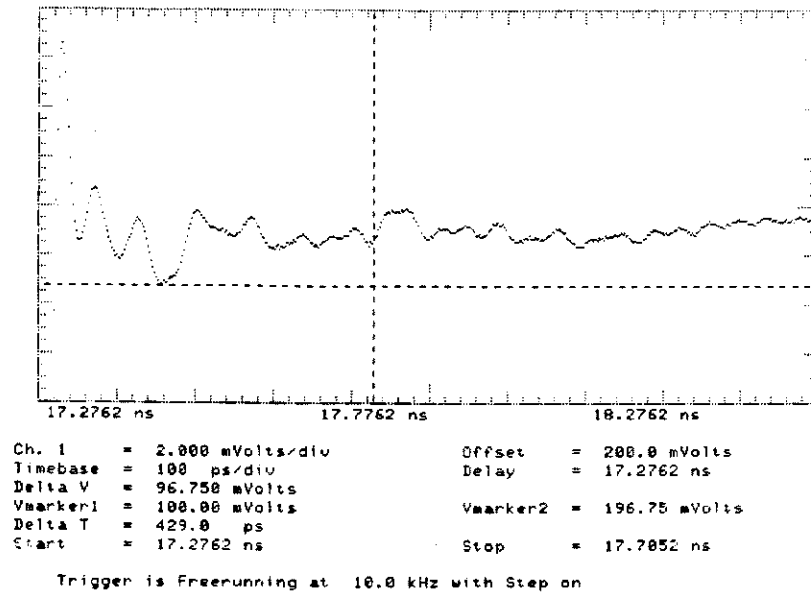


Figure 3-6. -3% Test. The Reflection Appears Before the Termination

24. Divide the value obtained step 23 by the final value obtained in step 12 and multiply the result by 100%.
 (step 23 _____ ÷ step 12 _____) 100% = _____
 Example $(-2.94 \text{ mV} \div 199.69 \text{ mV}) 100\% = -1.47\%$
 The absolute value of this number should be less than 3% (-3% at < 1 ns after edge).
25. Adjust marker 2 to the highest point of the signal on the screen
 V(2) _____. Example 206.56 mV
 Subtract the final value obtained in step 12 from V(2) and record that value in step 26.
26. +5% test _____ mV. Example 6.87 mV
27. Divide the value obtained step 26 by the final value obtained in step 12 and multiply the result by 100%.
 (step 26 _____ ÷ step 12 _____) 100% = _____
 Example $(6.87 \text{ mV} \div 199.69 \text{ mV}) 100\% = 3.44\%$
 The absolute value of this number should be less than 5% (+5% at < 1 ns after edge).
28. Using the keypad, adjust marker 2 to value obtained in step 11.
 Using the keypad, change the marker 1 value equal to the value recorded in step 5 above.
29. Change the sweep speed to 30 ps/div. Press the **Delay Ref at** key until **Center** is highlighted.
30. Change the delay value equal to start-marker value. Change the channel 1 vertical sensitivity to 30 mV/div and the offset to 100 mV.
31. Select the Delta V menu. Press the **Preset Levels** key until **10%-90%** is highlighted. **DO NOT** press the Auto Level Set key again.
32. Select the Delta T menu. Press the **START ON EDGE** key until **POS 1** is highlighted. Press the **STOP ON EDGE** key until **POS 1** is highlighted.
33. Press the **Precise Edge Find** key. The measured rise time (delta t) should be $\leq 45 \text{ ps}$.

Input Reflection Test

This test uses a calibrated four channel test set channel to measure the amount of reflection each channel reflects back to the test line when pulsed with a fast edge signal.

Specifications:

Percent Reflection
Channels 1-2 $\pm 5\%$ for 30 ps rise time
Channels 3-4 $\pm 5\%$ for 20 ps rise time
External Trigger $\leq 10\%$ for 100 ps rise time

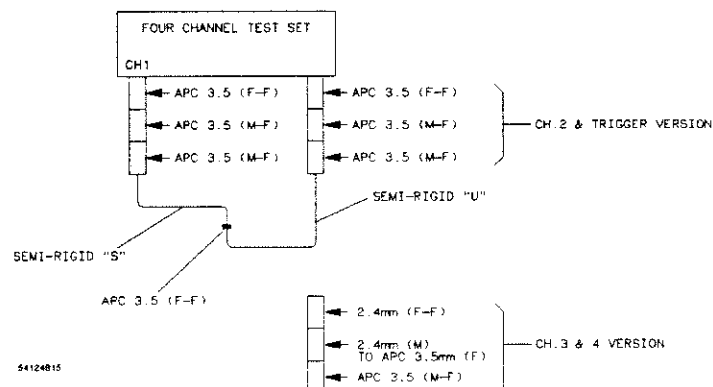
Equipment

This is a list of recommended test equipment for this performance test. However, you may use any instrument which satisfies the critical specifications.

| Equipment | Critical Specifications | Model/ Part |
|---------------|---------------------------|----------------|
| Termination | 50 Ω , APC 3.5 (f) | HP 909D/011 |
| Adapter | APC 3.5 (m-m) | HP 1250-1864 |
| Adapter | APC 3.5 (f-f) | HP 1250-1865 |
| Adapter | APC 3.5 (m-f), Qty 4 | HP 1250-1866 |
| Adapter | APC 3.5 (f) to 2.4 mm (m) | HP 11901C |
| Coaxial short | APC 3.5 (f) | HP 1250-2127 |
| Coaxial short | APC 3.5 (m) | HP 1250-2128 |
| Cable | Semi-rigid U shaped | HP 54121-61601 |
| Cable | Semi-rigid S shaped | HP 54121-61602 |

Connections:

1. Do not tighten the connections you make in steps 2 through 4, until step 5.
2. Connect the short end of a semi-rigid U cable to the short end of a semi-rigid S cable through an APC 3.5 (f-f) adapter. To each unconnected end of the cable assembly, connect two APC 3.5 (m-f) adapters (total 4).
3. Connect the end of the semi-rigid S cable with adapters to channel 1.
4. Without bending or damaging the semi-rigid cables, bring the other end of the semi-rigid U cable with adapters toward channel 2. You will connect the semi-rigid cable to channel 2 later in step 4 of the procedure.
5. Tighten all the semi-rigid cable connections and the adapter connections.



Equipment Setup:

Perform a one-keydown power up. Hold down any key. Turn the oscilloscope off then back on. Continue to hold the key down until graticules are displayed on the screen. Change the following oscilloscope settings.

HP 54120B

Display

| | |
|-----------------|----------|
| Mode | Averaged |
| No. of averages | 64 |
| Screen | Single |
| Bandwidth | Low |

Timebase

| | |
|----------|------------|
| Time/Div | 350 ps/div |
| Delay | 23.5 ns |

Channels

| | |
|-----------|-----------|
| Channel | 1 |
| Display | On |
| Volts/Div | 80 mV/div |
| Offset | 200 mV |
| Channels | 2-4 Off |

Network

| | |
|-------------------|---------|
| Reflect/Trans/CAL | Reflect |
| Step & Chan 1 | On |

Procedure

1. Adjust the delay so that the second rising edge of the signal (representing an open circuit condition) is 4 divisions to the left of center screen. Press the **Network** menu key. Press the **Reflect/Trans/CAL** key until **Cal** is highlighted.
2. Press the **Reflect Cal** key. Connect a coaxial short with an APC 3.5 (f) connector to the semi-rigid cable. Press the **Reflect Cal** key again.
3. Remove the coaxial short from the semi-rigid cable, then connect a 50 Ω termination APC 3.5 (f) to the semi-rigid cable. Press the **Reflect Cal** key again.
4. Remove the 50 Ω termination from the semi-rigid cable, then connect the semi-rigid cable to channel 2. Change the channel 1 sensitivity to 5 mV/div. Press the **Clear Display** key, then wait for 64 averages to accumulate.
5. Press the **Network** menu key. Press the **Reflect/Trans/Cal** key until **Reflect** is highlighted.
6. Set the normalized rise time to 30 ps, then press the **Normalize to mem 1** key.
7. Press the **Stop** key, then press the **Clear Display** key.
8. Press the **Cursor** key until **mem 1** is highlighted.
9. Press the **Min & Max Reflect** key. The absolute value of rho minimum and rho maximum should be < 5%.
10. Press the **Run** key.
11. Loosen the joint where the semi-rigid S and U cables join together. Move the semi-rigid cable from channel 2 to the external trigger input. Retighten the connection where the semi-rigid S and U cables join together. Press the **Clear Display** key and wait for 64 averages to accumulate.
12. Repeat steps 6 through 10 for the external trigger input except change the normalized rise time from 30 ps to 100 ps and change the rho limits from 5% to 10%.

13. Loosen the connection where the semi-rigid S and U cables join together.
14. Disconnect the cable from the trigger input. Replace one of the two APC 3.5 (m-f) adapters with a 2.4 mm (m) to APC 3.5 (f) adapter.
15. Move the semi-rigid cable from the trigger input to channel 3. Retighten the connection where the semi-rigid S and U cables join together.
16. Press the **Clear Display** key, then wait for 64 averages to accumulate.
17. Repeat steps 6 through 10 for channel 3, except change the normalized rise time to 20 ps. The rho limits remain at 5%.
18. Loosen the connection where the semi-rigid S and U cables join together. Move the semi-rigid from channel 3 to channel 4. Retighten the connection where the semi-rigid S and U cables join together.
19. Press the **Clear Display** key, then wait for 64 averages to accumulate.
20. Repeat steps 6 through 10 for channel 4, except change the normalized rise time to 20 ps. The rho limits remain at 5%.
21. Remove the semi-rigid S and U cables from the oscilloscope. Connect the precision short to the channel 1 input APC 3.5 connector.
22. Select the waveform save menu. Press the **WAVEFORM MEMORY** key until 1 is highlighted. Press the **Display** key until On is highlighted.
23. Change the channel 1 offset to 0 V. Change the sweep speed to 2 ns/div and the delay to 35 ns.
24. Select the Delta V menu, then overlay both voltage markers on channel 1.
25. Press the **MARKER 1 POSITION**, then overlay this marker on the center of the trace.
26. Press the **MARKER 2 POSITION**, then overlay this marker on the highest portion of ringing that occurs near center of the screen and is greater than marker 1.
27. The delta V value should be $< 10 \text{ mV}$, (+5%).
28. Reposition marker 2 to the highest portion of ringing that occurs near center of the screen and is less than marker 1.
29. The absolute value of Delta V should be $< 10 \text{ mV}$, (+5%).

Table 3-1. Performance Test Record

| Four Channel Test Set HP 54124A HP 54120B Serial No. _____ HP 54124A Serial No. _____ | | Tested by _____ Work Order No. _____ Date Tested _____ Test Interval _____ months | |
|--|-------------------------------------|--|----------|
| Test | | Results | |
| | | Actual | Maximum |
| Low bandwidth at 12.4 GHz | channel 1 | _____ | –3.0 dB |
| Low bandwidth at 18 GHz | channel 2 | _____ | –3.0 dB |
| Low bandwidth at 26.5 GHz | channel 3 | _____ | –3.0 dB |
| Low bandwidth at 26.5 GHz | channel 4 | _____ | –3.0 dB |
| High bandwidth at 19.98 GHz | channel 1 | _____ | –2.99 dB |
| High bandwidth at 34 GHz | channel 2 | _____ | –3.0 dB |
| High bandwidth at 50 GHz | channel 3 | _____ | –3.0 dB |
| High bandwidth at 50 GHz | channel 4 | _____ | –3.0 dB |
| Channel 1 dc Accuracy Test | | Minimum | Actual |
| Low bandwidth | 0 V offset | –2.16 mV | _____ |
| High bandwidth | 0 V offset | –2.16 mV | _____ |
| Low bandwidth | + Offset Gain 500 mV offset | 496 mV | _____ |
| | – Offset Gain 500 mV offset | –504 mV | _____ |
| | Delta V Offset Gain | 992 mV | _____ |
| | + Sampler Gain 250 mV offset | 247.0 mV | _____ |
| | – Sampler Gain –250 mV offset | –253.0 mV | _____ |
| High bandwidth | + sampler Gain 250 mV offset | 247.0 mV | _____ |
| | – Sampler Gain -250 mV offset | –253.0 mV | _____ |
| | rms noise 0 V offset Low bandwidth | | _____ |
| | rms noise 0 V offset High bandwidth | | _____ |
| Channel 2 dc Accuracy Test | | | |
| Low bandwidth | 0 V offset | –2.16 mV | _____ |
| High bandwidth | 0 V offset | –2.16 mV | _____ |
| High bandwidth | + Offset Gain 500 mV offset | 496 mV | _____ |
| | – Offset Gain 500 mV offset | –504 mV | _____ |
| | Delta V Offset Gain | 992 mV | _____ |
| | + Sampler Gain 250 mV offset | 247.0 mV | _____ |
| | – Sampler Gain –250 mV offset | –253.0 mV | _____ |

Table 3-1. Performance Test Record (continued)

| Test | | Results | | |
|--------------------------------------|-------------------------------------|-----------|--------|-----------|
| Channel 2 dc Accuracy Test Continued | | Minimum | Actual | Maximum |
| High bandwidth | + sampler Gain 250 mV offset | 247.0 mV | _____ | 253.0 mV |
| | – Sampler Gain –250 mV offset | –253.0 mV | _____ | –247.0 mV |
| | rms noise 0 V offset Low bandwidth | | _____ | 1 mV |
| | rms noise 0 V offset High bandwidth | | _____ | 2 mV |
| Channel 3 dc Accuracy Test | | | | |
| Low bandwidth | 0 V offset | –2.16 mV | _____ | 2.16 mV |
| High bandwidth | 0 V offset | –2.16 mV | _____ | 2.16 mV |
| Low bandwidth | + Offset Gain 500 mV offset | 496 mV | _____ | 504 mV |
| | – Offset Gain 500 mV offset | –504 mV | _____ | –496 mV |
| | Delta V Offset Gain | 992 mV | _____ | 1.0080 V |
| | + Sampler Gain 250 mV offset | 247.0 mV | _____ | 253.0 mV |
| | – Sampler Gain –250 mV offset | –253.0 mV | _____ | –247.0 mV |
| High bandwidth | + sampler Gain 250 mV offset | 247.0 mV | _____ | 253.0 mV |
| | – Sampler Gain -250 mV offset | –253.0 mV | _____ | –247.0 mV |
| | rms noise 0 V offset Low bandwidth | | _____ | 1 mV |
| | rms noise 0 V offset High bandwidth | | _____ | 2 mV |
| Channel 4 dc Accuracy Test | | | | |
| Low bandwidth | 0 V offset | –2.16 mV | _____ | 2.16 mV |
| High bandwidth | 0 V offset | –2.16 mV | _____ | 2.16 mV |
| Low bandwidth | + Offset Gain 500 mV offset | 496 mV | _____ | 504 mV |
| | – Offset Gain 500 mV offset | –504 mV | _____ | –496 mV |
| | Delta V Offset Gain | 992 mV | _____ | 1.0080 V |
| | + Sampler Gain 250 mV offset | 247.0 mV | _____ | 253.0 mV |
| | – Sampler Gain –250 mV offset | –253.0 mV | _____ | –247.0 mV |
| High bandwidth | + sampler Gain 250 mV offset | 247.0 mV | _____ | 253.0 mV |
| | – Sampler Gain -250 mV offset | –253.0 mV | _____ | –247.0 mV |
| | rms noise 0 V offset Low bandwidth | | _____ | 1 mV |
| | rms noise 0 V offset High bandwidth | | _____ | 2 mV |

Table 3-1. Performance Test Record (continued)

| Test | | | Results | | |
|---------------|---------------|----------|------------------|--------|-------------------|
| Short Delta T | | | Minimum | Actual | Maximum |
| | Delay Setting | 16 ns | 40.0 ps | _____ | 60.2 ps |
| | | 18 ns | 40 ps | _____ | 60.2 ps |
| | | 19.9 ns | 40 ps | _____ | 60.2 ps |
| | | 19.95 ns | 40 ps | _____ | 60.2 ps |
| | | 23.95 ns | 40 ps | _____ | 60.2 ps |
| | | 27.95 ns | 40 ps | _____ | 60.2 ps |
| | | 55.95 ns | 40 ps | _____ | 60.2 ps |
| | Frequency | 10 GHz | 89.9 ps | _____ | 110.1 ps |
| | | 5 GHz | 189.8 ps | _____ | 210.2 ps |
| | | 2 GHz | 489.5 ps | _____ | 510.5 ps |
| | | 1 GHz | 0.9890 ns | _____ | 1.011 ns |
| | | 500 MHz | 1.988 ns | _____ | 2.012 ns |
| | | 200 MHz | 4.985 ns | _____ | 5.015 ns |
| | | 100 MHz | 9.980 ns | _____ | 10.02 ns |
| | | 50 MHz | 19.97 ns | _____ | 20.03 ns |
| | | 20 MHz | 49.95 ns | _____ | 50.06 ns |
| Long Delta T | | 10 MHz | 99.89 ns | _____ | 100.11 ns |
| | | 5 MHz | 199.79 ns | _____ | 200.21 ns |
| | | 2 MHz | 499.49 ns | _____ | 500.51 ns |
| | | 1 MHz | .99899 μ s | _____ | 1.00101 μ s |
| | | 500 kHz | 1.99799 μ s | _____ | 2.00201 μ s |
| | | 200 kHz | 4.99499 μ s | _____ | 5.00501 μ s |
| | | 100 kHz | 9.98999 μ s | _____ | 10.01001 μ s |
| | | 50 kHz | 19.97999 μ s | _____ | 20.02001 μ s |
| | | 20 kHz | 49.94999 μ s | _____ | 50.05001 μ s |
| | | 10 kHz | 99.89999 μ s | _____ | 100.10001 μ s |

Table 3-1. Performance Test Record (continued)

| Test | | | Results | | |
|--------------------------|-----------------------|--------------------|---------------------------------------|--------|------------|
| Trigger Sensitivity Test | | | Minimum | Actual | Maximum |
| | Trigger Hysteresis | V _{pos} | | _____ | 40 mV |
| | | V _{neg} | | _____ | |
| | | V _{hyst} | | _____ | |
| | 100 MHz Trigger Sens. | V _{pos} | | _____ | 40 mV |
| | | V _{neg} | | _____ | |
| | | V _{sens.} | | _____ | |
| | HF Reject On | V _{pos} | | _____ | 57 mV |
| | | V _{neg} | | _____ | |
| | | V _{sens.} | | _____ | |
| | 2.5 GHz Trigger Sens. | V _{pos} | | _____ | 200 mV |
| | | V _{neg} | | _____ | |
| | | V _{sens.} | | _____ | |
| Jitter Test | | | Minimum | Actual | Maximum |
| | | | | _____ | See Specs. |
| Example | | | < 3.525 ps with 20.5 ns delay setting | | |

Table 3-1. Performance Test Record (continued)

| Test | | | Results | | |
|-----------------------|------------|-----|---------|--------|---------|
| TDR System Test | | | Minimum | Actual | Maximum |
| | Low level | | –2 mV | _____ | 2 mV |
| | High level | | 198 mV | _____ | 202 mV |
| Flatness > 1 ns | +1% | | | _____ | +1% |
| | –1% | | –1% | _____ | |
| | < 1 ns | –3% | –3% | _____ | |
| | +5% | | | _____ | +5% |
| Risetime | | | | _____ | 45 ps |
| Input Reflection Test | | | | Actual | Maximum |
| Channel 2 | pos | | | _____ | 5% |
| | neg | | | _____ | 5% |
| Channel 3 | pos | | | _____ | 5% |
| | neg | | | _____ | 5% |
| Channel 4 | pos | | | _____ | 5% |
| | neg | | | _____ | 5% |
| External Trigger | pos | | | _____ | 10% |
| | neg | | | _____ | 10% |
| Channel 1 | pos | | | _____ | 5% |
| | neg | | | _____ | 5% |

Adjustments

Table Of Contents

Adjustments

| | |
|---|------|
| Introduction | 4-1 |
| Recommended Test Equipment | 4-1 |
| Adjustment Sequence | 4-1 |
| Special Procedures | 4-2 |
| Range Adjustment | 4-3 |
| Step Recovery Diode (SRD) Adjustments | 4-4 |
| Frequency Adjustments | 4-7 |
| END and 4 ns CAL Adjustments | 4-9 |
| Sampler Bias Adjustments | 4-12 |
| Offset Gain Adjustments | 4-16 |
| TDR Step Adjustments | 4-18 |
| Feedthrough Compensation Adjustments | 4-24 |
| Trigger Adjustments | 4-27 |
| Channel Skew Calibration | 4-29 |

Introduction

This section describes the adjustments for returning the instrument to peak operating capabilities after repairs have been made, during routine preventive maintenance, or after the performance tests have been done. See section 3, "Performance Test Cycle."

Warning



Read the "Safety Summary" at the front of this manual before performing adjustment procedures. The instrument should be disconnected from all voltage sources before it is opened for any adjustments, replacements, maintenance, or repairs.

Caution



The four channel test set is very sensitive to static discharge. Failure to observe proper antistatic procedures may result in damage to the gallium arsenide samplers. Perform all maintenance or operation while using the antistatic mat and wrist strap supplied with the instrument.

Recommended Test Equipment

Table 1-1 in section 1, "Recommended Test Equipment," lists the recommended test equipment to use for the adjustment procedures. Any equipment that satisfies the critical specifications may be used.

Adjustment Sequence

The following list is the factory recommended sequence of adjustments. The mainframe adjustments must be performed before the test set adjustments.

- Range
- Step Recovery Diode (SRD) Adjustments
- Frequency and TB Fine Tune Adjustments
- END and 4 ns CAL Adjustments
- Sampler Bias Adjustments
- Vertical Soft Cal
- Offset Gain Adjustments
- TDR Step Adjustments
- Feedthrough Compensation Adjustments
- Trigger Hysteresis and Offset Null Adjustments
- Channel Skew Calibration

Special Procedures

1. All connectors should be clean and undamaged to ensure accurate measurements. Check all test set APC 3.5 (f-f) and 2.4 mm (f-f) connectors mechanically and visually before inserting any calibration test tool in them. Damaged connectors or loose connections can cause unreliable adjustment results. Refer to Appendix A in the *HP 54120B Mainframe Service Manual* for more information.
2. The instruments should be allowed to warm up for at least 15 minutes.
3. To avoid damage to the test set connectors, use the APC 3.5 (f-f) and 2.4 mm (f-f) connector savers. These connector savers are supplied with the instrument. Refer to Appendix A in the *HP 54120B Mainframe Service Manual* for information on mating APC 3.5 connectors to SMA connectors.
4. Avoid sharp bends in the two 17-inch coaxial cables, HP part numbers 8120-4941 and 8120-4942.
5. When mating APC 3.5 to APC 3.5 or 2.4 mm to 2.4 mm, torque connections to 8 in/lbs. When mating APC 3.5 to SMA or SMA to SMA, torque connections to 5 in/lbs.
6. Keep connector swapping to a minimum during the procedures. APC 3.5, 2.4 mm, and SMA connectors wear out with repeated use. All test tool connectors should be inspected both visually and mechanically every few calibrations.
7. The adjustment procedures outlined in this section make use of extra connectors. These are used to save expensive parts from repeated excessive wear caused by many reconnections. These parts are not required, but their use is highly advised. They will not interfere with measurement capabilities.
8. Throughout the procedure identical connectors are used in different ways. One way is precise at both ends. This means that both ends of the APC 3.5 connector should be precise and should never be connected to an SMA connector. The other way is precise at one end. This means that one of the APC 3.5 ends may be used with SMA connectors, but the other end should never be connected to SMA connectors. Unless otherwise stated, all APC 3.5 calibration test connectors should never be connected to SMA connectors.



Make sure the 2.4 mm connectors are only connected to 2.4 mm connectors and never to APC 3.5 or SMA.



Electrostatic discharge can seriously damage the test set's inputs. Use the antistatic mat and wrist strap supplied with the mainframe. To eliminate any electrostatic build up from a cable you're connecting to the test set, connect a female short to either end of the cable. Touch the short to the test set's frame or to the ground clip on the antistatic mat to discharge any electrostatic build up to ground. Remove the female short. Use this procedure for all cables before connecting them to the test set.

Range Adjustment

This adjustment matches the linear input range of the time base hybrid to the linear output range of operational amplifier U8 on the horizontal assembly. Anytime this adjustment is performed, you must also do the frequency, end, and 4 ns cal adjustments. If this adjustment fails, perform the "Time Base Delta Current Adjustment" in section 3 of the *HP 54120B Mainframe Service Manual*.

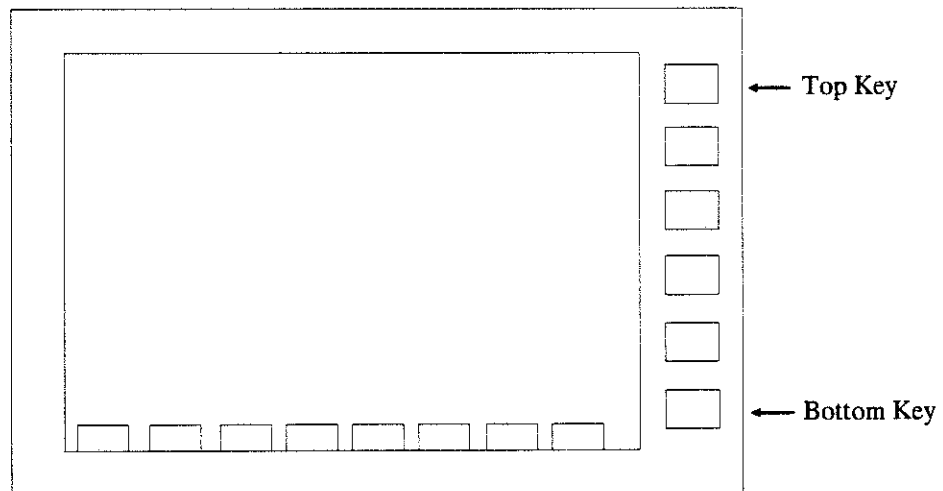
Equipment This is a list of the recommended test equipment for this adjustment. However, you may use any instrument that satisfies the critical specifications.

| Equipment | Critical Specifications | Model |
|-----------|-------------------------|----------|
| DMM | 0.3% accuracy | HP 3478A |

Procedure The adjustment locations are shown in figure 4-12 on page 4-30.

1. Remove the top and bottom covers from the test set.
2. Perform a two key-down power up. This must be performed to make sure that the value on TP1 is correct, otherwise the adjustment may drift on the next trigger event. Turn the power switch to STBY. Hold down the top and bottom function keys immediately to right of the screen. Turn the power switch to ON. Continue pressing the function keys until the graticule display is on the screen. Ignore the "Front Panel Cals Lost" warning at the top of the screen; the calibrations will be performed later.

Keys to Hold Down



3. Change the time base delay to 18 ns, and the sweep to Trg'd mode.
4. Connect the positive DMM lead to the horizontal assembly (A1) TP1. The horizontal assembly is on the bottom side of the test set. Connect the negative DMM lead to the chassis ground near TP1.
5. Adjust RANGE (R52) for a reading of $+5\text{ V} \pm 1\text{ V}$ on the DMM.

Step Recovery Diode (SRD) Adjustments

The sampler hybrids for each channel contain step recovery diodes. The bias on the diodes is adjusted for optimum performance. SRD BIAS adjusts the bias of the step recovery diode for a zero temperature coefficient. SRD DRIVE adjusts the output level of the sample pulse generator. SRD DRIVE affects the bandwidth of all four channels simultaneously. Anytime the SRD is adjusted, the SBIAS and offset gain must also be adjusted. If the SRD adjustment fails, perform the "10 V Reference Adjustment" in section 3 of the *HP 54120B Mainframe Service Manual*.

Note 

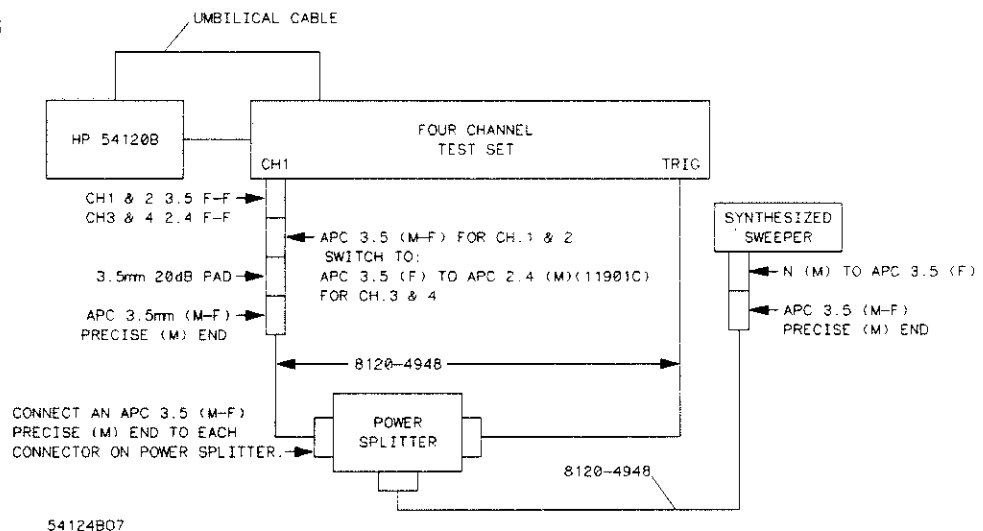
If this adjustment is performed out of the recommended adjustment sequence, a two key-down power up must be performed before starting the procedure.

Equipment

This is a list of the recommended test equipment for this adjustment. However, you may use any instrument that satisfies the critical specifications.

| Equipment | Critical Specifications | Model |
|---------------------|--------------------------------|---------------|
| Synthesized sweeper | 20 GHz +12 dBm | HP 8341B/003 |
| Power splitter | APC 3.5 connectors | HP 11667B |
| 20 dB pad | APC 3.5 connectors | HP 33340C/020 |
| Adapter | APC 3.5 (m-f), Qty – 6 | HP 1250-1866 |
| Adapter | N (m) to APC 3.5 (f) | HP 1250-1744 |
| Adapter | APC 3.5 (f) to 2.4 mm (m) | HP 11901C |
| Coaxial cable | APC 3.5 (m-m), 18 GHz, Qty – 3 | HP 8120-4948 |

Equipment Connections



Equipment Setup

| | |
|---------------|---------|
| Signal Source | |
| Frequency | 250 MHz |
| Amplitude | +12 dBm |

HP 54120B

Display

| | |
|-----------------|----------|
| Display Mode | Averaged |
| No. of Averages | 4 |
| Screen | Single |
| Graticule | Grid |
| Bandwidth | Low |

Time base

| | |
|---------------|----------|
| Time/Div | 1 ns/div |
| Delay | 16 ns |
| Delay Ref. at | Left |
| Sweep | Trg'd |

Channels

| | |
|--------------|---|
| Channel 1 | On |
| Volts/Div | 25 mV/div (Chs 1 & 2) 20 mV/div Chs 3 & 4) |
| Offset | Center signal |
| Channels 2-4 | Off |
| Attenuation | 1.0 |

Trigger

| | |
|---------------|-----|
| Trigger Level | 0 V |
| Slope | Pos |
| Attenuation | 1 |
| HF Sens. | Off |
| HF Reject | Off |

Procedure

The adjustment locations are shown in figures 4-12 and 4-13 on page 4-30.

Note



It is mandatory that step 1 in this procedure be performed, otherwise the Sampler Bias adjustment performed later in this procedure will fail.

1. Preset the following adjustments.
LB1-LB4 (R153-R156) – fully counterclockwise
HB1-HB4 (R161-R164) – fully counterclockwise
RC1-RC4 (R5-R8) – fully counterclockwise
CC1-CC4 (R9-R12) – fully counterclockwise
OG1-OG4 (R113-R116) – mechanical center
SRD Drive – fully clockwise
SRD Bias – mechanical center
2. Readjust the channel offset to recenter the signal on the screen.
3. Press the **Delta V** key. Turn on the V Markers and overlay them on channel 1.
4. Press the **Preset Levels** key until **Variable** is highlighted.
5. Press the **Variable Levels** key, then set the variable levels to –10% and +110%.
6. Use the offset on the oscilloscope to center the signal.
7. Press the **Auto Level Set** key.
8. Press the **Display Mode** key.
9. Set the display to a persistence of 300 ms.

10. Adjust SRD DRIVE (R167) for a signal amplitude of -10% and $+110\%$ on the screen.



An offset may exist in the signal during this portion of the adjustments. If the signal peaks do not overlay the -10% and $+110\%$ markers, adjust SRD DRIVE for equal amounts of signal above or below the markers in the following steps. The offset level may be adjusted any time during this procedure.

11. Slowly adjust the SRD BIAS (R168) for maximum signal amplitude. The waveform will compress and slightly increase in amplitude, R168 must be adjusted slowly to see the slight amplitude increase.
12. Repeat steps 10 and 11 until the maximum signal amplitude is -10% and $+110\%$.
13. Turn channel 1 off and channel 2 on. Set the display to averaged.
14. Move the input signal from channel 1 to channel 2.
15. Adjust the channel 2 offset to center the signal on the screen. If a sinewave is not displayed, only a baseline, slowly increase the SRD drive until the signal appears on the screen. Do not overadjust. If a sinewave cannot be obtained, the channel is defective.
16. Press the **Delta V** menu key. Turn on the V Markers. Press the **Preset Levels** key until $-10 + 110\%$ is highlighted.
17. Allow the signal to converge to the final value, then press the **Auto Level Set** key.
18. Change the display to persistence.
19. If the amplitude is less than the V Markers (-10 and $+110\%$), repeat steps 10 through 12.
20. Turn channel 2 off and channel 3 on. Set the display to averaged and to high bandwidth.
21. Move the input signal from channel 2 to channel 3. The 2.4 mm inputs of channels 3 and 4 require the use of a different adapter. See the "Equipment Connections" on page 4-4.
22. Repeat steps 15 through 19 for channel 3, except use the 20% to 80% marker levels.
23. Turn channel 3 off and channel 4 on. Set the display to averaged and to high bandwidth.
24. Move the input signal from channel 3 to channel 4. Repeat steps 15 through 19 for channel 4, except use the 20% to 80% marker levels.

Frequency Adjustments

This adjusts the 250 MHz time base oscillator inside the time base hybrid. A trimmer cap (FREQ) on the time base hybrid is a coarse adjustment, and TB FINE TUNE (A1R54) is a fine adjustment. Anytime this adjustment is performed, the END and 4 ns cal adjustments must also be performed. If the frequency adjustment fails, perform the "Time Base Delta Current Adjustment" in section 3 of the *HP 54120B Mainframe Service Manual*, and the "Range Adjustment" in of this section.

Equipment & Connections

Refer to the "Step Recovery Diode Adjustment" in this section. There is a coarse frequency adjustment on the time base hybrid (FREQ). This coarse adjustment normally only needs adjusted if the timebase hybrid has been replaced. Normally the TB FINE TUNE adjustment should have enough range to compensate for slight variances in the coarse adjustment. If the coarse adjustment needs to be performed, a non-metallic tool with a blade 0.010 inches thick and 0.040 inches wide is used. An adjustment tool, HP part number 8710-1300, filed down to fit the adjustment size is adequate.

Equipment Setup

| | |
|---------------|---------|
| Signal Source | |
| Frequency | 250 MHz |
| Amplitude | +12 dBm |

HP 54120B

Display

| | |
|-----------------|----------|
| Display Mode | Averaged |
| No. of Averages | 4 |
| Screen | Single |
| Graticule | Grid |
| Bandwidth | Low |

Time base

| | |
|--------------|------------|
| Time/Div | 500 ps/div |
| Delay | 16 ns |
| Delay Ref at | Left |
| Sweep | Trg'd |

Channels

| | |
|--------------|-----------|
| Channel 1 | On |
| Volts/Div | 20 mV/div |
| Offset | 0 V |
| Channels 2-4 | Off |
| Attenuation | 1 |

Trigger

| | |
|---------------|-----|
| Trigger Level | 0 V |
| Slope | Pos |
| Attenuation | 1 |
| HF Sens. | Off |
| HF Reject | Off |

Procedure

The adjustment locations are shown in figure 4-12 on page 4-30.



Note

For best results with this procedure, perform all adjustments with the test set in the normal operating position.

1. Adjust the offset to center the signal vertically.
2. Adjust the trigger level until the positive or negative slope of the trace begins near the center horizontal graticule on the left side of the screen, and remains triggered.
3. Press the **Measure** key, then press the **Frequency** key. If the results are $250 \text{ MHz} \pm 250 \text{ kHz}$, go to step 6. Otherwise, go to step 4.
4. Remove the tape from the **FREQ** (frequency) adjustment (trimmer capacitor on U9) on the horizontal assembly.
5. Remeasure the frequency while making small incremental adjustments to the **FREQ** adjustment capacitor on the time base hybrid with a 40/1000 inch non-metallic alignment tool. After the frequency measures $250 \text{ MHz} \pm 250 \text{ kHz}$, proceed with step 6.
6. Change the time base time/div to 200 ns/div .
7. There should be a flat horizontal trace on screen. If the trace is horizontally flat ± 1 major division go to step 12. Otherwise, go to step 8.
8. Preset the **TB FINE TUNE** (R54) on the horizontal assembly to mechanical center.
9. Adjust the **FREQ** adjustment on the time base hybrid until the trace is flat ± 1 major division.
10. Replace the tape over the **FREQ.** adjustment on U9. If the original tape is misplaced or damaged, masking tape or electrical tape can be used. The tape is needed to prevent air currents from upsetting the thermal stability of the time base hybrid.
11. Allow 10 minutes for U9 to stabilize its temperature, with the tape installed over the **FREQ.** adjustment hole.
12. Change the time base time/div to $1 \mu\text{s/div}$.
13. Adjust the **TB FINE TUNE** (R54) for the flattest trace possible on the screen.

END and 4 ns CAL Adjustments

The time base hybrid operates at 250 MHz which is a 4 ns period. END adjusts the time base ramp's ending point to the next time base ramp's beginning point. The 4 ns CAL adjusts the discontinuity that occurs at 4 ns intervals after 16 ns. The END adjustment must be performed before the 4 ns CAL adjustment. If the End and 4 ns CAL adjustment fails, perform the "Time Base Delta Current Adjustment" in section 3 of the *HP 54120B Mainframe Service Manual*. Also perform the "Range Adjustment" and the "Frequency Adjustment" in this section.

Equipment & Connections

Refer to "Step Recovery Diode Adjustments" in this section.

Equipment Setup

Signal Source

| | |
|-----------|---------|
| Frequency | 250 MHz |
| Amplitude | +12 dBm |

HP 54120B

Display

| | |
|-----------------|----------|
| Display Mode | Averaged |
| No. of Averages | 4 |
| Screen | Single |
| Graticule | Grid |
| Bandwidth | Low |

Time base

| | |
|---------------|------------|
| Time/Div | 500 ps/div |
| Delay | 16 ns |
| Delay Ref. at | Left |
| Sweep | Trg'd |

Channels

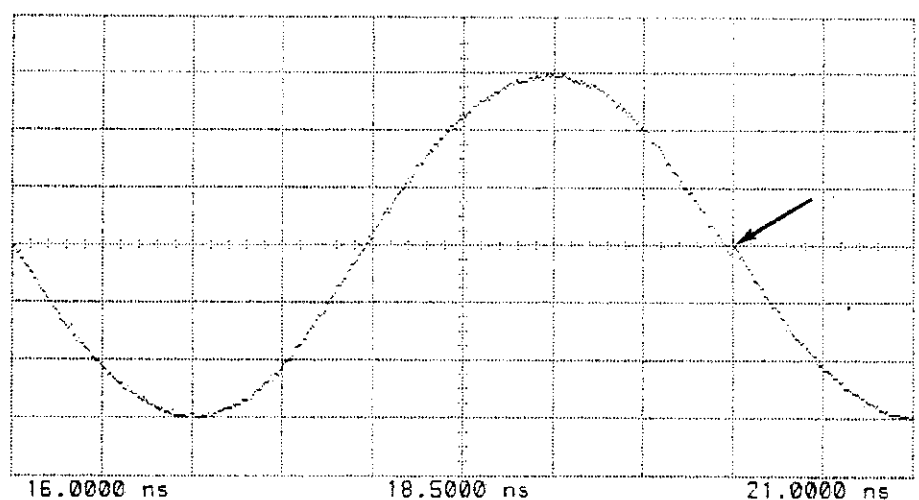
| | |
|--------------|---------------|
| Channel 1 | On |
| Volts/Div | 20 mV/div |
| Offset | Center signal |
| Channels 2-4 | Off |
| Attenuation | 1.0 |

Trigger

| | |
|---------------|-----|
| Trigger Level | 0 V |
| Slope | Pos |
| Attenuation | 1 |
| HF Sens. | Off |
| HF Reject | Off |

Procedure The adjustment locations are shown in figure 4-12 on page 4-30.

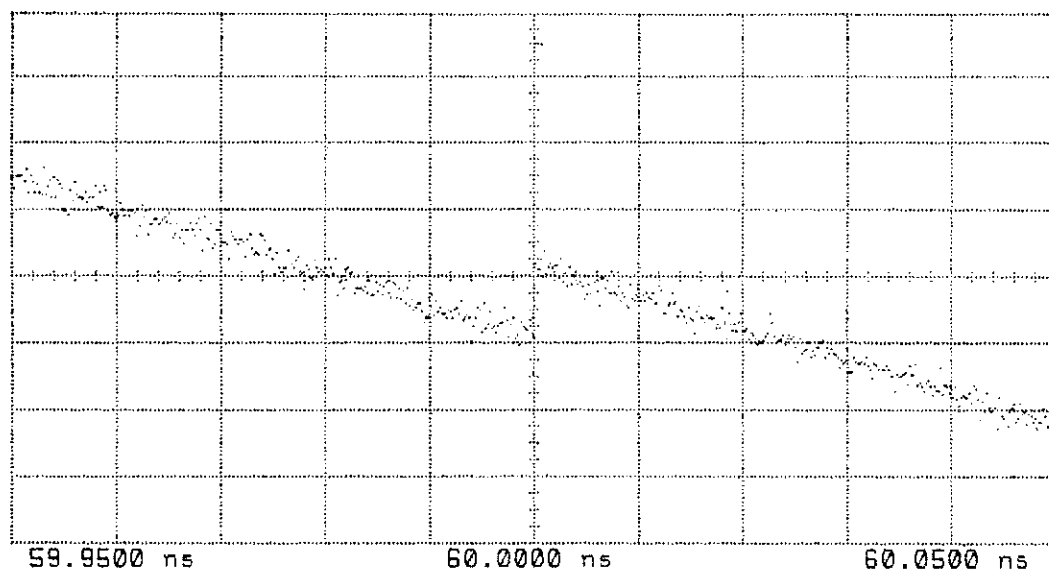
1. Preset the 4 ns CAL (R62) on the horizontal assembly (A1) to fully counterclockwise.
2. Adjust the END (R61) for a small amount of trace discontinuity at beginning of the eighth vertical graticule division. Refer to figure 4-1. If necessary, adjust the trigger level to center the trace discontinuity vertically on the screen. Refer to figure 4-2.
3. Change the time base time/div to 10 ps/div and delay to 59.95 ns.
4. Change the volts/div to 2 mV/div.
5. If necessary, adjust the trigger level to the center trace discontinuity vertically on the screen. Refer to figure 4-2.
6. Readjust the END (R61) to eliminate any trace discontinuity. Refer to figure 4-3.
7. Change the time base delay to 19.95 ns.
8. Adjust the 4 ns cal (R62) on the horizontal assembly from the counterclockwise limit to the first null point (minimum trace discontinuity). Adjusting to the second null point can cause time base errors (the adjustment may be left fully counterclockwise if minimum discontinuity occurs at this point).
9. Change the time base delay to 59.95 ns. If necessary, repeat steps 6 through 8 until the discontinuity at both 19.95 ns and 59.95 ns is minimized.



| | | | |
|----------|--------------------|--------|---------------|
| Ch. 1 | = 20.00 mVolts/div | Offset | = 0.000 Volts |
| Timebase | = 500 ps/div | Delay | = 16.0000 ns |

Trigger on External at Pos. Edge at 370.5 mvolts

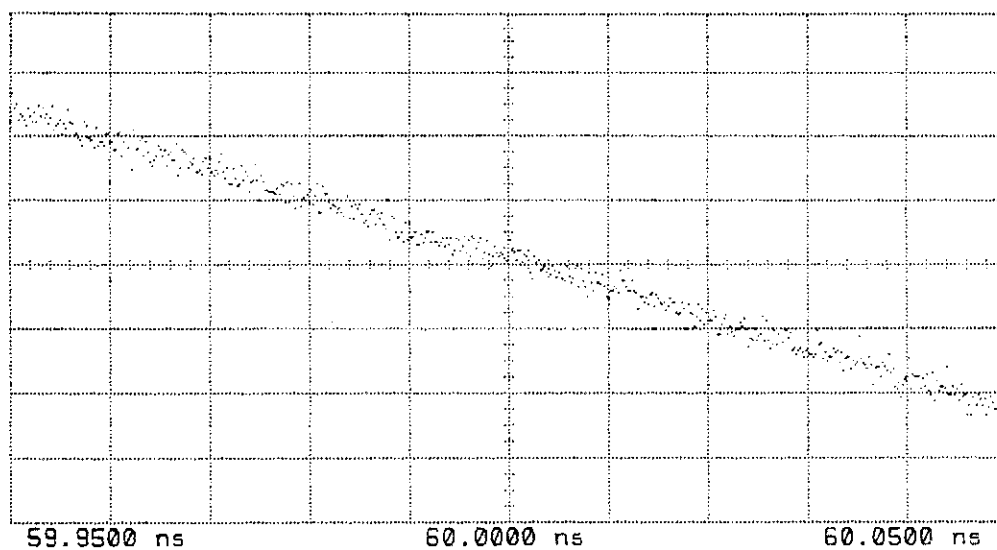
Figure 4-1. Trace Discontinuity at Eighth Graticule



Ch. 1 = 2.000 mVolts/div Offset = -750.0 uVolts
 Timebase = 10.0 ps/div Delay = 59.9500 ns

Trigger on External at Pos. Edge at 31.50 mvolts

Figure 4-2. Expanded Trace Discontinuity



Ch. 1 = 2.000 mVolts/div Offset = -750.0 uVolts
 Timebase = 10.0 ps/div Delay = 59.9500 ns

Trigger on External at Pos. Edge at 31.50 mvolts

Figure 4-3. Correct End Adjustment, No Discontinuity

Sampler Bias Adjustments

This procedure adjusts the bandwidth of individual channels for Low and High bandwidth. If the Sampler Bias adjustment fails, perform the "10 V Reference Adjustment" in section 3 of the *HP 54120B Mainframe Service Manual*, and the SRD bias adjustments in this section.

Equipment & Connections

Refer to step recovery diode adjustments.

Note

If this adjustment is performed out of the normal adjustment sequence, a two key-down powerup must be performed first.

Equipment Setup

| | | | |
|-----------------|----------------------------------|------------------|----------|
| Signal Source | | | |
| Frequency | 250 MHz | | |
| Amplitude | +12 dBm | | |
| HP 54120B | | | |
| Display | | Time base | |
| Display Mode | Averaged | Time/Div | 1 ns/div |
| No. of Averages | 4 | Delay | 16 ns |
| Screen | Single | Delay Ref. at | Left |
| Graticule | Grid | Sweep | Trg'd |
| Bandwidth | Low | | |
| Channels | | Trigger | |
| Channel 1 | On | Trigger Level | 0 V |
| Volts/Div | 20 mV/div (on all 4 channels) | Slope | Pos |
| Offset | Center signal | Attenuation | 1 |
| Channels 2-4 | Off | HF Sens. | Off |
| Attenuation | 1.0 | HF Reject | Off |

Procedure The adjustment locations are shown in figure 4-13 on page 4-30.

1. Preset LB1-LB4 (R153-R156) and HB1-HB4 (R161-R164) fully counterclockwise.
2. Press the **Delta V** key. Turn on the V Markers , then overlay the markers on channel 1.
3. Press the **Preset Levels** key until 0-100% is highlighted.
4. Press the **Auto Level Set** key.
5. Change the Display to 300 ms persistence.
6. Adjust the LB1 (R153) on the vertical assembly (A2) for a signal amplitude of 0% to 100%. Adjustment LB1 is the low bandwidth adjust for channel 1 only. Refer to figure 4-4. If the signal does not line up with the markers, adjust for equal amounts above or below the markers.

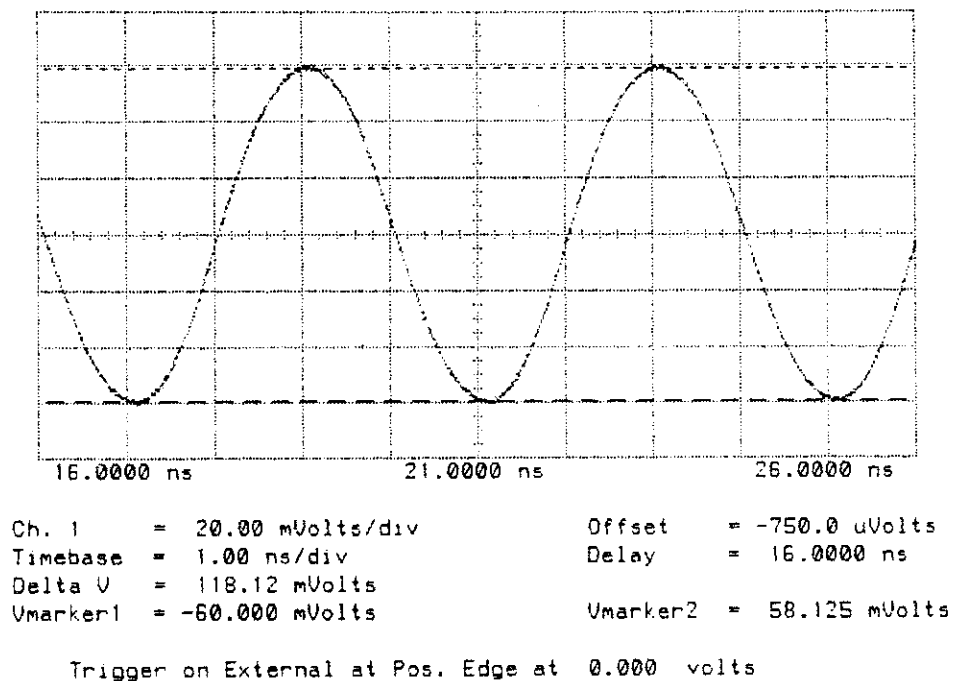


Figure 4-4. Low Bandwidth Adjustment with Markers

7. Change the display to averaged, number of averages to 4, and bandwidth to High.
8. Press the **Delta V** key.
9. Press the **Preset Levels** key until **Variable** is highlighted.
10. Press the **Variable** key, then set the levels to **25%–75%**.
11. Press the **Auto Level Set** key.
12. Change the display to 300 ms persistence.
13. Adjust the HB1 (R161) until the signal amplitude overlays the 25% and 75% markers. Refer to figure 4-5. Adjustment HB1 is the high bandwidth adjustment for channel 1 only.
14. Turn channel 1 off and channel 2 on. Change the bandwidth to Low and the display to averaged.
15. Move the input signal from channel 1 to channel 2.
16. Repeat steps 2-13 for channel 2, except use adjustments LB2 (R154) and HB2 (R162).
17. Turn channel 2 off and channel 3 on. Change the bandwidth to Low and the display to averaged.

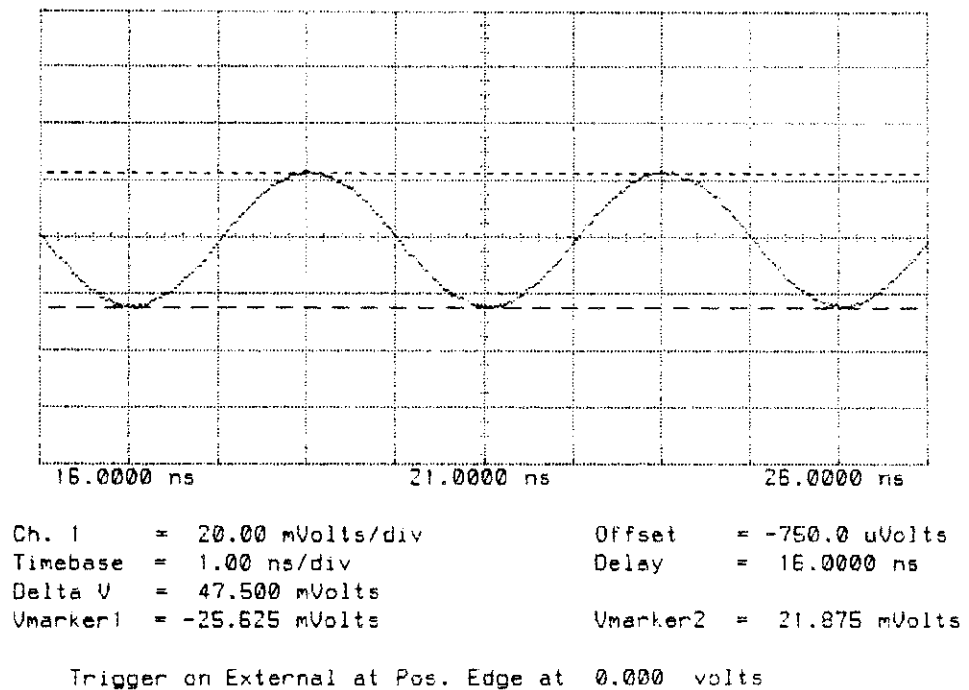


Figure 4-5. High Bandwidth Adjustment with Markers

18. Move the input signal from channel 2 to channel 3. The 2.4 mm inputs of channels 3 and 4 require the use of a different adapter. See the "Equipment Connections" on page 4-4.
19. Repeat steps 2-13 for channel 3, except use adjustments LB3 (R155) and HB3 (R163).
20. Turn channel 3 off and channel 4 on. Change the bandwidth to Low and display to averaged.
21. Move the input signal from channel 3 to channel 4.
22. Repeat steps 2-13 for channel 4, except use adjustments LB4 (R156) and HB4 (R164).
23. Turn the V Markers off.
24. Press the **Utility** key.
25. Press the **Cal Menu** key.
26. Press the **Vertical Cal** key, then follow the instructions displayed on the screen.

Offset Gain Adjustments

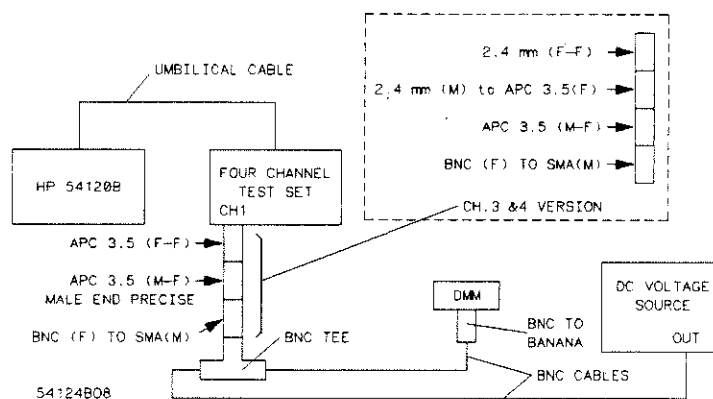
With the oscilloscope set to the same offset value as a dc voltage source, the OFFSET GAIN for each channel is adjusted until the trace overlays center screen.

Equipment

This is a list of the recommended test equipment for this adjustment. However, you may use any instrument that satisfies the critical specifications.

| Equipment | Critical Specifications | Model/Part |
|----------------|---|--------------|
| Voltage source | 1 mV resolution, less than 100 mV ripple | HP 3325A/001 |
| DMM | 10 mV accuracy | HP 3478A |
| Adapter | BNC (f) to SMA (m), (Adapts dc voltage source to APC 3.5) | HP 1250-1200 |
| Adapter | BNC to banana | HP 1250-2277 |
| Adapter | 2.4 mm (m) to APC 3.5 (f) | HP 11901C |
| BNC Tee | 1 (m) end and 2 (f) ends | HP 1250-0781 |
| BNC cables | Qty - 2 | HP 10503A |

Equipment Connections



Equipment Setup

HP 54120B

Display

| | |
|-----------------|----------|
| Display Mode | Averaged |
| No. of Averages | 8 |
| Screen | Single |
| Graticule | Grid |
| Bandwidth | Low |

Channels

| | |
|--------------|----------|
| Channel 1 | On |
| Volts/Div | 1 mV/div |
| Offset | 0 V |
| Channels 2-4 | Off |
| Attenuation | 1.0 |

Time base

| | |
|---------------|---------------|
| Time/Div | 1 μ s/div |
| Delay | 200 ns |
| Delay Ref. at | Left |
| Sweep | Freerun |
| Freerun Rate | 10 KHz |

Network

| | |
|-------------------|---------|
| Reflect/Trans/Cal | Reflect |
| Step& Chan 1 | Off |

Procedure

The adjustment locations are shown in figure 4-13 on page 4-30.



Caution

Exceeding 2 V on the dc power supply may damage the oscilloscope inputs.

1. Disconnect all input signals from the oscilloscope, then perform a vertical calibration routine. Press the **Utility** menu key, **Cal Menu** key, **Channel Vertical Cal** key, then follow the instructions displayed on the screen.
2. Set the dc voltage source to 490 mV into 50 Ω .
3. Connect the voltage source to channel 1.
4. Read the output of the dc voltage source on the DMM to a 100 μ V accuracy.
5. Change the offset to within 100 μ V of the reading obtained on DMM.
6. Adjust OG1 (R113) on the vertical assembly (A2) until the trace is at the center graticule. Adjustment OG1 is the Offset Gain adjustment for channel 1 only. Adjust OG1 slowly in small increments, then wait for the averages to accumulate.
7. Turn channel 1 off and channel 2 on, then move the input to channel 2.
8. Repeat steps 4-6 for channel 2, except adjust OG2 (R114).
9. Turn channel 2 off and channel 3 on, then move the input to channel 3. Notice that the HP 11901C adapter is required for channel 3.
10. Repeat steps 4-6 for channel 3, except adjust OG3 (R115).
11. Turn channel 3 off and channel 4 on, then move the input to channel 4. Notice that the HP 11901C adapter is required for channel 4.
12. Repeat steps 4-6 for channel 4, except adjust OG4 (R116).
13. Press the **Utility** key.
14. Press the **Cal Menu** key.
15. Press the **Vertical Cal** key, then follow the instructions displayed on the screen.

TDR Step Adjustments

This procedure adjusts the TDR pulse for a rise time of about 45 ps, an overshoot between 2.5% to 3.5% in the average display mode, and a flat pulse top.

The final value in this procedure is adjusted so that when a 50.0 Ω termination is connected to channel 1, the final value will measure 200 mV. The first part of this procedure measures the actual dc resistance of the 50 Ω termination you are using. A compensation value is then added to 200 mV so you are performing the adjustment to the actual dc resistance of your 50 Ω termination.

Equipment

This is a list of the recommended test equipment for this adjustment. However, you may use any instrument that satisfies the critical specifications.

| Equipment | Critical Specifications | Model |
|---------------|--------------------------|--------------|
| Termination | APC 3.5 (f), 50 Ω | HP 909D/011 |
| DMM | 5 – 1/2 digits | HP 3478A |
| Adapter | BNC (m-m) | HP 1250-0216 |
| Adapter | BNC (f) to banana | HP 1250-2277 |
| Adapter | BNC (f) to SMA (m) | HP 1250-1200 |
| Adapter | APC 3.5 (m-f) | HP 1250-1866 |
| Coaxial short | APC 3.5 (f) | HP 1250-2127 |

Equipment Setup

HP 54120B

Display

| | |
|-----------------|----------|
| Display Mode | Averaged |
| No. of Averages | 16 |
| Screen | Single |
| Graticule | Frame |
| Bandwidth | Low |

Channels

| | |
|--------------|-----------|
| Channel 1 | On |
| Volts/Div | 30 mV/div |
| Offset | 100 mV |
| Channels 2-4 | Off |
| Attenuation | 1 |

Time base

| | |
|--------------|------------|
| Time/Div | 200 ps/div |
| Delay | 16 ns |
| Delay Ref at | Left |
| Sweep | Freerun |
| Freerun Rate | 10 KHz |

Network

| | |
|-------------------|---------|
| Reflect/Trans/CAL | Reflect |
| Step & Chan 1 | On |



Note

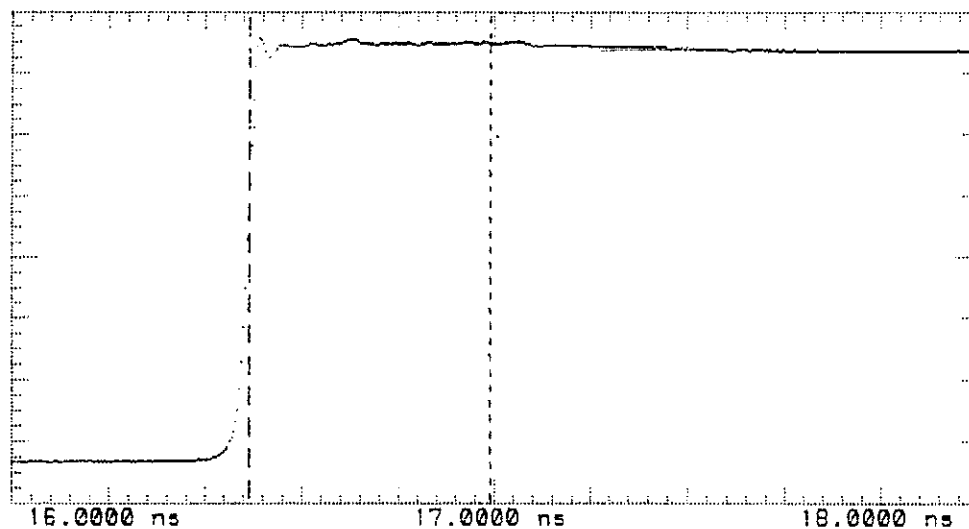
Repeatedly pressing the Clear Display key will help in performing the adjustments.

Procedure

The adjustment locations are shown in figure 4-12 on page 4-30.

1. Assemble a fixture by connecting a banana to BNC (f) adapter to a BNC (m-m) adapter. Connect this to a BNC (f) to SMA (m) adapter. Connect this to an APC 3.5 (m-f) adapter (male end precise). Connect the fixture to the DMM. Connect an APC 3.5 (f) precise $50\ \Omega$ termination to the fixture.
Record dc resistance of $50\ \Omega$ termination here _____ Ω Example $50.390\ \Omega$
2. Remove $50\ \Omega$ termination, then connect the APC 3.5 (f) short to fixture.
Record dc resistance of fixture here _____ Ω Example $0.050\ \Omega$
3. Subtract the fixture resistance (step 2) from the termination resistance (step 1).
Step 1 _____ Ω - Step 2 _____ Ω = Z_L _____ Ω Example $50.340\ \Omega$
4. Solve for E_R using the formula for E_R (E_R may be a negative number).
$$E_R = 200 ((Z_L - 50) \div (Z_L + 50))$$
 (round to nearest $0.01\ \text{mV}$)
Example $0.68\ \text{mV}$
5. Add $200\ \text{mV}$ to the value obtained in step 4, then round to the nearest $0.01\ \text{mV}$.
 E_R (step 4) _____ $+ 200\ \text{mV} =$ _____ mV Example $200.68\ \text{mV}$

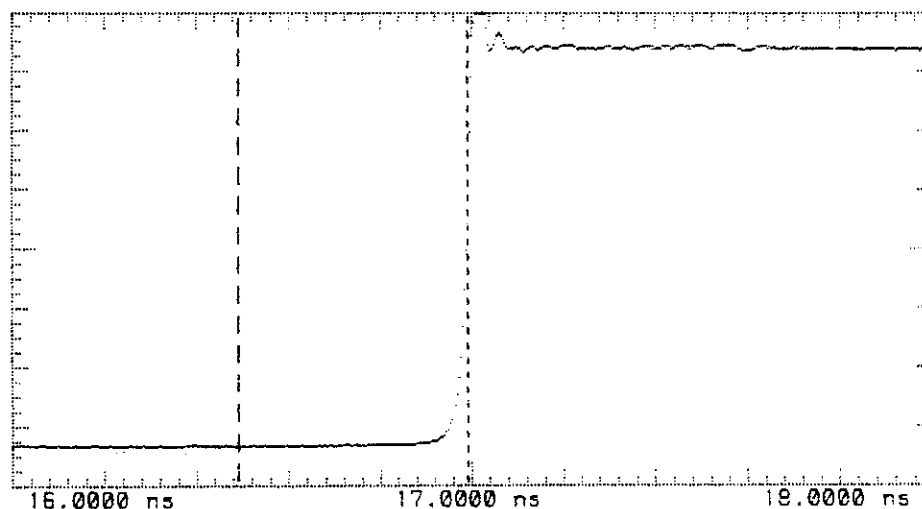
6. Connect the APC 3.5 precise (f) 50 Ω termination to channel 1.
7. Adjust the time base delay until the rising edge is approximately two divisions from the left side of the screen. Refer to figure 4-6.
8. Preset the TDR DRIVE (R44) on the horizontal assembly (A1) fully clockwise. Reposition the delay setting to place the edge two divisions from the left side of the screen.
9. Preset the TDR BIAS (R45) fully counterclockwise, then slowly adjust the TDR BIAS clockwise until the pulse overshoot just starts to appear (first overshoot). Refer figure 4-6. If the overshoot is already on the screen with the TDR BIAS fully counterclockwise, turn the TDR DRIVE slightly counterclockwise until the overshoot disappears. Then increase the TDR BIAS clockwise until the overshoot reappears.
10. Press the **Delta T** key, then turn on the markers.
11. Set the start marker to the leading edge of the step, then set the stop marker 500 ps to right of start marker. Refer to figure 4-6.
12. Adjust the TDR BIAS until the rising edge of the step coincides with the stop marker. Refer to figure 4-7. If this adjustment does not line up with the stop marker, return to step 9 and turn the TDR DRIVE slightly counterclockwise.
13. Adjust the TDR DRIVE so that the pulse overshoot is between 2.5% to 3.5%, use the measure menu to check your adjustment. If the TDR DRIVE adjustment moves the edge off the screen, reposition the edge with more delay in the time base menu.
14. Select the Delta V menu, then press the **Preset Levels** key until 50-50% is highlighted. Press the **Auto Level Set** key.
15. Select the Delta T menu, then press the **START ON EDGE** key until **POS 1** is highlighted. Press the **STOP ON EDGE** key until **POS 1** is highlighted. Press the **Precise Edge Find** key.
16. Turn channel 1 off, then turn channel 1 back on again. Change the channel 1 sensitivity to 2 mV/div and offset to 0 V.



| | | | |
|----------|--------------------|--------|----------------|
| Ch. 1 | = 30.00 mVolts/div | Offset | = 100.0 mVolts |
| Timebase | = 200 ps/div | Delay | = 16.0000 ns |
| Delta T | = 500.0 ps | | |
| Start | = 16.4920 ns | Stop | = 16.9920 ns |

Trigger on External with Pos. Edge at 1.000 volts

Figure 4-6. Setting Start and Stop Markers on Pulse

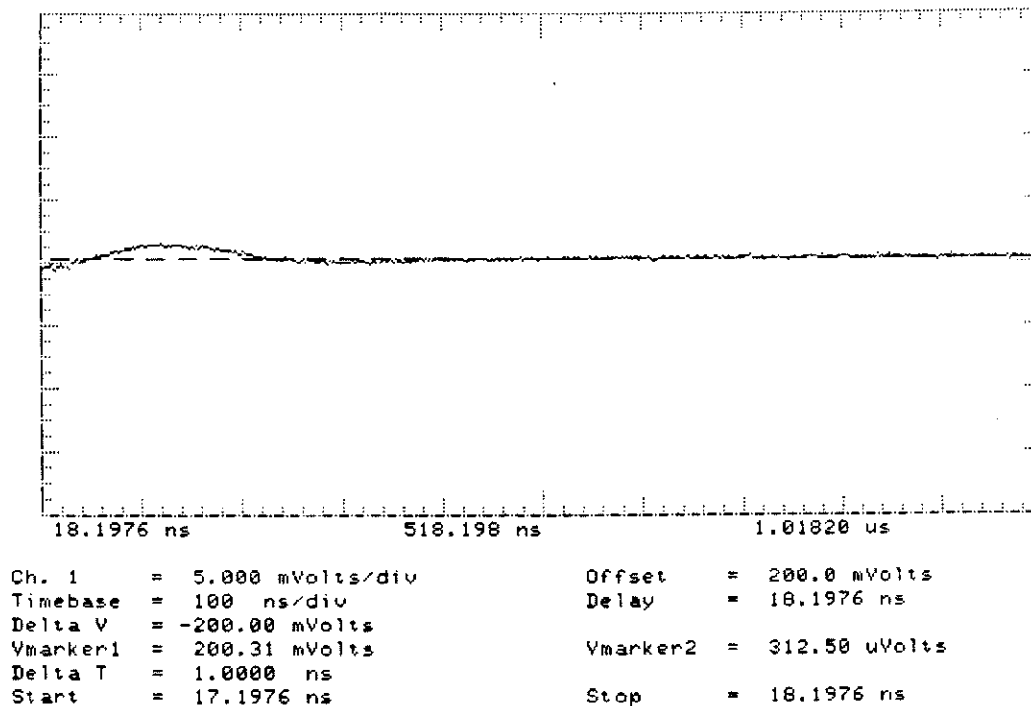


| | | | |
|----------|--------------------|--------|----------------|
| Ch. 1 | = 30.00 mVolts/div | Offset | = 100.0 mVolts |
| Timebase | = 200 ps/div | Delay | = 16.0000 ns |
| Delta T | = 500.0 ps | | |
| Start | = 16.4920 ns | Stop | = 16.9920 ns |

Trigger on External with Pos. Edge at 1.000 volts

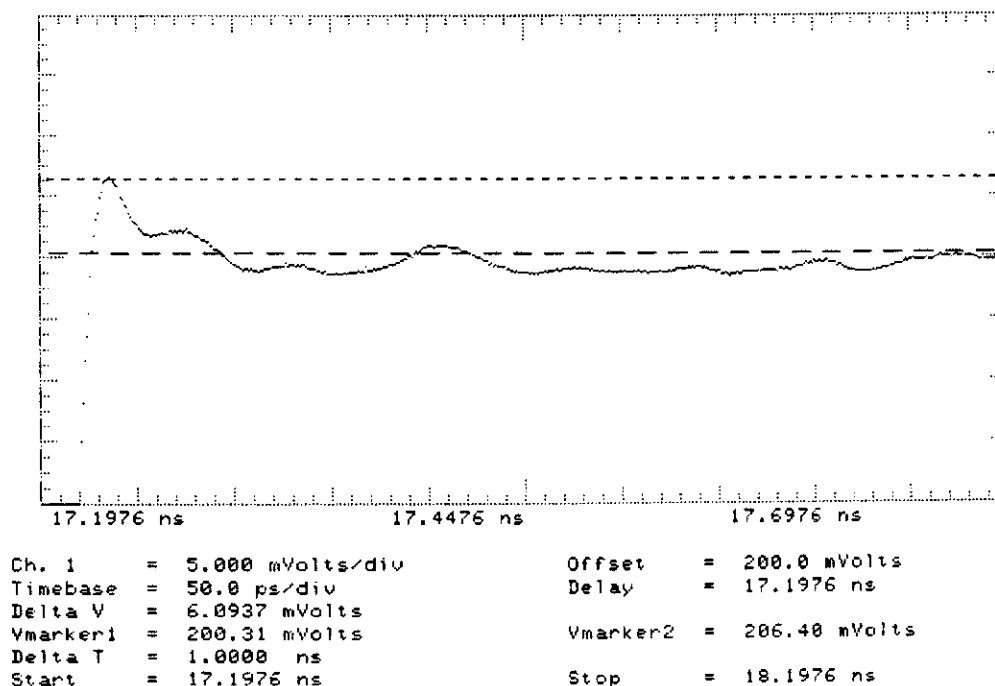
Figure 4-7. Adjusting TDR Pulse to Stop Marker

17. Select the Delta V menu, then press the **Preset Level** key until **50-50%** is highlighted. Press the **Auto Level Set** key. If $V(1) > 0.5$ mV, perform a vertical calibration. Change the marker-2 value to 200 mV. Adjust the front panel RPG control until the Delta V value equals the value recorded in step 5 from the previous page (marker resolution limits this to within 0.06 mV at this sensitivity setting).
18. Select the Network menu, then press the **Reflect/Trans/Cal** key until **Reflect** is highlighted. Press the **Step & Chan 1** key until **On** is highlighted.
19. Select the Delta T menu, then change the stop-marker value to the start-marker value plus 1 ns.
20. Change the time base sweep speed to 100 ns/div, delay to stop-marker value, and channel 1 offset to 200 mV.
21. Select the Delta V menu. Make sure that the marker-2 position is highlighted.
22. Adjust the TOP (R169) on the horizontal assembly (A1) until the trace on right edge of the screen coincides with the marker-2 position. Refer to figure 4-8.
23. Change the time base sweep speed to 50 ps/div, delay to 16 ns, and channel 1 offset to 0 V.
24. Select the Delta V menu. Make sure that the marker-1 position is highlighted.
25. Adjust the BOTTOM (R170) on the horizontal assembly (A1) until the trace coincides with the marker-1 position.
26. Change time base delay to the start-marker value, and channel 1 offset to 200 mV.
27. Select the Delta V menu. Change the marker-1 value equal to the value obtained in step 5 on the previous page. Press the **MARKER 2** key until that cursor is highlighted. Adjust the front panel RPG control for a Delta V reading of between 5 mV to 7 mV (this will correspond to an overshoot of about 2.5% to 3.5%).
28. Slowly adjust the TDR DRIVE (R44) on the horizontal assembly (A1) until the peak of the overshoot coincides with the marker-2 position. Refer to figure 4-9. If the overshoot moves off the screen, reposition the waveform with the delay. If this adjustment fails, repeat the TOP and BOTTOM adjustments.



Trigger is Freerunning at 10.0 kHz with Step on

Figure 4-8. TOP Adjustment



Trigger is Freerunning at 10.0 kHz with Step on

Figure 4-9. Overshoot Fine Adjustment

Feedthrough Compensation Adjustments

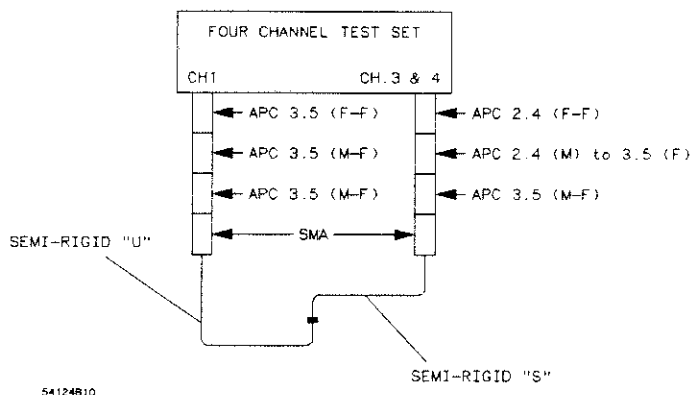
When the sampler's are turned off, there is a small amount of parasitic (unwanted) feedthrough of signals or noise through the samplers. This is caused by parasitic capacitive and resistive coupling near the samplers. This procedure nulls passive feedthrough of the input signal through the samplers.

Equipment

This is a list of the recommended test equipment for this adjustment. However, you may use any instrument that satisfies the critical specifications.

| Equipment | Critical Specifications | Model |
|-----------|---------------------------|--------------|
| U cable | Semi-rigid | 54121-61601 |
| S cable | Semi-rigid | 54121-61602 |
| Adapter | APC 3.5 (m-f), Qty - 3 | HP 1250-1866 |
| Adapter | 2.4 mm (m) to APC 3.5 (f) | HP 11901C |

Equipment Connections



Equipment Setup

HP 54120B

Display

Display Mode Persistence
Display Time 500 ms
Screen Single
Graticule Grid
Bandwidth Low

Time base

Time/Div 20 μ s/div
Delay 16 ns
Delay Ref at Left
Sweep Freerun
Freerun Rate 3 KHz

Channels

Channel 1 On
Volts/Div 10 mV/div (all 4 channels)
Offset 200 mV
Channels 2-4 Off
Attenuation 1

Network

Reflect/Trans/CAL Reflect
Step & Chan 1 On

Procedure The adjustment locations are shown in figure 4-13 on page 4-30.

1. Connect the semi-rigid S and U cables from channel 1 to channel 2. Place an APC 3.5 (m-f) adapter at each end.
2. Preset the eight adjustments on the vertical assembly (A2) RC1-RC4 (R5-R8) and CC1-CC4 (R9-R12) fully counterclockwise.
3. The signal on the screen should resemble figure 4-10.

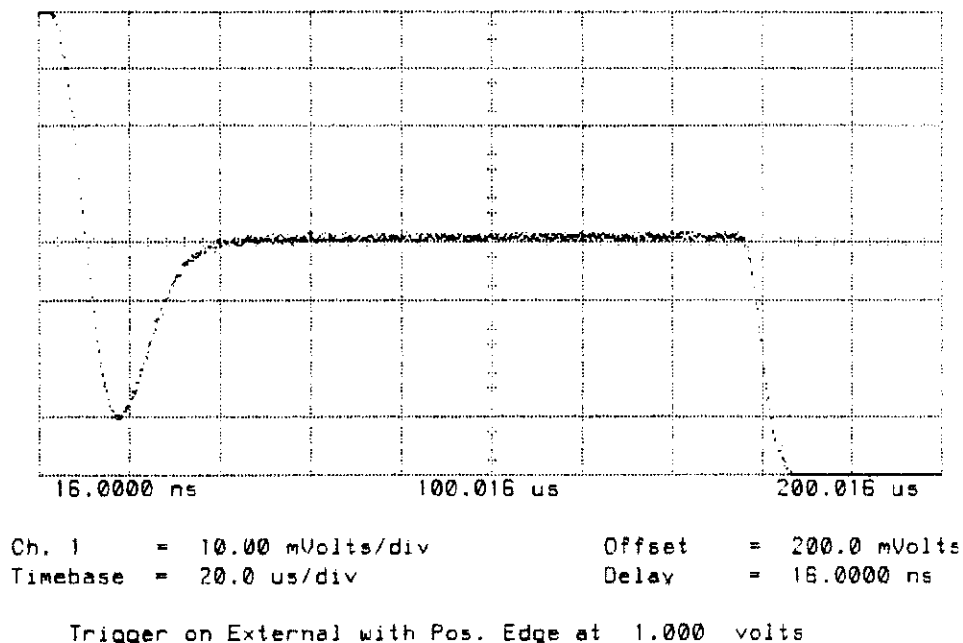
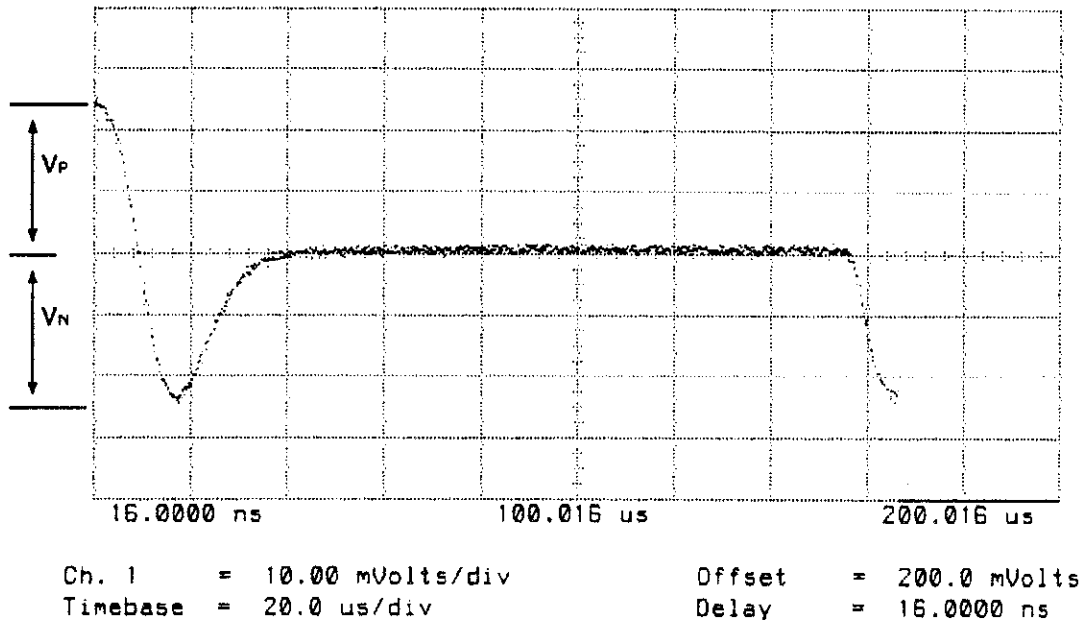


Figure 4-10. Feedthrough Not Compensated

4. Adjust RC1 (R5) until the positive and negative pulse peaks are equidistant from the flat portion of the pulse, $V_P = V_N$. The Delta V markers may help you determine when the pulse peaks are equidistant. Refer to figure 4-11.



Trigger on External with Pos. Edge at 1.000 volts

Figure 4-11. Adjusting RC1 for Equidistant Pulse Peaks.

5. Adjust CC1 (R9) until the positive and negative pulse peaks are the lowest in amplitude. Re-adjust RC1 and CC1 until the pulse top is as flat as possible.
6. Change channel 1 to 1 mV/div and offset to 300 mV (do not turn channel 1 off). Turn channel 2 on.
7. Repeat steps 4-5, except use adjustments RC2 (R6) and CC2 (R10).
8. Turn channel 2 off and channel 3 on. Move the semi-rigid cables from channel 2 to channel 3. Two additional adapters are required. See the "Equipment Connections" on page 4-24.
9. Repeat steps 4-5, except use adjustments RC3 (R7) and CC3 (R11).
10. Turn channel 3 off and channel 4 on. Move the semi-rigid cables from channel 3 to channel 4.
11. Repeat steps 4-5 except use adjustments RC4 (R8) and CC4 (R12). Remove the semi-rigid cables from the oscilloscope.

Trigger Adjustments

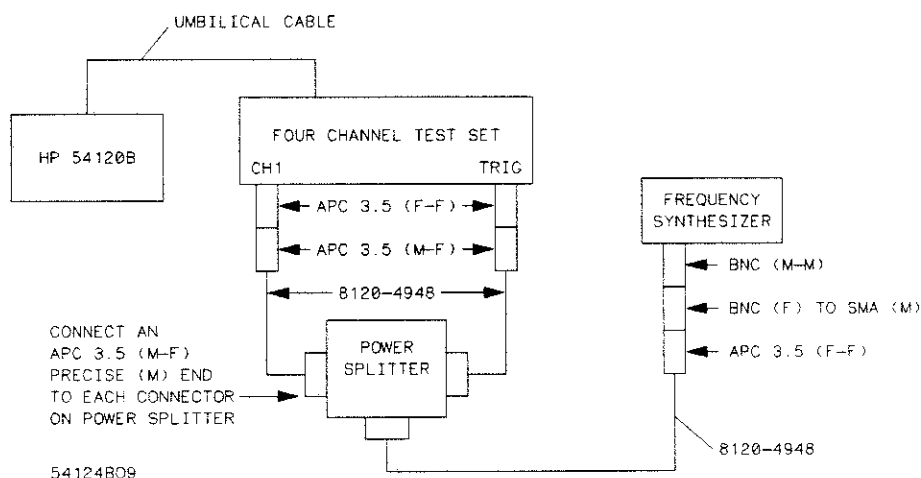
HYSTERESIS and OFFSET are adjusted by observing the voltage level where the displayed waveform crosses the time reference, which is set to the screen's left side.

Equipment

This is a list of the recommended test equipment for this adjustment. However, you may use any instrument that satisfies the critical specifications.

| Equipment | Critical Specifications | Model |
|-----------------------|---------------------------------|--------------|
| Power divider | > 10 GHz Bandwidth | HP 11667B |
| Frequency Synthesizer | 100 kHz at 100 mV p-p amplitude | HP 3325A/B |
| Adapter | BNC (f) to SMA (m) | HP 1250-1200 |
| Adapter | APC 3.5 (m-f), Qty – 5 | HP 1250-1866 |
| Adapter | APC 3.5 (f-f) | HP 1250-1865 |
| Adapter | BNC (m-m) | HP 1250-0216 |
| Coaxial cable | APC 3.5 (m-m), 18 GHz, Qty – 3 | HP 8120-4948 |

Equipment Connections



| | | | |
|------------------------|----------------------|------------|------------------------|
| Equipment Setup | Signal Source | | |
| | Function | Sine Wave | |
| | Frequency | 100 kHz | |
| | Amplitude | 100 mV p-p | |
| | HP 54120B | | |
| | Display | | Time base |
| | Display Mode | Averaged | Time/Div 1 μ s/div |
| | No. of Averages | 4 | Delay 16 ns |
| | Screen | Single | Delay Ref at Left |
| | Graticule | Grid | Sweep Trg'd |
| | Bandwidth | Low | |
| | Channels | | Trigger |
| | Channel 1 | On | Trigger Level 0 V |
| | Volts/Div | 10 mV/div | HF Sens. Off |
| | Offset | 0 mV | HF Reject Off |
| | Channels 2-4 | Off | Attenuation 1 |
| | Attenuation | 1 | |
| | Network | | |
| | Reflect/Trans/CAL | Reflect | |
| | Step & Chan 1 | Off | |

Procedure The adjustment locations are shown in figure 4-13 on page 4-30.

1. Connect the signal generator to the oscilloscope.
2. There should be one period of a 100 kHz sine wave with an amplitude of about 50 mV p-p. If not, adjust HYST (R4) fully counterclockwise, then adjust the OFFSET (R47) to center the starting point on the left side of the screen.
3. While switching the trigger slope between positive and negative, adjust the trigger hysteresis (R48 HYST) on the horizontal assembly (A1) until there is 15 mV (six minor divisions or 1.5 major divisions) between the starting point for the positive slope vs the starting point for the negative slope at the left side of the screen.
4. Continue switching the slope between positive and negative as you adjust the OFFSET NULL (R47) until the starting point of the sine wave is centered vertically around the center of the screen.

Channel Skew Calibration

The channel skew calibration is an operator's calibration. It is recommended that the operator do a channel skew calibration using the signals and cables similar to those with that are used with the oscilloscope.

Equipment & Connections

Refer to step recovery diode adjustments.

Equipment Setup

| | | | |
|-------------------|----------|------------------|-----------|
| Signal Source | | | |
| Frequency | 250 MHz | | |
| Amplitude | +12 dBm | | |
| HP 54120B | | | |
| Channels | | Time base | |
| Channels | 1-4 | Time/Div | 20 ps/div |
| Display | On | Delay | 19.9 ns |
| Volts/Div | 2 mV/div | Delay Ref at | Left |
| Offset | 0 V | Sweep | Trg'd |
| Attenuation | 1 | | |
| Trigger | | Display | |
| Trigger Level | 0 V | Display Mode | Averaged |
| Slope | Pos | No. of Averages | 64 |
| Network | | | |
| Reflect/Trans/Cal | Reflect | | |
| Step & Chan. 1 | Off | | |

Procedure

1. Press the **Utility** key. Press the **Cal Menu** key.
2. Press the **Channel Skew Cals** key. Verify that "Channel Skew Chan 1" is highlighted.
3. Adjust the channel skew with the **RPG** knob or arrow keys to align the 0 V crossing of the trace at the center of the screen.
4. Move the input to the next channel, then press the **Channel Skew** key until the number of the next channel is highlighted. Channels 3 and 4 are a 2.4 mm input. This requires the use of a 2.4 mm (m) to APC 3.5 (f) adapter.
5. Repeat steps 5 and 6 until all channels have been skewed.
6. Press the **Exit Cal Menu** key.

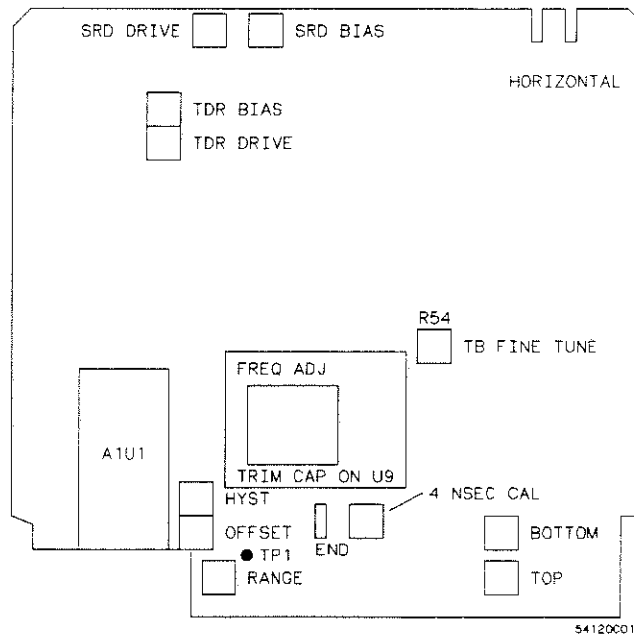


Figure 4-12. Horizontal Assembly (A1) Adjustments

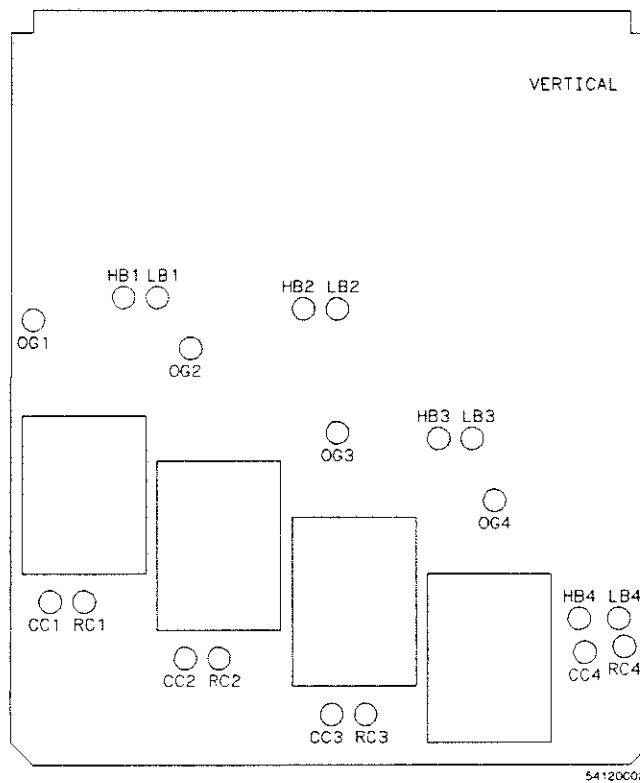


Figure 4-13. Vertical Assembly (A2) Adjustments

Replacable Part

Table Of Contents

Replaceable Parts

| | |
|------------------------------------|-----|
| Introduction | 5-1 |
| Abbreviations | 5-1 |
| Replaceable Parts List | 5-1 |
| Exchange Assemblies | 5-1 |
| Ordering Information | 5-2 |
| Direct Mail Order System | 5-2 |
| Replaceable Parts List | 5-9 |

Introduction

This section contains information for ordering parts. Service support for this instrument is to the assembly level. The replaceable parts include assemblies and chassis parts. Figure 5-1 shows an assembled view of the instrument.

Abbreviations

Table 5-1 lists the abbreviations used in the parts list and throughout this manual. Abbreviations in the replaceable parts list are in capital letters. In other sections of this manual, abbreviations may be in uppercase or lowercase letters.

Replaceable Parts List

Table 5-2 lists the replaceable parts and is organized as follows:

1. Electrical assemblies in alphanumerical order by reference designation.
2. Chassis-mounted parts in alphanumerical order by reference designation.

Information given for each part consists of the following:

- Reference designation.
 - HP part number.
 - Part number Check Digit (CD).
 - Total quantity (Qty) in the instrument or on the assembly. The total quantity is given once at the first appearance of the part number in the list.
 - Description of the part.
 - Typical manufacturer of the part in a five digit code. All the parts in this list (except hardware) is manufactured by or for Hewlett-Packard, the manufactures code is 28480.
-

Exchange Assemblies

Some of the assemblies used in this instrument have been set up on the exchange program. This allows the customer to exchange his faulty assembly with one that has been repaired, calibrated, and performance verified by the factory. The cost is significantly less than that of a new assembly. The exchange assemblies have a part number in the form XXXXX-695XX.

After receiving the repaired exchange assembly from Hewlett-Packard, a United States customer has 30 days to return the faulty assembly. For orders not originating in the United States, contact the local HP service organization. If the faulty assembly is not returned within the warranty time limit, the customer will be charged an additional amount. The additional amount will be the difference in price between a new assembly and that of an exchange assembly.

Ordering Information

To order a replaceable part, indicate the HP part number, check digit, and quantity required. Send the order to the nearest HP Sales and Service office.

To order a part that is not listed in the replaceable parts table, include the instrument model number, serial number, description and function of part, and total quantity required. Address an order to the nearest HP Sales/Service office.

Direct Mail Order System

Within the USA, Hewlett-Packard can supply parts through a direct mail order system. Advantages of using this system are as follows:

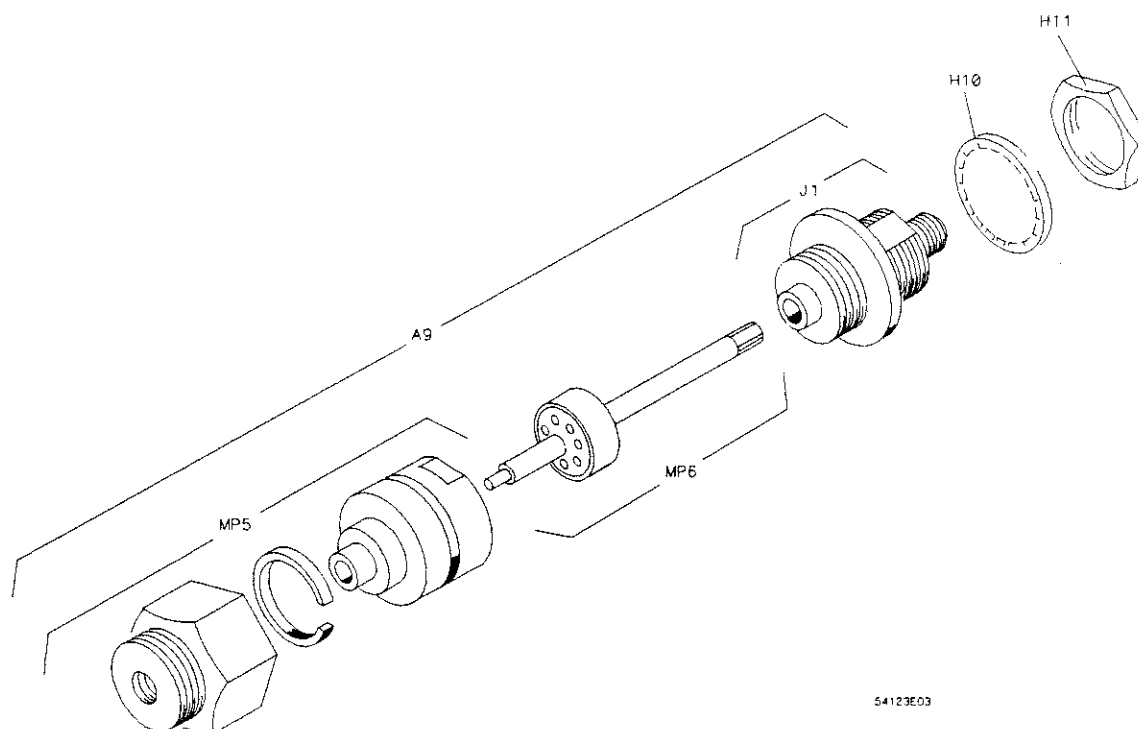
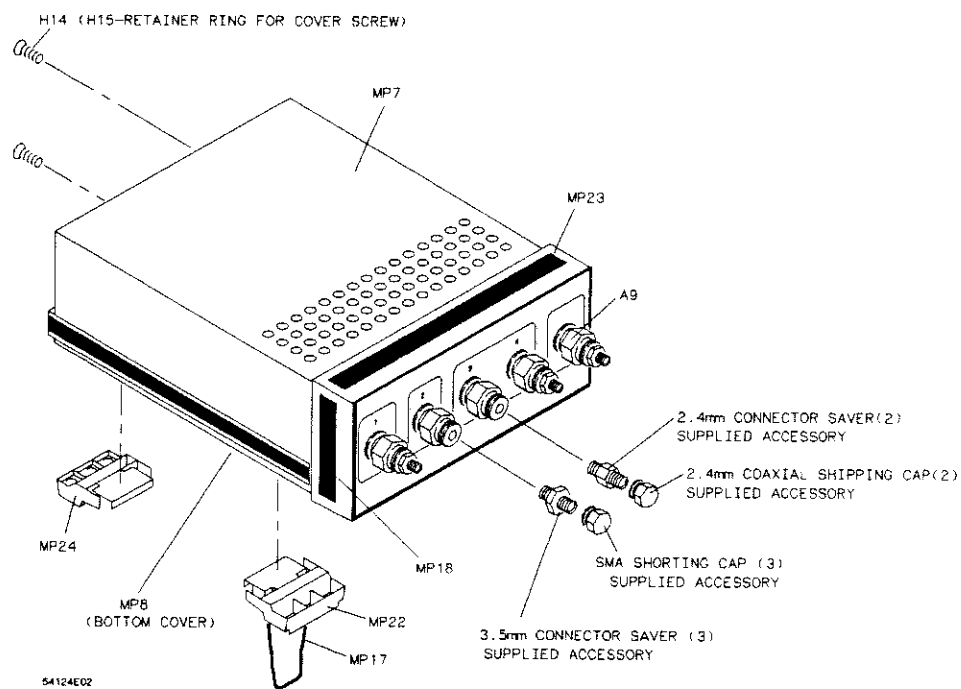
- Direct ordering and shipment from HP Parts Center, California, U.S.A. Call your local Hewlett-Packard office for the toll free number.
- No maximum or minimum on any mail order (there is a minimum order amount for parts ordered through local HP offices when orders require billing and invoicing).
- Prepaid transportation (there is a small handling charge for each order).
- No invoices.

To provide these advantages, check or money order must accompany each order. Mail order forms and specific ordering information are available through your local HP offices.

Table 5-1. Reference Designators and Abbreviations

| REFERENCE DESIGNATOR | | | |
|---------------------------------------|---|---------------------------------------|---|
| A = assembly | F = fuse | Q = transistor; SCR; triode thyristor | V = electron tube; glow lamp |
| B = fan; motor | FL = filter | R = resistor | VR = voltage regulator; breakdown diode |
| BT = battery | H = hardware | RT = thermistor | W = cable |
| C = capacitor | J = electrical connector (stationary portion); jack | S = switch; jumper | X = socket |
| CR = diode; diode thyristor; varactor | L = coil; inductor | T = transformer | Y = crystal unit (piezo-electric or quartz) |
| DL = delay line | MP = misc. mechanical part | TB = terminal board | |
| DS = annunciator; lamp; LED | P = electrical connector (moveable portion); plug | TP = test point | |
| E = misc. electrical part | | U = integrated circuit; microcircuit | |

| ABBREVIATIONS | | | |
|--|--|--|---|
| A = amperes | ECL = emitter coupled logic | MISC = miscellaneous | S = Schottky-clamped; seconds(time) |
| A/D = analog-to-digital | ELAS = elastomeric | MLD = molded | SCR = screw; silicon controlled rectifier |
| AC = alternating current | EXT = external | MM = millimeter | SEC = second(time); secondary |
| ADJ = adjust(ment) | F = farads; metal film (resistor) | MO = metal oxide | SEG = segment |
| AL = aluminum | FC = carbon film/ composition | MTG = mounting | SEL = selector |
| AMPL = amplifier | FD = feed | MUX = multiplexer | SGL = single |
| ANLG = analog | FEM = female | MW = milliwatt | SHF = shift |
| ANSI = American National Standards Institute | FF = flip-flop | N = nano(10^{-9}) | SI = silicon |
| ASSY = assembly | FL = flat | NC = no connection | SIP = single in-line package |
| ASTIG = astigmatism | FM = foam; from | NMOS = n-channel metal-oxide-semiconductor | SKT = skirt |
| ASYNCHRO = asynchronous | FR = front | NPN = negative-positive-negative | SL = slide |
| ATTEN = attenuator | FT = gain bandwidth product | NPRN = neoprene | SLDR = solder |
| AWG = American wire gauge | FW = full wave | NRFR = not recommended for field replacement | SLT = slot(ted) |
| BAL = balance | FXD = fixed | NSR = not separately replaceable | SOLD = solenoid |
| BCD = binary-code decimal | GEN = generator | NUM = numeric | SPCL = special |
| BD = board | GND = ground(ed) | OBD = order by description | SQ = square |
| BFR = buffer | GP = general purpose | OCTL = octal | SREG = shift register |
| BIN = binary | GRAT = graticule | OD = outside diameter | SRQ = service request |
| BRDG = bridge | GRV = groove | OP AMP = operational amplifier | STAT = static |
| BSHG = bushing | H = henries; high | OSC = oscillator | STD = standard |
| BW = bandwidth | HD = hardware | P = plastic | SYNCHRO = synchronous |
| C = ceramic; cermet (resistor) | HDND = hardened | P/O = part of | TA = tantalum |
| CAL = calibrate; calibration | HG = mercury | PC = printed circuit | TBAX = tube axial |
| CC = carbon composition | HGT = height | PCB = printed circuit board | TC = temperature coefficient |
| CCW = counterclockwise | HLC = helical | PD = power dissipation | TD = time delay |
| CER = ceramic | HLCCL = horizontal | PF = picofarads (10^{-12}) | THD = thread(ed) |
| CFM = cubic feet/minute | HP = Hewlett-Packard | PI = plug in | THK = thick |
| CH = choke | HP-IB = Hewlett-Packard Interface Bus | PL = plate(d) | THRU = through |
| CHAM = chamfered | HR = hour(s) | PLA = programmable logic array | TP = test point |
| CHAN = channel | HV = high voltage | PLST = plastic | TPG = tapping |
| CHAR = character | HZ = Hertz | PNP = positive-negative-positive | TPL = triple |
| CM = centimeter | I/O = input/output | POLYE = polyester | TRANS = transformer |
| CMOS = complementary metal-oxide-semiconductor | IC = integrated circuit | POS = positive; position | TRIG = trigger(ed) |
| CMR = common mode rejection | ID = inside diameter | POT = potentiometer | TRMR = trimmer |
| CNDCT = conductor | IN = inch | POZI = pozidrive | TRN = turn(s) |
| CNTR = counter | INCL = include(s) | PP = peak-to-peak | TTL = transistor-transistor logic |
| CON = connector | INCAND = incandescent | PPM = parts per million | TX = transmitter |
| CONT = contact | INP = input | PRCN = precision | U = micro(10^{-6}) |
| CRT = cathode-ray tube | INTEN = intensity | PREAMP = preamplifier | UL = Underwriters Laboratory |
| CW = clockwise | INTL = internal | PRGMBL = programmable | UNREG = unregulated |
| D = diameter | INV = inverter | PRL = parallel | VA = voltampere |
| D/A = digital-to-analog | JFET = junction field-effect transistor | PROG = programmable | VAC = volt, ac |
| DAC = digital-to-analog converter | JKT = jacket | PSTN = position | VAR = variable |
| DARL = darlington | K = kilo(10^3) | PT = point | VCO = voltage-controlled oscillator |
| DAT = data | L = low | PW = potted wirewound | VDC = volt, dc |
| DBL = double | LB = pound | PWR = power | VERT = vertical |
| DBM = decibel referenced to 1mW | LCH = latch | R-S = reset-set | VF = voltage, filtered |
| DC = direct current | LCL = local | RAM = random-access memory | VS = versus |
| DCDR = decoder | LED = light-emitting diode | RECT = rectifier | W = watts |
| DEG = degree | LG = long | RET = retainer | W/O = without |
| DEMUX = demultiplexer | LI = lithium | RF = radio frequency | WW = wirewound |
| DET = detector | LK = lock | RGLTR = regulator | XSTR = transistor |
| DIA = diameter | LKWR = lockwasher | RGTR = register | ZNR = zener |
| DIP = dual in-line package | LS = low power Schottky | RK = rack | °C = degree Celsius (Centigrade) |
| DIV = division | LV = low voltage | RMS = root-mean-square | °F = degree Fahrenheit |
| DMA = direct memory access | M = mega(10^6); megohms; meter(distance) | RND = Round | °K = degree Kelvin |
| DPDT = double-pole, double-throw | MACH = machine | ROM = read-only memory | |
| DRC = DAC refresh controller | MAX = maximum | RPG = rotary pulse generator | |
| DRVVR = driver | MFR = manufacturer | RX = receiver | |
| DWL = dowel | MICPROC = microprocessor | | |
| | MINTR = miniature | | |



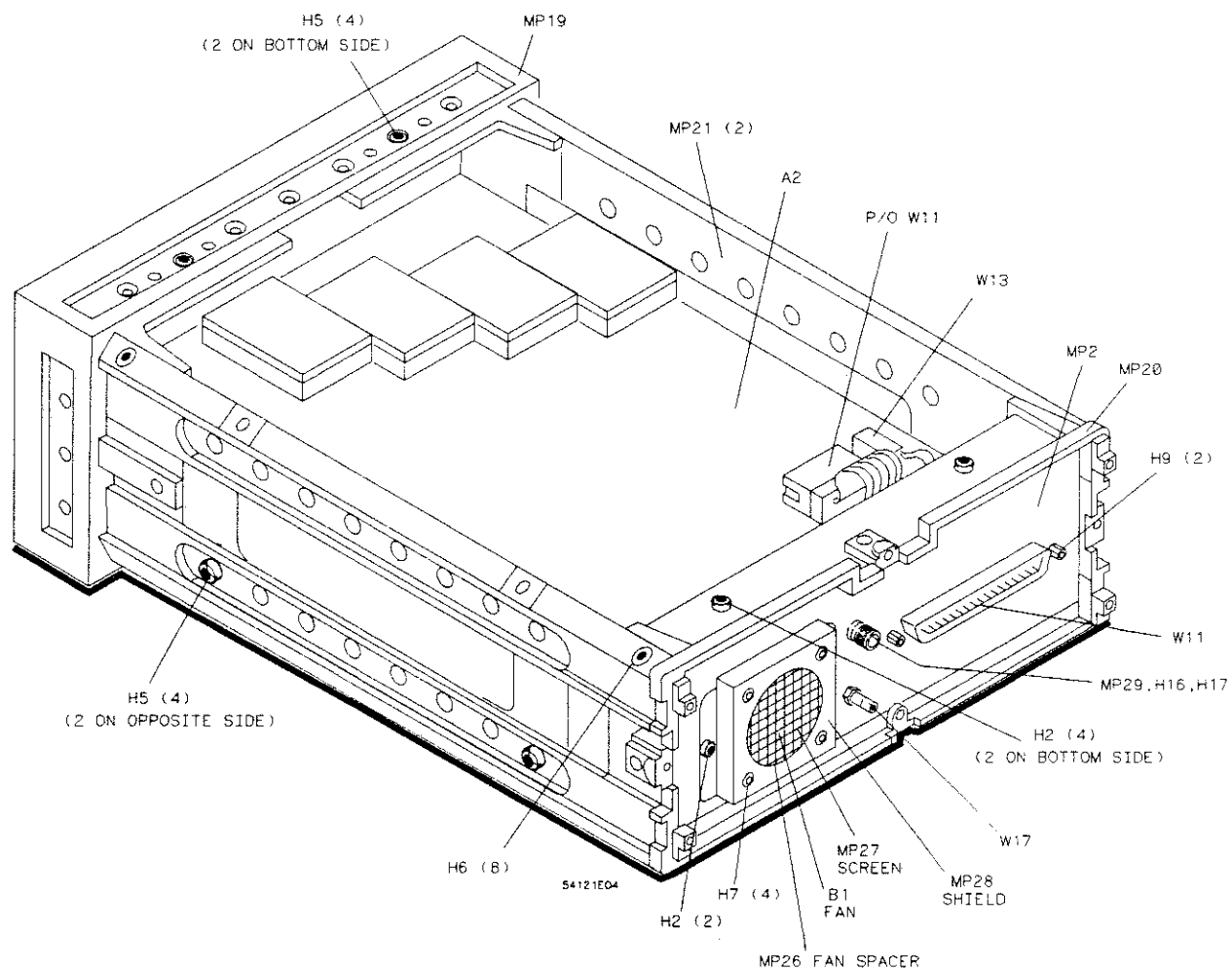


Figure 5-3. Top View

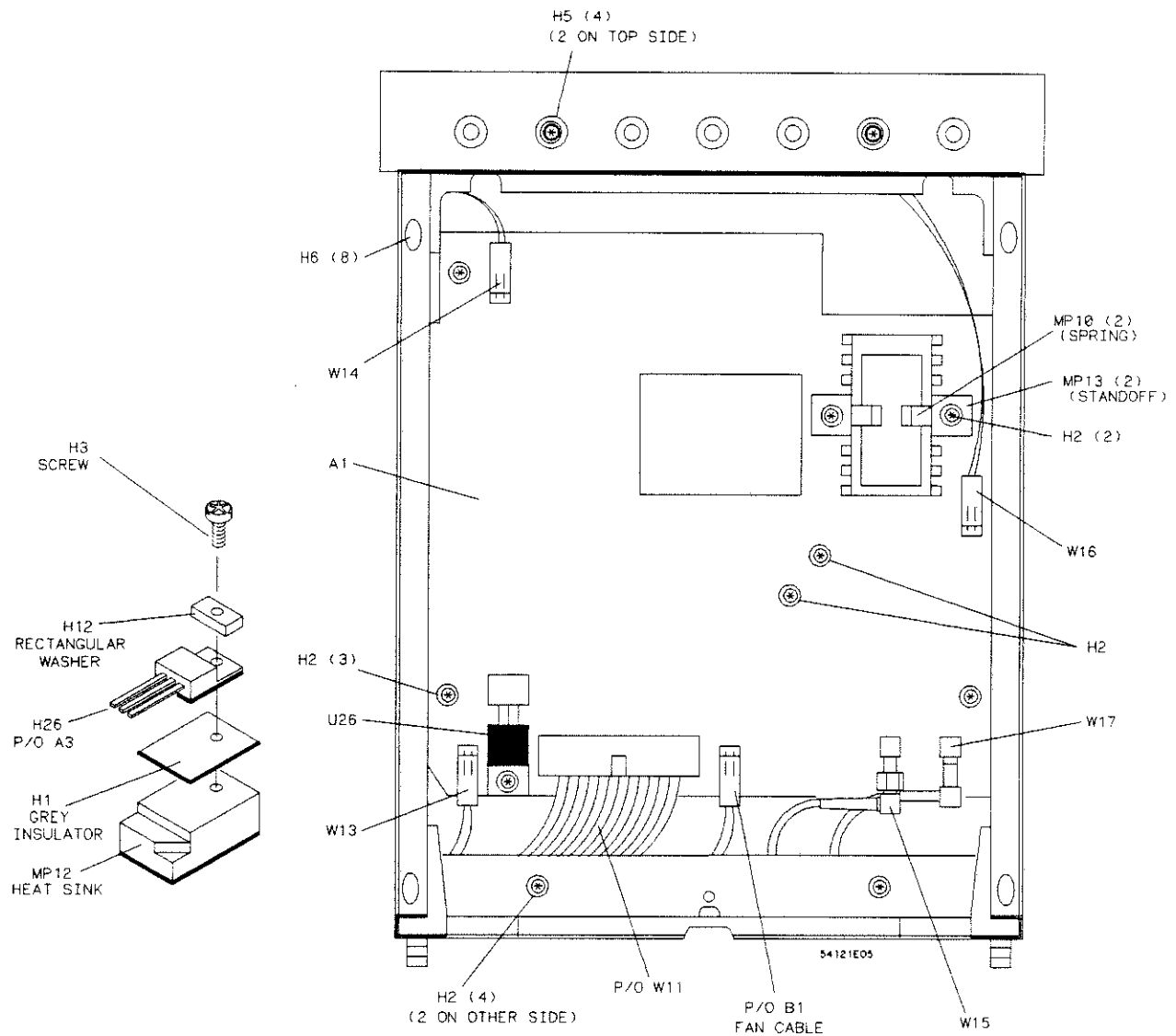


Figure 5-4. Bottom View

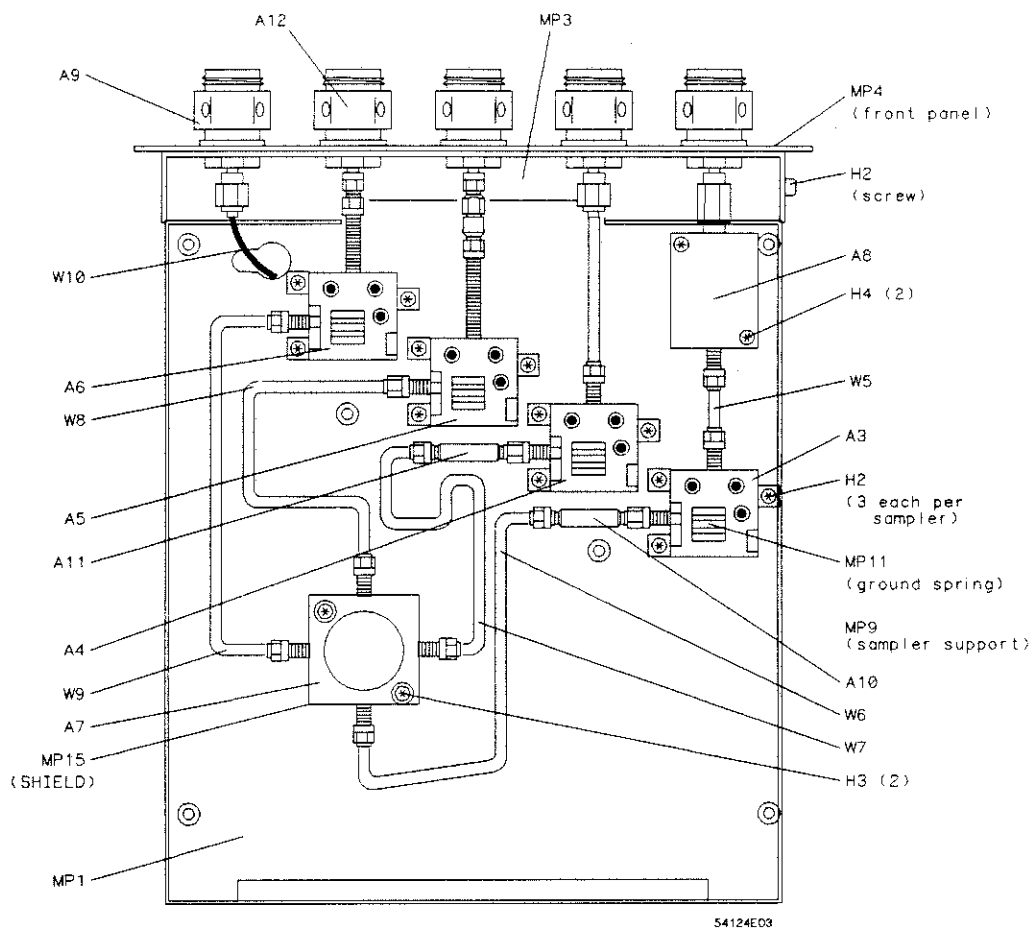


Figure 5-5. Main Deck without Vertical Assembly

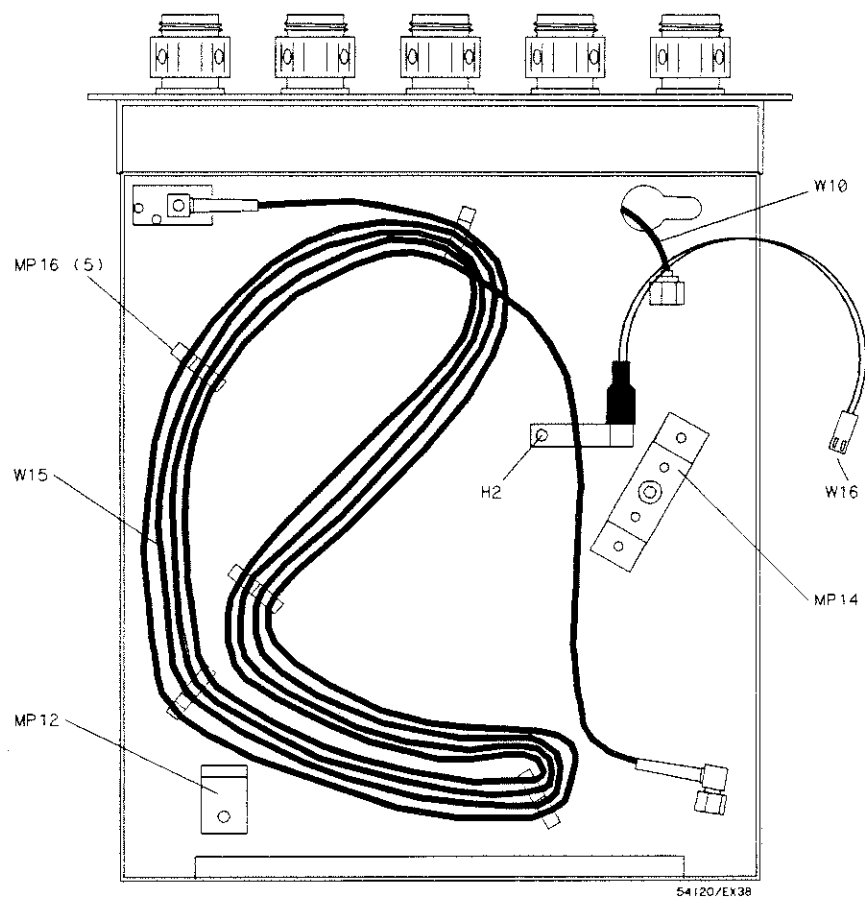


Figure 5-6. Main Deck without Horizontal Assembly

Table 5-2. Replaceable Parts List

| Reference Designator | HP Part Number | CD | Qty | Description | Mfr Code | Mfr Part Number |
|----------------------|----------------|----|-----|--|----------|-----------------|
| *EXCHANGE ASSEMBLIES | | | | | | |
| *A1 | 54123-69506 | 2 | 0 | HORIZONTAL ASSEMBLY | 28480 | 54123-69506 |
| *A2 | 54120-69511 | 6 | 0 | VERTICAL ASSEMBLY | 28480 | 54120-69511 |
| A1 | 54123-66506 | 6 | 1 | HORIZONTAL ASSEMBLY | 28480 | 54123-66506 |
| A2 | 54120-66511 | 0 | 1 | VERTICAL ASSEMBLY | 28480 | 54120-66511 |
| A3 | 5086-7460 | 7 | 2 | SAMPLER, CHANNEL 1 | 28480 | 5086-7460 |
| A4 | 5086-7460 | 7 | | SAMPLER, CHANNEL 2 | 28480 | 5086-7460 |
| A5 | 5086-7577 | 7 | 2 | SAMPLER, CHANNEL 3 | 28480 | 5086-7577 |
| A6 | 5086-7577 | 7 | | SAMPLER, CHANNEL 4 | 28480 | 5086-7577 |
| A7 | 5086-7461 | 8 | 1 | PULSE FILTER | 28480 | 5086-7461 |
| A8 | 5086-7471 | 3 | 1 | TDR STEP GENERATOR | 28480 | 5086-7471 |
| A9 | 5062-1247 | 6 | 3 | APC 3.5 CONNECTOR (BULKHEAD) | 28480 | 5062-1247 |
| A10 | 84851-60001 | 8 | 2 | PULSE CONDITIONER | 28480 | 84851-60001 |
| A11 | 84851-60001 | 8 | | PULSE CONDITIONER | 28480 | 84851-60001 |
| A12 | 5062-6615 | 2 | 2 | 2.4 mm CONNECTOR (BULKHEAD) | 28480 | 5062-6615 |
| A1U1 | 1NB7-8130 | 6 | 1 | 2.5 GHZ TRIGGER HYBRID | 28480 | 1NB7-8130 |
| B1 | 54121-88501 | 5 | 1 | FAN-TUBAXIAL WITH CONNECTOR | 28480 | 54121-88501 |
| H1 | 0340-1074 | 2 | 1 | INSULATOR-XSTR THRM-CNDCT | 28480 | 0340-1074 |
| H2 | 0515-0372 | 3 | 31 | SCREW-MACHINE ASSEMBLY M3 X 0.5 8MM-LG | 28480 | 0515-0372 |
| H3 | 0515-0664 | 5 | 6 | SCREW-MACHINE ASSEMBLY M3 X 0.5 12MM-LG | 28480 | 0515-0664 |
| H4 | 0515-0666 | 7 | 2 | SCREW-MACHINE ASSEMBLY M3 X 0.5 18MM-LG | 28480 | 0515-0666 |
| H5 | 0515-1031 | 2 | 4 | SCREW-MACH M3 X 0.5 6MM-LG 90-DEG-FLH-HD | 28480 | 0515-1031 |
| H6 | 0515-1403 | 2 | 8 | SCREW-SPCL M4 X 0.7 6MM-LG 90-DEG-FLH-HD | 28480 | 0515-1403 |
| H7 | 0515-1038 | 9 | 4 | M3 PANHEAD 35L | 28480 | 0515-1038 |
| H7-8 | NOT ASSIGNED | | | | | |
| H9 | 1251-2942 | 7 | 2 | SCREW LOCK KIT-SUBMIN D CONN | 28480 | 1251-2942 |
| H10 | 2190-0914 | 0 | 5 | WASHER-LK INTL T 7/16 IN .472-IN-ID | 28480 | 2190-0914 |
| H11 | 2950-0132 | 6 | 5 | NUT-HEX-DBL-CHAM 7/16 (THD .094-IN-THK | 28480 | 2950-0132 |
| H12 | 5041-2676 | 3 | 1 | SHOULDER WASHER | 28480 | 5041-2676 |
| H13 | NOT ASSIGNED | | | | | |
| H14 | 0515-1245 | 0 | 2 | COVER SCREW | 28480 | 0515-1245 |
| H15 | 0515-1253 | 0 | 2 | RETAIN RING FOR COVER SCREW | 28480 | 0515-1253 |
| H16 | 2950-0072 | 3 | 1 | NUT 1/4 - 32 .062 | 28480 | 2950-0072 |
| H17 | 2190-0027 | 6 | 1 | WASHER-LK INTL .256 .478 .02 | 28480 | 2190-0027 |
| J1 | 08513-20017 | 6 | 3 | APC 3.5 BULKHEAD CONNECTOR P/O A9 | 28480 | 08513-20017 |
| MP1 | 54120-00102 | 7 | 1 | MAIN DECK | 28480 | 54120-00102 |
| MP2 | 54121-00206 | 3 | 1 | REAR PANEL | 28480 | 54121-00206 |
| MP3 | 54120-00204 | 0 | 1 | SUB PANEL LOWER BRACKET | 28480 | 54120-00204 |
| MP4 | 54124-00201 | 1 | 1 | FRONT PANEL | 28480 | 54124-00201 |
| MP5 | 5062-1245 | 4 | 3 | APC 3.5 CONNECTOR BODY P/O A9 | 28480 | 5062-1245 |
| MP6 | 5062-1243 | 2 | 3 | APC 3.5 CENTER CONDUCTOR P/O A9 | 28480 | 5062-1243 |
| MP7 | 54120-04104 | 7 | 1 | TOP COVER | 28480 | 54120-04104 |
| MP8 | 54120-04105 | 8 | 1 | BOTTOM COVER | 28480 | 54120-04105 |
| MP9 | 54124-04701 | 4 | 4 | SAMPLER SUPPORT | 28480 | 54124-04701 |
| MP10 | 54120-09101 | 4 | 2 | TRIGGER SPRING | 28480 | 54120-09101 |

Table 5-2. Replaceable Parts List

| Reference Designator | HP Part Number | CD | Qty | Description | Mfr Code | Mfr Part Number |
|----------------------|----------------|----|-----|--|----------|-----------------|
| MP11 | 54120-09102 | 5 | 4 | SAMPLER GROUND SPRING | 28480 | 54120-09102 |
| MP12 | 54120-21102 | 1 | 1 | HEATSINK | 28480 | 54120-21102 |
| MP13 | 0380-1949 | 4 | 2 | TRIGGER STANDOFF | 28480 | 0380-1949 |
| MP14 | 54120-24701 | 2 | 1 | PULSE FILTER GROUND BLOCK | 28480 | 54120-24701 |
| MP15 | 54120-45401 | 3 | 1 | PULSE FILTER SHIELD | 28480 | 54120-45401 |
| MP16 | 1400-0866 | 7 | 5 | CLAMP-CABLE .187-DIA .25-WD NYL | 28480 | 1400-0866 |
| MP17 | 1460-1345 | 5 | 2 | TILT STAND SST | 28480 | 1460-1345 |
| MP18 | 5001-0438 | 7 | 2 | SIDE TRIM STRIP | 28480 | 5001-0438 |
| MP19 | 5021-5813 | 4 | 1 | FRONT FRAME | 28480 | 5021-5813 |
| MP20 | 5021-5814 | 5 | 1 | REAR FRAME | 28480 | 5021-5814 |
| MP21 | 5021-5884 | 9 | 2 | SIDE STRUT | 28480 | 5021-5884 |
| MP22 | 5040-7201 | 8 | 2 | BOTTOM FEET | 28480 | 5040-7201 |
| MP23 | 5040-7203 | 0 | 1 | TOP FRONT TRIM STRIP | 28480 | 5040-7203 |
| MP24 | 5040-7222 | 3 | 2 | NON SKID FOOT | 28480 | 5040-7222 |
| MP25 | NOT ASSIGNED | | | | | |
| MP26 | 54121-04701 | 1 | 1 | FAN SPACER | 28480 | 54121-04701 |
| MP27 | 54120-00604 | 4 | 1 | FAN SCREEN | 28480 | 54120-00604 |
| MP28 | 54120-00605 | 5 | 1 | FAN SHIELD | 28480 | 54120-00605 |
| MP29 | 1510-0038 | 2 | 1 | BINDING POST | 28480 | 1510-0038 |
| W1 | NOT ASSIGNED | | | | | |
| W2 | 11900A | 0 | 1 | 2.4 mm ADAPTER CH4 SAMPLER TO FRONT PANEL | 28480 | 11900A |
| W3 | 11900AL | 7 | 1 | 2.4 mm ADAPTER CH3 SAMPLER TO FRONT PANEL | 28480 | 11900AL |
| W4 | 54120-61604 | 2 | 1 | SEMI-RIGID CABLE CH2 SAMPLER TO FRONT PANEL | 28480 | 54120-61604 |
| W5 | 54120-61605 | 3 | 1 | SEMI-RIGID CABLE CH1 SAMPLER TO TDR | 28480 | 54120-61605 |
| W6 | 54123-61601 | 2 | 1 | SEMI-RIGID CABLE CH1 CONDIT. TO PULSE FILTER | 28480 | 54123-61601 |
| W7 | 54123-61602 | 3 | 1 | SEMI-RIGID CABLE CH2 CONDIT. TO PULSE FILTER | 28480 | 54123-61602 |
| W8 | 54124-61601 | 3 | 1 | SEMI-RIGID CABLE CH3 SAMPLER TO PULSE FILTER | 28480 | 54124-61601 |
| W9 | 54124-61602 | 4 | 1 | SEMI-RIGID CABLE CH4 SAMPLER TO PULSE FILTER | 28480 | 54124-61602 |
| W10 | 54120-61610 | 0 | 1 | SEMI-RIGID CABLE TRIGGER TO FRONT PANEL | 28480 | 54120-61610 |
| W11 | 54120-61611 | 1 | 1 | TEST SET CABLE ASSEMBLY | 28480 | 54120-61611 |
| W12 | NOT ASSIGNED | | | | | |
| W13 | 54120-61613 | 1 | 2 | WIRE INTERCONNECT CABLE VERTICAL TO HORIZON | 28480 | 54120-61613 |
| W14 | 54120-61614 | 1 | 2 | WIRE CABLE TDR TO HORIZONTAL ASSEMBLY | 28480 | 54120-61614 |
| W15 | 54120-61615 | 5 | 1 | TDR DELAY LINE COAXIAL CABLE-ON MAIN DECK | 28480 | 54120-61615 |
| W16 | 54120-61616 | 6 | 1 | 2 WIRE CABLE TEMPERATURE SENSE TO HORIZON | 28480 | 54120-61616 |
| W17 | 54120-61617 | 7 | 1 | TRIGGER CABLE-REAR PANEL | 28480 | 54120-61617 |

Disassembly

Table Of Contents

Disassembly

| | |
|---|-------|
| Introduction | 6A-1 |
| Safety Considerations | 6A-1 |
| Tools Required | 6A-1 |
| Fan | 6A-2 |
| Rear Panel | 6A-3 |
| Test Set Cable Assembly | 6A-4 |
| Trigger Power Cable | 6A-5 |
| Main Deck Assembly | 6A-6 |
| Vertical Assembly | 6A-7 |
| Sampler, Pulse Filter, and Pulse Conditioner Assemblies | 6A-8 |
| TDR (Step Generator) | 6A-10 |
| Trigger Hybrid | 6A-12 |
| Horizontal Assembly | 6A-13 |
| Temperature Sense Thermistor | 6A-14 |
| TDR Delay Line | 6A-15 |
| APC 3.5 Center Conductor Replacement | 6A-16 |
| Front Panel Connector | 6A-17 |
| Front Panel | 6A-18 |

Introduction

This section contains removal and replacement procedures for HP 54124A Four Channel Test Set assemblies.

Safety Considerations

The following warnings and cautions must be followed for your protection and to avoid damage to the equipment.

These procedures are used while repairing an instrument that has protective covers removed and may have had power applied. Maintenance should be performed only by trained service personnel who are aware of the hazards involved (for example, fire and electrical shock). Read the Safety Summary in the front of this manual.

Do not remove or replace any of the circuit board assemblies in the instrument unless instrument power is removed. The boards contain components which may be damaged if the board is removed or replaced when instrument power is applied.

The HP 54124A Four Channel Test Set is very sensitive to electrostatic discharge. Failure to observe proper antistatic methods may result in damage to the gallium arsenide samplers. All maintenance or operation should be performed while using an antistatic mat and wrist strap which are supplied with the HP 54120B Mainframe.

Tools Required

The hardware requires TORXI type tools for removal and replacement. Sizes required for the procedures in this section are #10 and #15. A medium posi drive is used for the covers. The other tools used in this section are: 5/16 inch open end wrench, 9/16 inch open end wrench (this wrench is a thin wrench, HP part number 8710-1770, used in the "APC 3.5 Center Conductor Replacement" procedure on page 6A-16), 1/4 inch nut driver, 5 mm nut driver, and torque wrench set to 5 in/lbs.

Fan

Removal

1. Disconnect the power cable.
2. Remove the bottom cover.
3. Remove the two screws holding the fan assembly to the rear panel. Refer to figure 6A-1.
4. Unplug the fan cable from J6 on the horizontal assembly.
5. Slowly pull the fan assembly away from the test set while feeding the fan cable through the fan opening in the rear panel.
6. Remove the four screws that hold the fan to the fan assembly.

Replacement

1. Reverse the removal procedure to install the fan.

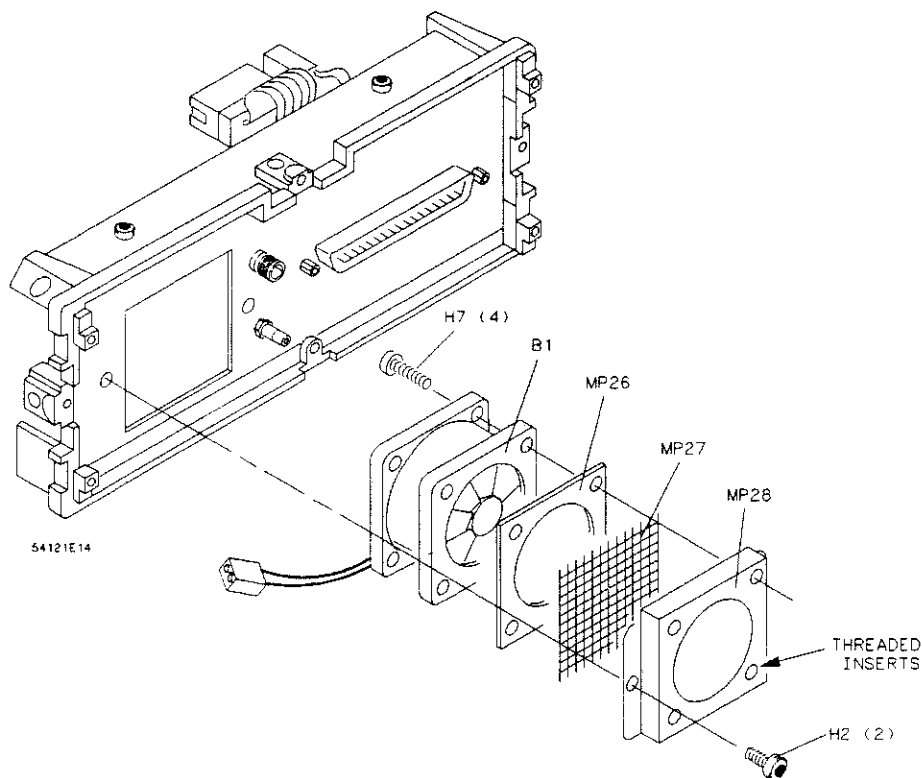


Figure 6A-1. Fan Removal

Rear Panel

Removal

1. Disconnect the power cable.
2. Remove the top and bottom covers.
3. Remove the four screws from the top and bottom of the rear casting. Refer to figure 6A-2.
4. Disconnect the fan cable from J6 on the horizontal assembly.
5. Disconnect the ribbon cables from J7 on the horizontal assembly and J1 on the vertical assembly.
6. Disconnect the trigger power cable from connector J3 on the horizontal assembly.
7. Pull the rear panel away from the test set.

Replacement

1. Reverse the removal procedure to install the rear panel.

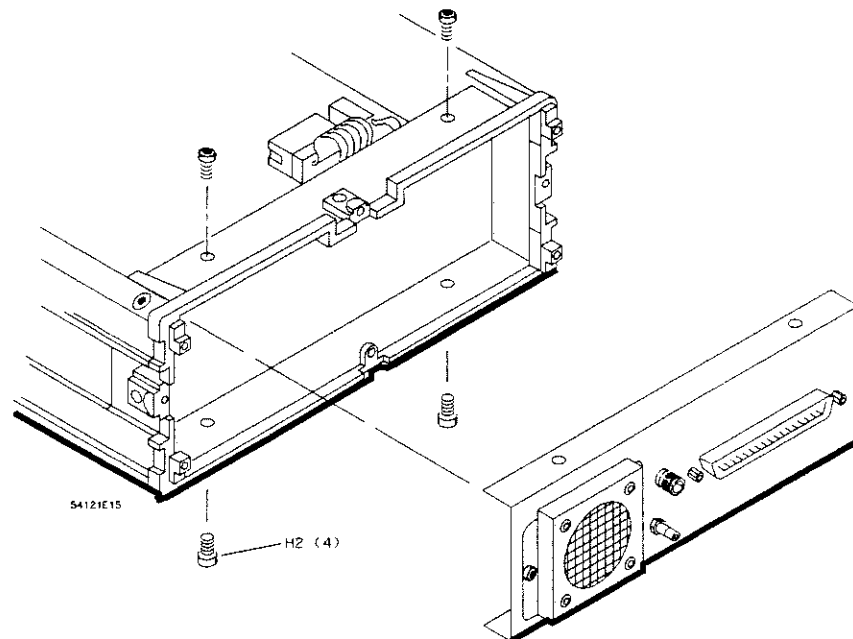


Figure 6A-2. Rear Panel Removal

Test Set Cable Assembly

Removal

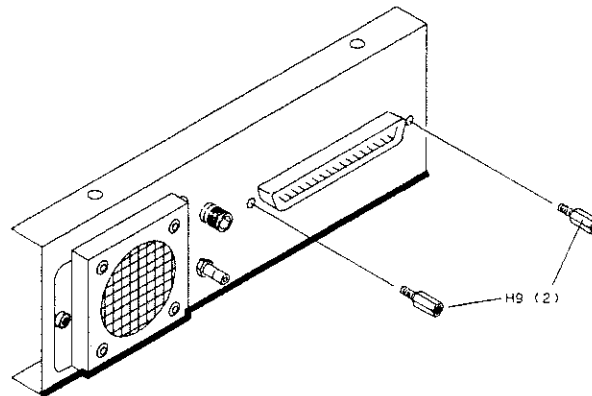
1. Disconnect the power cable.
2. Remove the umbilical cable from the test set.
3. Remove the rear panel from the test set. Refer to the "Rear Panel" removal procedure on page 6A-3.
4. Remove the two screws that attach the test set cable assembly to the rear panel with a 5 mm nut driver or wrench. Refer to figure 6A-3.

Replacement

1. Reverse the removal procedure to install the cable.

Note

Hewlett-Packard applies a small amount of loctite on the threads of each screw before installing the screws. The loctite prevents the screws from loosening after repeated removal and installing of the umbilical cable.



54121E27

Figure 6A-3. Test Set Cable Assembly Removal

Trigger Power Cable

Removal

1. Disconnect the power cable.
2. Remove the rear panel from the test set. Refer to the "Rear Panel" removal procedure on page 6A-3.
3. Use a 1/4 inch nut driver or wrench to remove the hex nut and washer that attach the trigger power cable to the rear panel. Refer to figure 6A-4.

Replacement

1. Reverse the removal procedure to install the cable.

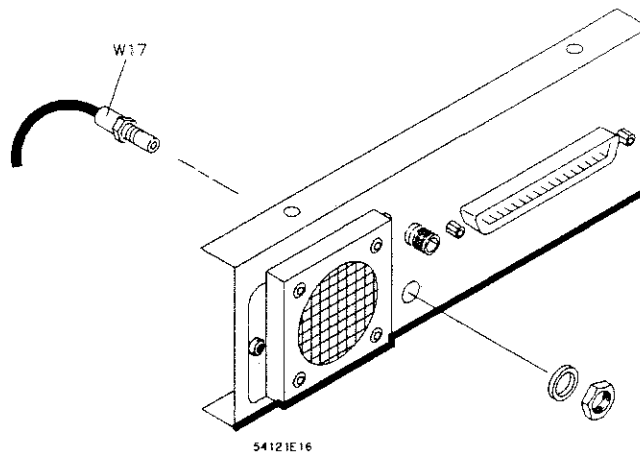


Figure 6A-4. Trigger Power Cable Removal

Main Deck Assembly

Removal

1. Disconnect the power cable.
2. Remove the top and bottom covers.
3. Remove the two screws from each side rail. Refer to figure 6A-5.
4. Remove the four screws from the top and bottom of the front casting. Refer to figure 6A-5.
5. Disconnect the fan assembly cable from J6 on the horizontal assembly.
6. Disconnect the TDR delay line from connector J4 on the horizontal assembly.
7. Disconnect the ribbon cables from J1 on the vertical and J7 on the horizontal assembly.
8. To avoid snagging parts on frame, slowly pull the main deck assembly out of the frame.

Replacement

1. Reverse the removal procedure to install the main deck assembly.

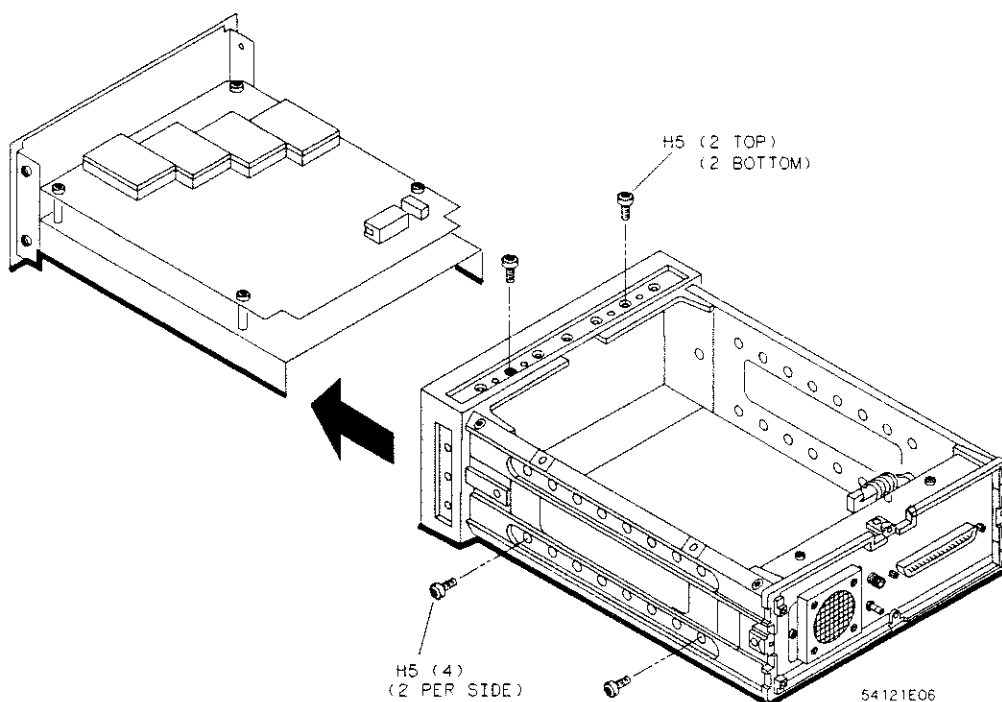


Figure 6A-5. Main Deck Assembly Removal

Vertical Assembly

Removal

1. Disconnect the power cable.
2. Remove the main deck assembly. Refer to the "Main Deck Assembly" removal procedure on page 6A-6.
3. Remove the six screws holding the vertical assembly to the main deck. Refer to figure 6A-6.
4. Disconnect the interconnect cable connected to J2 on the vertical assembly.
5. While gently rocking assembly from side to side, slowly pull the vertical assembly straight up until the assembly is free of the main deck. The rocking motion can help free the assembly from the sampler pins.

Caution

The exposed sampler pins are very sensitive to electrostatic damage (ESD).

Replacement

1. Reverse the removal procedure to install the main deck assembly. Be very careful not to bend any of the sampler hybrid pins when pushing the vertical assembly onto the main deck.

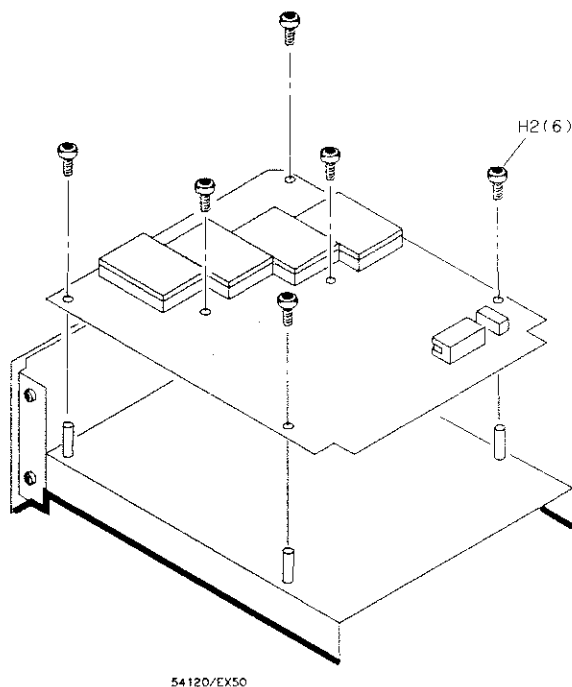


Figure 6A-6. Vertical Assembly Removal

Sampler, Pulse Filter, and Pulse Conditioner Assemblies

Removal

1. Disconnect the power cable.
2. Remove the main deck assembly and vertical assembly. Refer to the "Main Deck Assembly" removal procedure on page 6A-6 and the "Vertical Assembly" removal procedure on page 6A-7.

Caution

The exposed sampler, pulse filter, and TDR pins are very sensitive to electrostatic damage (ESD). All maintenance should be performed while using an antistatic mat and wrist strap which are supplied with the instrument.

3. Use a 5/16 inch open end wrench to unscrew the semi-rigid cables from the assembly and the pulse conditioner. Do not disconnect the semi-rigid cables from the assembly yet. The semi-rigid cables should not be stressed or bent. Refer to figure 6A-7.
4. Use a 5/16 inch open end wrench to unscrew the pulse conditioner from the sampler or the semi-rigid cable. There is no pulse conditioner to remove for channel 3 or channel 4.
5. If you are replacing a defective pulse conditioner, go to the Replacement procedure. Step 6 is for replacing defective samplers.
6. Loosen the screws holding the assembly to the main deck. The semi-rigid cables can now be slipped out of the assembly.

Replacement

1. Connect the pulse conditioner to sampler. There is no pulse conditioner to connect for channel 3 or channel 4. If a sampler was removed, attach the replacement assembly to the main deck with screws, but do not tighten screws.
2. Install the semi-rigid cable into the pulse conditioner. When pushing the semi-rigid cables into the connectors, a definite slight snap sound can be heard as the cable and the connector are seated together.
3. Tighten the assembly screws.
4. Torque the semi-rigid cables to 5 in/lbs. Torque the pulse conditioners to the sampler to 8 in/lbs.
5. Reverse the remainder of the assembly removal to complete the installation of the assembly.

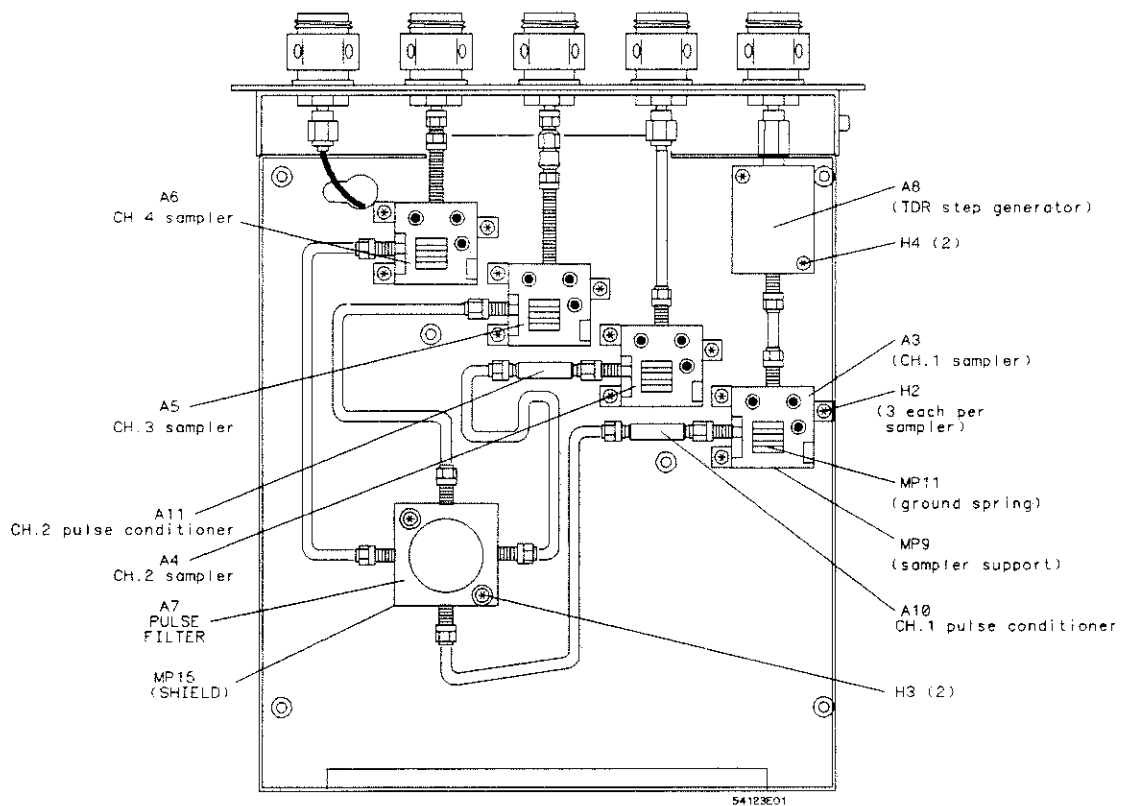


Figure 6A-7. Sampler and Pulse Filter Assembly Locations

TDR (Step Generator)

Removal

1. Remove the channel 1 sampler. Refer to the "Sampler" removal procedure on page 6A-8.
2. Remove the delay line from the TDR (step generator) with a 5/16 inch open end wrench. If you require additional room for the wrench, the horizontal assembly can be removed. To remove the horizontal assembly, refer to the "Horizontal Assembly" removal procedure on page 6A-13.
3. Disconnect the TDR levels cable (W14) from the TDR.
4. Loosen the connection between the TDR and the front panel bulk head connector with a 5/16 inch open end wrench.
5. Remove the two screws holding the TDR to the main deck.
6. Gently pull the TDR from the bulkhead connector, then lift the TDR from the main deck.

Replacement

1. Install the TDR to the bulkhead connector, then loosely connect the bulkhead connector to the TDR.
2. Install the two screws that hold the TDR to the main deck, do not tighten the screws.
3. Reconnect the TDR levels cable to the TDR and loosely connect the TDR delay line to the TDR.
4. Reinstall the channel 1 sampler. Refer to the "Sampler Replacement" procedure on page 6A-8.
5. Tighten the screws that hold the TDR to the main deck.
6. Tighten the bulkhead and the delay line SMA connectors to 5 in/lbs.

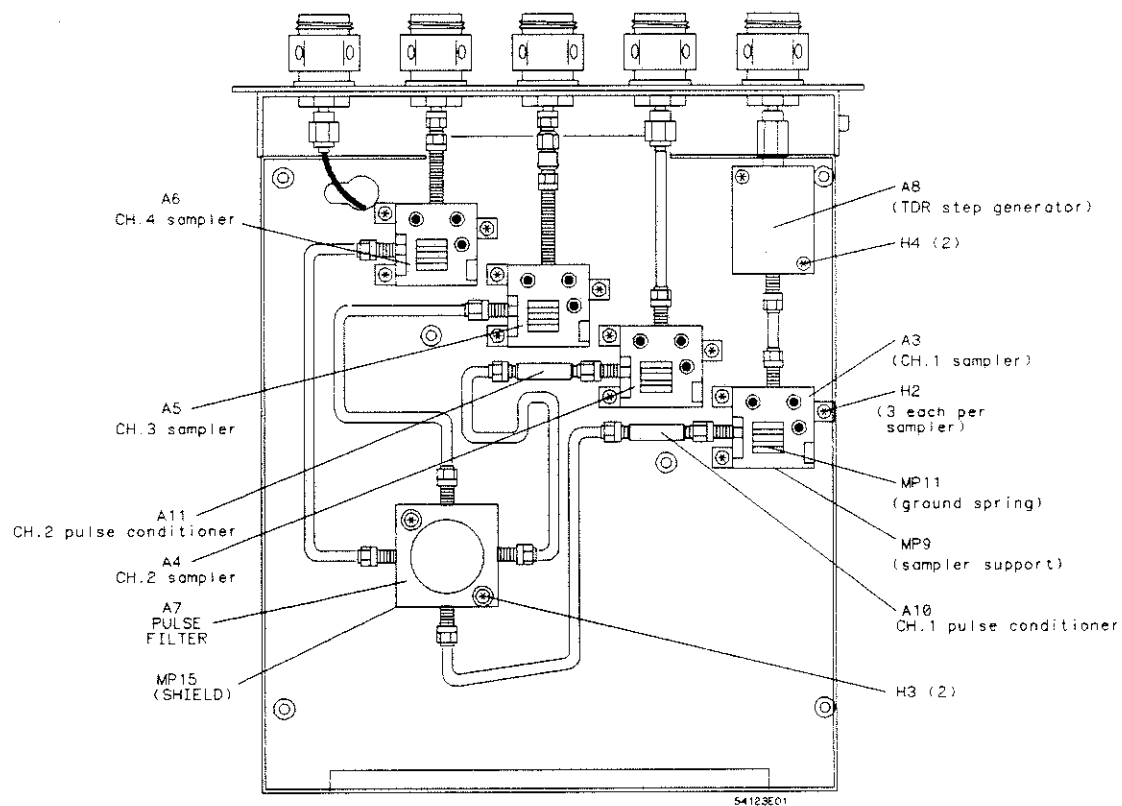


Figure 6A-8. Sampler and TDR Assembly Locations

Trigger Hybrid

Removal

1. Disconnect the power cable.
2. Remove the bottom cover.
3. Use a 5/16 inch wrench to disconnect the SMA connector from the trigger hybrid.
4. Remove the two screws and two springs that hold the trigger hybrid in place.

Caution

The exposed hybrid pins are very sensitive to electrostatic damage (ESD). All maintenance should be performed while using an antistatic mat and wrist strap which are supplied with the HP 54120B Mainframe.

5. Gently lift the trigger hybrid from the horizontal assembly. Refer to figure 6A-9. There can be some resistance from the socket holding the trigger hybrid in place. Gently rocking the trigger hybrid while lifting can help in the removal. There is a large heat sink on the bottom side of the trigger hybrid.

Replacement

1. Reverse the removal procedure to install the trigger hybrid. Torque the SMA connector to 5 in/lbs.

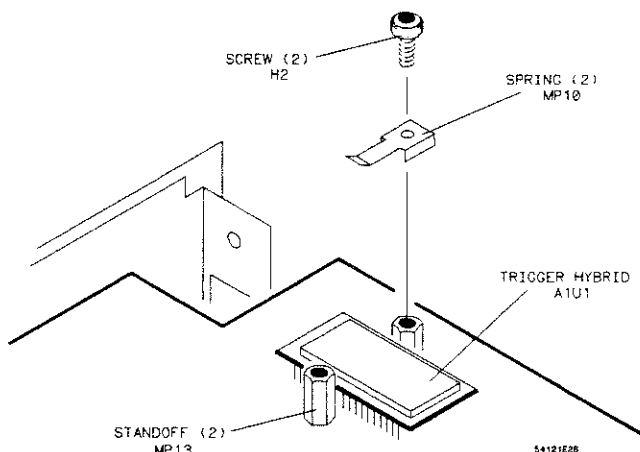


Figure 6A-9. Trigger Hybrid Removal

Horizontal Assembly

Removal

1. Disconnect the power cable.
2. Remove the main deck. Refer to the "Main Deck Assembly" removal procedure on page 6A-6.
3. Remove the triggerhybrid. Refer to the "Trigger Hybrid" removal procedure on page 6A-12.
4. Remove the five screws and two standoffs that hold the horizontal assembly to the main deck. Refer to figure 6A-10.
5. Disconnect the interconnect cable connected to J9, and disconnect the temperature cable connected to J2 on the horizontal assembly.
6. Use a 5/16 inch wrench to disconnect the TDR delay line cable from the SMA connector J4 on the horizontal assembly.
7. Disconnect the TDR levels cable from J8 on the horizontal assembly.
8. Slowly pull the horizontal assembly straight up until free of main deck.

Replacement

1. Reverse the removal procedure to install the horizontal assembly. The SMA connectors are torqued to 5 in/lbs.

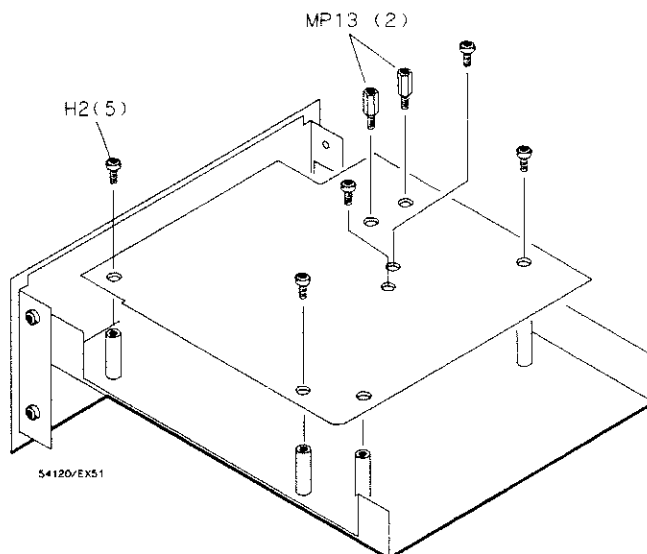


Figure 6A-10. Horizontal Assembly Removal

Temperature Sense Thermistor

Removal

1. Disconnect the power cable.
2. Remove the main deck. Refer to the "Main Deck Assembly" removal procedure on page 6A-6.
3. Remove the horizontal assembly. Refer to the "Horizontal Assembly" removal procedure on page 6A-13.
4. Disconnect the thermistor from the main deck. Refer to figure 6A-11.

Replacement

1. Apply a small amount of thermal compound to the thermistor.
2. Reverse the removal procedure to install the thermistor. All SMA connectors are torqued to 5 in/lbs.

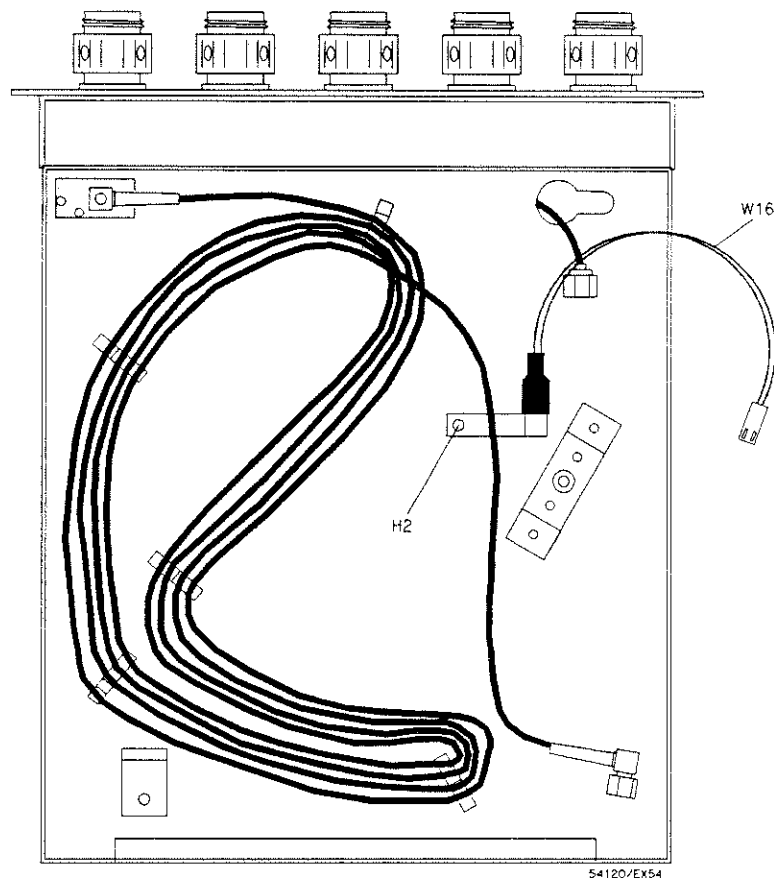


Figure 6A-11. Temperature Sense Thermistor Removal

TDR Delay Line

Removal

1. Disconnect the power cable.
2. Remove the main deck. Refer to the "Main Deck Assembly" removal procedure on page 6A-6.
3. Remove the horizontal assembly. Refer to the "Horizontal Assembly" removal procedure on page 6A-13.
4. Use a 5/16 inch wrench to disconnect the TDR delay line connected to the TDR on the main deck. Refer to figure 6A-12.
5. Unwind the TDR delay line while paying attention to how the delay line was wound. It will be rewound in the same fashion.

Replacement

1. Reverse the removal procedure to install the TDR delay line. All SMA connectors are torqued to 5 in/lbs.

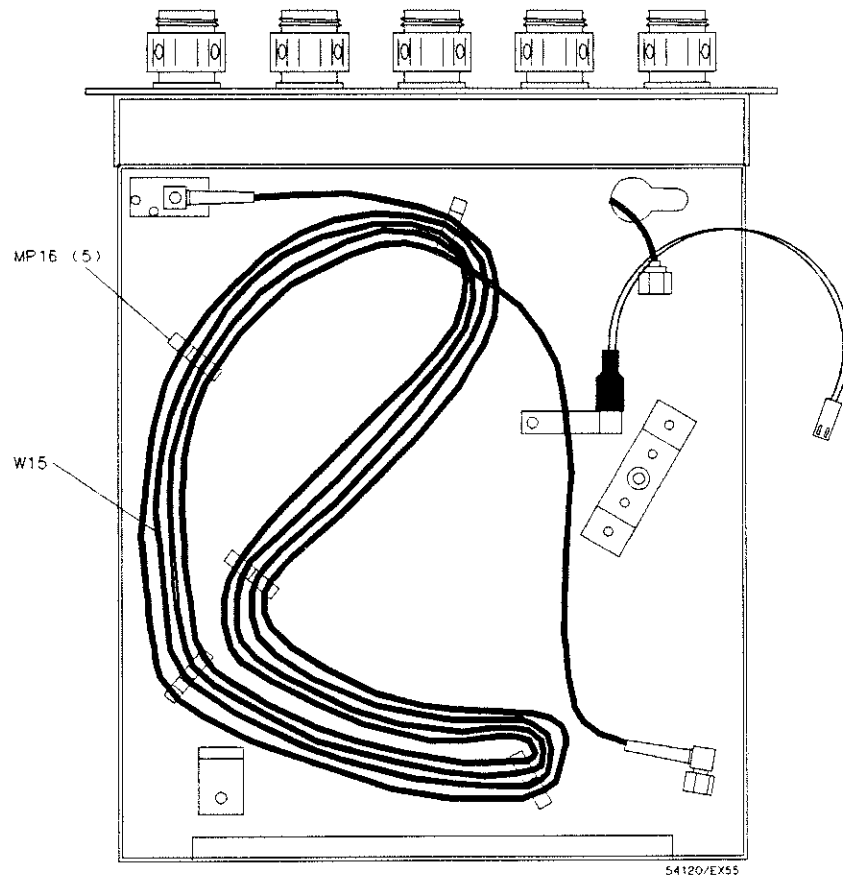


Figure 6A-12. TDR Delay Line Removal

APC 3.5 Center Conductor Replacement

Channel 1, channel 2, and the trigger have APC 3.5 connectors. Channel 3 and channel 4 have 2.4 mm connectors. The 2.4 mm connectors are replaced as a unit because they have no individual replaceable parts.

Caution

The APC 3.5 center conductor assembly connect directly to either a sampler or trigger hybrid input. These inputs are very sensitive to electrostatic damage (ESD). All maintenance should be performed while using an antistatic mat and wrist strap which are supplied with the instrument.

Removal

1. Use the antistatic mat with the wrist strap to avoid damage to the gallium arsenide samplers, pulse filter, or TDR assemblies.
2. Use a thin 9/16 inch open end wrench (HP part number 8710-1770) to turn the brass nut between the APC 3.5 connector and the front panel counterclockwise. Refer to figure 6A-13.
3. Remove the front portion of APC 3.5 connector from the front panel.
4. Remove the center conductor assembly from the front panel.

Replacement

1. Place the center conductor assembly into the APC 3.5 connector.
2. Thread the APC 3.5 connector onto the front panel, then tighten with a 9/16 inch wrench.

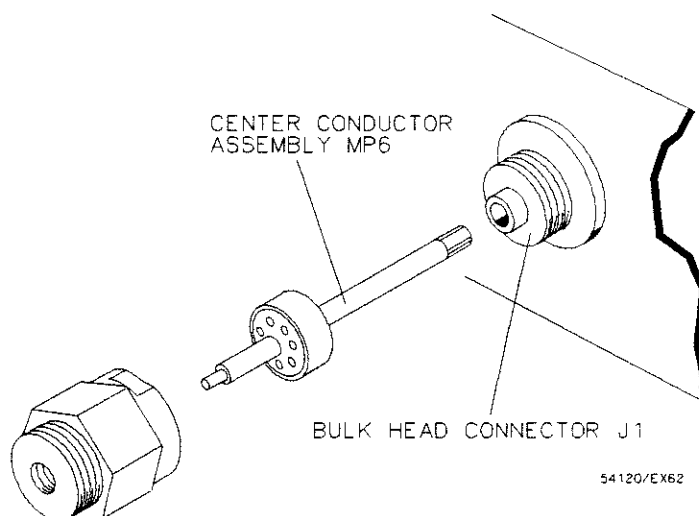


Figure 6A-13. APC 3.5 Center Conductor Removal

Front Panel Connectors

Caution



Channel 1, channel 2, and the trigger have APC 3.5 connectors. Channel 3 and channel 4 have 2.4 mm connectors. The 2.4 mm connectors are replaced as a unit because they have no individual replaceable parts.

The center conductor of the APC 3.5 and 2.4 mm connectors connect directly to the sampler and trigger hybrid inputs. These inputs are very sensitive to electrostatic damage (ESD). All maintenance should be performed while using an antistatic mat and wrist strap that are supplied with the instrument.

Removal

1. Use the antistatic mat with the wrist strap to avoid damage to the gallium arsenide samplers, pulse filter, TDR, or trigger hybrid.
2. Disconnect the power cable.
3. Remove the main deck. Refer to the "Main Deck Assembly" removal procedure on page 6A-6.
4. Remove the vertical assembly from the main deck. Refer to the "Vertical Assembly" removal procedure on page 6A-7.
5. Use a 5/16 open end wrench to unscrew the semi-rigid cable or the adapter from the defective front panel connector. Refer to figure 6A-14.
6. Use a 9/16 inch open end wrench to unscrew the defective connector.
7. Remove the connector from the front panel.

Replacement

1. Reverse the removal procedure to install the connector. When pushing the semi-rigid cables into the connectors, a definite slight snap sound can be heard as the cable and connector are seated together. The semi-rigid cables are torqued to 5 in/lbs. The 2.4 mm connectors are torqued to 8 in/lbs.

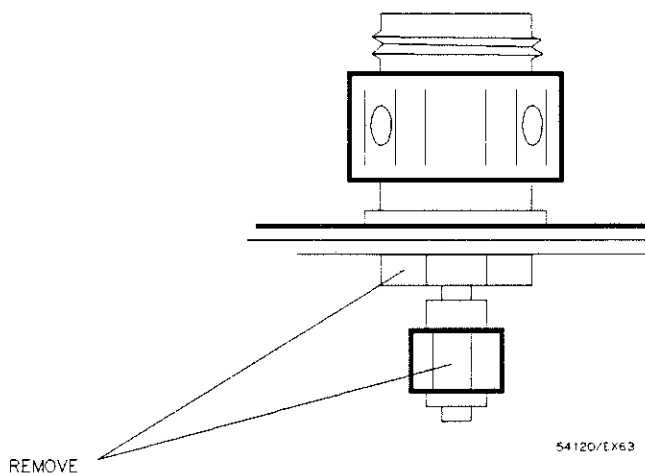


Figure 6A-14. Front Panel Connector Removal

Front Panel

Removal

1. Disconnect the power cable.
2. Remove the main deck. Refer to the "Main Deck Assembly" removal procedure on page 6A-6.
3. Remove the vertical assembly. Refer to the "Vertical Assembly" removal procedure on page 6A-7.
4. Remove the five front panel connectors. Refer to the "Front Panel Connector" removal procedure on page 6A-17.
5. Remove the two screws from each side of the front panel. Refer to figure 6A-15.

Replacement

1. Reverse the removal procedure to install the front panel.

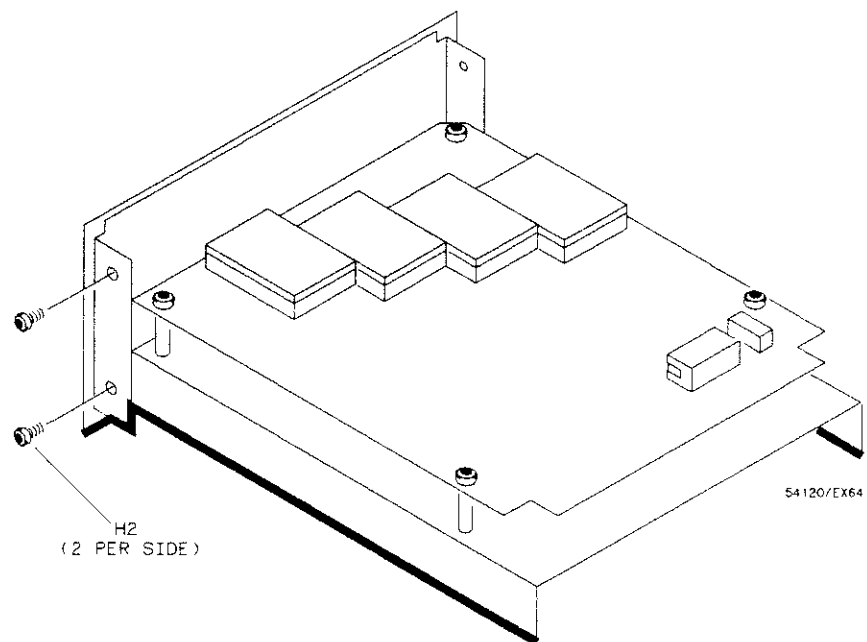


Figure 6A-15. Front Panel Removal

Theory

Table Of Contents

Theory

| | |
|----------------------------------|------|
| Introduction | 6B-1 |
| Simplified Signal Flow | 6B-1 |
| Vertical Assembly | 6B-4 |
| Horizontal Assembly | 6B-6 |

Introduction

This section is the theory of operation for the HP 54124A Four Channel Test Set. It includes printed circuit assembly (PCA) block diagrams and PCA block level theory of operation. For overall system theory and simplified signal flow, refer to section 6B, "Theory," in the *HP 54120B Mainframe Service Manual*.

Simplified Signal Flow

The following theory refers to figure 6B-1 Simplified Signal Flow Diagram and tracks a signal through the system. The signal flow only refers to channel 1 and the external trigger path. Channels 1-4 operate identically except channel 1 has the TDR hybrid in its input signal path. The TDR is discussed at the end of the simplified signal flow theory.

An acquisition cycle is defined as the sequence of events that must occur in order to acquire a SINGLE data point per enabled channel. It will normally be the case that several acquisition cycles will be required to adequately display a waveform.

The microprocessor (CPU) starts an acquisition cycle by programming the fine delay DAC and the coarse delay counters. The CPU then enables the trigger hybrid. The next external trigger edge which meets the criteria set by the trigger criteria latches will cause the trigger hybrid to output an edge. This edge enables the timebase hybrid to start the fine delay ramp. The fine delay DAC signal sets the starting point for the fine delay ramp. This fine delay ramp represents fine delay, which has a range from 0 to 3.99975 ns. When the fine delay ramp reaches 0 volts, the 250 MHz startable oscillator starts running. The sample pulse generator drive is enabled when all the coarse delay counters reach terminal count. The 250 MHz signal clocks the coarse delay counters on the horizontal assembly. These counters continue recounting to zero which results in the output line toggling at a 7.8 MHz rate. The 7.8 MHz clocks the remainder of the coarse delay counters on the horizontal control assembly. When these counters reach terminal count, they output a signal called terminal count back to the horizontal assembly. This is one of the enable signals for the sample pulse generator drive circuit. The coarse delay counters on the horizontal assembly continue to count until they reach terminal count also.

This terminal count is the last enable for the sample pulse generator drive circuit. With all the coarse delay counters at terminal count, one pulse of the 250 MHz is allowed through the sample pulse generator drive circuit. This circuit places 1 A of current for 1 ns into the sample pulse generator. This causes the sample pulse generator to momentarily turn on the sampler hybrids.

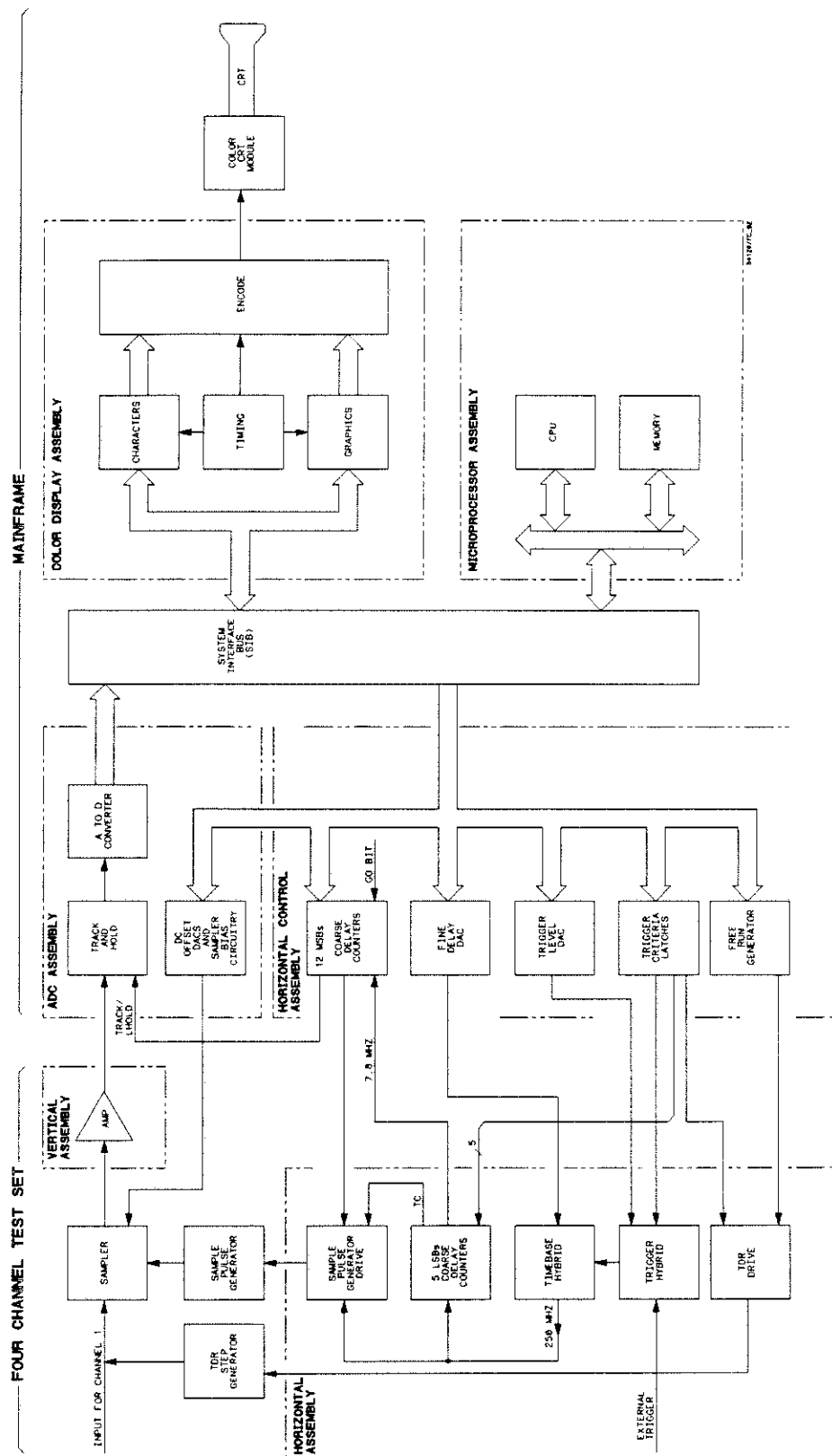


Figure 6B-1. Simplified Signal Flow

The sampler measures the difference between the input signal's present amplitude and the dc offset DAC's level. The difference is amplified and converted to a bipolar pulse. It is important to remember that only one data point is digitized for each enabled channel during each acquisition cycle. The bipolar pulse on the vertical assembly represents only the sampled portion of the incoming signal during a very narrow time window of 10 ps.

The track and hold circuit follows the amplitude of the bipolar pulse. When the bipolar pulse reaches peak amplitude, the track and hold circuit holds the peak analog value. The A to D converter converts the track and hold's level to a 12-bit digital word.

The CPU reads the output of the A to D converter and either uses the digital word in waveform math functions or sends it to the color display assembly.

The display assembly sends the digitized input waveform to the graphics section of the display assembly. The graphics and any associated characters are sent to the CRT display module where they are displayed on the CRT. Another acquisition cycle will then be started.

The TDR generates a fast step pulse for TDR applications. When the TDR is disabled, incoming signals pass unaffected through the TDR, except channel 1's bandwidth is lowered slightly. When the TDR is enabled, it outputs a fast edge pulse which splits two ways. First, the TDR pulse is applied to channel 1's sampler input and is digitized as any other incoming signal. Second, the TDR pulse is an output from channel 1's APC 3.5 input connector.

An important point to remember is that external trigger is not used when the TDR is enabled. Circuitry on the horizontal assembly generates the trigger signal when trigger is enabled. If the external trigger signal is left connected it may cause false triggering.

Another important point about this system is that there is no provision for an internal sync pickoff in the samplers. Only an external trigger is used when incoming signals are to be digitized.

Vertical Assembly

The following block level theory of operation refers to the vertical assembly block diagram in figure 6B-2.

| | |
|---|---|
| TDR | The time domain reflectometry (TDR) step generator is a thru-line current switching circuit. It is used to create a fast step for TDR applications. |
| Sampler | A pulse from the sample pulse generator momentarily turns the sampler diodes on. The sampler measures the difference between an input signal and dc offset at a specific point in time (approximately 10 ps window) and converts this difference to a differential charge on both IF outputs. |
| Sampler Bias Network | This circuitry combines the offset, bias, and temperature compensation inputs to produce the proper voltages to bias the sampler IF pins. H/LL selects either the high or low bandwidth bias modes. |
| Feedthrough Compensation Network | When the sampler is turned off, there will be passive feedthrough of the input signal through the sampler by parasitic capacitive and resistive coupling. The circuit corrects for this passive feedthrough of the sampler diodes to a bandwidth greater than the matched filter's bandwidth. |
| Charge Sensitive Amps | The charge sensitive amps measure the differential charge on the IF outputs and converts this to differential tail pulses with time constants of approximately 100 μ s. |
| Summation Amp | The summation amp combines the differential tail pulses from the charge sensitive amps into a single-ended tail pulse. It also subtracts effects of changes in dc offset signal on the charge sensitive amps. |
| Amp And Matched Filter | The matched filter converts and amplifies the tail pulse from the summation amp and converts the tail pulse to a bipolar pulse which drives the track and hold circuitry on the ADC assembly. |

| Mnemonics | Definition |
|------------------|---|
| CC1 | Capacitive Compensation for channel 1 |
| HB1 | High Bandwidth adjust for channel 1 |
| LL/H | Low enables Low bandwidth bias adjust and a High enables High bandwidth bias adjust |
| LB1 | Low Bandwidth bias adjust for channel 1 |
| OG1 | Offset Gain adjust for channel 1 |
| RC1 | Resistive Compensation for channel 1 |
| VHB | High Bandwidth bias enable |
| VLB | Low Bandwidth bias enable |
| V Temp | Temperature compensation voltage from horizontal assembly |
| 10.000 V | Precise 10 volts from horizontal assembly |

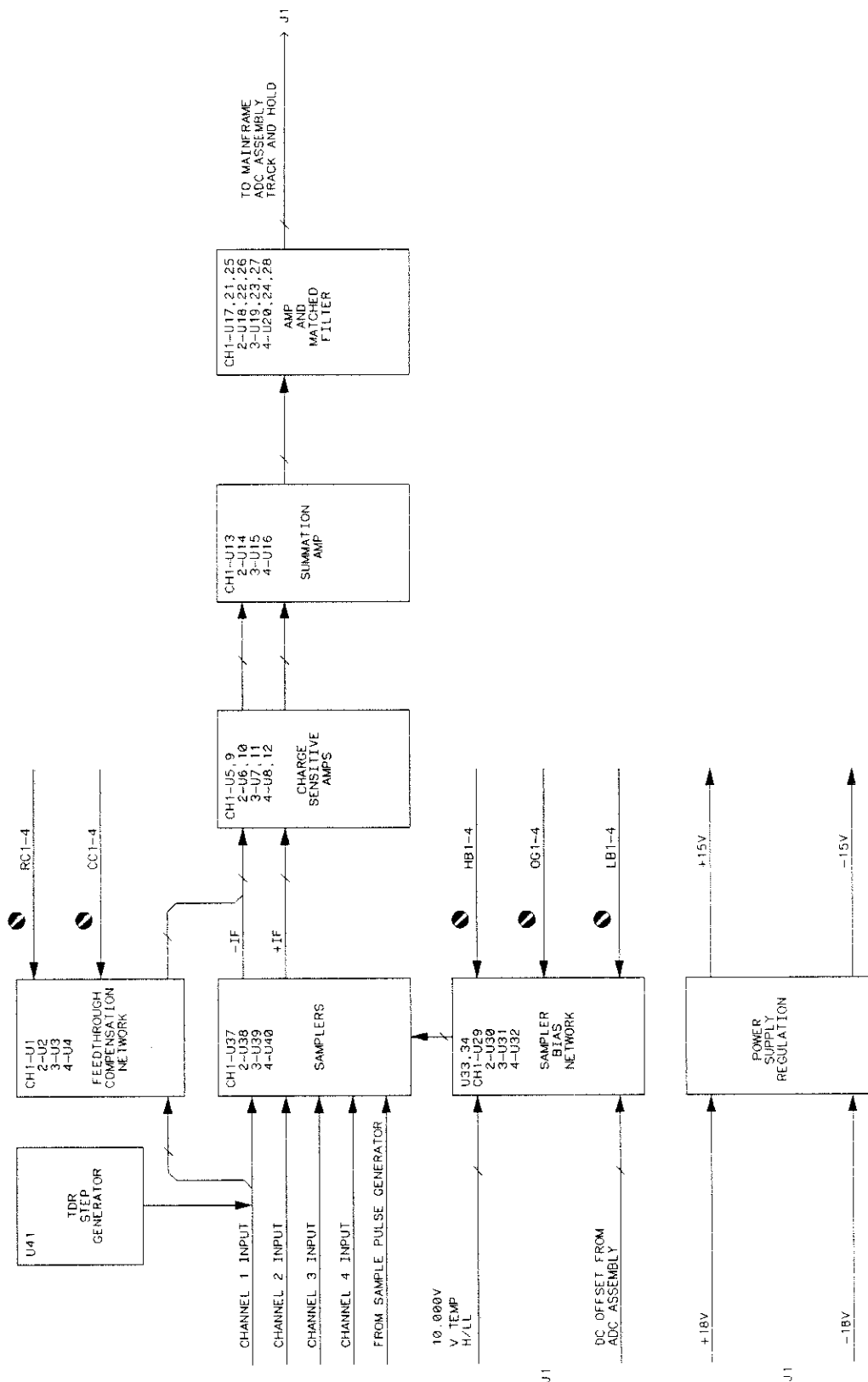


Figure 6B-2. Vertical Assembly Block Diagram

Horizontal Assembly

The following block level theory of operation refers to the horizontal assembly block diagram in figure 6B-3.

Trigger Hybrid

When the TDR is disabled, the trigger enable line enables the trigger hybrid. The next external trigger edge which meets the criteria set up by the trigger criteria signals will cause the trigger hybrid to output an edge. The trigger criteria signals are trigger slope select, high frequency reject, hysteresis on or off, and a separate signal called trigger level. Trigger level sets a threshold which the incoming trigger signal must cross for a trigger to occur. When the trigger hybrid triggers, it outputs an edge to the timebase hybrid.

Trigger Source For TDR Mode

When the TDR is enabled, external trigger pulses are inhibited from causing U1 to trigger. The CPU sets the trigger level high enough so that any incoming external trigger pulses would not be expected to cross the trigger level threshold. This keeps any external trigger pulses from causing the trigger hybrid to trigger. It is essential that when the TDR is enabled all external trigger sources be disconnected from the instrument, otherwise the instrument will not trigger properly and will appear inoperative. When the trigger enable line enables U2 and U3, the next positive edge of freerun clock will cause the trigger hybrid to trigger. The trigger hybrid will output an edge to the timebase hybrid.

TDR Drive

When the TDR OFF/LON line is low, U4 and Q2 allow the freerun clock signal to drive the TDR on and off at the freerun clock rate. The freerun clock rate is determined by the freerun rate selected in the front-panel timebase menu.

Timebase Hybrid

Fine delay sets the starting point for the fine delay ramp. This fine delay ramp represents a fine delay range from 0 to 3.99975 ns. When the timebase hybrid receives the trigger edge from the trigger hybrid, it starts the fine delay ramp. When the fine delay ramp reaches 0 volts, the 250 MHz startable oscillator inside the timebase hybrid will start running. The timebase hybrid outputs 250 MHz to the sample pulse generator drive circuitry and to the coarse delay counters on the horizontal board.

Coarse Delay Counters

The part of the coarse delay counters, which counts the 5 LSB's of the 17-bit coarse delay word is on the horizontal assembly. The 250 MHz signal from the timebase hybrid clocks these counters. Each time the 5 LSBs are counted and the counters roll over, the output of the counter's last stage toggles at a rate of 7.8 MHz (250 MHz divided by five counter stages is 7.8 MHz). The 7.8 MHz clocks the rest of the coarse delay counters which are on the horizontal control assembly. They count the 12 MSBs of the coarse delay word. Eventually all the counters reach terminal count and pull the LTC2 line to a logic low level. The next time the 5 LSB counters reach terminal count, they pull their own terminal count line to a logic low level. With all the coarse delay counters momentarily reaching terminal count at the same time, the sample pulse drive circuitry will pass one cycle of the 250 MHz.

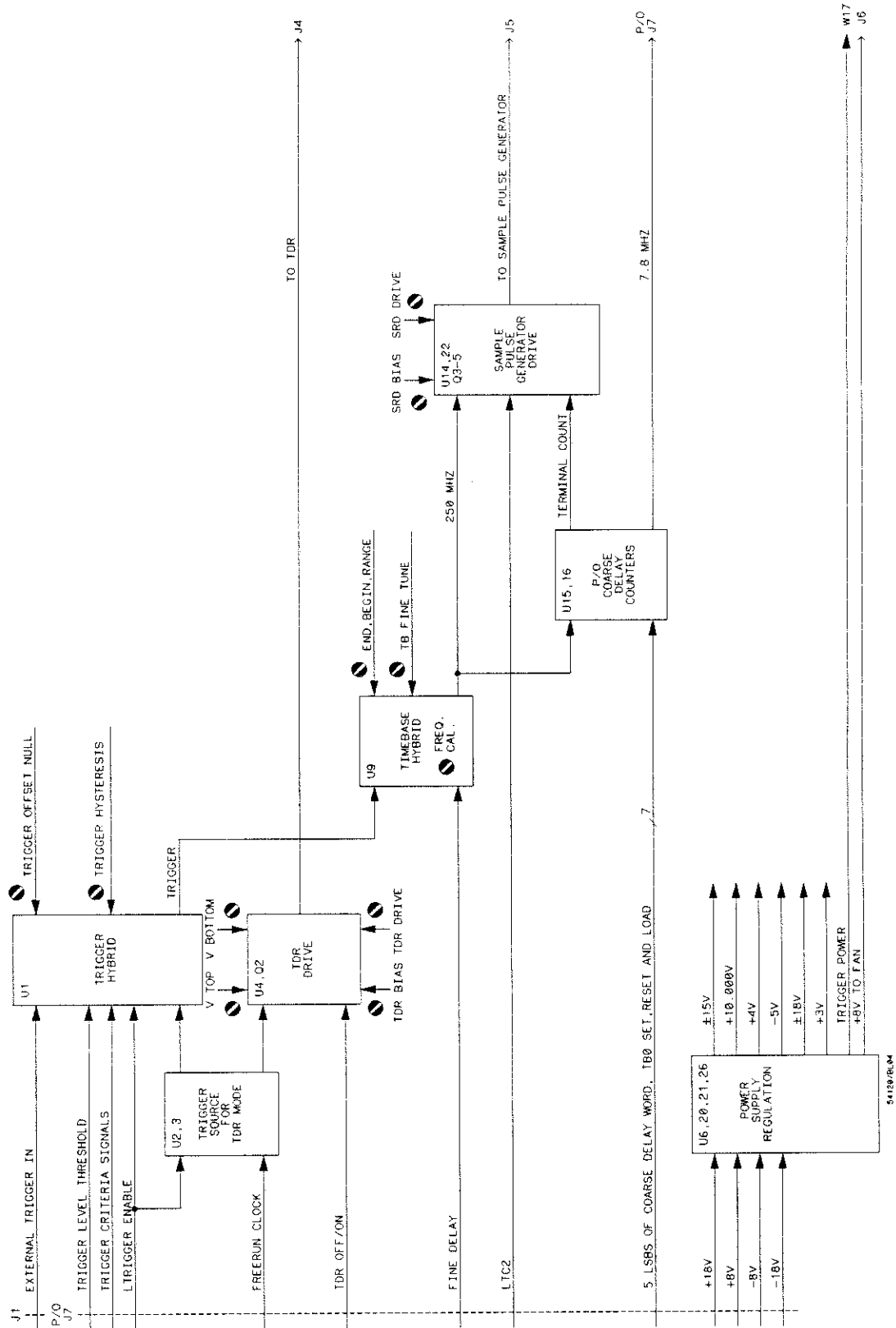


Figure 6B-3. Horizontal Assembly Block Diagram

**Sample Pulse
Generator Drive**

When all 17 bits of the coarse delay word have reached terminal count, the sample pulse generator drive circuitry will allow one pulse of the 250 MHz to pass. The sample pulse generator drive circuitry places 1 A of current for 1 ns in the sample pulse generator. The sample pulse generator outputs a fast edge pulse (rise time of about 50 ps), which momentarily turns on all four samplers at the same time.

| Mnemonics | Definition |
|------------------|--|
| HF REJECT | Trigger High Frequency Reject |
| LSB | Least Significant Bit |
| LTC2 | Low Terminal Count line 2 |
| MSB | Most Significant Bit |
| NEG/LPOS | Trigger Slope Select Negative or Positive |
| SRD | Step Recovery Diode (part of sample pulse generator) |
| TB0 SET | Timebase Bit 0 Set (TB0-4 are the 5 LSB's of the) |
| TB0 RESET | Timebase Bit 0 Reset (17 bit coarse delay word) |
| TB LOAD | Timebase Bit Load |
| TB1-4 | Timebase Bits 1-4 |
| TDR OFF/LON | Turns TDR Generator Off and On |
| LENABLE/RESET | Trigger Low Enable/Reset |

Troubleshooting

Table of Contents

Troubleshooting

| | |
|---|-------|
| Introduction | 6C-1 |
| Safety Considerations | 6C-1 |
| Recommended Test Equipment | 6C-1 |
| Logic Families Used | 6C-2 |
| Diagnostic Overview | 6C-2 |
| Data Acquisition Troubleshooting | 6C-2 |
| Preliminary Investigation | 6C-2 |
| Internal Diagnostic Loop Test | 6C-2 |
| Extended Service Test | 6C-3 |
| Analyzing Failures | 6C-3 |
| After Repairs Are Made | 6C-15 |
| Temperature Failures | 6C-20 |
| Internal Diagnostic Loop Tests | 6C-20 |
| Test Loop Considerations | 6C-21 |
| Loop 20 Data Acquisition | 6C-24 |
| Loop 21 Trigger Off/Freerun Off | 6C-27 |
| Loop 22 Trigger Level (1) | 6C-28 |
| Loop 23 Pos/Neg Slope | 6C-29 |
| Loop 24 Trigger Level (2) | 6C-31 |
| Loop 25 Coarse Delay Time | 6C-33 |
| Loop 26 Rate Generator | 6C-36 |
| Loop 27 Hysteresis Band Off | 6C-39 |
| Loop 28 A/D Conversion | 6C-40 |
| Loop 29 Feedthrough | 6C-43 |
| Loop 30 Data Acquisition (2) | 6C-44 |
| Loops 31-34 Channels 1-4 Check | 6C-45 |
| Loops 35-38 Channels 1-4 Sampler Gain | 6C-46 |
| Loop 39 TDR | 6C-47 |
| Extended Service Tests | 6C-48 |
| Sampler Test | 6C-50 |
| Umbilical Cable Test | 6C-51 |
| Fine Delay Test | 6C-54 |
| Sampler Input Test | 6C-58 |
| Sampler Swap Test | 6C-58 |
| Vertical Test | 6C-58 |
| A/D Test | 6C-62 |
| Pulse Filter Test | 6C-64 |
| TDR Test | 6C-67 |
| TDR System Test | 6C-68 |
| Trigger Test | 6C-70 |
| Probing Trigger Test | 6C-71 |
| Timebase/Trigger Test | 6C-72 |
| Horizontal Test | 6C-72 |

Introduction

This section contains internal diagnostics (Self-Tests) and troubleshooting information for fault location to the PC assembly level. Reading section 6B, "Theory," and section 6D, "Troubleshooting," in the *HP 54120B Mainframe Service Manual* can help in understanding this section.



This section assumes you have already performed all troubleshooting procedures, section 6D, in the *HP 54120B Mainframe Service Manual*.

Safety Considerations

The following warnings and cautions must be followed for your protection and to avoid damage to the equipment.



Maintenance described in this section is performed with power supplied to the instrument and with protective covers removed. Maintenance should be performed only by trained service personnel who are aware of the hazards involved (for example, fire and electrical shock). Where maintenance can be performed without power applied, the power should be removed. Read the Safety Summary in the front of this manual.



The HP 54124A is very sensitive to static discharge. Failure to observe proper antistatic methods may result in damage to the gallium arsenide samplers. All maintenance or operation should be performed while using an antistatic mat and wrist strap, which are supplied with the instrument.



Do not remove or replace any of the circuit board assemblies in this instrument unless instrument power is removed. The boards contain components which may be damaged if the board is removed or replaced when instrument power is applied.

Recommended Test Equipment

The equipment recommended for service is listed in table 1-1, section 1, "Recommended Test Equipment." Any equipment that satisfies the critical specifications stated in the table may be substituted.

Logic Families Used

Two different logic families are used in the HP 54124A, ECL and EECL. The horizontal assembly used ECL and EECL, and the vertical assembly uses EECL.

- ECL ranges from -0.9 V to -1.7 V and is used more often in the data acquisition circuitry where speed is of great importance.
- EECL ranges from 0 V to -0.8 V and is used on the outputs of many custom IC's.

Because the ECL high and the EECL low share about the same voltage level, it's possible that a misinterpretation of a logic level could occur. Extra care should be taken when dealing with these levels. The typical monitor oscilloscope offset levels are -1.3 V for ECL and -0.4 V for EECL.

Diagnostic Overview

This section is divided into two subsections for ease of use, internal diagnostic loop tests and extended service test. Start the diagnostics by first verifying the failure mode. The data acquisition troubleshooting will refer to paragraphs in the extended service tests.

Data Acquisition Troubleshooting

Data acquisition troubleshooting involves three processes: preliminary investigation, internal diagnostic loop test evaluation, and extended service test evaluation.

Note

The HP 54124A contains gallium arsenide samplers that are very sensitive to electrostatic discharge (ESD) damage. The samplers may be the cause of many data acquisition problems. Before analyzing other data acquisition failures, the extended service sampler test should be run first.

Preliminary Investigation

Preliminary investigation involves three processes: determining which data acquisition assemblies are operating properly, making an informed decision on which assembly or assemblies might be causing the fault, checking some common failure mechanisms. To achieve these results loop test failures are compared against the assemblies which might cause the failure, loop failure patterns are compared against a known set of loop failure patterns, and the functional block diagram is used to decide the fault's probable location.

Internal Diagnostic Loop Test

Internal diagnostic loop tests evaluate why a particular loop failed. The preliminary investigation may indicate which loop to evaluate first; however, the lowest numbered loop is usually evaluated first. When evaluating loop failures, first decide why this loop failed and why others may have passed. This will often indicate the possible failing assembly. Second, use the loop failure status codes to indicate why this loop is failing. Third, probe specific interconnect points to verify which assembly is faulty.

| | |
|-----------------------------------|---|
| Extended Service Test | Extended service tests execute routines which check if assemblies are supplying the correct signals to other assemblies. This may indicate why a loop failed and the probable faulty assembly. Executing all the extended service tests would take more time than an analysis of the internal individual diagnostic loop tests. There are two reasons for the extended service tests. First, for persons familiar with the oscilloscope it may be a troubleshooting short cut because they sometimes can predict which extended service test to execute for particular failure symptoms. Second, internal diagnostic loop tests do not cover all instrument failures. |
| Analyzing Failures | <ol style="list-style-type: none"> 1. Analyze the functional block diagram and the simplified assembly interconnect diagram, figures 6C-1 and 6C-2, to determine which assemblies could cause the failure. 2. Analyze the failing loop tests and refer to tables 6C-1 and 6C-2 to determine which assembly might be failing. 3. Eliminate working assemblies and eliminate assemblies that appear to fail but are failing because of a different problem. 4. Refer to the following troubleshooting hints. |
| Not Triggering | This could be caused by the trigger hybrid, timebase hybrid, A/D assembly, pulse filter, interconnecting ribbon cables, horizontal assembly, or horizontal control assembly. |
| Vertical Problems | This could be caused by the sampler, vertical assembly, A/D assembly, or interconnecting cables. |
| Horizontal Problems | This could be caused by the trigger hybrid, horizontal assembly, horizontal control assembly, or interconnecting cables. |
| Multiple Channel Failures | If the oscilloscope is triggering and the horizontal is working, the problem could be the A/D assembly. If the oscilloscope is not triggering, the fault may be the trigger hybrid, horizontal assembly, horizontal control assembly, or interconnecting cables. |
| One Channel Failure | This could be caused by the sampler, vertical assembly, A/D assembly, umbilical cable, pulse filter, or semi-rigid cables. |
| Channel 1 Failure Only | In addition to the single channel failures listed above, possibly the TDR step generator. |
| TDR Problem | This could be caused by the TDR step generator, horizontal assembly, horizontal control assembly, umbilical cable, and two ribbon cables which connect the umbilical cable to the vertical and horizontal assemblies. |
| One Channel Offset Problem | Probably caused by the sampler hybrid. Other failures may be the A/D assembly, vertical assembly, umbilical cable, or interconnecting cables. |

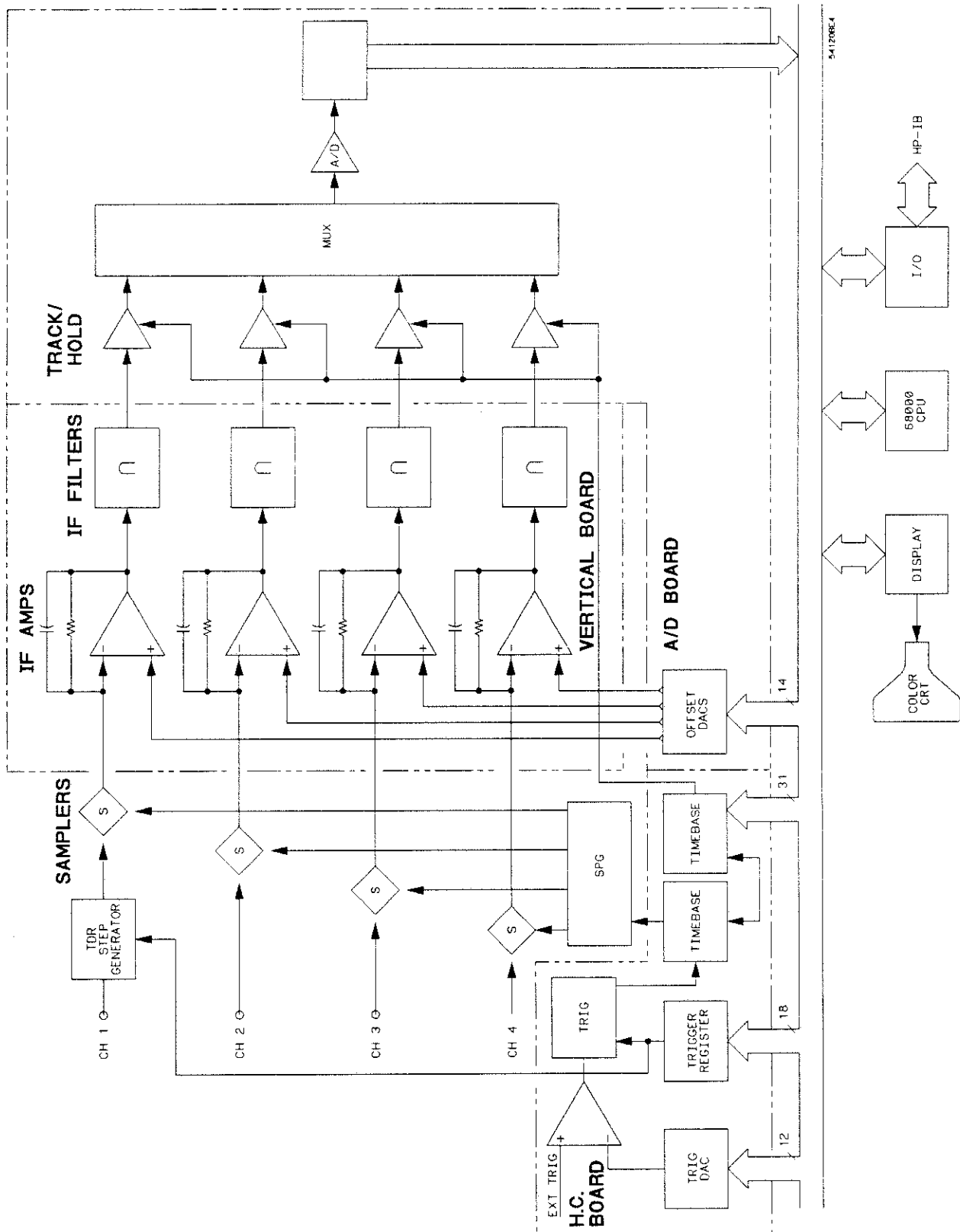


Figure 6C-1. HP 54120 System Functional Block Diagram



HP 54124A

Service Manual

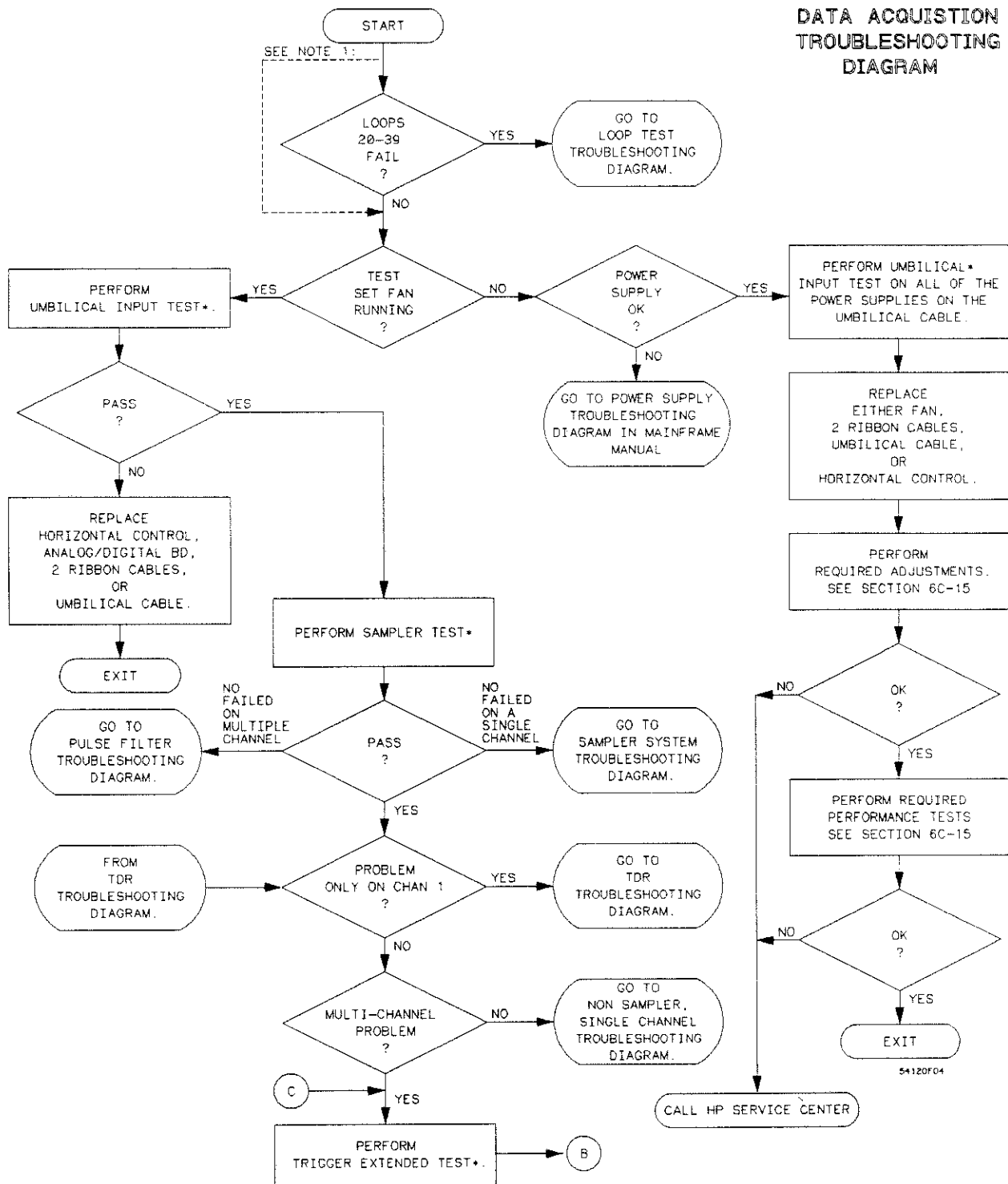
Table 6C-1. Assemblies Tested by Loop Tests

| Assembly | Loop No. |
|--------------------|-----------------|
| TDR | 39 |
| A/D | 16, 28-39 |
| Horizontal control | 17, 20, 22-30 |
| Vertical | 35-38 |
| Horizontal | 20, 22-29 |
| Samplers | 31-39 |
| Pulse filter | 31-39 |
| Trigger hybrid | 20, 21-38 |
| Display | 5-9, 41, 42 |
| I/O | 10-15, 43 |
| CPU | 0-4, 40 |
| RPG | 15 |

Table 6C-2. Adjustments That Can Cause Loop Failures

| Loop No. | Adjustment |
|-----------------|--|
| 1-17 | None |
| 18-19 | Loop not used |
| 20 | Hysteresis |
| 21 | None |
| 22-25 | Hysteresis (loop 24 - trigger offset also) |
| 26 | None |
| 27-30 | Hysteresis (loop 30 - offset gain also) |
| 31-34 | SRD Drive and Sampler Bias, Hysteresis |
| 35 | SRD Drive and Sampler Bias, Hysteresis, LB1, HB1 |
| 36 | SRD Drive and Sampler Bias, Hysteresis, LB2, HB2 |
| 37 | SRD Drive and Sampler Bias, Hysteresis, LB3, HB3 |
| 38 | SRD Drive and Sampler Bias, Hysteresis, LB4, HB4 |
| 39 | SRD Drive and Sampler Bias, V top and bottom |
| 40-43 | None |

DATA ACQUISITION TROUBLESHOOTING DIAGRAM



* SEE EXTENDED SERVICE TEST SECTION
NOTE 1: DEPENDING ON THE FAILURE AND THE EXPERIENCE OF THE TECHNICIAN, THE DECISION BOX MAY BE SKIPPED.

Figure 6C-3. Data Acquisition Troubleshooting Flowchart 1

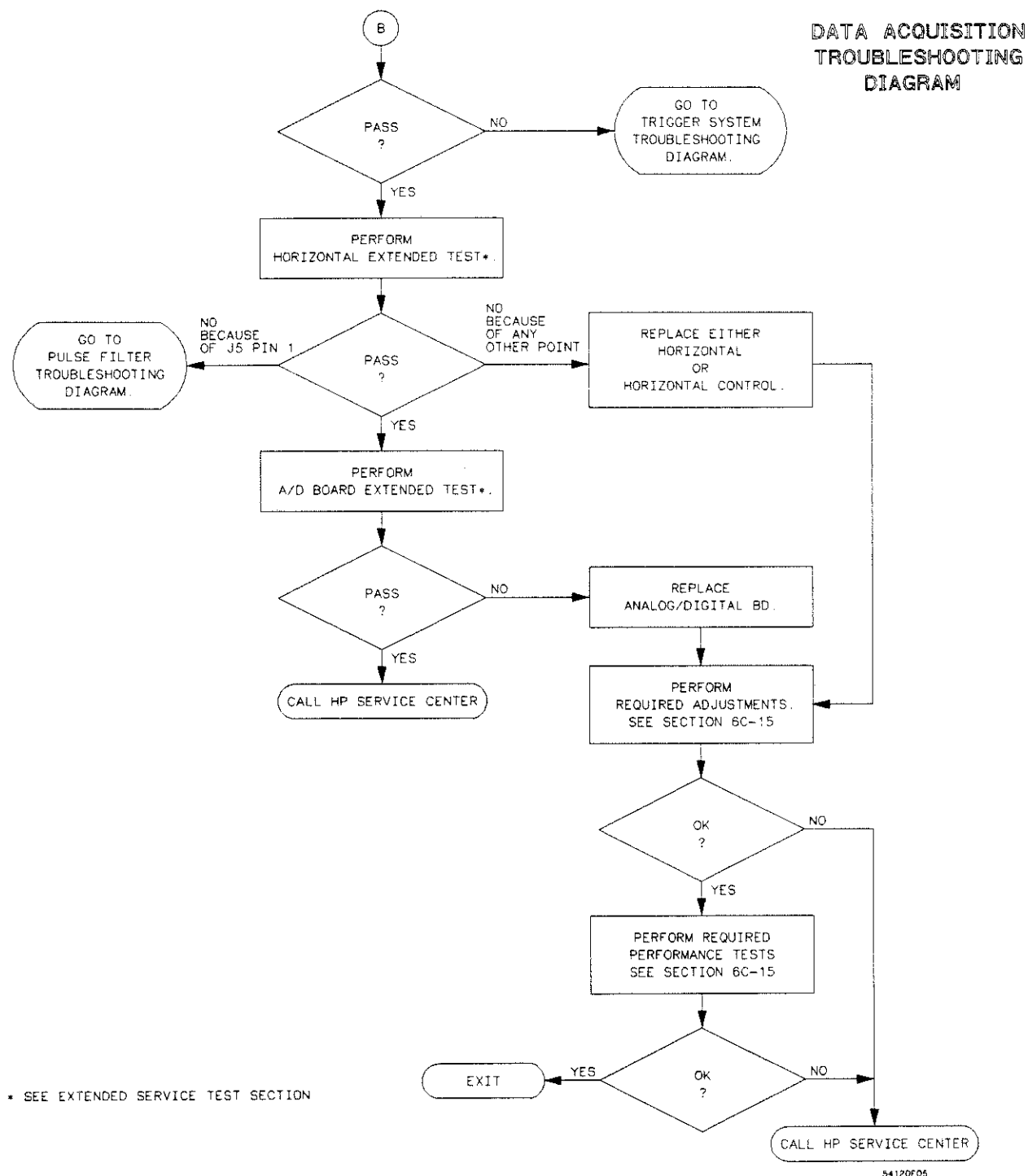


Figure 6C-4. Data Acquisition Troubleshooting Flowchart 2

LOOP TEST TROUBLESHOOTING DIAGRAM

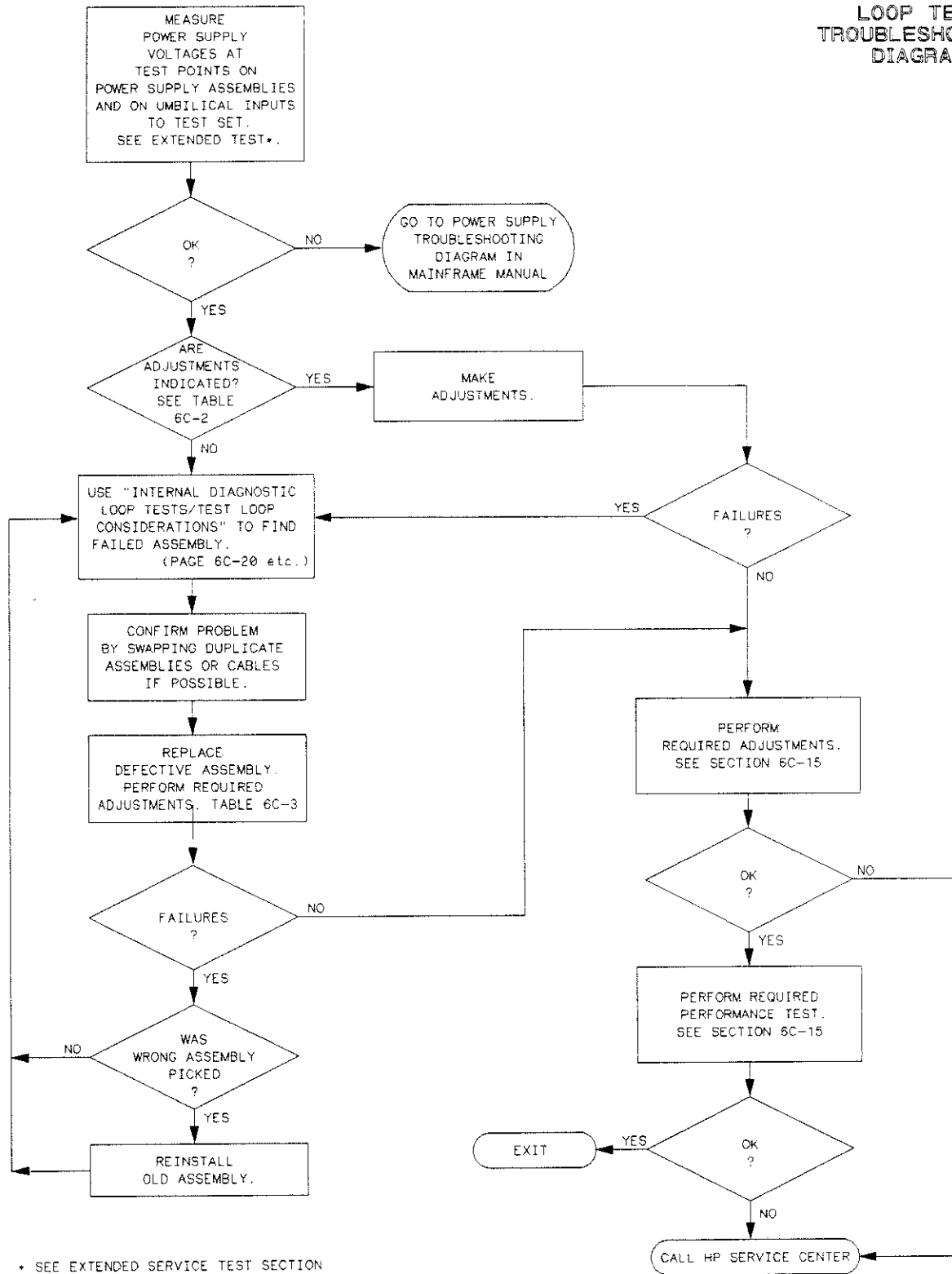


Figure 6C-5. Loop Test Troubleshooting Flowchart

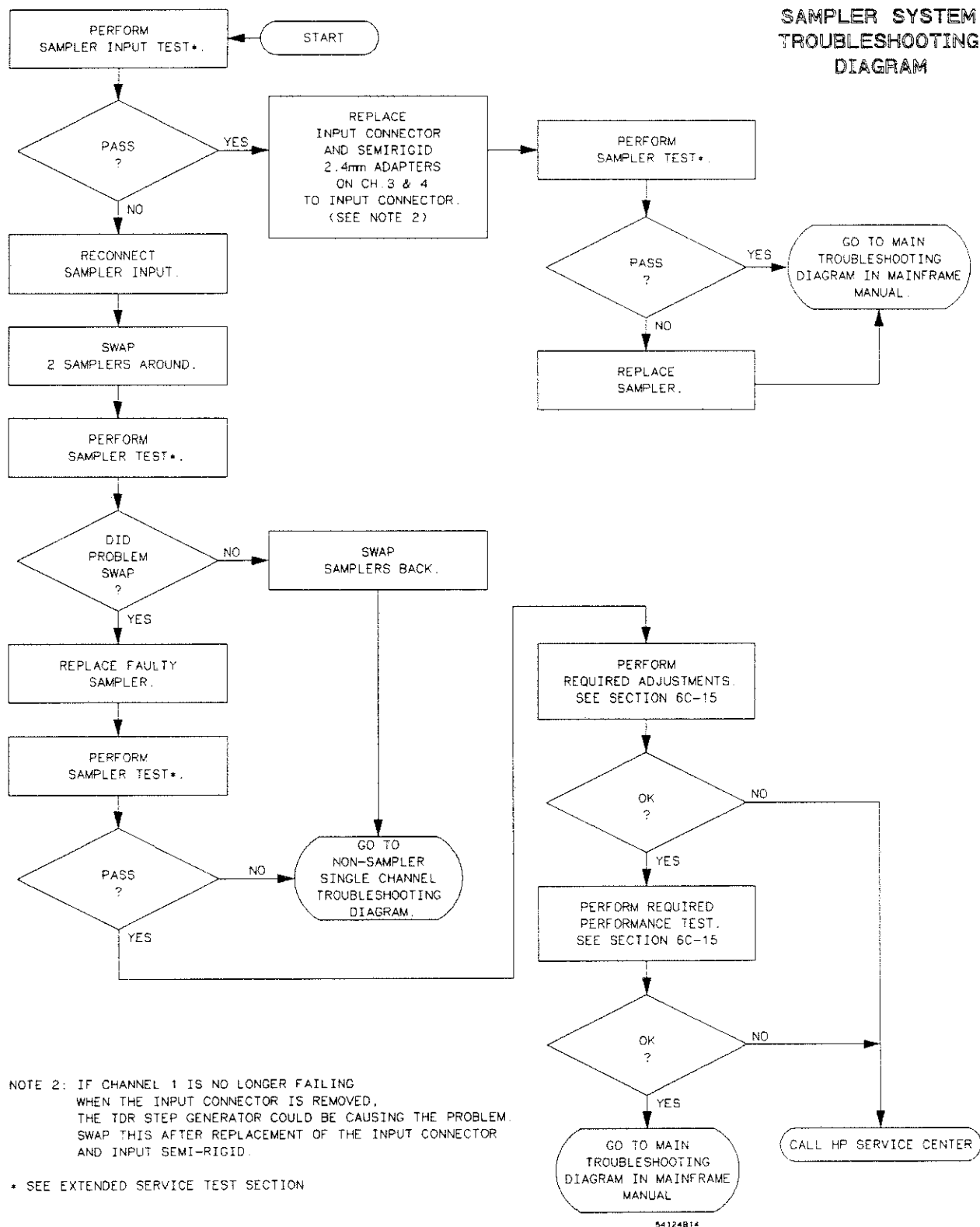
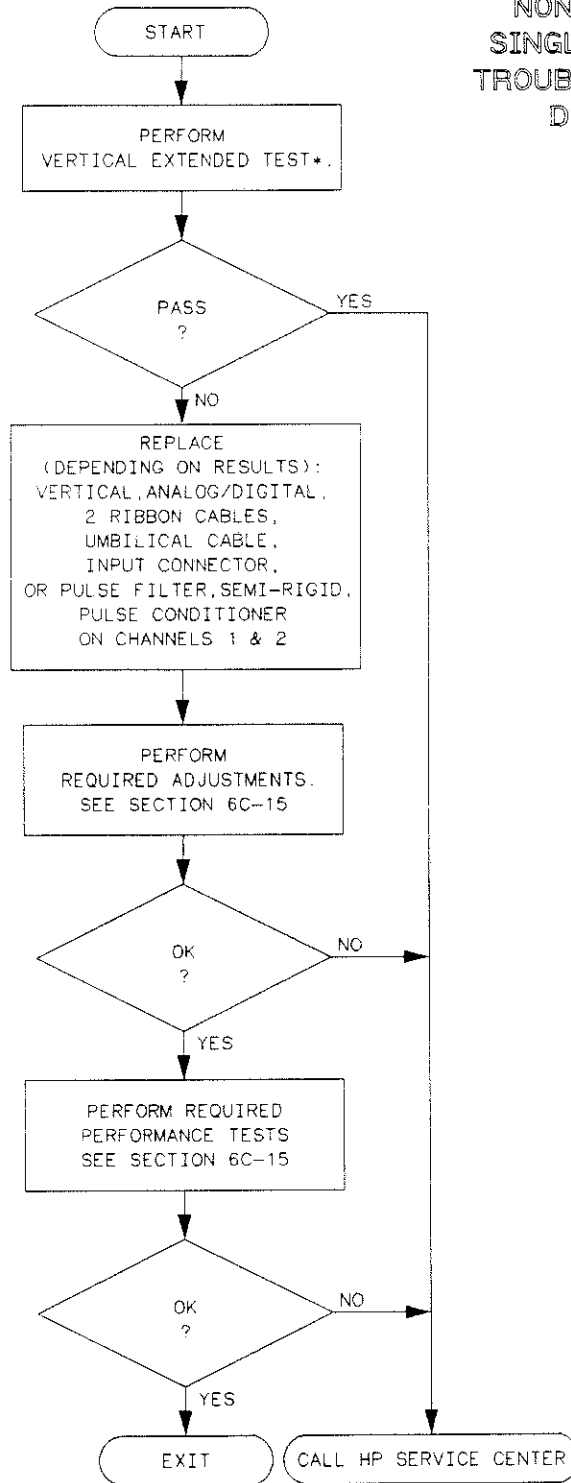


Figure 6C-6. Sampler Troubleshooting Flowchart

NON-SAMPLER
SINGLE CHANNEL
TROUBLESHOOTING
DIAGRAM

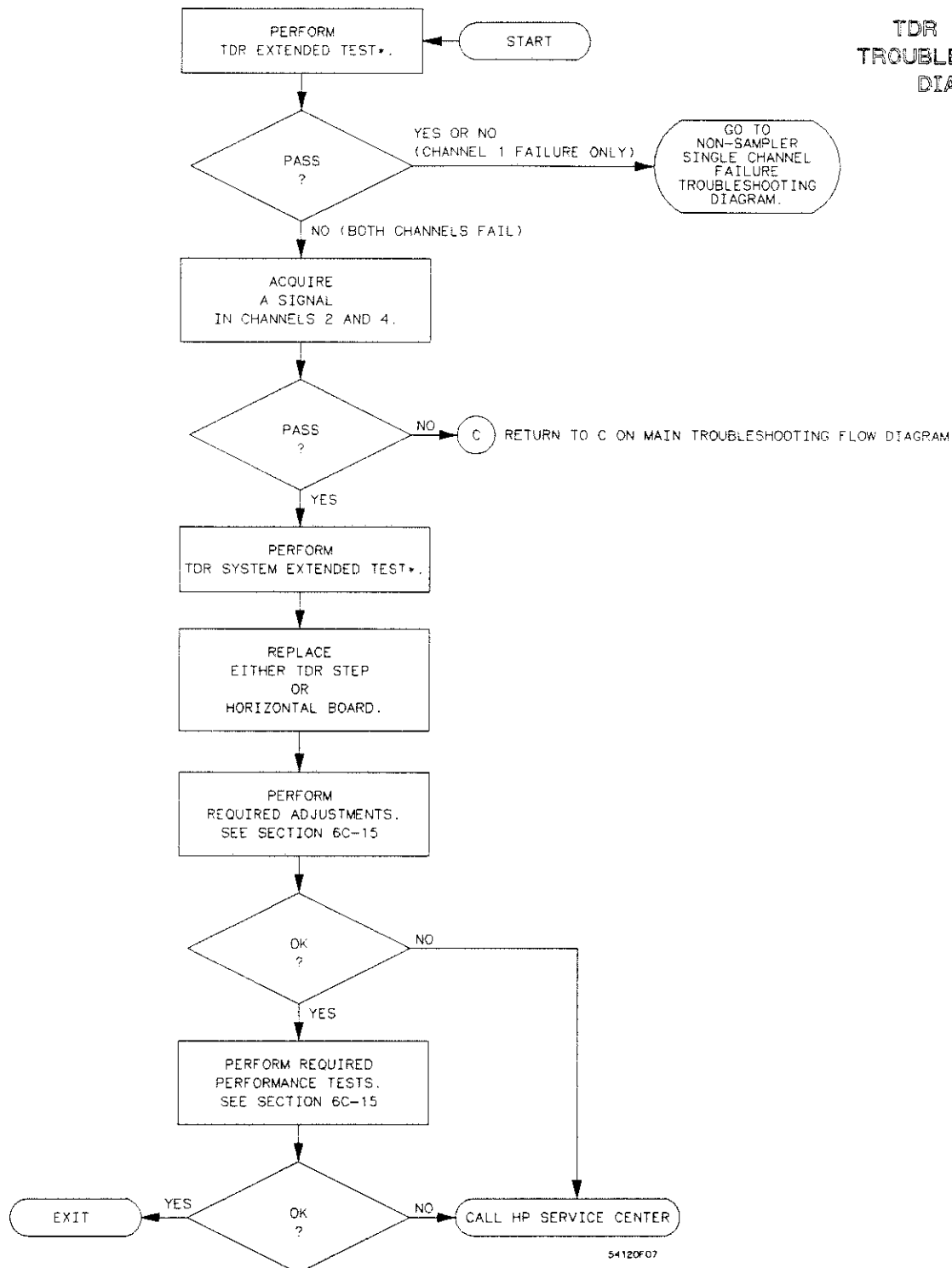


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* SEE EXTENDED SERVICE TEST SECTION

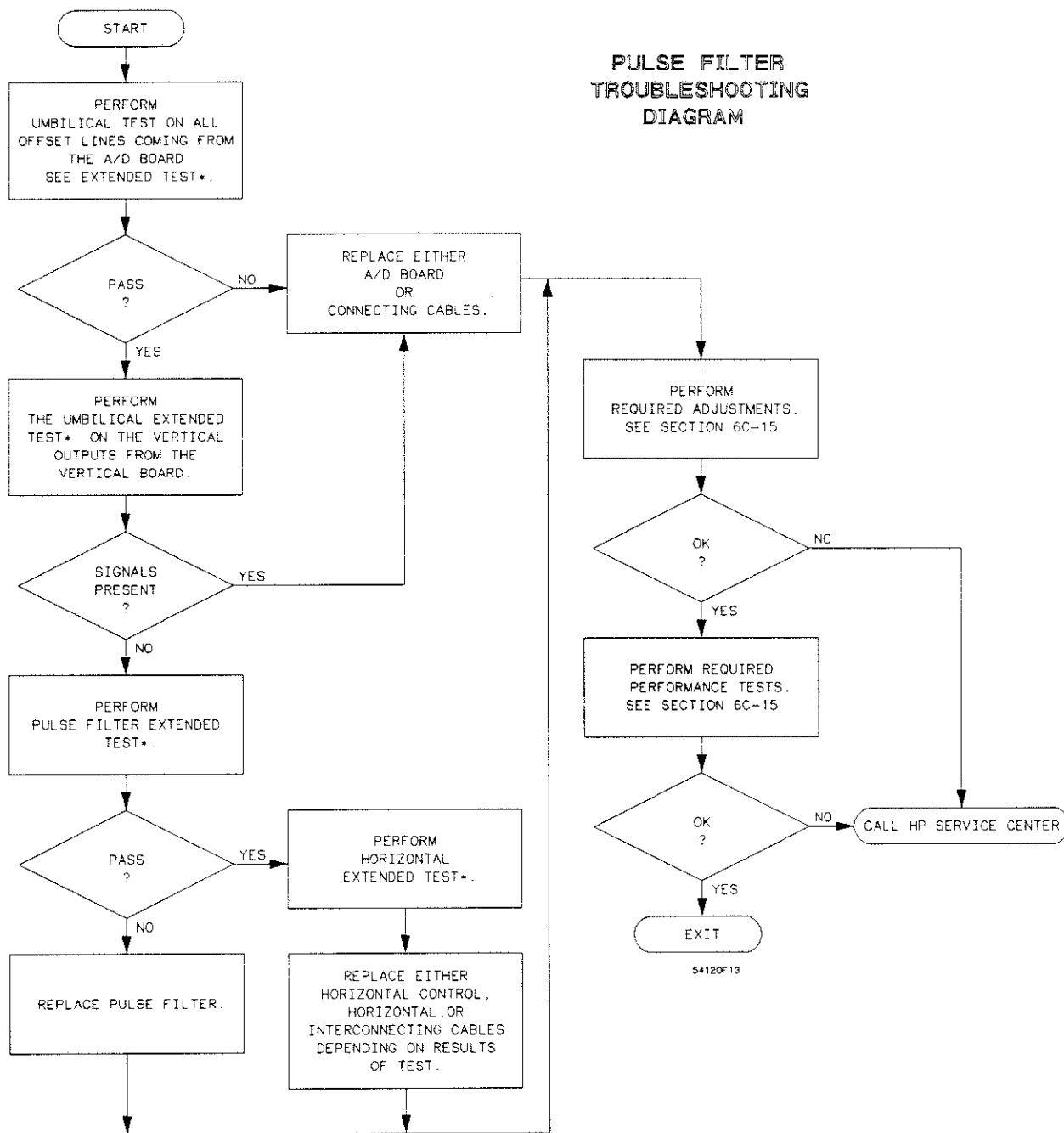
Figure 6C-7. Single Channel Troubleshooting Flowchart

TDR SYSTEM TROUBLESHOOTING DIAGRAM



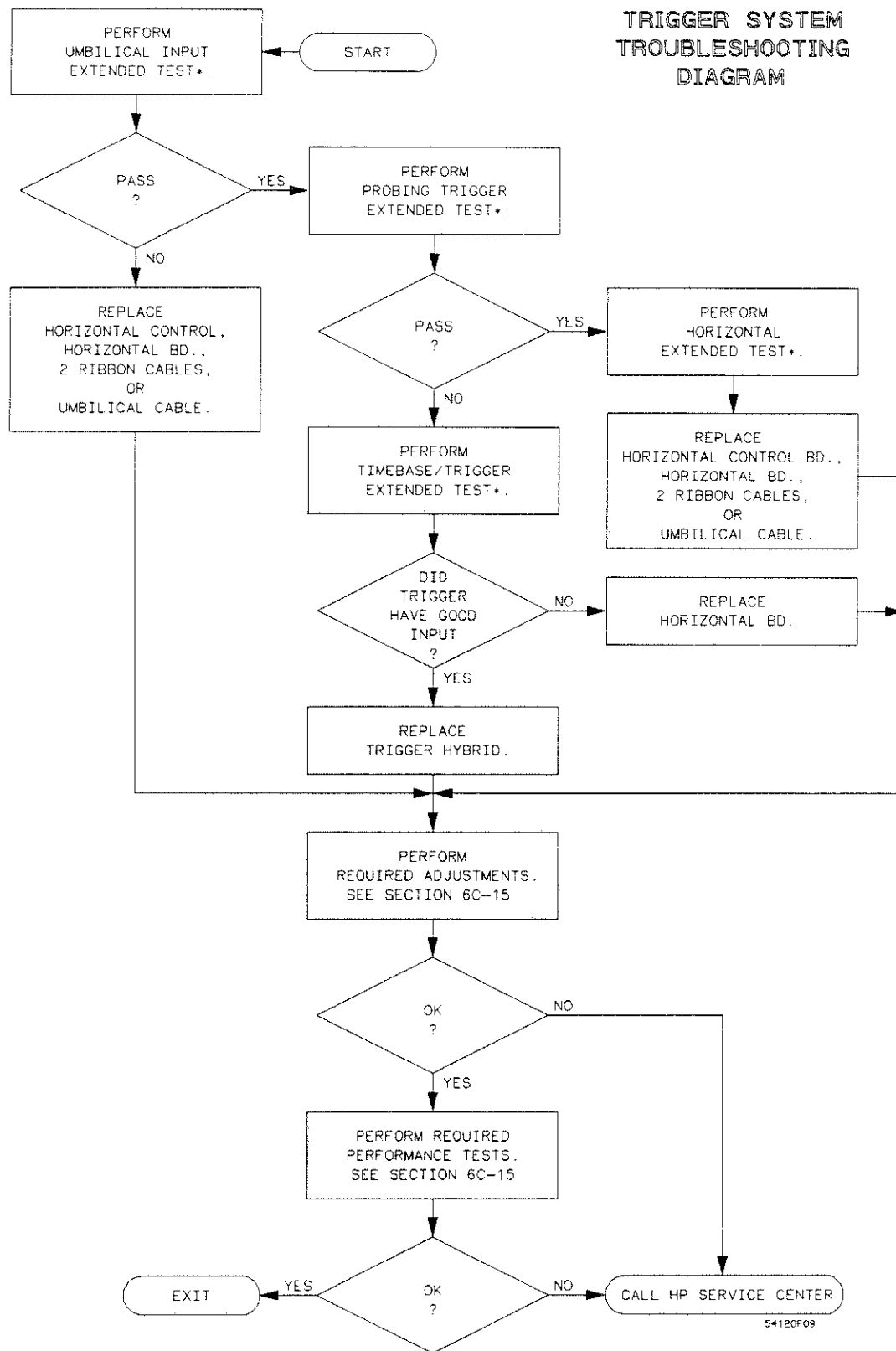
* SEE EXTENDED SERVICE TEST SECTION

Figure 6C-8. TDR Troubleshooting Flowchart



* SEE EXTENDED SERVICE TEST SECTION

Figure 6C-9. Pulse Filter Troubleshooting Flowchart



* SEE EXTENDED SERVICE TEST SECTION

Figure 6C-10. Trigger Troubleshooting Flowchart

After Repairs Are Made

After the faulty assembly has been found, the following three tables should be used. Table 6C-3 cross references which adjustments to perform after replacing an assembly. Table 6C-4 cross references which performance tests to check after doing the adjustments. Table 6C-5 cross references which performance tests to perform after replacing an assembly.

Table 6C-3. Adjustments to Check after Assembly Repairs

| Assembly Replaced | Adjustments that should be performed |
|--------------------------|--|
| A/D Assembly | 10 V reference, Software calibration |
| Horizontal Control | Delta Current, Software calibration |
| Horizontal Assembly | All horizontal adjustments, vertical adjustments, software calibration |
| Vertical Assembly | LB1-4, HB1-4, OG1-4, RC1-4, CC1-4, Software calibration |
| Sampler | LB, HB, OG, RC, CC, and Softcal (only on channel where sampler was replaced) |
| TDR Step Generator | TDR Bias and Drive, V top and bottom, Software calibration |
| Pulse Filter | SRD Drive and Bias, Sampler Bias, Offset Gain, vertical software calibration |
| Display Assembly | No adjustments need to be performed |
| I/O | Software calibration |
| CPU | Software calibration |
| Color CRT Assembly | No adjustments need to be performed |
| Trigger Hybrid | Trigger hysteresis and offset null |
| Pulse Conditioner | SRD Drive and Bias, Sampler Bias, Vertical software calibration |

Table 6C-4. Performance Tests to Check after Adjustments

| Adjustment Made | Performance Test to Perform |
|--------------------------|---|
| Power Supply | None |
| Delta Current | Time base accuracy |
| 10 V reference | dc measurement accuracy |
| Range | Timebase accuracy |
| SRD | Bandwidth, dc measurement accuracy |
| Frequency, END, 4 ns cal | Time base accuracy |
| Sampler Bias | Adjusted channel only: bandwidth, dc measurement accuracy |
| TDR | TDR |
| Feedthrough compensation | Adjusted channel only: bandwidth, dc measurement accuracy |
| Trigger | Trigger sensitivity, jitter |
| Channel Skew Cals | None |
| Vertical Vertical Cal | None |
| Display | Color confidence test |

Table 6C-5. Performance Tests to Check after Repairs

| Assembly Replaced | Performance Tests That Should Be Performed |
|--------------------------|---|
| Vertical | Bandwidth, dc Measurement Accuracy, Input Reflection on channels only |
| A/D | Bandwidth, dc Voltage Measurement Accuracy |
| Horizontal | Timebase Accuracy, Input Reflection on external trigger input only, Trigger, Sensitivity, Jitter, TDR |
| Horizontal Control | Timebase Accuracy |
| Sampler | Bandwidth, dc Voltage Measurement Accuracy, Input Reflection, Jitter (perform these tests on channel with replaced sampler) |
| TDR Step Generator | TDR system |
| Pulse Filter | Jitter |
| Trigger Hybrid | Input Reflection on external trigger input only |
| CPU | None |
| I/O | None |
| Display | Color Confidence Test |
| Color CRT Assembly | Color Confidence Test |
| Pulse Conditioner | Bandwidth |

Table 6C-6. Adjustment Effect on the Displayed Performance

Several adjustments directly influence the performance of the waveform displayed on the screen. The following is a list of common symptoms which are caused by misadjustments. Many adjustments interact with other adjustments and should not be varied without first referring to the description of each adjustment.

| Symptom | Adjustment to check |
|--|----------------------------------|
| Unstable out of specification timebase measurements | Range |
| Stable out of specification timebase measurements | Frequency |
| Discontinuities on sine waves > 250 MHz | END and 4 ns cal |
| TDR levels not 0 V and 200 mV | TDR top and bottom |
| TDR overshoot not between 2.5% and 3.5% | TDR bias and drive |
| TDR pulse response not flat | TDR bias and drive |
| Channel to channel skew off | Timebase software calibration |
| Gain difference between the 12.4 GHz and 20 GHz or between persistence and average modes | Vertical software calibration |
| Minimum trigger sensitivity > 1 division | Trigger |
| Trigger offset problems | Trigger |
| Not triggering at center screen (remember there is always 16 ns minimum delay) | Trigger |
| Faulty color purity | Color monitor |
| Faulty contrast or brightness | Front panel display controls |
| Faulty low frequency square wave response | Feedthrough compensation |
| Faulty gain tracking between 12.4 GHz and 20 GHz bandwidth modes | Sampler bias |
| Loops 31-38 failing | Sampler bias |
| Faulty gain on all channels or loops 31-38 failing | SRD |
| Faulty performance when swapping four channel test sets | 10 V reference and delta current |

Table 6C-7. Loops Affected by Hardware Failures

Hardware failures are indicated with the following loop failures and status line indications.

| Hardware | Loop | Status Line |
|---|-----------------------|-----------------------------------|
| A to D converter on A/D assembly | 28 | STS 1 = -4 |
| | 29 | |
| | 30 | |
| | 31-34 | STS 1 = -4, STS 3 = -4 |
| | 35-38 | STS 1 = -6, STS 3 = -6 |
| | 39 | STS 1 = -5, STS 4 = 0 |
| A/D assembly output wrong bit pattern | 28 | STS 2 = read pattern |
| Offset DAC on A/D assembly Chan 1 | 31, 35 | STS 1 = -4, -5, STS 3 = -4, -5 |
| Offset DAC on A/D assembly Chan 2 | 32, 36 | STS 1 = -4, -5, STS 3 = -4, -5 |
| Offset DAC on A/D assembly Chan 3 | 33, 37 | STS 1 = -4, -5, STS 3 = -4, -5 |
| Offset DAC on A/D assembly Chan 4 | 34, 38 | STS 1 = -4, -5, STS 3 = -4, -5 |
| Bandwidth bias | 35-38 | STS 1 = -4, STS 3 = -4 |
| Sampler Chan 1 | 31, 35, 39 | STS 1 = 5, STS 3 = 0 (on loop 39) |
| Sampler Chan 2 | 32, 36 | |
| Sampler Chan 3 | 33, 37 | |
| Sampler Chan 4 | 34, 38 | |
| SRD not generating a pulse | 31- 34, 35-38 | STS 1, 3 = -4, STS 2, 4 = 0 |
| | 39 | STS 1 = -5, STS 4 = 0 |
| SRD pulse not getting to samplers | 39 | STS 1 = -5, STS 4 = 0 |
| Timebase on horizontal or horizontal control assemblies | 20, 24, 27, 28, 31-39 | STS 1 = -2 |
| | 22, 26 | STS 1 = -3 |
| | 23 | STS 1 = -3, STS 2 = -3 |
| | 25 | STS 1 = -2, STS 2 = -2 |
| | 29 | STS 1 = 8002H, STS 2-4 = 8002H |
| | 30 | STS 1 = 8002H |
| Freerun clock not being generated | 26 | STS 1 = -3 |
| Trigger hybrid slope not changing | 39 | STS 1 = -2 |
| | 20, 27, 28, 31-38 | STS 1 = -2 |
| | 23 | STS 1 = -3 or STS 2 = -3 |
| | 25 | STS 1 = -2 or STS 2 = -2 |
| | 29 | STS 1 = 8002H, STS 2-4 = 8002H |
| | 30 | STS 1 = 8002H |
| Trigger level DAC output not changing or trigger hybrid not responding to a change in trigger level | 22 | STS 1 = -3 |
| | 23 | STS 1 = -3, STS 2 = -3 |
| | 24, 27 | STS 1 = -2 |
| RPG cannot be reset | 15 | STS 1 = -1 |
| Static RAMs | 2 | Chip problems |
| | 40 | Address line problem |
| Graphics RAMs | 8 | Chip problems |
| | 41 | Address line problem |
| I/O RAM's | 11 | Chip problems |
| | 43 | Address line problem |
| Priority RAMs | 9 | Chip problems |
| | 42 | Address line problem |
| Character RAMs | 7 | Chip problems |

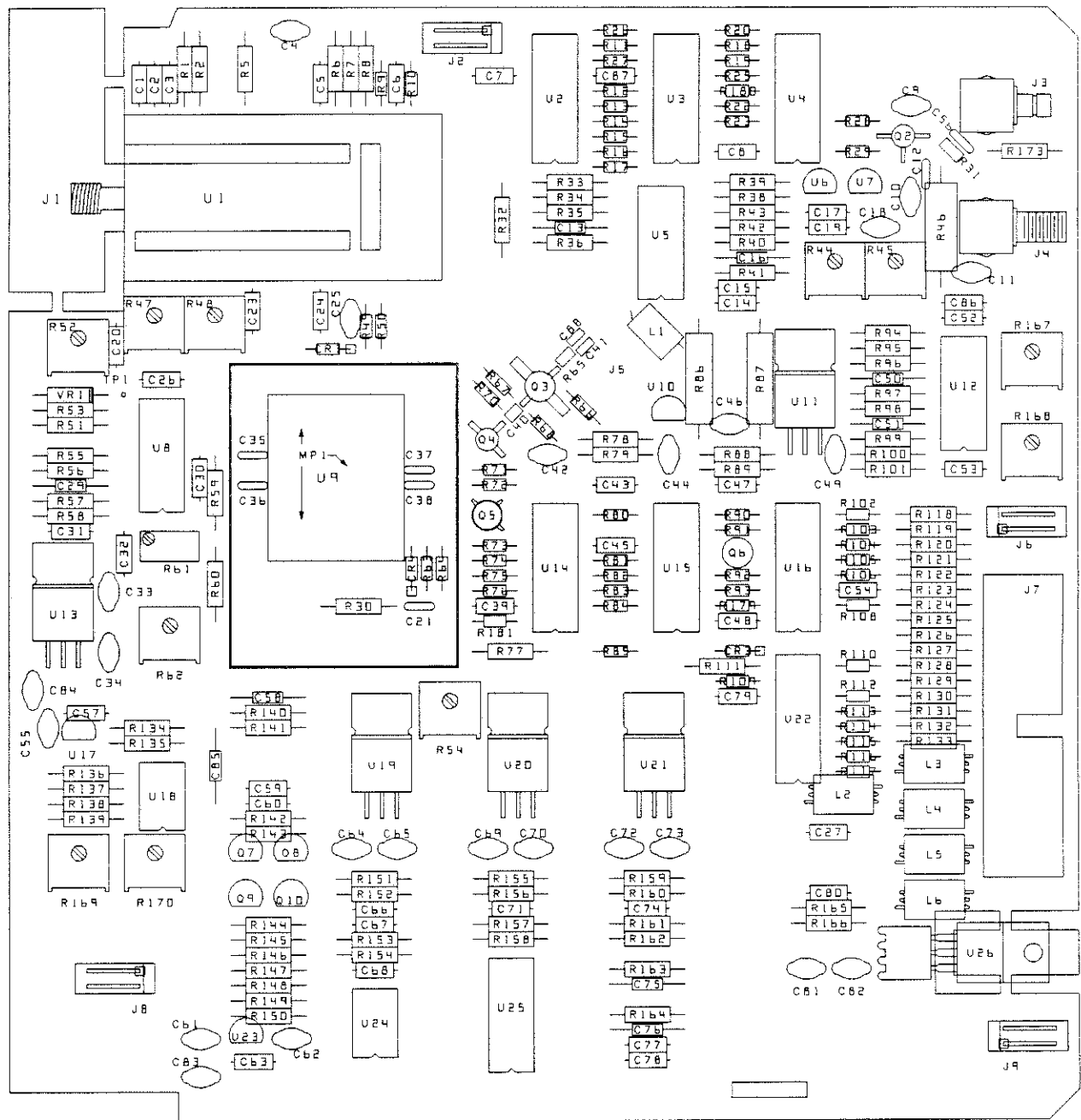


Figure 6C-11. Horizontal Assembly Component Locator

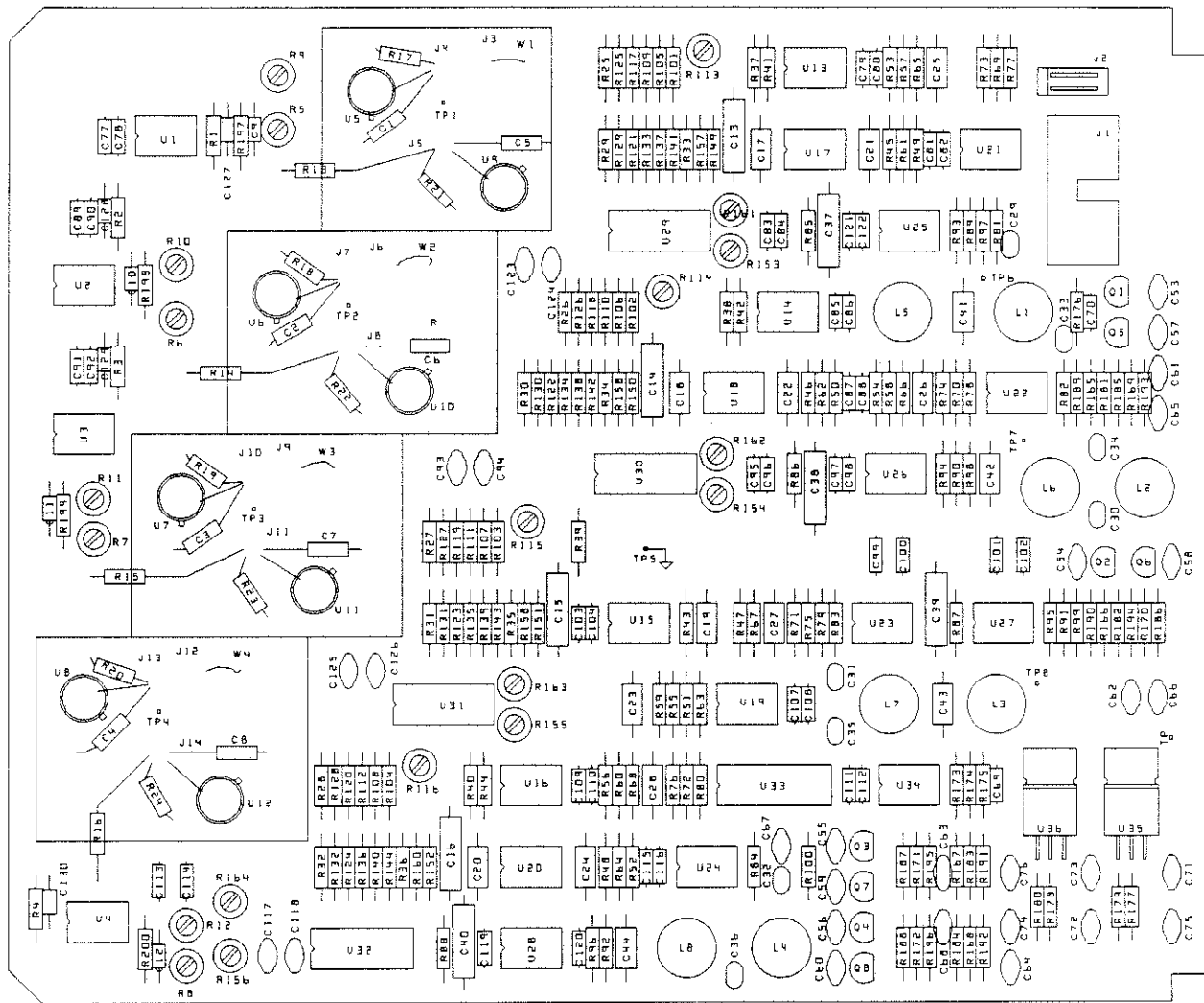


Figure 6C-12. Vertical Assembly Component Locator

Temperature Failures

The four channel test set contains two temperature compensation networks. The first is a temperature sensor attached to the main deck and is used to vary some operating bias levels with changing instrument temperatures. The second is a temperature sensing network for keeping the timebase hybrid working consistently with changes in temperature.

When a temperature problem occurs in the four channel test set, first verify that the fan is operating by visually checking to see if its blades are turning. If the fan seems inoperative, then measure between J6 pins 1 and 2 on the horizontal assembly. The voltage level should be approximately 8 V dc.

If the fan is operating, replace temperature sensor and cable W16 fastened to the test set's main deck. If temperature problems persist, then monitor U5 pins 6 and 13 on the horizontal control assembly while using a heat source and cool spray on the timebase hybrid (U9) on the horizontal assembly in the test set. U5 pin 6 should change -100 mV per degree C, and U5 pin 13 will change +100 mV per degree C.

Internal Diagnostic Loop Tests

The HP 54120B and HP 54124A are tested by 44 (numbered 0-43) internal diagnostic loop tests. When these loop tests pass, the instrument is considered functionally operational to a 90% confidence level. The loop tests are also a major troubleshooting tool for the instrument. To run the loop tests follow these five steps.

1. Remove the SMA short from channel 1 (if one is installed), then perform a one key-down powerup.
2. Press the **More** menu key, **Utility** menu key, **Test Menu** key, and **Extended Tests** key. Press keys numbered 1 and 2 on the keyboard, then press the **Enter** key. Press the **Start Test** key.
3. The instrument will run loops 0-43 executing each loop once whether they pass or fail.
4. Wait a few seconds until the oscilloscope displays graticules on the screen.
5. Press the **More** menu key, **Utility** menu key, and **Test Menu** key, and press **Display Errors** key. The failing loops will be displayed on the screen.

Repeat Loop

Selecting this mode continuously executes the Loop number entered at REPEAT LOOP. Pressing Start Test will start execution and the loop will continuously run until the Stop Test key is pressed. Pressing Display Errors will show how many times the loop was executed and the number of times the loop failed.

There are a number of loops that will blank or overwrite the Stop Test key display on the CRT. However, the test can still be terminated by pressing the third function key from the top.

Run From Loop

Selecting this mode starts execution from the loop entered and will proceed to execute all higher numbered loops. Upon reaching the last test, the cycle will be repeated.

If any test should fail, the instrument will change from **RUN FROM LOOP** to **REPEAT LOOP** and will repeatedly execute the loop that failed until the Stop Test key is pressed.

Test Loop Considerations

Troubleshoot the lowest loop numbers first. Higher loop numbers are usually dependent on lower loop numbers passing. Table 6C-9 cross references which assemblies are tested by which loops.

Some loops may fail if the adjustments are misadjusted. Before replacing costly assemblies refer to table 6C-8 to find out if any adjustments are causing loop failures.

The powerup self test routine includes only loops 0-17.

Before analog loops 20-39 are executed, loops 16 and 17 must pass. Loops 20-39 also require a trigger pulse for the samplers and A/D. There are three ways to generate this trigger.

1. FR - Freerun clock
2. SL - switching the trigger slope, this toggles the trigger slope line to the trigger comparator
3. TL - Changing the trigger level, this changes the trigger level DAC's output. Table 6D-15 describes which of these trigger generation methods is used for each of the loop tests.

If the SMA short is not removed from channel 1's input connector, loop 39 will fail and display a caution message on the screen.

Loops 20-24 test the oscilloscope's triggering capability. For these loops to pass, the following must be operating: horizontal control assembly, umbilical cable, ribbon cables connecting umbilical cable to horizontal and vertical assemblies, trigger hybrid, trigger input, and horizontal assembly. The vertical assembly, A/D assembly, samplers, pulse filter, and vertical input circuitry are not checked by these loops.

Loops 25-26 test the oscilloscope's horizontal assembly. Loops 20-24 must pass before loops 25-26 will pass. The circuitry tested and not tested for loops 25-26 are the same as loops 20-24.

Loop 27 tests the operation of HF reject and trigger sensitivity. For this loop to pass, loops 20-26 must pass. The circuitry tested and not tested in loop 27 are the same as loops 20-24.

Loops 28-30 test the vertical signal path with signals at ground levels. This requires that all the data acquisition modules are functional. If loops 20-27 pass, then the failure of loops 28-30 usually indicates the failure is in the vertical signal path: sampler, vertical assembly, A/D assembly. Loop 28 also checks the A/D assembly timing between channels during the A to D conversion.

Loops 31-38 test the data acquisition system's ability to acquire data. It tests the samplers, vertical assembly, and A/D assembly.

Loop 39 tests the TDR step's high and low levels. This loop requires all the data acquisition loops to pass. If only this loop fails, it probably indicates a failure in the TDR step generator system, horizontal assembly's TDR bias circuitry, or possibly a problem in channel 1. Loop 39 will fail if channel 1 is terminated.

Table 6C-8. Adjustments That Can Cause Loop Failures

| Loop No. | Adjustment |
|-----------------|--|
| 1-17 | None |
| 18-19 | Loop not used |
| 20 | Hysteresis |
| 21 | None |
| 22-25 | Hysteresis (loop 24 - trigger offset also) |
| 26 | None |
| 27-30 | Hysteresis (loop 30 - offset gain also) |
| 31-34 | SRD Drive and Sampler Bias, Hysteresis |
| 35 | SRD Drive and Sampler Bias, Hysteresis, LB1, HB1 |
| 36 | SRD Drive and Sampler Bias, Hysteresis, LB2, HB2 |
| 37 | SRD Drive and Sampler Bias, Hysteresis, LB3, HB3 |
| 38 | SRD Drive and Sampler Bias, Hysteresis, LB4, HB4 |
| 39 | SRD Drive and Sampler Bias, V top and bottom |
| 40-43 | None |

Table 6C-9. Assemblies Tested by Loop Tests

| Assembly | Loop Number |
|--------------------|----------------------------|
| TDR | 39 |
| A/D | 16, 28-39 |
| Horizontal control | 17, 20, 22-39 |
| Vertical | 31-39 |
| Horizontal | 20, 22-39 |
| Samplers | 31-39 |
| Pulse filter | 31-39 |
| Trigger hybrid | 21-39 |
| Display | 5-9, 41, 42 |
| I/O | 0-43, especially 10-15, 43 |
| CPU | 0-43, especially 0-4, 40 |
| RPG | 15 |

Table 6C-10. Loop Descriptions

| Loop No. | Loop Name | Trigger Source |
|-----------------|------------------------------------|-----------------------|
| 0 | Bus error check | N/A |
| 1 | ROM checksum | N/A |
| 2 | Static RAM R/W | N/A |
| 3 | N/A | N/A |
| 4 | CTC (counter timer chip) | N/A |
| 5 | Display assembly ID | N/A |
| 6 | CRTC (CRT controller) | N/A |
| 7 | Character RAM R/W | N/A |
| 8 | Graphics RAM R/W | N/A |
| 9 | Priority RAM R/W | N/A |
| 10 | I/O assembly ID | N/A |
| 11 | I/O RAM R/W | N/A |
| 12 | HP-IB chip | N/A |
| 13 | Keyboard controller chip | N/A |
| 14 | Power detect circuitry | N/A |
| 15 | RPG counter reset | N/A |
| 16 | A/D assembly ID | N/A |
| 17 | Horizontal control assembly ID | N/A |
| 18 | N/A | N/A |
| 19 | N/A | N/A |
| 20 | Data Acquisition (1) | SL |
| 21 | Trigger off/freerun off | N/A |
| 22 | Trigger level (1) | TL |
| 23 | Pos/Neg slope | TL |
| 24 | Trigger level (2) | TL |
| 25 | Coarse delay counters | SL |
| 26 | Rate generator/multi sample period | FR |
| 27 | Hysteresis band off | TL |
| 28 | A/D | SL |
| 29 | Feedthrough compensation | SL |
| 30 | Data acquisition (2) | SL |
| 31 | Channel 1 check | SL |
| 32 | Channel 2 check | SL |
| 33 | Channel 3 check | SL |
| 34 | Channel 4 check | SL |
| 35 | Channel 1 sampler gain | SL |
| 36 | Channel 2 sampler gain | SL |
| 37 | Channel 3 sampler gain | SL |
| 38 | Channel 4 sampler gain | SL |
| 39 | TDR | FR |
| 40 | Static RAM addressing test | N/A |
| 41 | Graphics RAM addressing test | N/A |
| 42 | Priority RAM addressing test | N/A |
| 43 | I/O RAM addressing test | N/A |

Loop 20 Data Acquisition

This loop tests if the GO bit can be reset. This is done by toggling the trigger slope bit to create triggers which toggles the GO bit. If any lower numbered loops fail, troubleshoot them first.

Status line 1 indicates the time in μ s between trigger and the GO bit.

- 1 GO bit turns true while the trigger and freerun was off.
- 2 GO bit never turns true.

Procedure

Use an oscilloscope to probe the points in figures 6C-13 through 6C-17 on the horizontal assembly.

U1 pin 35 is bad Suspect one of the following: horizontal control assembly, umbilical cable, ribbon cables. Go to the extended service section and perform the umbilical cable test to determine the faulty module.

U1 pin 19 is bad Go to the extended service section and perform the umbilical cable test. If umbilical cable test passes, then perform timebase/trigger test and replace either the trigger hybrid or the horizontal assembly as indicated by the test results. If the umbilical cable test fails, use the following test to determine the faulty module.

Perform umbilical cable extended service test on the trigger level input line only. If this test fails, use the umbilical test to determine the faulty module.

Trigger hybrid's output is bad Probe the following trigger hybrid input pins on the horizontal assembly.

| Location | Signal | Signal Name |
|-----------|------------------|-----------------------|
| U1 pin 3 | 2.8 V | Trigger level |
| U1 pin 33 | – 0.8 V | High frequency reject |
| U1 pin 32 | – 0.8 V | Sensitivity |
| U1 pin 22 | See figure 6C-17 | Enable/disable |
| U1 pin 24 | – 0.6 V | Freerun on/off |
| U1 pin 35 | See figure 6C-17 | Trigger slope |

Trigger hybrid inputs are good Replace the trigger hybrid; otherwise replace the horizontal assembly.

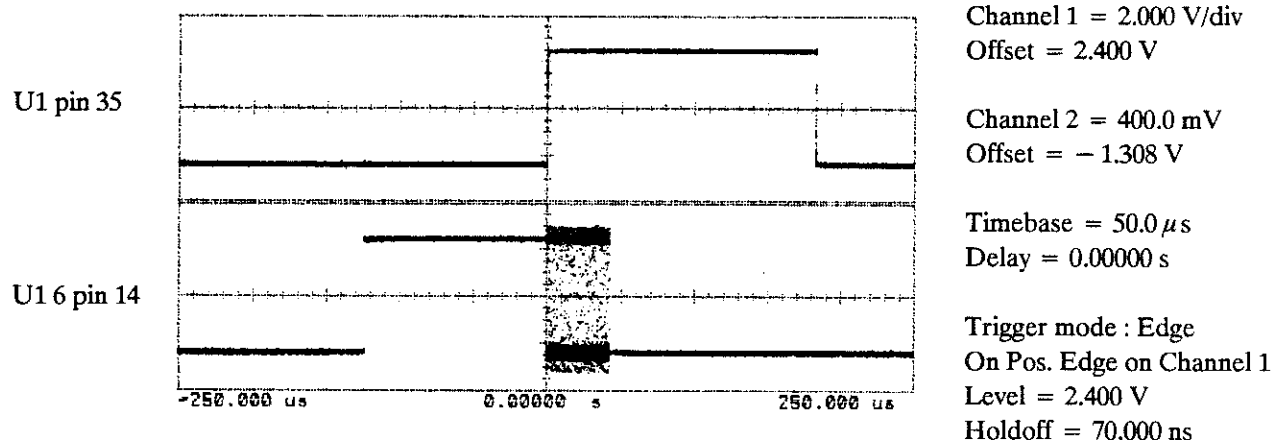


Figure 6C-13. Test Loop 20 Troubleshooting Waveform on the Horizontal Assembly

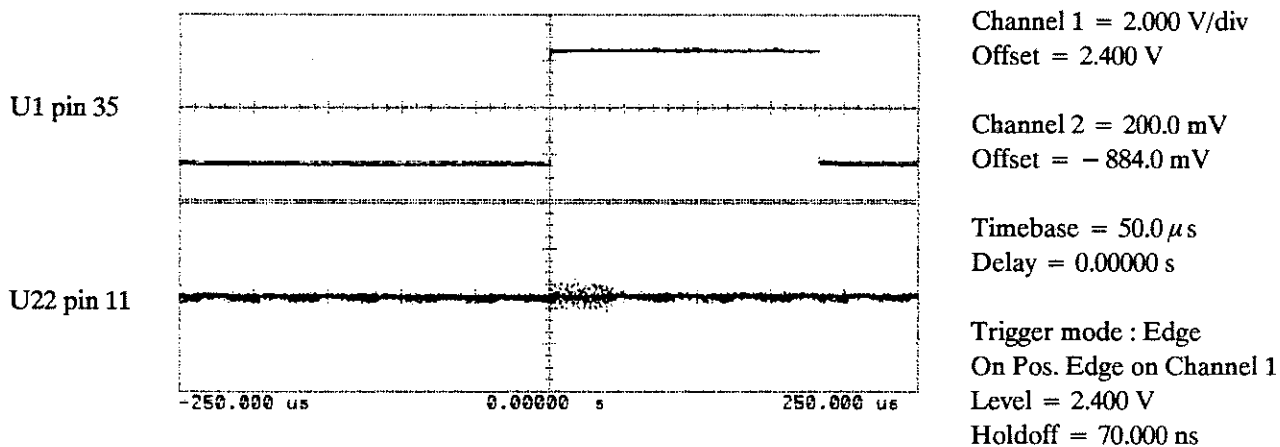


Figure 6C-14. Test Loop 20 Troubleshooting Waveform on the Horizontal Assembly

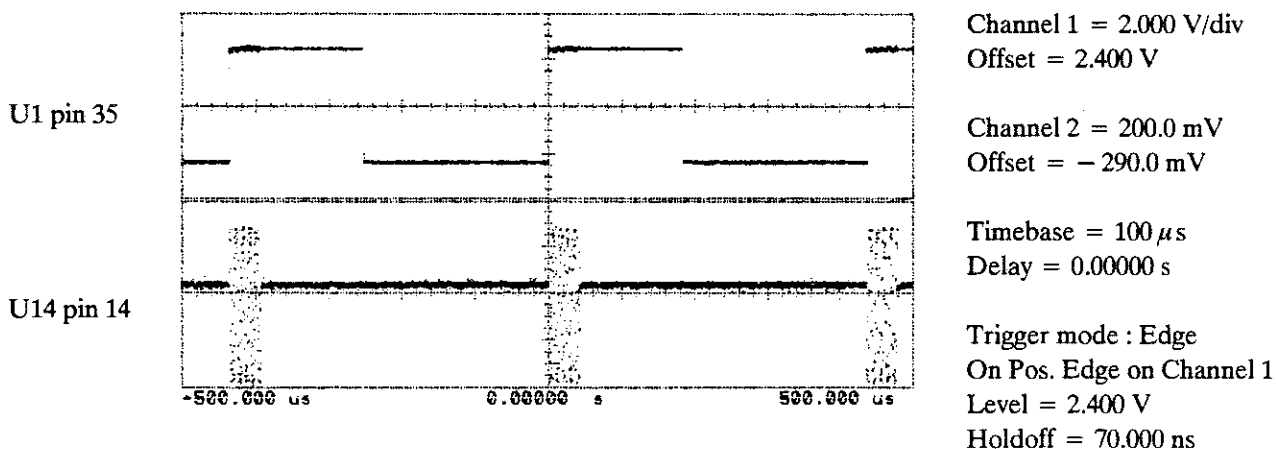


Figure 6C-15 Test Loop 20 Troubleshooting Waveform on the Horizontal Assembly

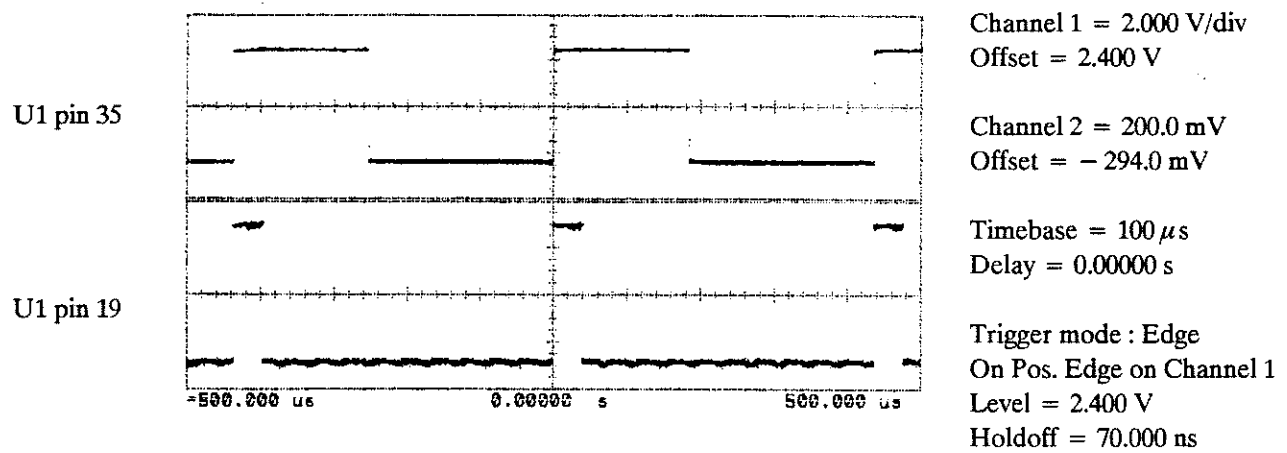


Figure 6C-16. Test Loop 20 Troubleshooting Waveform on the Horizontal Assembly

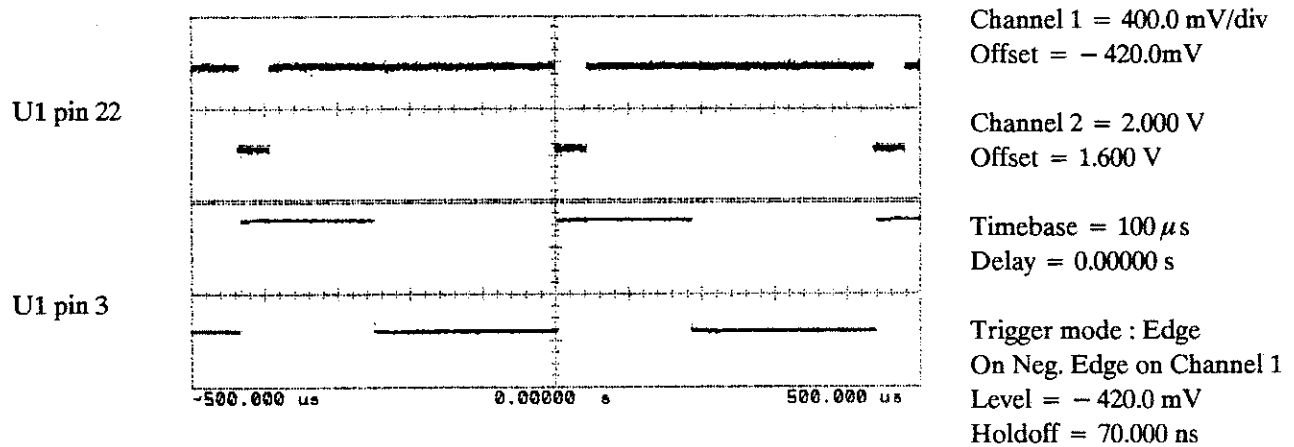


Figure 6C-17. Test Loop 20 Troubleshooting Waveform on the Horizontal Assembly

Loop 21 Trigger Off/Freerun Off

This loop verifies that triggers are not generated when either the trigger is disabled and freerun is enabled, or when trigger is enabled and freerun is disabled. If any lower numbered loops fail, troubleshoot them first. When this loop passes, status lines 1 and 2 should contain zero.

Status line 1 indicates the following

- 1 GO bit turned true while the trigger was disabled and freerun was enabled. There should not be a trigger pulse in this case.

Status line 2 indicates the following

- 2 GO bit turned true while the trigger hybrid was enabled and freerun was disabled. This would mean freerun cannot be turned off.

Procedure

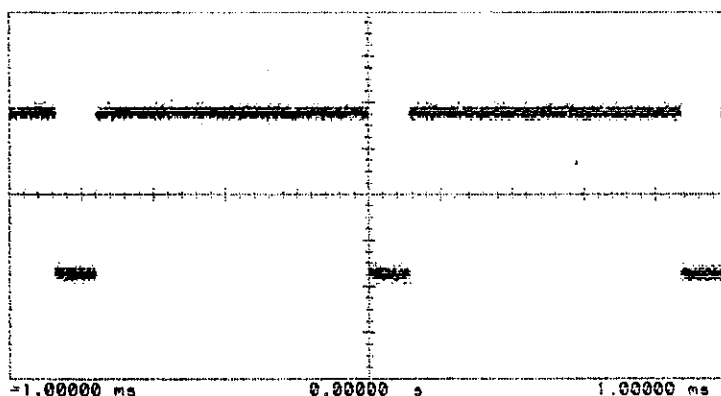
Use an oscilloscope to probe the following trigger hybrid inputs from the horizontal control assembly.

| Location | Signal | Signal Name |
|-----------|------------------|-----------------------|
| U1 pin 3 | 2.8 V | Trigger level |
| U1 pin 33 | – 0.8 V | High frequency reject |
| U1 pin 32 | – 0.8 V | Sensitivity |
| U1 pin 22 | See figure 6C-18 | Enable/disable |
| U1 pin 24 | – 0.6 V | Freerun on/off |
| U1 pin 35 | 0 V | Trigger slope |

If any of the above signals are bad, perform the extended service umbilical cable test on trigger level input line only. This will determine if the test set is receiving the correct signals from the horizontal control assembly.

Probe U1 pin 19 with an oscilloscope. The level should be about 0.8 V with no pulse activity. If this signal is bad, replace the trigger hybrid.

U1 pin 22



Channel 1 = 200.0 mV/div
Offset = – 420.0 mV

Channel 2 Off

Timebase = 200 μ s
Delay = 0.00000 s

Trigger mode : Edge
On Neg. Edge on Channel 1
Level = – 420.0 mV
Holdoff = 70.000 ns

Figure 6C-18. Test Loop 21 Troubleshooting Waveform on the Horizontal Assembly

Loop 22 Trigger Level (1)

This loop tests if the trigger level can be changed. This is done by toggling the trigger level from +1 V to -1 V and back to +1 V (slope is not important). The trigger is enabled before the level is changed to -1 V which should allow the instrument to trigger. If any loops below 22 fail, troubleshoot them first.

Status line 1 indicates if the instrument triggered.

- 0 The loop passed.
- 1 GO bit turned true while trigger and freerun were disabled.
- 2 GO bit turned true without changing the trigger level.
- 3 GO bit never turned true when the trigger level changed.

Procedure Perform extended service umbilical cable test on trigger level input line only.

If the umbilical cable test passes, perform the timebase/trigger test. If the trigger hybrid's output is bad (no activity on U1 pin 19), probe the following trigger input points on the horizontal assembly.

| Location | Signal | Signal Name |
|-----------|------------------|-----------------------|
| U1 pin 3 | See figure 6C-19 | Trigger level |
| U1 pin 33 | - 0.8 V | High frequency reject |
| U1 pin 32 | - 0.8 V | Sensitivity |
| U1 pin 22 | See figure 6C-19 | Enable/disable |
| U1 pin 24 | - 0.6 V | Freerun on/off |
| U1 pin 35 | 0 V | Trigger slope |

If the inputs to the trigger hybrid are good, replace the trigger hybrid; otherwise replace the horizontal assembly.

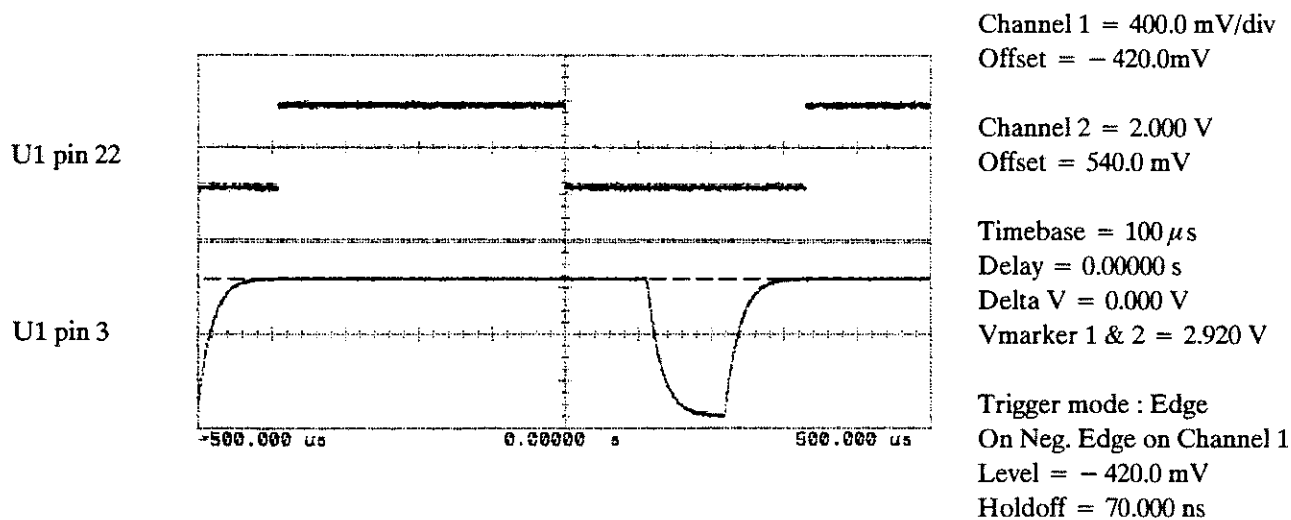


Figure 6C-19. Test Loop 22 Troubleshooting Waveform on the Horizontal Assembly.

Loop 23

Pos/Neg Slope

This loop tests that triggers are generated by toggling the Pos/Neg slope line when trigger is enabled and trigger level is toggled. If any lower numbered loops fail, troubleshoot them first.

Status line 1 indicates the following.

- 0 Positive level triggering works properly.
- 1 GO bit turned true while trigger was disabled, freerun was off, and slope was positive.
- 2 GO bit turned true before the trigger level was toggled from + 1V to – 1 V.
- 3 GO bit never turned true by toggling the trigger level from + 1 V to – 1 V. (slope cannot be set positive)

Status line 2 indicates the following.

- 0 Positive level triggering works properly.
- 1 GO bit turned true while trigger was disabled, freerun was off, and slope was negative.
- 2 GO bit turned true before the trigger level was toggled from – 1 V to + 1V.
- 3 GO bit never turned true by toggling the trigger level from – 1 V to + 1 V. (slope cannot be set to negative)

Procedure Perform the input umbilical cable extended service test on the trigger slope line.

Umbilical cable test passes Perform the timebase/trigger test.

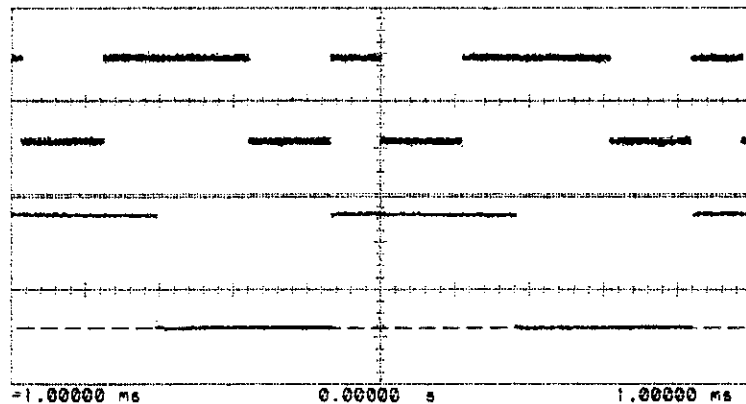
Trigger hybrid's output is bad No activity on U1 pin 19, probe the following points on the horizontal assembly.

| Location | Signal | Signal Name |
|-----------|--------------------------|-----------------------|
| U1 pin 3 | See figure 6C-21 | Trigger level |
| U1 pin 33 | – 0.8 V | High frequency reject |
| U1 pin 32 | – 0.8 V | Sensitivity |
| U1 pin 22 | See figures 6C-20, 6C-21 | Enable/disable |
| U1 pin 24 | – 0.6 V | Freerun on/off |
| U1 pin 35 | See figure 6C-21 | Trigger slope |

If the inputs to the trigger hybrid are good, replace the trigger hybrid; otherwise replace the horizontal assembly.

U1 pin 22

U1 pin 35



Channel 1 = 400.0 mV/div
Offset = - 420.0mV

Channel 2 = 2.000 V
Offset = 1.600 V

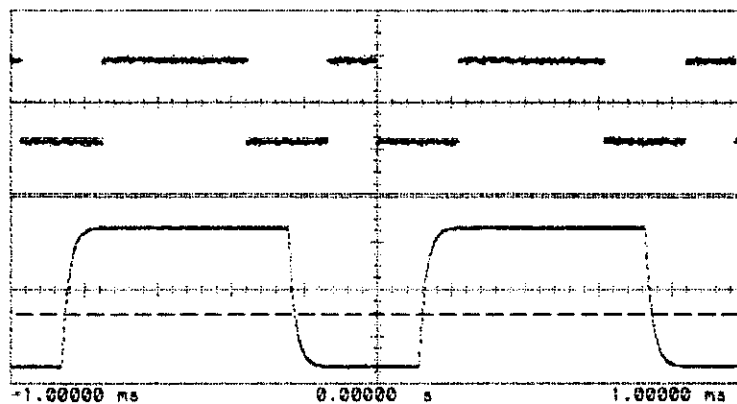
Timebase = 200 μ s
Delay = 0.00000 s
Delta V = 0.000 V
Vmarker 1 & 2 = - 20 mV

Trigger mode : Edge
On Neg. Edge on Channel 1
Level = - 420.0 mV
Holdoff = 3 Events

Figure 6C-20. Test Loop 23 Troubleshooting Waveform on the Horizontal Assembly.

U1 pin 22

U1 pin 3



Channel 1 = 400.0 mV/div
Offset = - 420.0mV

Channel 2 = 2.000 V
Offset = 340.0 mV

Timebase = 200 μ s
Delay = 0.00000 s
Delta V = 0.000 V
Vmarker 1 & 2 = - 720.0 mV

Trigger mode : Edge
On Neg. Edge on Channel 1
Level = - 420.0 mV
Holdoff = 3 Events

Figure 6C-21. Test Loop 23 Troubleshooting Waveform on the Horizontal Assembly.

Loop 24 Trigger Level (2)

This loop tests the trigger offset and trigger hysteresis band. If any lower numbered loops fail, troubleshoot them first.

Status line 1 indicates the following.

- 0 The Loop passed.
- 1 GO bit turned true while trigger was disabled and freerun was off.
- 2 GO bit never turned true by changing the trigger level.
- 3 Hysteresis offset is out of range.
- 4 Hysteresis band is out of range.

Status line 2 indicates the trigger offset range, valid range = $0\text{ V} \pm 12\text{ mV}$.

Status line 3 indicates the trigger hysteresis band, valid range = $15\text{ mV} \pm 12\text{ mV}$.

Procedure When this loop fails, perform the "Trigger Adjustments" in section 4 of this manual.

Perform the umbilical cable extended service test on the trigger slope line. If the umbilical cable test passes, perform the timebase/trigger test in this section.

If the trigger hybrid's output is bad (no activity on U1 pin 19), probe the following trigger hybrid input points on the horizontal assembly.

| Location | Signal | Signal Name |
|-----------|------------------|-----------------------|
| U1 pin 3 | See figure 6C-22 | Trigger level |
| U1 pin 33 | – 0.8 V | High frequency reject |
| U1 pin 32 | – 0.8 V | Sensitivity |
| U1 pin 22 | See figure 6C-23 | Enable/disable |
| U1 pin 24 | – 0.6 V | Freerun on/off |
| U1 pin 35 | See figure 6C-22 | Trigger slope |

If the trigger hybrid inputs are good, replace the trigger hybrid; otherwise replace the horizontal assembly.

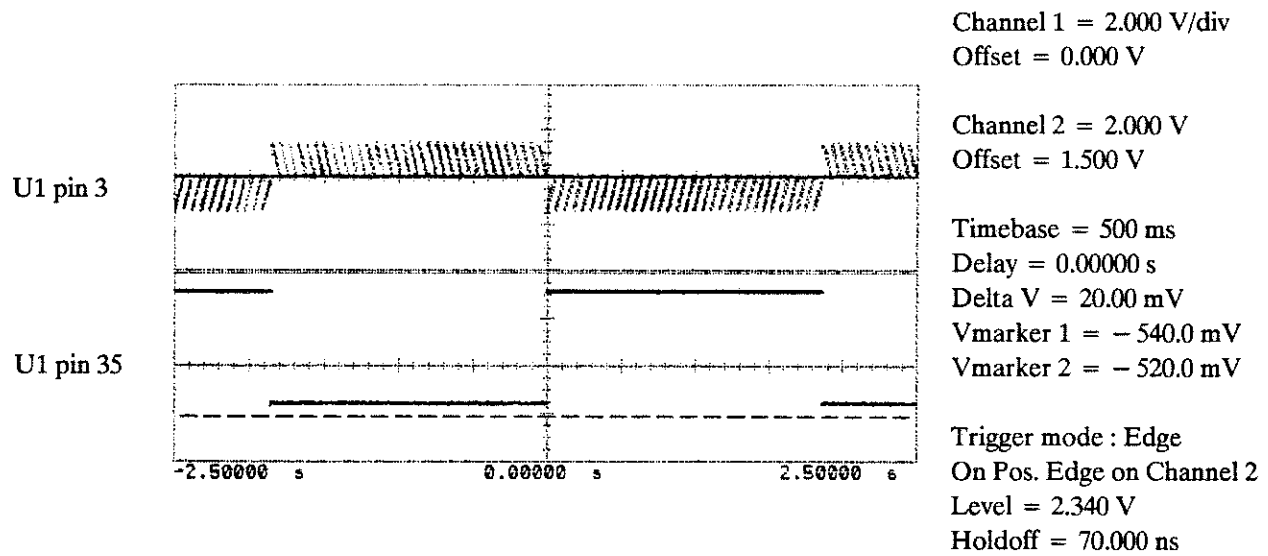


Figure 6C-22. Test Loop 24 Troubleshooting Waveform on the Horizontal Assembly.

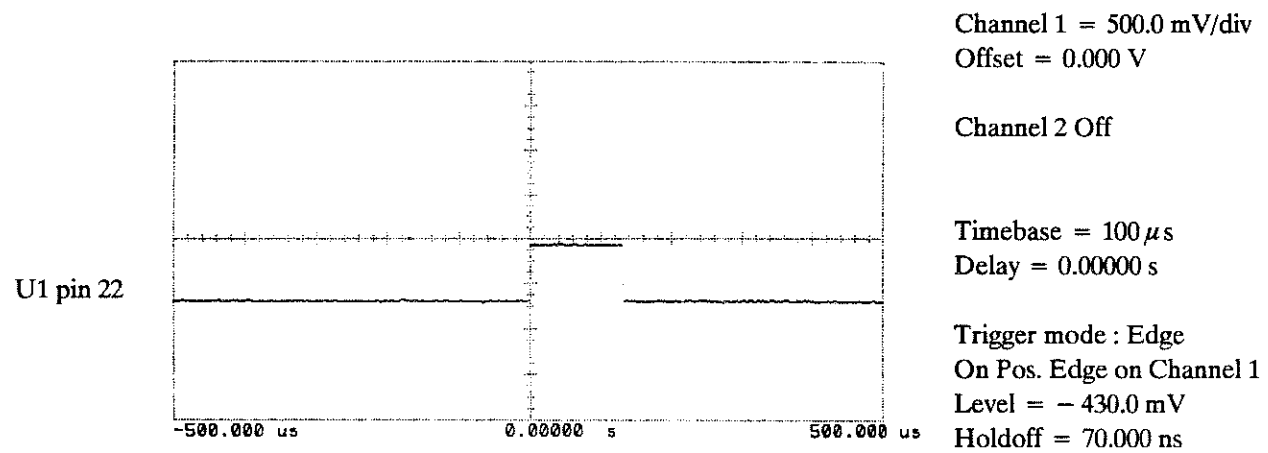


Figure 6C-23. Test Loop 24 Troubleshooting Waveform on the Horizontal Assembly.

Loop 25 Coarse Delay Time

This loop tests the coarse delay timer by timing how long it takes for the GO bit to become true after a trigger pulse occurs at two states. First, when the coarse delay counters are loaded with 4 ns. Second, when the coarse delay counter is loaded with 458.752 μ s.

Status line 1 indicates the following.

- 0 The loop passed.
- 1 GO bit turned true while trigger was disabled and freerun was off.
- 2 GO bit never turned true when delay = 4 ns.
- 3 Difference between short and long delay times is out of range. The valid range is 450 μ s to 470 μ s.

Status line 2 indicates the following.

- 2 GO bit never turned true when delay was set to 458.752 μ s.

Status line 3 indicates the time in ms between the trigger occurrence and the GO bit going true for 4 ns of delay.

Status line 4 indicates the time in μ s between the trigger occurrence and the GO bit going true for 458.752 μ s of delay.

Procedure

If this test fails, perform the frequency adjustments in section 4, adjustments, in this manual. Perform the umbilical cable extended service test, in this section, on the test set's inputs only. Probe the following signals and refer to figures 6C-24 and 6C-25.

| Location | Signal Name | Assembly |
|-----------|----------------|-----------------------------|
| U1 pin 19 | Trigger clock | horizontal assembly |
| U8 pin 9 | | horizontal control assembly |
| U6 pin 2 | pin 3 inverted | horizontal control assembly |
| U8 pin 9 | GO bit | horizontal control assembly |

Trigger clock signal is bad A previous loop should have failed.

No signal at U8 pin 9 but U6 pins 2 and 3 are good Replace the horizontal control assembly.

No signal at U8 pin 9 and U6 pins 2 and 3 are bad Check the continuity of the umbilical cable and interconnect ribbon cable.

If the cable continuity test passes, probe the following points on the horizontal assembly and refer to figures 6C-26 and 6C-27 (U14 pin 14 is single shot measurement).

If any of these points test faulty, replace the horizontal assembly; otherwise call an HP service center.

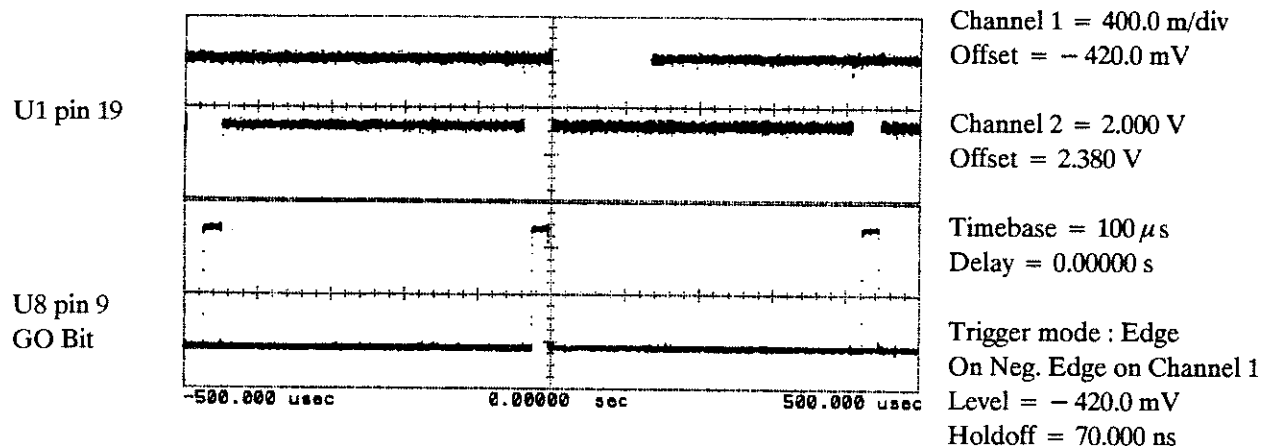


Figure 6C-24. Test Loop 25 Troubleshooting Waveforms on the Horizontal Assembly and on the Horizontal Control Assembly.

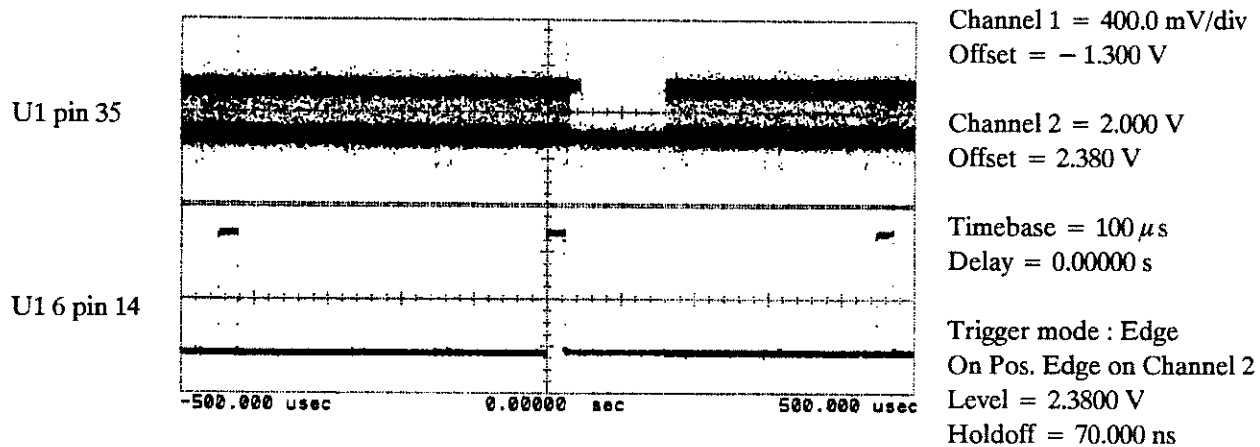


Figure 6C-25. Test Loop 25 Troubleshooting Waveforms on the Horizontal Control Assembly.

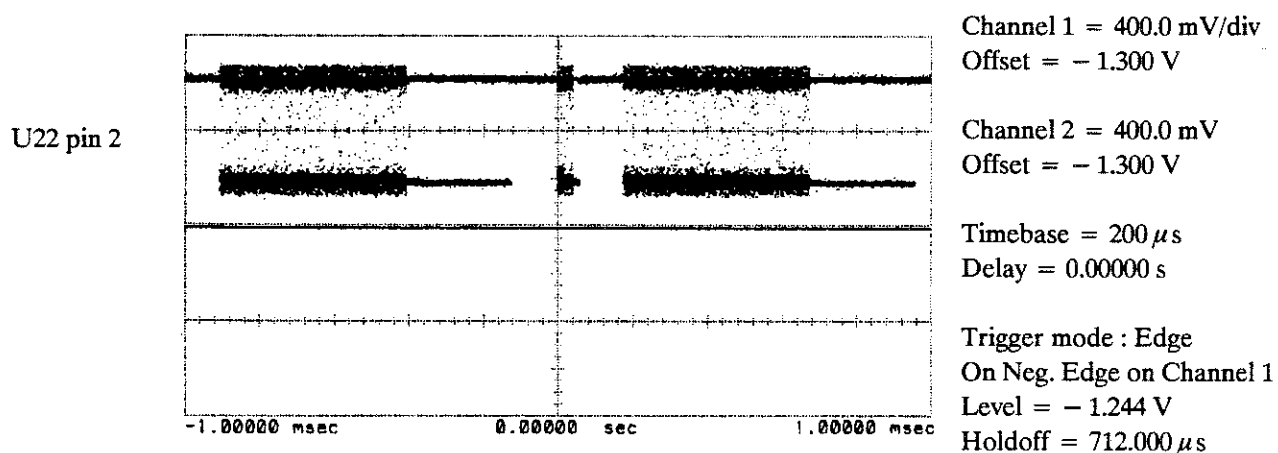


Figure 6C-26. Test Loop 25 Troubleshooting Waveform on the Horizontal Assembly.

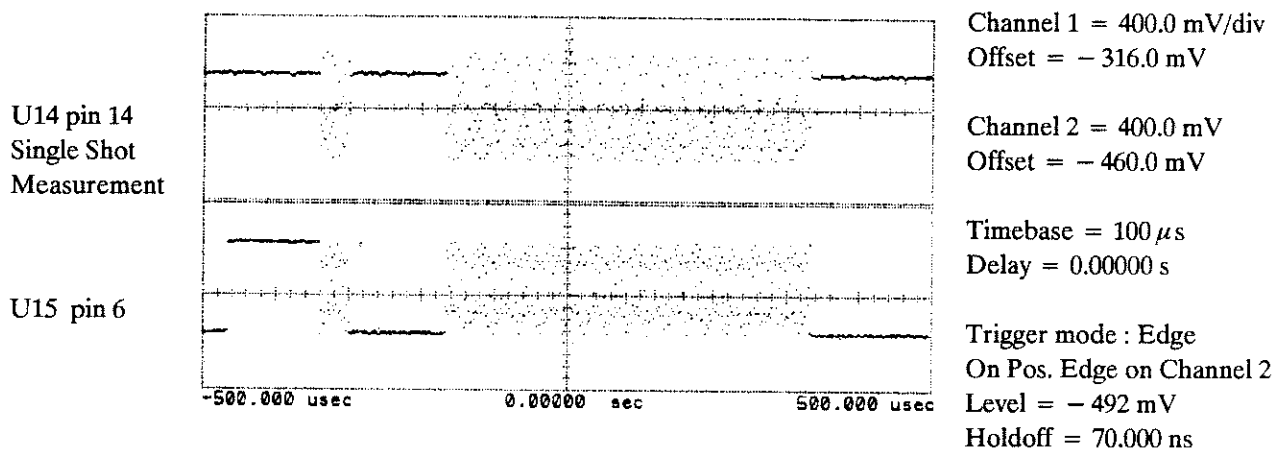


Figure 6C-27. Test Loop 25 Troubleshooting Waveform on the Horizontal Assembly.

Loop 26 Rate Generator

This test checks if the rate generator operates at a particular frequency as expected. The freerun clock is set to 1 kHz. The time between GO bit toggles is approximately 1 ms. It is possible for multiple samples to occur per trigger event at this frequency. The minimum time between samples is $458.752\ \mu\text{s}$. Therefore, in 1 ms two A/D conversions could occur. Each time a sample is taken, a trigger must start the process. Troubleshoot all lower number loops first.

Status line 1 indicates the following.

- 1 GO bit turned true while trigger was disabled and freerun was off.
- 2 GO bit turned true while trigger was enabled and freerun was off.
- 3 GO bit never turned true.
- 4 GO bit never turned true after the first trigger event.
- 5 GO bit never turned true after the second trigger event.
- 6 Rate generator frequency cannot be calculated.
- 7 Rate generator frequency is out of range.

Status line 2 indicates the frequency of the freerun generator, the valid range is 990 Hz to 1010 Hz.

Status line 3 indicates the following.

- 6 Sampling period cannot be calculated.
- 7 Sampling frequency is out of range.

Status line 4 indicates the period of multi-samples in μs , the valid range is $448\ \mu\text{s}$ to $468\ \mu\text{s}$.

Procedure

Frequency in status 2 is incorrect Perform the extended service input umbilical cable test. The umbilical cable and interconnect ribbon cables could cause this problem. If the test set is not receiving the proper signals and the cables are good, replace the horizontal control assembly.

Status 4 out of range Probe the following points and refer to figures 6C-28 to 6C-31

| Location | Signal Name | Assembly |
|-----------|---------------|-----------------------------|
| U3 pin 8 | Freerun clock | horizontal assembly |
| U1 pin 19 | Trigger clock | horizontal assembly |
| U8 pin 9 | GO bit | horizontal control assembly |
| U1 pin 19 | Trigger clock | horizontal assembly |
| U14 pin14 | L250 MHz | horizontal assembly |
| U1 pin 19 | Trigger clock | horizontal assembly |
| U22 pin 2 | 7.8 MHz | horizontal assembly |
| U1 pin 19 | Trigger clock | horizontal assembly |

If you are this far in the troubleshooting procedure, than U3 pin 8 and U1 pin 19 should be good. If U8 pin 9 is bad, check for 7.8 MHz at U6 pin 2. If 7.8 MHz is present at U6 pin 2, replace the horizontal control assembly; otherwise check the continuity of the umbilical cable and the interconnect ribbon cables. If the cable continuity is good and U22 pin 2 is bad, replace the horizontal assembly; otherwise call an HP service center. If U22 pin 2 is bad, replace the horizontal assembly.

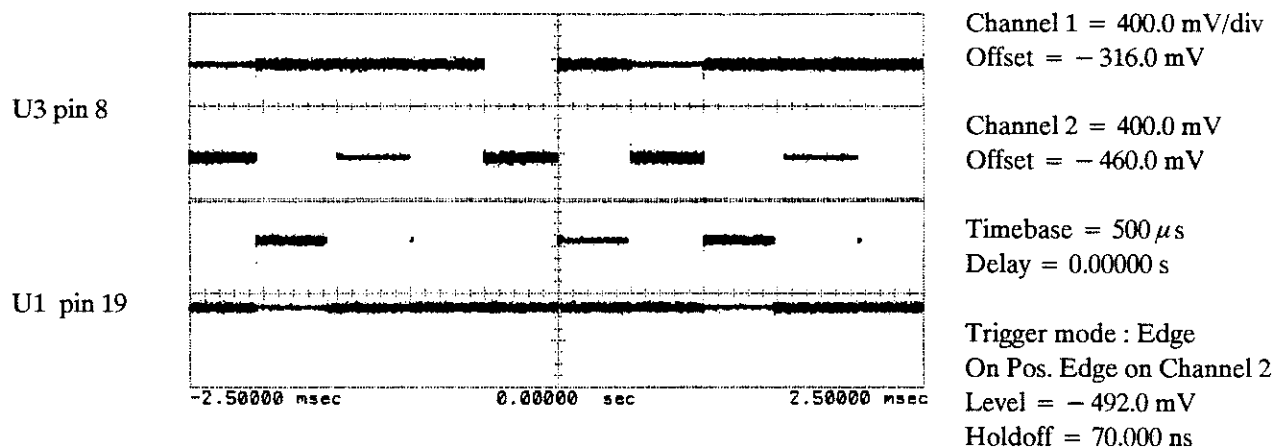


Figure 6C-28. Test Loop 26 Troubleshooting Waveform on the Horizontal Assembly.

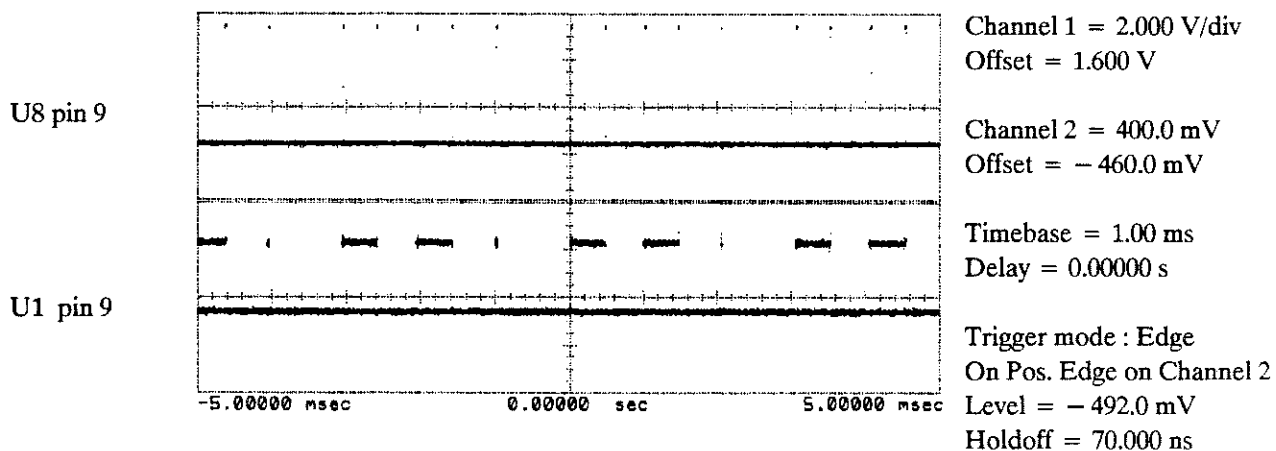


Figure 6C-29. Test Loop 26 Troubleshooting Waveform on the Horizontal Assembly.

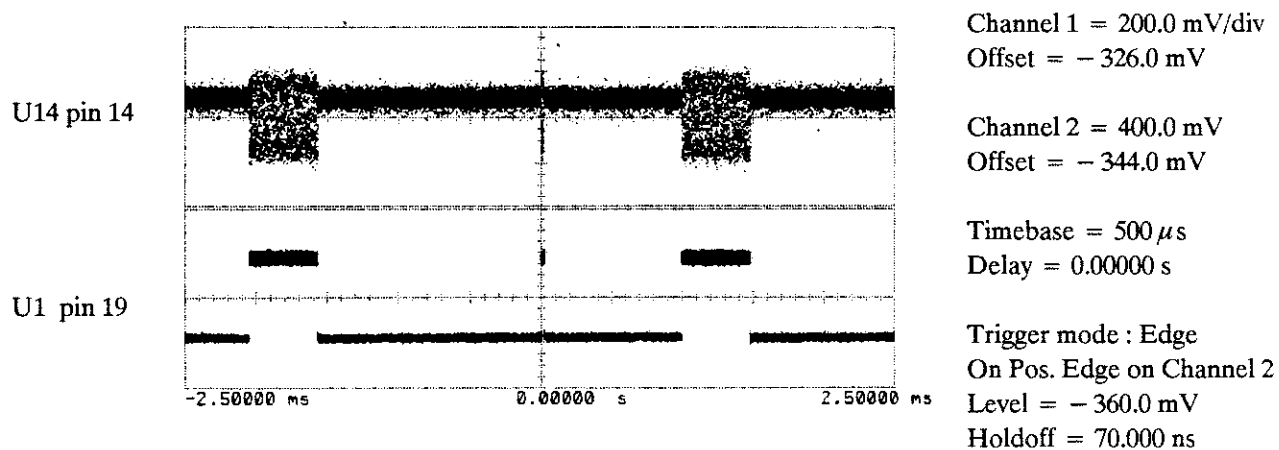


Figure 6C-30. Test Loop 26 Troubleshooting Waveform on the Horizontal Assembly.

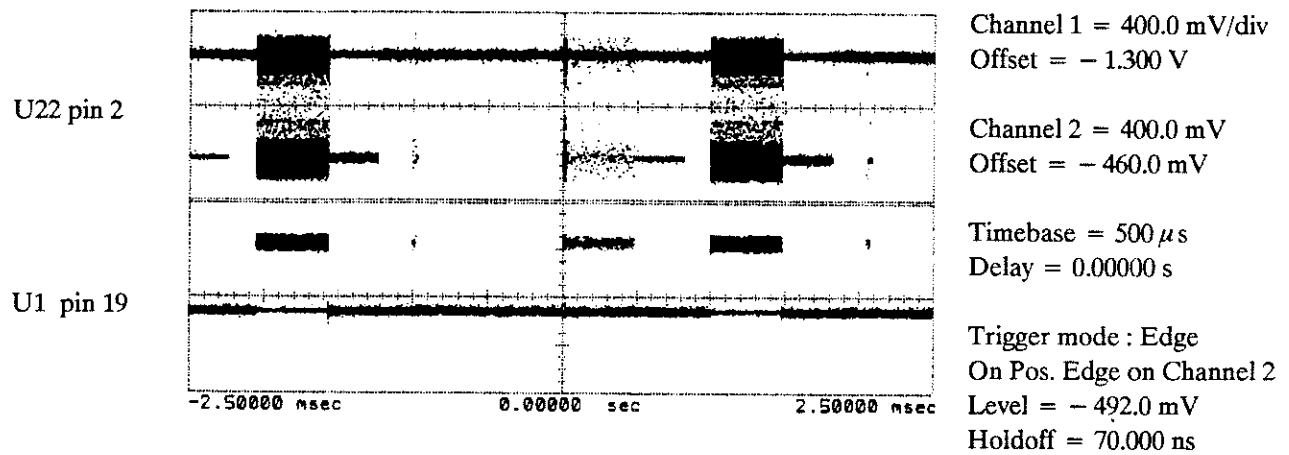


Figure 6C-31. Test loop 26 Troubleshooting Waveform on the Horizontal Assembly.

Loop 27 Hysteresis Band Off

This loop is similar to loop 24. It checks the trigger hysteresis band and trigger level with the HF sensitivity turned on (hysteresis is at minimum). This loop requires that loops 20-26 pass. If any lower numbered loops fail, troubleshoot them first.

Status line 1 indicates the following.

- 0 The loop passed.
- 1 GO bit turned true while trigger was disabled and freerun was off.
- 2 GO bit never turned true while changing trigger level.
- 3 Trigger offset is out of range.
- 4 Trigger hysteresis is out of range.

Status line 2 indicates trigger offset in mV, valid range $0\text{ V} \pm 12\text{ mV}$.

Status line 3 indicates trigger hysteresis band in mV, valid range $-5\text{ mV} \pm 12\text{ mV}$.

Procedure

Perform the input umbilical cable extended service test on the HF sense and HF reject lines to eliminate the umbilical cable or interconnect ribbon cables as the possible problem. If the test set is not receiving the proper signals and the cables are good, replace the horizontal control assembly.

Probe the following points. If any are bad, replace the horizontal assembly.

| | |
|-----------|--|
| U1 pin 3 | Alternating positive and negative ramps. |
| U1 pin 33 | – 0.8 V, no activity |
| U1 pin 32 | – 0.8 V, no activity. |
| U1 pin 24 | – 0.5 V, no activity |
| U1 pin 35 | Slow toggle, 0 V to -0.8 V |
| U1 pin 19 | 100 μ s pulses every 60 ms |

If all of these pins are correct except for U1 pin 19, replace the trigger hybrid.

Loop 28 A/D Conversion

This loop measures the time it takes from the reading of channel 3's A/D conversion to the acquisition complete status when acquiring four channels of data. The loop then reads the A/D value on channel 4. If any lower numbered loops fail, troubleshoot them first.

Status line 1 indicates the following.

- 0 The loop passed.
- 1 GO bit is always high while trigger is disabled.
- 2 GO bit is always low while forced trigger occurs.
- 3 A/D status bit is always busy for channels 1-3 conversions.
- 4 A/D status bit is always complete for channel 4's conversion.
- 5 A/D status bit is always busy for channel 4's conversion.
- 6 Wrong A/D bit pattern from channel 4's conversion.
- 7 A/D conversion time took too long (limit is 30 μ s).

Status line 2 indicates the channel 4 A/D output bit pattern. The expected pattern is 111X XXXX XXXX XXX0.

Status line 3 indicates the A/D conversion time in μ s. The expected time is 20 μ s.

Procedure

Measure the dc voltage at TP1 on the A/D assembly. If it's not approximately 10 V, perform the "10 V Reference Adjustment" in section 4 of this manual.

If status line 3 is in error, probe the following points on the A/D assembly. Refer to figures 6C-32 through 6C-36.

| | | |
|-----------|------------|-----------|
| U44 pin 1 | U21 pin 28 | U44 pin 1 |
| U42 pin 6 | U44 pin 1 | U42 pin 3 |
| U21 pin 5 | U21 pin 6 | |
| U42 pin 8 | U42 pin 11 | |

If U44 pin 1 is bad and there are no lower numbered loop failures, call an HP service center. If any other points are bad, replace the A/D assembly.

If status line 2 is in error, check to see if loops 29-38 fail. If any of these loops did fail, troubleshoot them first; otherwise perform the vertical extended service test on channel 4.

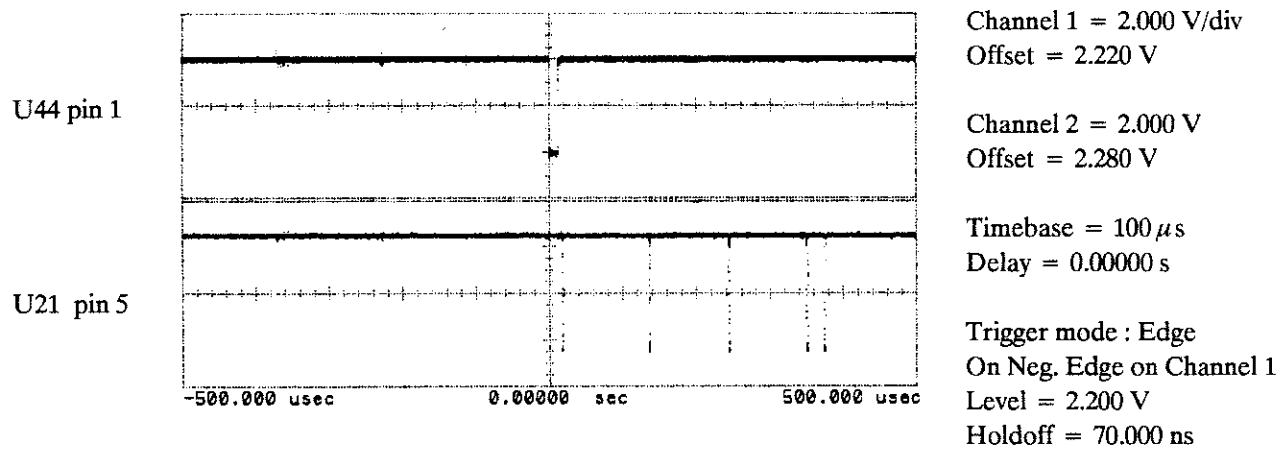


Figure 6C-32. Test Loop 28 Troubleshooting Waveform on the A/D Assembly.

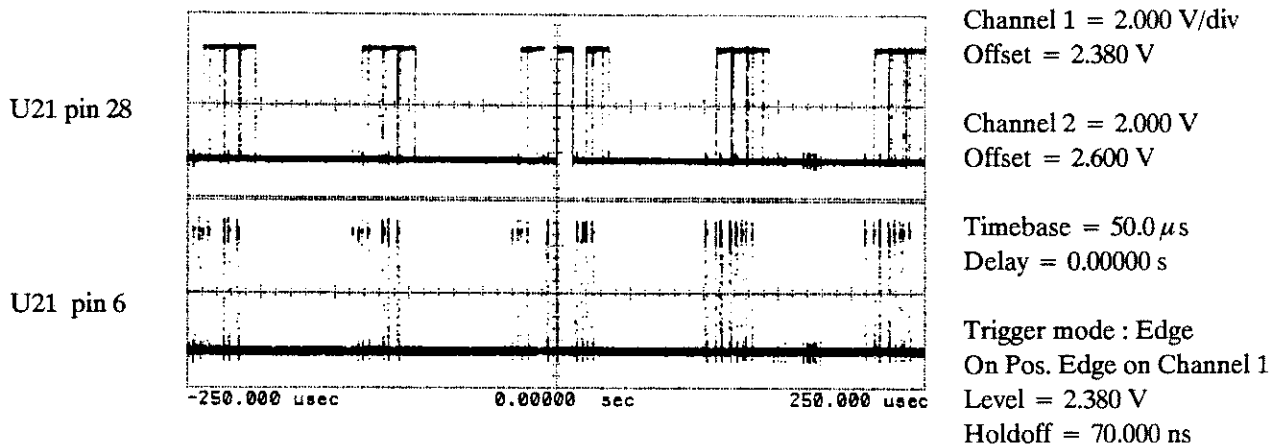


Figure 6C-33. Test Loop 28 Troubleshooting Waveform on the A/D Assembly.

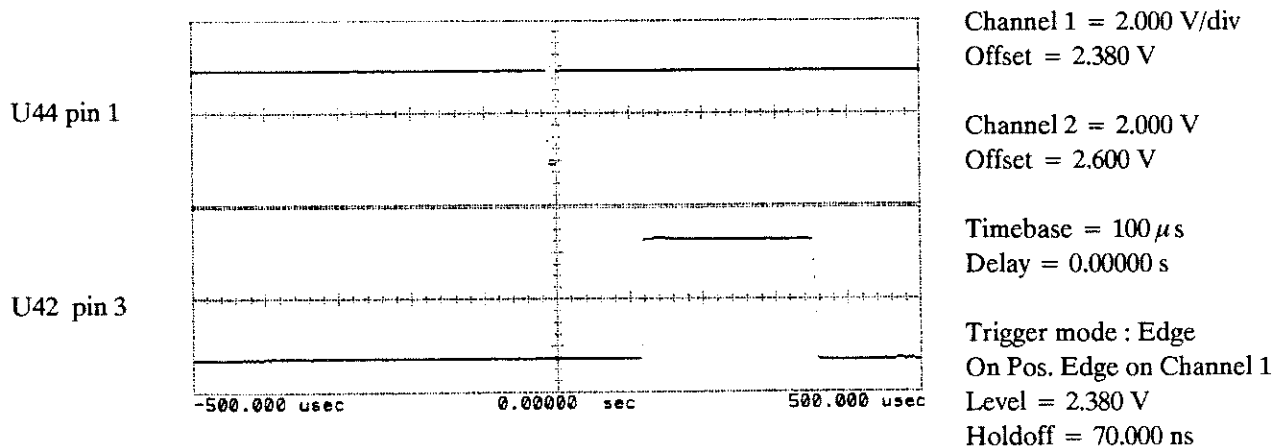


Figure 6C-34. Test Loop 28 Troubleshooting Waveform on the A/D Assembly.

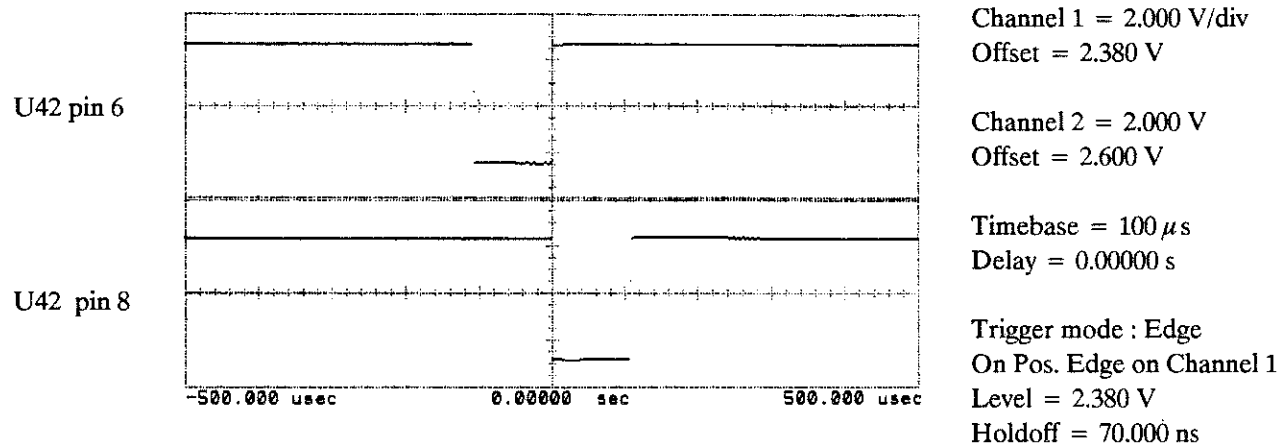


Figure 6C-35. Test Loop 28 Troubleshooting Waveform on the A/D Assembly.

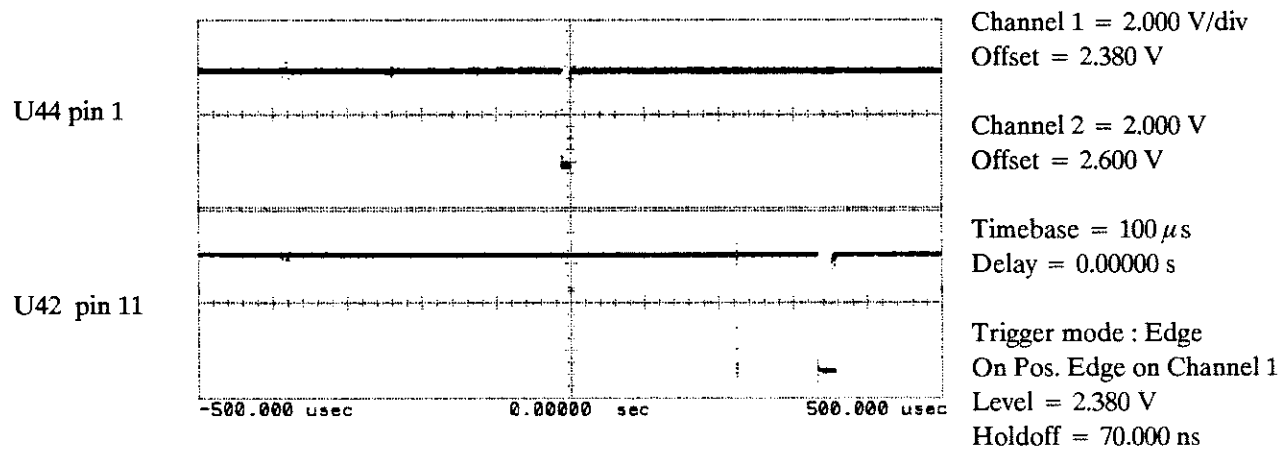


Figure 6C-36. Test Loop 28 Troubleshooting Waveform on the A/D Assembly.

Loop 29 Feedthrough

The sampler feedthrough is measured by setting sampler offset and performing an A/D conversion with the samplers turned off. Trigger events are forced by changing the trigger slope, this causes a data acquisition process to take place. If any lower numbered loops fail, troubleshoot them first.

Status line 1 indicates the A/D output for channel 1 with offset = - 320 mV when data can read.

| | |
|-------|--|
| 8001H | GO bit turned true while trigger was disabled and freerun was off. |
| 8002H | GO bit never turned true by changing the trigger slope. |
| 8003H | A/D status always busy, valid range for all A/D values is 800H \pm 140H. |

Status line 2 indicates the A/D output for channel 2 with offset = - 160 mV when data can be read.

Status line 3 indicates the A/D output for channel 3 with offset = + 160 mV when data can be read.

Status line 4 indicates the A/D output for channel 4 with offset = + 320 mV when data can be read.

Procedure

When status line 1 contains 8001H through 8003H, this should cause lower numbered loops to fail also. Troubleshoot these lower numbered loops first. If lower numbered loops did not fail, call the HP service center.

Loops 29 and 30 should be analyzed together. If loop 30 passes but loop 29 fails, replace the vertical assembly.

Register out of tolerance Refer to table 6C-8, adjustment vs loop failures.

One channel fails Swap samplers to verify that the sampler is not causing the failure.

Swapping samplers does not fix the problem Troubleshoot single channel failures with the vertical extended service test and input umbilical extended service test. Possible failures are vertical assembly, A/D assembly, ribbon cables, umbilical cable. If loops 31 through 34 or 35 through 38 are also failing, it may be helpful to troubleshoot these loops first.

All four channels fail Use the pulse flow diagram. If the pulse filter tests pass, replace the A/D assembly.

Loop 30 Data Acquisition (2)

This loop checks the A/D conversion on each channel with the samplers turned on and no input signals are applied. Each channel is checked 64 times and the results are averaged. Trigger pulses start the data acquisition process. Trigger pulses are forced by toggling the trigger slope line. If any lower numbered loops fail, troubleshoot them first.

Status line 1 indicates channel 1's A/D output.

- 8001H GO bit turned true while trigger was disabled and freerun was off.
- 8002H GO bit never turned true by changing the trigger slope.
- 8003H A/D status is always busy, valid range for all A/D values is 800H \pm 140H (0 V \pm 80 mV).

Status line 2 indicates channel 2's A/D output.

Status line 3 indicates channel 3's A/D output.

Status line 4 indicates channel 4's A/D output.

If status line 1 contains 8001H through 8003H, this should cause lower numbered loops to fail also. Troubleshoot these lower numbered loops first. If lower numbered loops do not fail, call the HP service center.

Procedure **Multiple status register failures** Refer to table 6C-8, adjustment vs loop failures.

Loop 30 fails but loop 29 passes Check the status registers. If only one status register is out of range, suspect a faulty sampler; otherwise suspect a faulty pulse filter.

Single channel failures Troubleshoot with the vertical extended service test and input umbilical extended service test. Possible failures are vertical assembly, A/D assembly, ribbon cables, umbilical cable. If loops 31 through 34 or 35 through 38 are also failing, it may be helpful to troubleshoot these loops first.

All four channels fail Use the pulse filter extended service test. If the pulse filter test passes, replace the A/D assembly.

Loops 31-34 Channels 1-4 Check

All inputs must be disconnected from the test set, this ensures the sampler input to be 0 V. The sampler measures the difference between the input signal and offset. The sampler input is expected to be 0 V, therefore the sampler will read the offset voltage. The offset voltage is set to 0 V. The sampler is turned on and the offset voltage is averaged 64 times. The process is repeated at 250 mV and – 250 mV. The averaged results are compared to the following values. Troubleshoot lower numbered loops first.

$$\text{250 mV Offset} \quad 60\% \leq \left| \frac{\text{averaged 250 mV offset} - \text{averaged 0 V offset}}{250 \text{ mV}} \times 100\% \right| \leq 120\%$$

Status line 1 indicates

- 0 The loop passes on the first measurement.
- 1 False trigger occurs when trigger is disabled.
- 2 GO bit always low while forcing triggers.
- 3 A/D status always busy.
- 4 Value out of range (too small)
- 5 Value out of range (too large)

Status line 2 is the result of status line 1 changed to a percentage of 250 mV. The limits are 60% to 120%

$$\text{– 250 mV Offset} \quad 60\% \leq \left| \frac{\text{averaged – 250 mV offset} - \text{averaged 0 V offset}}{250 \text{ mV}} \times 100\% \right| \leq 120\%$$

Status line 3 indicates the pass/fail

- 0 The loop passes on the second measurement.
- 1 False trigger occurs when trigger is disabled.
- 2 GO bit always low while forcing triggers.
- 3 A/D status always busy.
- 4 Value out of range (too small)
- 5 Value out of range (too large)

Status line 4 is the result of status line 3 changed to a percentage of 250 mV. The limits are 60% to 120%

Procedure

Value of status lines 1 and 3 are close to passing Perform the sampler bias adjustments and the offset and gain adjustments in section 4 of this manual.

All four channels fail and the status registers contain – 1, – 2, or – 3, the trigger loops 21 through 24 should also be failing. If the trigger loops are not failing, call an HP service center.

Single channel failures Swap samplers to verify they are not causing the problem. Perform the A/D extended service test to verify that the offset DACs are operating correctly. If the offset DACs are good and the problem stays in the original channel after swapping samplers, perform the vertical extended service test to determine the faulty module.

Loops 35-38 Channels 1-4 Sampler Gain

All inputs must be disconnected from the test set which causes the sampler input to be 0 V. The sampler measures the difference between the input signal and offset. The sampler input is expected to be 0 V, therefore the sampler will read the offset voltage. The offset voltage is set to 0 V. The sampler is turned on and the offset voltage is averaged 64 times. The process is repeated at 250 mV, and – 250 mV. The averaged results are compared to status line values. Troubleshoot lower numbered loops first.

250 mV Offset

$$33\% \leq \left| \frac{\text{Gain at } +250 \text{ mV at high bandwidth bias mode}}{\text{Gain at } +250 \text{ mV at low bandwidth bias mode}} \times 100\% \right| \leq 73\%$$

Status line 1 indicates

- 0 The loop passes on the first measurement.
- 1 GO bit always high while trigger is disabled.
- 2 GO bit always low while forcing triggers.
- 3 A/D status always busy.
- 4 Value out of range (too small)
- 5 Value out of range (too large)
- 6 Gain at +250 mV low bandwidth mode = 0

Status line 2 indicates the gain percentage of status line 1.

-250 mV Offset

$$33\% \leq \left| \frac{\text{Gain at } -250 \text{ mV at high bandwidth bias mode}}{\text{Gain at } -250 \text{ mV at low bandwidth bias mode}} \times 100\% \right| \leq 73\%$$

Status line 3 indicates

- 0 The loop passes on the second measurement.
- 1 GO bit always high while trigger is disabled.
- 2 GO bit always low while forcing triggers.
- 3 A/D status always busy.
- 4 Value out of range (too small)
- 5 Value out of range (too large)
- 6 Gain at – 250 mV low bandwidth mode = 0

Status line 4 indicates the gain percentage of status line 3.

Procedure

All four channels fail and the status registers contain – 1, – 2, or – 3, the trigger loops 21 through 24 should also be failing. If the trigger loops are not failing, call an HP service center.

Value of status lines 1 and 3 are close to passing Perform sampler bias adjustments and offset and gain adjustments, section 4 of this manual.

Single channel failures Swap samplers to verify that they not causing the problem. Perform the A/D extended service test to verify that the offset DACs are operating correctly. If the offset DACs are good and the problem stays in the original channel after swapping samplers, perform the vertical extended service test to determine the faulty module.

Loop 39 TDR

This loop tests the TDR step's low value (V_L) by delaying $1.5\ \mu\text{s}$ from the trigger event and high value (V_H) by delaying $2.5\ \mu\text{s}$ from the trigger event. Freerun clock is the trigger event. V_H and H_L are averaged 64 times. $V_V = V_H - V_L$ and should be between 180 mV and 480 mV. Troubleshoot lower numbered loops first.



If there is an SMA short on channel 1's input connector, the SMA short must be removed before this test will pass.

Status line 1 indicates the following

- 1 False triggers occurred when trigger is disabled.
- 2 Trigger does not occur when sampler is turned on.
- 3 Trigger does not occur when sampler is turned off.
- 4 A/D status bit is always busy.
- 5 ΔV is out of range.

Status line 2 indicates V_H in hex – expected $> 800H$.

Status line 3 indicates V_L in hex – expected $< 800H$.

Status line 4 indicates V_V in mV – expected $330\ \text{mV} \pm 150\ \text{mV}$.

Procedure

Status line 1 Contains – 1, – 2, – 3, or – 4 and no lower numbered loops are also failing, call an HP service center.

Perform TDR adjustments in section 4 of this manual.

Perform the TDR extended service test.

Channels 1 and 3 fail Perform the TDR system extended service test. If both channels 1 and 3 still fail, call an HP service center.

Channel 1 fails Perform the vertical extended service test.

Extended Service Tests

The internal diagnostic loop tests find a very large number of instrument failures and some gross parametric failures. Because of the interaction of many assemblies it may be difficult to troubleshoot the instrument using only the loop tests. Several extended service tests have been developed as an aid in troubleshooting.

The extended service tests are used in two ways. First, when a loop test fails, the troubleshooting information usually refers to one of the extended service tests. Second, with experience the extended service tests may be used without the loops tests for quicker isolation of the problem.

A few of the extended service tests are executed at only some instrument settings. If your instrument is failing at other instrument settings, you may want to adjust the test settings to correlate with your failure.

The extended service test are listed as a procedure with steps. If a step fails, replace the indicated part. If there are no indications on what part to replace, return to the flow diagrams for instructions. If a step passes, continue on with the next step in the procedure.

Figure 6C-37 illustrates the pin locations for the umbilical cable and the ribbon cables. Umbilical cable pins 1-16 correspond with pins 1-16 (respectively) on the ribbon cable connecting to the vertical assembly and A/D assembly. Umbilical cable pins 17-50 correspond with ribbon cable pins 34-1 (respectively) connecting to the horizontal assembly and horizontal control assembly.

Figure 6C-38 illustrates the pin definition of various three pin devices which may require probing.

| | |
|-----------------------------------|--|
| Sampler Test | This is a front panel test which looks for the ability of each sampler to increment and decrement in offset with no signal applied. It also checks if each channel passes the Low bandwidth noise specification. If either test fails, a sampler is the first suspected module. |
| Umbilical Cable Test | This test checks the signals which interconnect the test set to the mainframe. The input and output lines to the test set are checked, and a test is provided to check the functioning of each line. |
| Umbilical Cable Input Test | This test checks if the A/D assembly, horizontal control assembly, and umbilical cable are delivering the proper signals to the test set. This is done by exercising various front panel controls on the mainframe and probing points in the test set. This test is similar to the umbilical cable test, but only the input lines to the test set are checked. |
| Sampler Input Test | This test ensures that the input connectors and channel 1's TDR generator are not causing apparent sampler failures. The sampler input connectors are disconnected and the sampler test is performed. |

| | |
|---------------------------------|--|
| Sampler Swap Test | This test swaps a suspected bad sampler with a known good sampler and then performs the sampler test. If the failure follows the suspected bad sampler, then that sampler is actually faulty. If the problem stays with the original channel, swap the samplers back and perform the vertical test to determine the faulty module. |
| Vertical Test | This test checks if the A/D assembly, vertical assembly, or an interconnecting cable is causing a vertical problem. Various points on the failing channel are compared to the other three channels to help isolate the problem. The four channel paths on the vertical assembly follow separate paths and it would be a very rare problem where more than one channel on the vertical assembly had the same problem (except for multiple faulty samplers). |
| A/D Assembly Test | This test checks two major circuits on the A/D assembly. First, it checks that the A/D assembly is generating outputs for the other assemblies and that the offset DAC circuitry is operating. Second, it checks the analog switch and ADC clocking circuitry. If either of these circuit tests fail, the A/D assembly is suspected as faulty. |
| Pulse Filter System Test | This test determines what part of the sample pulse generator circuitry is preventing sample pulses from arriving at the samplers. The suspected faulty components are the pulse filter and horizontal assembly. |
| TDR Test | This is a front panel test which determines if the TDR system is working properly. For this test to work, it requires at least one channel of channels 2 through 4 to operate properly. The TDR specifications are checked in channel 1 and the known good channel. If either channel fails, suspect a faulty channel. If both channels fail, suspect a faulty TDR system. |
| TDR System Test | This test determines which part of the TDR system is faulty. The suspect modules are TDR step generator, TDR drive circuitry on the horizontal assembly, or TDR delay line. |
| Trigger Test | This is a quick front panel test to see if the instrument is receiving triggers in both the triggered mode and freerun mode. The message "Running" on the screen's top left corner does not indicate the instrument is receiving triggers, it indicates the RUN key has been pressed. |
| Probing Trigger Test | This test verifies that the trigger hybrid is functioning properly. External triggers are applied to the instrument and the trigger hybrid's output line is checked. If this test fails, the timebase/trigger test should be run to determine if the trigger hybrid is functioning correctly. If this test passes, the horizontal test should be run to find out why the trigger signal is not being received. |
| Timebase/Trigger Test | This test verifies that the horizontal assembly is applying the proper signals to the trigger hybrid. If this test passes, the probing trigger test should be run to see if the trigger hybrid is good. If this test fails, the umbilical input test should be run to determine if the horizontal assembly is receiving the correct signals from the mainframe. |
| Horizontal Test | This test checks for a timebase fault in either the horizontal assembly, horizontal control assembly, or interconnect cable. The instrument is setup in a known operating state, and the interface between the two boards is probed. |

Sampler Test

This is a front panel test which looks for the ability of each sampler to increment and decrement in offset with no signal applied. It also checks if each channel passes the Low bandwidth noise specification. If either test fails, suspect a faulty sampler first. This test is performed on all four channels. However, if only one channel is suspected as faulty, it may be performed on only that channel.

1. Perform a one key-down powerup.
2. Change display mode to 500 ms persistence, single screen, and grid graticules. Turn one channel on and the other channels off. Set the channel that is turned on to 10 mV/div. Change the timebase to the freerun mode.
3. Use the RPG control to change the channel offset in a positive direction, then in a negative direction. If the trace only moves in one direction or not at all, or if the dc level drifts, this test fails. Return to the flow diagram for instructions.
4. Press the **Histogram** menu key. Press the **Time/Voltage** key until **Voltage** is highlighted. Press the **Window/Acquire/Results** key until **Acquire** is highlighted. Set the number of samples to 10000. Press the **Start Acquiring** key. Press the **Window/Acquire/Results** key until **Results** is highlighted. Press the **Sigma** key.
5. If sigma is > 1 mV, this test fails. Return to the flow diagram for instructions on the failed channel. If the sigma is < 1 mV, this channel passes. Continue with the procedure.
6. Turn channel 1 off and channel 2 on. Set channel 2 to 10 mV/div, then repeat steps 3-5 for channel 2.
7. Repeat step 6 for channels 3 and 4.
8. If all the channels pass, this test passes.

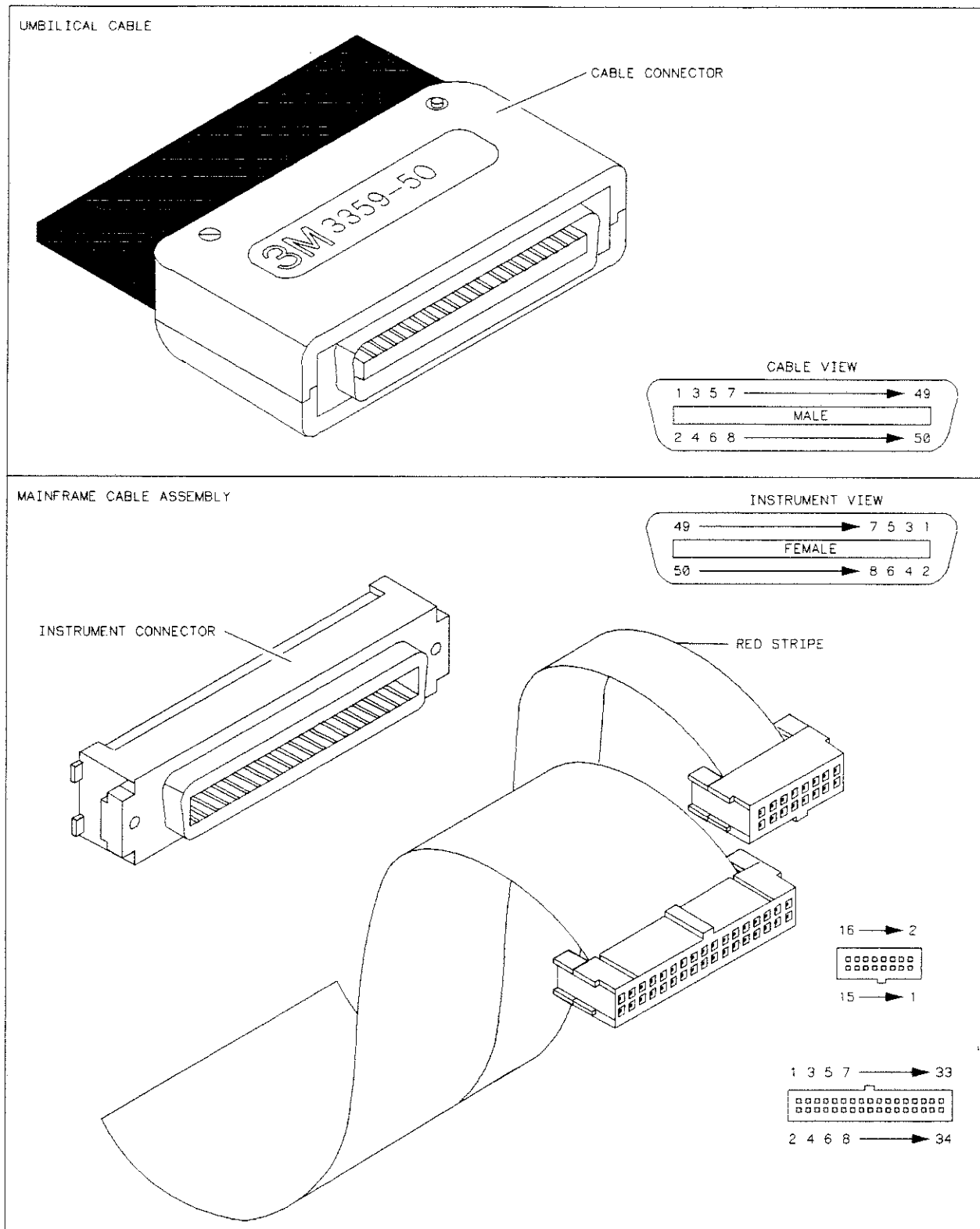
Umbilical Cable Test

This test checks the interface between the test set and the mainframe. This is done by exercising various front panel controls on the mainframe and probing points for expected results. This test should be used to verify the umbilical interface test. Probable faulty assemblies are ribbon cables, umbilical cable, horizontal control assembly, and A/D assembly,

Note

Most signals originate at the mainframe, check these signals first. If the mainframe signals are failing the test set cannot be expected to operate properly. If a signal is faulty (except for current signals), disconnect the umbilical cable from the signal source and probe the signal again.

1. Perform a one key-down powerup.
2. Remove the top and bottom covers from the test set.
3. Start at the top of table 6C-11, then perform each test while probing the test set.
4. If all the probing points test good, then either the vertical assembly or the horizontal assembly is faulty. Return to the flow diagram.
5. Check the continuity of the umbilical cable. If the continuity check fails, replace the umbilical cable and return to the flow diagram; otherwise continue with step 6.
6. Check the continuity of the ribbon cable connecting the umbilical cable to the vertical assembly and horizontal assembly in the test set on the lines that failed. If the continuity check fails, replace the ribbon cable and return to the flow diagram; otherwise continue with step 7.
7. Check the continuity of the ribbon cable connecting the umbilical cable to the A/D assembly and horizontal control assembly in the mainframe, on the lines that failed. If the continuity check fails, replace the ribbon cable and return to the flow diagram; otherwise continue with step 8.
8. Replace the assembly that is a source for the failing signals, then return to flow diagram.



54120E33

Figure 6C-37. Umbilical Cable and Ribbon Cable Pin Locations

Table 6C-11. Signal and Pin Description for Umbilical Cable

| 16 Pin Ribbon Cable | Umbilical Cable Pin No. | Description | Test Set Vert Assy Location | Mainframe A/D Assy Location | Source | Test Description |
|---------------------------|-------------------------------|-----------------|-----------------------------------|------------------------------------|--------|--|
| 1 | 1 | Ch 1 offset | R105 & R109* | Current Sig | A/D | **Infit perst, freerun mode. Vary offset from +100 mV to -100 mV, points will vary from +100 mV to -100 mV. |
| 2 | 2 | AGND | TP5 | | | |
| 3 | 3 | Ch 2 offset | R106 & R110* | Current Sig | A/D | Same as channel 1 |
| 4 | 4 | AGND | TP5 | | | |
| 5 | 5 | Ch 3 offset | R107 & R111* | Current Sig | A/D | Same as channel 1 |
| 6 | 6 | ID0 | TP5 | U25 pin 4 | | |
| 7 | 7 | Ch 4 offset | R108 & R112* | Current Sig | A/D | Same as channel 1 |
| 8 | 8 | ID1 | U19 out | U25 pin 6 | | |
| 9 | 9 | AGND | TP5 | | | |
| 10 | 10 | Ch 4 Vert Sig | U28 pin 6 | U12 pin 2 | Vert. | **Infit perst, freerun mode, offset = +300 mV, probe for fig. 6C-39, Vary offset, pulse height should vary. |
| 11 | 11 | LL/H | U33 pin 15 | U44 pin 1 | Vert. | Toggles when switching between low and high bandwidth |
| 12 | 12 | Ch 3 Vert Sig | U27 pin 6 | U11 pin 2 | Vert. | Same as channel 4 |
| 13 | 13 | -18 V | U36 pin 3 | U18 pin 3 | A/D*** | DMM |
| 14 | 14 | Ch 2 Vert Sig | U26 pin 6 | U10 pin 2 | Vert. | Same as channel 4 |
| 15 | 15 | +18 V | U35 pin 2 | U17 pin 1 | A/D*** | DMM |
| 16 | 16 | Ch 1 Vert Sig | U25 pin 6 | U9 pin 2 | Vert. | Same as channel 4 |
| 34 Pin Ribbon Cable | Umbilical Cable Pin No. | Description | Test Set Horz Assy Location | Mainframe Horz Cntl Location | Source | Test Description |
| 34 | 17 | TDR on/Loff | U4 pin 8 | U1 pin 10 | H.C. | ****Toggle step on/off, OFF = 0 V, ON = -0.8 V |
| 33 | 18 | NC | | | | |
| 32 | 19 | NC | | | | |
| 31 | 20 | AGND | | | | |
| 30 | 21 | AGND | | | | |
| 29 | 22 | AGND | | | | |
| 28 | 23 | Freerun clock | U3 pin 8 | U7 pin 10 | H.C. | ****freerun on, ECL freerun rates |
| 27 | 24 | AGND | | | | |
| 26 | 25 | LEN/RESET | U3 pin 16 | U7 pin 2 | H.C. | ****Trg'd mode, Probe for figure 6C-42 |
| 25 | 26 | AGND | | | | |
| 24 | 27 | Slope | U1 pin 35 | U1 pin 16 | H.C. | ****Toggle slope, POS = 0 V, NEG = 5 V |
| 23 | 28 | Trig hysteresis | U1 pin 32 | U1 pin 15 | H.C. | ****Toggle HF sens. ON = 0 V, OFF = -0.7 V |
| 22 | 29 | Trig level | U1 pin 3 | Current Sig | H.C. | ****Trg'd mode, Refer to table 6C-13. |
| 21 | 30 | Fine delay | R140 & R141* | Current Sig | H.C. | See fine delay test on next page. |
| 20 | 31 | LTC2 | U22 pin 11 | U3 pin 6 | H.C. | Refer to fig 6C-43 |
| 19 | 32 | LTBLOAD | U16 pin 5 | U5 pin 4 | H.C. | This test applies to umbilical pins 33-38 also Refer to figures 6C-43 through 6C-47. |
| 18 | 33 | TB4 | U16 pin 11 | U11 pin 9 | H.C. | ****Trg'd mode Probe figures 6C-43 and 6C-44, U16 pins 9-11 are all high levels until particular delay settings are selected. Refer to figure 6C-45. The delay settings are approximate. Set delay to 16 ns and probe for figures 6C-46 and 6C-47. |
| 17 | 34 | TB3 | U16 pin 10 | U11 pin 11 | H.C. | |
| 16 | 35 | TB2 | U16 pin 9 | U11 pin 14 | H.C. | |
| 15 | 36 | TB1 | U16 pin 7 | U11 pin 1 | H.C. | |
| 14 | 37 | TB0 reset | U15 pin 8 | U5 pin 6 | H.C. | |
| 13 | 38 | TB0 set | U15 pin 12 | U5 pin 10 | H.C. | |
| 12 | 39 | HF reject | U1 pin 33 | U2 pin 9 | H.C. | ****Toggle HF reject, ON = 0 V, OFF = -0.7 V |
| 11 | 40 | -18 V | U20 pin 3 | U16 pin 3 | H.C. | DMM Refer to Figure 6C-38 for pinouts. |
| 10 | 41 | -8 V | U26 pin 3 | U18 pin 3 | H.C. | DMM Refer to Figure 6C-38 for pinouts. |
| 9 | 42 | -8 V | U26 pin 3 | U18 pin 3 | H.C. | DMM Refer to Figure 6C-38 for pinouts. |
| 8 | 43 | AGND | | | | |
| 7 | 44 | +18 V | U21 pin 2 | U15 pin 1 | H.C. | DMM Refer to Figure 6C-38 for pinouts. |
| 6 | 45 | AGND | | | | |
| 5 | 46 | +8 V | U11 pin 2 | U17 pin 1 | H.C. | DMM Refer to Figure 6C-38 for pinouts. |
| 4 | 47 | AGND | | | | |
| 3 | 48 | L7.8 MHz | U22 pin 2 | U6 pin 3 | Horz | ****Freerun mode, figures 6C-40 and 6C-41. |
| 2 | 49 | 7.8 MHz | U22 pin 3 | U6 pin 2 | Horz | Same as U22 pin 2 except inverted. |
| 1 | 50 | AGND | | | | |

*Measurement is made at the junction of these two resistors.

**Initialize the instrument using the oscilloscope setup on page 6C-6.

*** Refer to figure 6C-37 for pinouts.

Fine Delay Test

1. Perform a one key-down power up.
2. Set to the freerun mode.
3. Change the timebase to 10 ps/div.
4. Probe between R140 and R141 on the horizontal assembly. The signal will be noisy and untriggerable with the signal's bottom at 0 V and top at 7 mV.
5. Probe the signals in table 6C-12

Table 6C-12. Fine Delay Test Signals

| Sweep Speed | Signal's low level | Signal's high level |
|----------------------|--------------------|---------------------|
| 20 ps/div | 0 V | 125 mV |
| 50 ps/div | 0 V | 250 mV |
| 100 ps/div | 0 V | 500 mV |
| 200 ps/div | 0 V | 1 V |
| 500 ps/div and above | 0 V | 2 V |

6. If the above signals are good, this test passes.

Table 6C-13. Trigger Level Settings vs Measured Results

| On Screen TriggerLevel Value | Measured Value |
|---------------------------------|----------------|
| 0 V | 0 V |
| +100 mV | +290 mV |
| -100 mV | -290 mV |
| +1 V | +2.9 V |
| -1 V | -2.9 V |

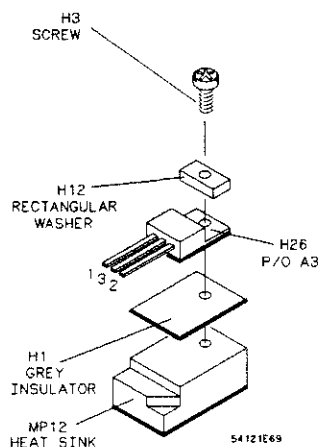


Figure 6C-38. Package Pin Locations

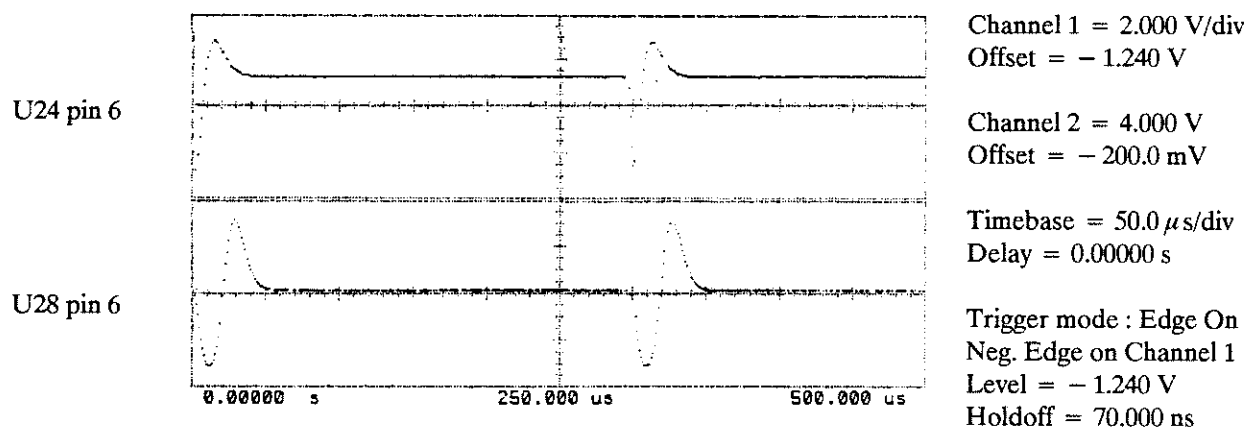


Figure 6C-39. 1KDPU, Infinite Persistence, Single Channel Display, Freerun Channel 4 Offset = +300 mV on the Vertical Assembly.

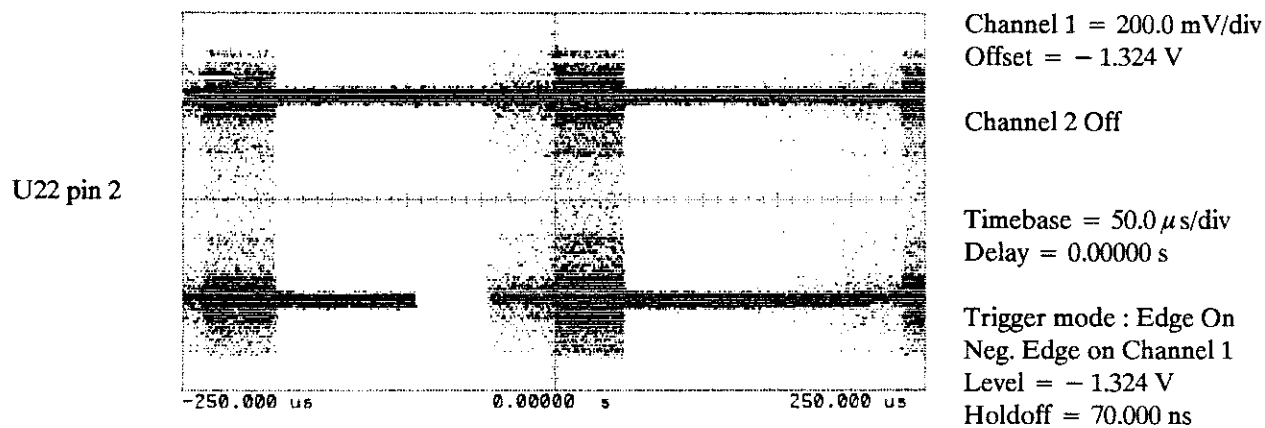


Figure 6C-40. On the Horizontal Assembly.

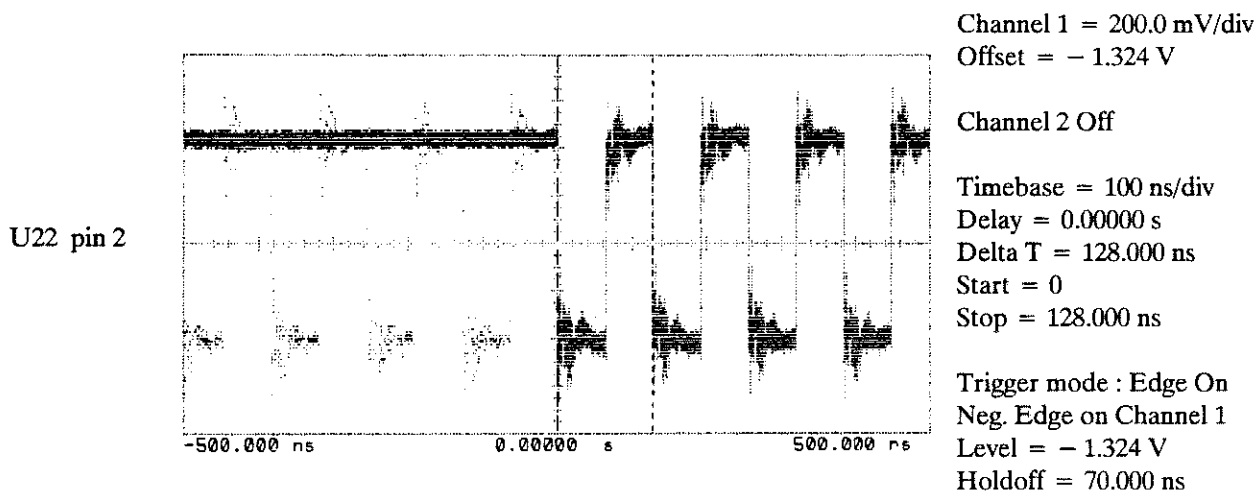
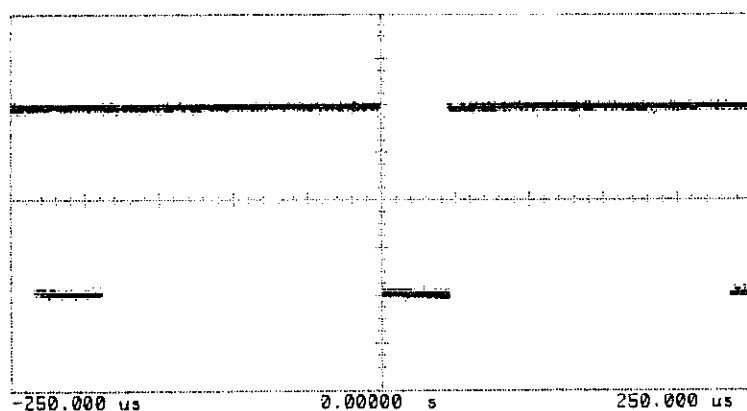


Figure 6C-41. On the Horizontal assembly.

U3 pin 16



Channel 1 = 200.0 mV/div
Offset = -368.0 mV

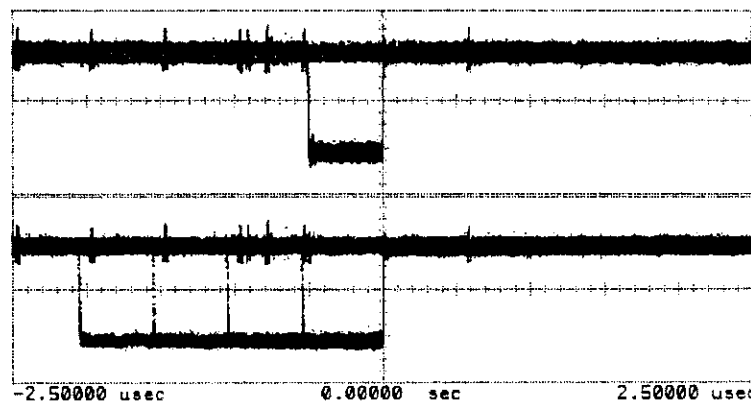
Channel 2 Off

Timebase = 50.0 μ s/div
Delay = 0.00000 s

Trigger mode : Edge On
Neg. Edge on Channel 1
Level = -368.0 mV
Holdoff = 70.000 ns

Figure 6C-42. 1KDPU, Freerun, on the Horizontal Assembly.

U16 pin 5



Channel 1 = 400.0 mV/div
Offset = -1.300 V

Channel 2 = 400.0 mV
Offset = -1.300 V

Timebase = 500 ns/div
Delay = 0.00000 s

Trigger mode : Pattern
On Pattern [HHXX] when
entered

Ch. 1 Level = -1.300 V

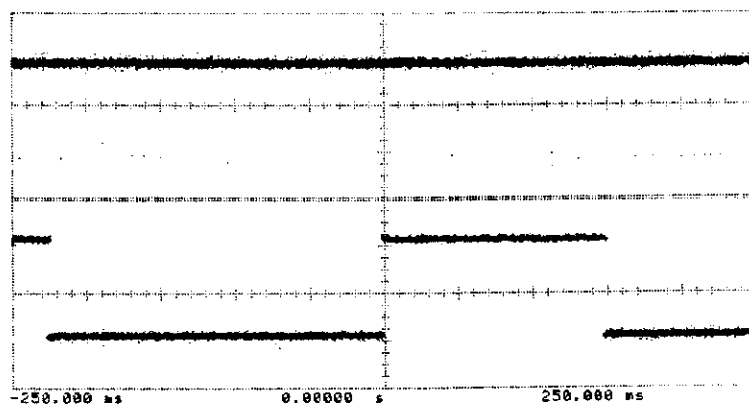
Ch. 2 Level = -1.300 V

Holdoff = 70.000 ns

U22 pin 11

Figure 6C-43. 1KDPU, Freerun, Trigger Mode Pattern HHXX, on the Horizontal Assembly.

U16 pin 5



Channel 1 = 400.0 mV/div
Offset = -1.224 V

Channel 2 = 400.0 mV
Offset = -1.300 V

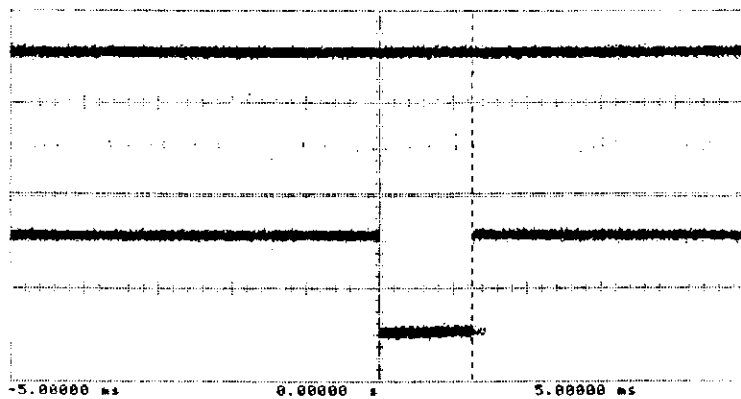
Timebase = 50.0 ms/div
Delay = 0.00000 s

Trigger mode : Edge On
Pos. Edge on Channel 2
Level = -1.300 V
Holdoff = 70.000 ns

U16 pin 7

Figure 6C-44. On the Horizontal Assembly.

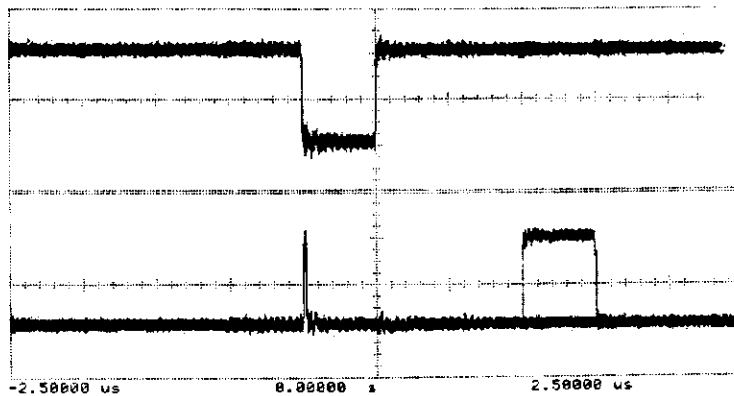
U16 pin 5
 17.98 ns delay
 U16 pin 9
 34.04 ns delay
 U16 pin 10
 66.04 ns delay
 U16 pin 11



Channel 1 = 400.0 mV/div
 Offset = -1.300 V
 Channel 2 = 400.0 mV
 Offset = -1.300 V
 Timebase = 1.00 ms/div
 Delay = 0.00000 s
 Trigger mode : Edge On
 Neg. Edge on Channel 2
 Level = -1.300 V
 Holdoff = 70.000 ns

Figure 6C-45. On the Horizontal Assembly.

U16 pin 5

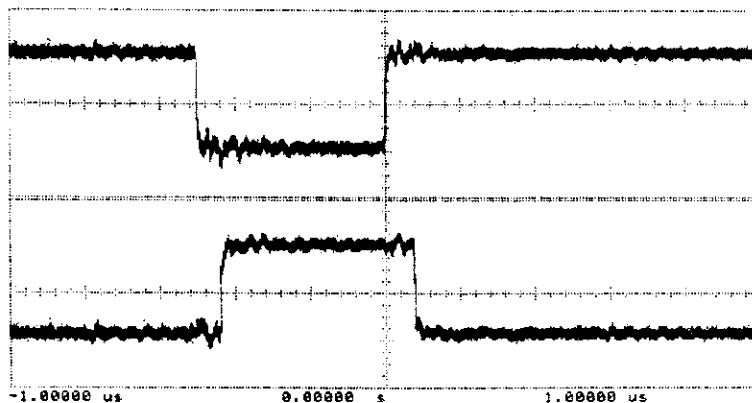


Channel 1 = 400.0 mV/div
 Offset = -1.300 V
 Channel 2 = 400.0 mV
 Offset = -400.0 mV
 Timebase = 500 ns/div
 Delay = 0.00000 s
 Trigger mode : Edge On
 Pos. Edge on Channel 1
 Level = -1.300 V
 Holdoff = 70.000 ns

U15 pin 8

Figure 6C-46. Delay = 16 ns. On the Horizontal Assembly.

U16 pin 5



Channel 1 = 400.0 mV/div
 Offset = -1.300 V
 Channel 2 = 400.0 mV
 Offset = -400.0 mV
 Timebase = 200 ns/div
 Delay = 0.00000 s
 Trigger mode : Edge On
 Pos. Edge on Channel 1
 Level = -1.300 V
 Holdoff = 70.000 ns

U15 pin 12

Figure 6C-47. On the Horizontal Assembly.

Sampler Input Test

This test ensures that each of the channel input connectors and channel 1's TDR generator are not causing apparent sampler failures. The sampler inputs are disconnected and the sampler test is performed.

1. Remove the sampler inputs using a torque wrench on the sampler. Refer to sampler removal procedure on page 6A-8, in section 6A.
2. Reinstall the sampler.
3. Perform sampler test.
4. Return to flow diagrams.

Sampler Swap Test

This tests swaps a suspected faulty sampler with a known good sampler and then performs the sampler test. If the failure follows the suspected faulty sampler, then that sampler should be replaced. If the problem stays with the original channel, swap the samplers back and ensure the original operating channel is still good. If the channel that was operating before the swap is still good, perform the vertical test on the faulty channel; otherwise, replacement of both samplers, vertical assembly, or pulse filter may be required.

Vertical Test

This test checks if the A/D assembly, vertical assembly, or an interconnecting cable is causing a vertical problem. Various probing points on the bad channel are compared to the other three channels to help isolate the problem. The four channel paths on the vertical assembly follow separate paths and it would be a very rare problem where more than one channel on the vertical assembly had the same problem (except for multiple faulty samplers). Usually a multiple channel failure is caused by a faulty trigger hybrid, horizontal control assembly, horizontal assembly, A/D assembly, pulse filter, or pulse filter interconnects.

1. Perform a one key-down power up.
2. Change channel under test to the following settings and turn other channels off: display to single screen, persistence to infinite, offset to 320 mV, timebase to freerun.
3. Remove the test set's top and bottom covers.
4. Probe the following points on the vertical assembly. Refer to figures 6C-48 through 6C-52.

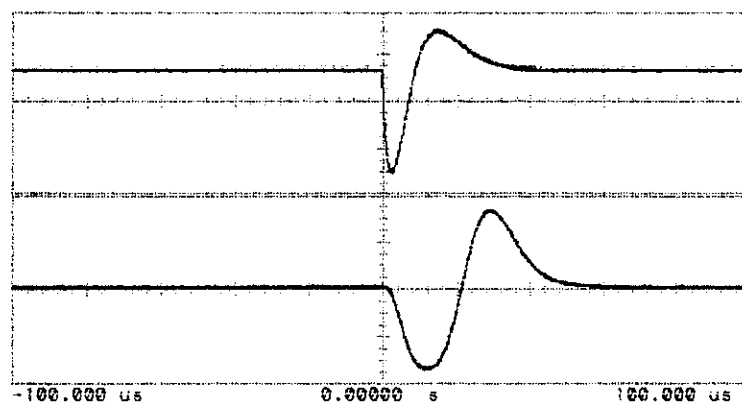
| Figure | Point No. | Channel 1 | Channel 2 | Channel 3 | Channel 4 |
|--------|-----------|----------------|-----------------|-----------------|-----------------|
| 6C-48 | A | U21 pin 6 | U22 pin 6 | U23 pin 6 | U24 pin 6 |
| | B | U25 pin 6 | U26 pin 6 | U27 pin 6 | U28 pin 6 |
| 6C-49 | C | U17 pin 6 | U18 pin 6 | U19 pin 6 | U20 pin 6 |
| | D | U25 pin 6 | U26 pin 6 | U27 pin 6 | U28 pin 6 |
| 6C-50 | E | U13 pin 6 | U14 pin 6 | U15 pin 6 | U16 pin 6 |
| | F | U25 pin 6 | U26 pin 6 | U27 pin 6 | U28 pin 6 |
| 6C-51 | G | U5 pin 6 – R25 | U6 pin 6 – R26 | U7 pin 6 – R27 | U8 pin 6 – R28 |
| | H | U25 pin 6 | U26 pin 6 | U27 pin 6 | U28 pin 6 |
| 6C-52 | I | U9 pin 6 – R29 | U10 pin 6 – R30 | U11 pin 6 – R31 | U12 pin 6 – R32 |
| | J | U25 pin 6 | U26 pin 6 | U27 pin 6 | U28 pin 6 |

5. If points G and I are bad and the sampler has been proven good by swapping it into another channel, then suspect either the pulse filter, pulse conditioner (channel 1 and channel 2 only), or semi-rigid cable connecting the pulse filter to the sampler (there is a very slight chance that the vertical assembly may still be at fault). Return to the flow diagram.
6. If any of the above test points are faulty for any of the channels, replace the vertical assembly and return to the flow diagram.
7. If all of the test points are good, then suspect either the A/D assembly, umbilical cable, or ribbon cables connecting to the umbilical cable. Probe the following points on the A/D assembly. If the points on the A/D assembly are not identical to the vertical assembly points, replace either the umbilical cable or the ribbon cables and return to the flow diagram; otherwise replace the A/D assembly and return to the flow diagram. Adjustments affect the pulse height.

| Channel | Vertical Assembly | A/D Assembly |
|---------|-------------------|--------------|
| 1 | U25 pin 6 | U9 pin 2 |
| 2 | U26 pin 6 | U10 pin 2 |
| 3 | U27 pin 6 | U11 pin 2 |
| 4 | U28 pin 6 | U12 pin 2 |

Point A
U21 pin 6

Point B
U25 pin 6
Channel 1



Channel 1 = 2.000 V/div
Offset = -1.340 V

Channel 2 = 4.000 V/div
Offset = -200.0 mV

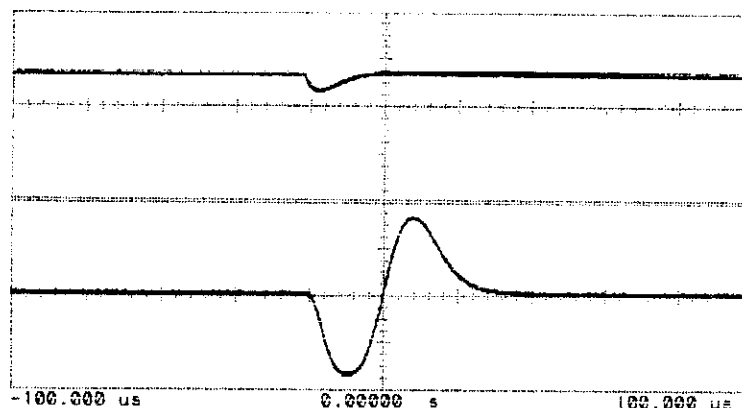
Timebase = 20.0 μ s/div
Delay = 0.00000 s

Trigger mode : Edge On
Neg. Edge on Channel 1
Level = -1.340 V
Holdoff = 70.000 ns

Figure 6C-48. U21 Pin 6 and U25 Pin 6 on the Vertical Assembly.

Point C
U17 pin 6

Point D
U25 pin 6
Channel 1



Channel 1 = 2.000 V/div
Offset = -1.340 V

Channel 2 = 4.000 V/div
Offset = -200.0 mV

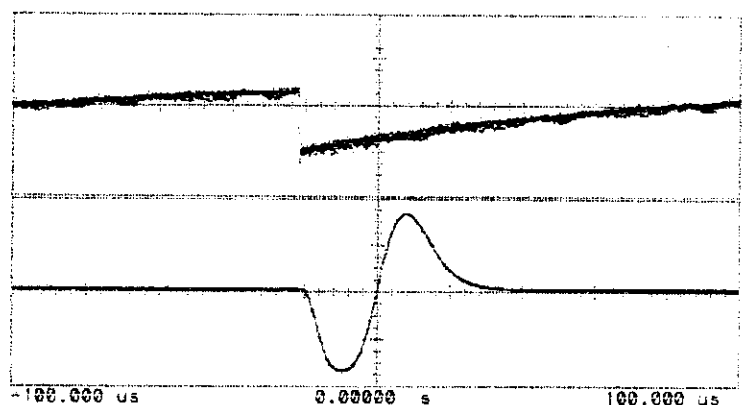
Timebase = 20.0 μ s/div
Delay = 0.00000 s

Trigger mode : Edge On
Pos. Edge on Channel 2
Level = -200.0 mV
Holdoff = 70.000 ns

Figure 6C-49. U17 Pin 6 and U25 Pin 6 on the Vertical Assembly.

Point E
U13 pin 6

Point F
U25 pin 6
Channel 1



Channel 1 = 200.0 mV/div
Offset = 630.0 mV

Channel 2 = 4.000 V/div
Offset = -200.0 mV

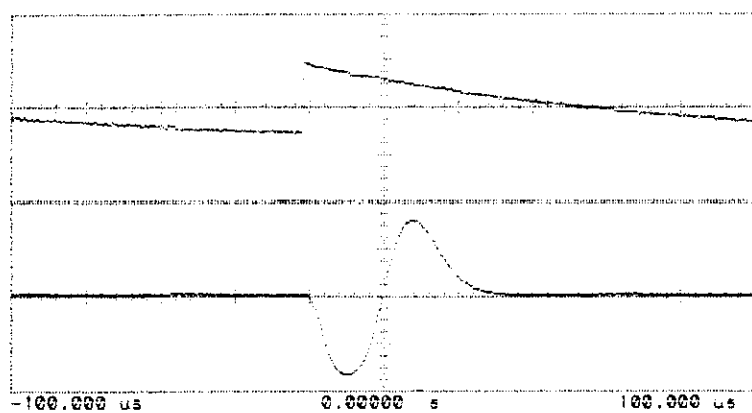
Timebase = 20.0 μ s/div
Delay = 0.00000 s

Trigger mode : Edge On
Neg. Edge on Channel 2
Level = -200.0 mV
Holdoff = 70.000 ns

Figure 6C-50. U13 Pin 6 and U25 Pin 6 on the Vertical Assembly.

Point G
U9 pin 6 - R29

Point H
U25 pin 6
Channel 1



Channel 1 = 200.0 mV/div
Offset = -648.0 mV

Channel 2 = 4.000 V/div
Offset = -200.0 mV

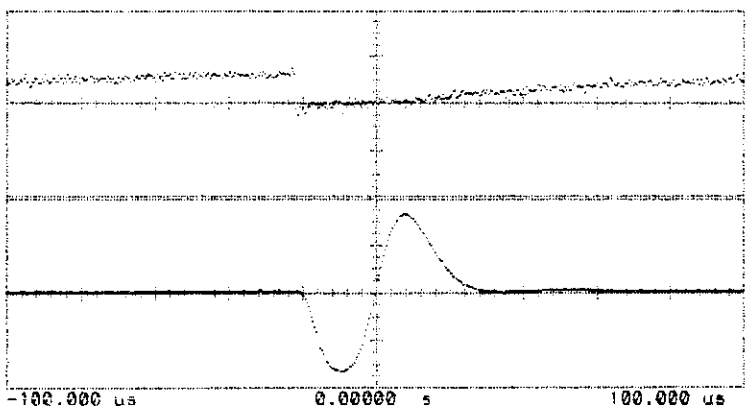
Timebase = 20.0 μ s
Delay = 0.00000 s

Trigger mode : Edge On
Pos. Edge on Channel 2
Level = -40.00 mV
Holdoff = 70.000 ns

Figure 6C-51. U9 Pin 6 - R29 and U25 Pin 6 on the Vertical Assembly.

Point I
U5 pin 6 - R25

Point J
U25 pin 6
Channel 1



Channel 1 = 40.61 mV/div
Offset = -888 mV

Channel 2 = 4.000 V/div
Offset = -200.0 mV

Timebase = 20.0 μ s/div
Delay = 0.00000 s

Trigger mode : Edge On
Pos. Edge on Channel 2
Level = -40.00 mV
Holdoff = 70.000 ns

Figure 6C-52. U5 Pin 6 - R25 and U25 Pin 6 on the Vertical Assembly.

A/D Test

This test verifies the operation of three A/D assembly circuits: offset circuitry, analog switch, and clocking circuitry.

1. Remove umbilical cable from mainframe.
2. Initialize the instrument using the oscilloscope setup on page 6C-6 and change persistence to 300 ms.
3. Adjust each channel's offset in a positive and a negative direction. Probe the following points and verify the dc values vary linearly with changing offset values. When the offset is set to 500 mV and -500 mV, the point under test should measure approximately 500 mV and -500 mV, respectively.
A/D – U1 pin 13 for channel 1
A/D – U2 pin 13 for channel 2
A/D – U3 pin 13 for channel 3
A/D – U4 pin 13 for channel 4
If these points fail, replace the A/D assembly.
4. Reconnect the umbilical cable to the mainframe and perform the umbilical test on the four offset lines going to the test set.
5. If the four offset lines are good, go to step 7.
6. If the four offset lines are bad, check the continuity of the umbilical cable.
7. If the umbilical cable is good, initialize the instrument using the oscilloscope setup on page 6C-6, set to freerun mode, and probe the following points on the A/D assembly. Refer to figures 6C-53 through 6C-56.
U44 pin 1 and U42 pin 3 Infinite persistence
U42 pin 6 and U42 pin 8 Infinite persistence
U42 pin 11 and U44 pin 1 Infinite persistence
U21 pin 28 and U21 pin 6 Single shot, varies depending on trigger position

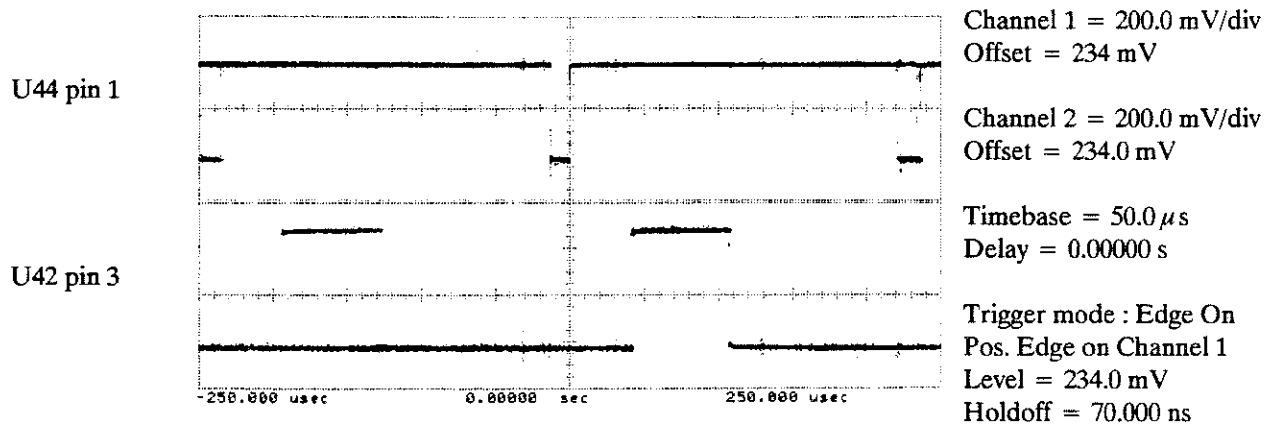


Figure 6C-53. On the A/D Assembly.

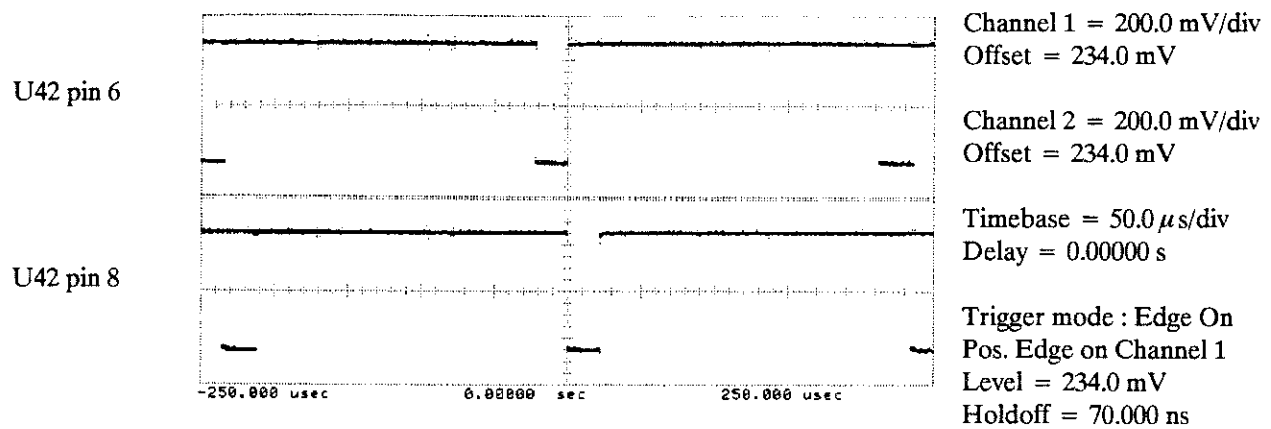


Figure 6C-54. On the A/D Assembly.

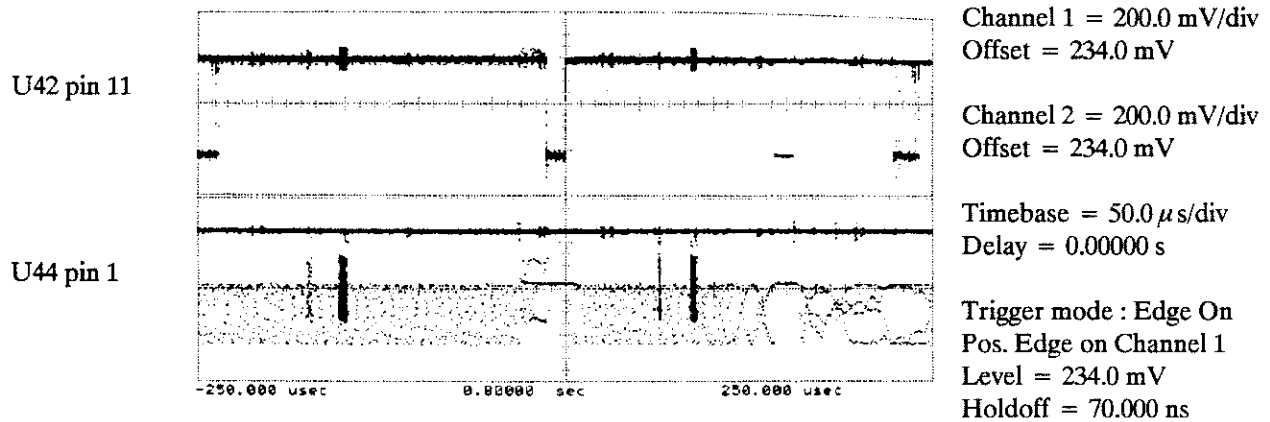


Figure 6C-55. On the A/D Assembly.

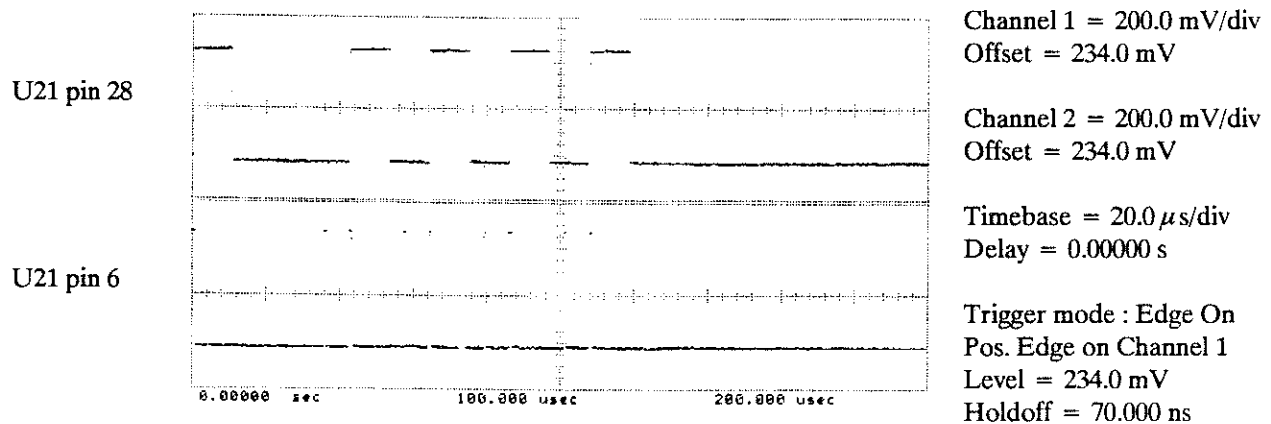


Figure 6C-56. On the A/D Assembly.

Pulse Filter Test

This test determines if the pulse filter or its bias circuit is faulty.

1. Initialize the instrument using the oscilloscope setup on page 6C-6. and place in "FreeRun" mode.
2. Probe the following points on the horizontal assembly and compare to figures 6C-57 through 6C-60.
 Between L1 and C41 at 100 ns/div and 2 μ s/div
 Between collector of Q3 and R66
 U14 pin 11 at 20 ns/div and 50 μ s/div
 Between collector of Q5 and R72
3. Lift the legs of C41 and C88, on the oppsite side of Q3, from the board.
4. Probe the points listed in step 2 above but use figures 6C-61 through 6C-64.
5. If the waveforms in step 2 were bad and the waveforms in step 4 were good, replace the pulse filter; otherwise replace the horizontal assembly.
6. Reinstall the legs of C41 and C88 into the board, then return to the flow diagram.

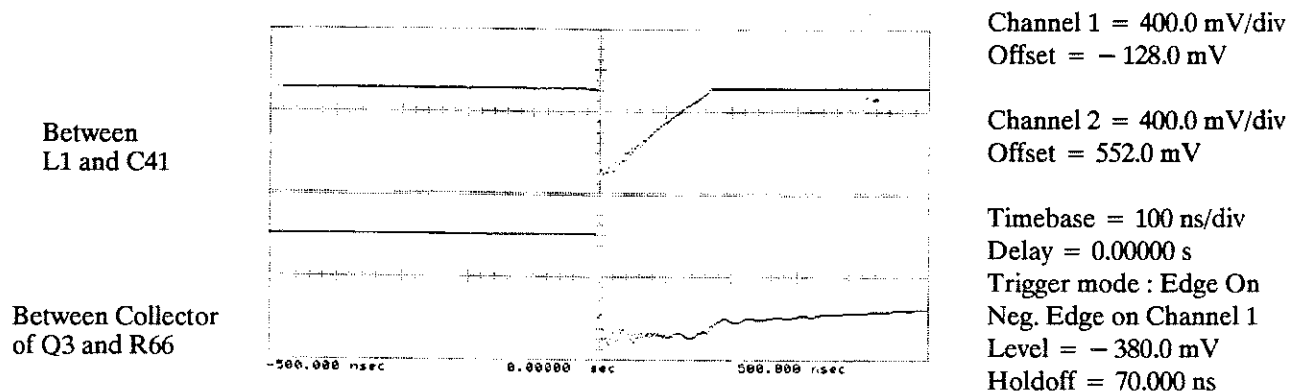


Figure 6C-57. With Pulse Filter Installed in Test Set, on the Horizontal Assembly, 100 ns/div.

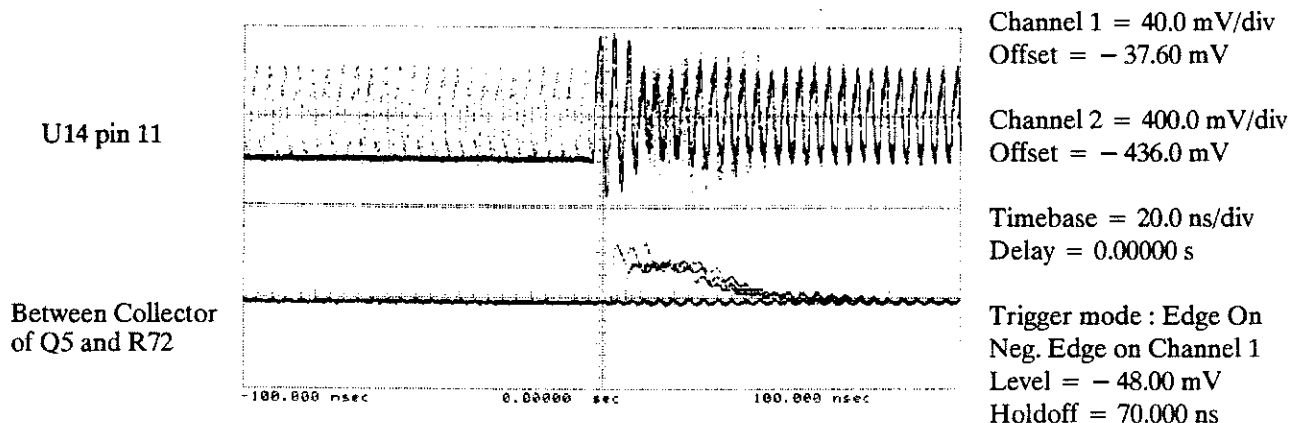


Figure 6C-58. With Pulse Filter Installed in Test Set, on the Horizontal Assembly, 20 ns/div.

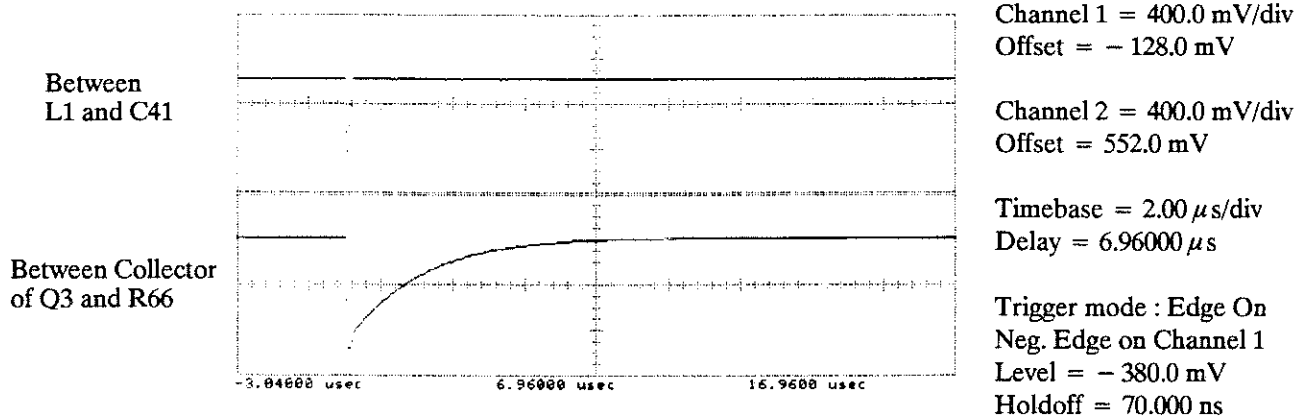


Figure 6C-59. With Pulse Filter Removed from Test Set, on the Horizontal Assembly, 2 μ s/div.

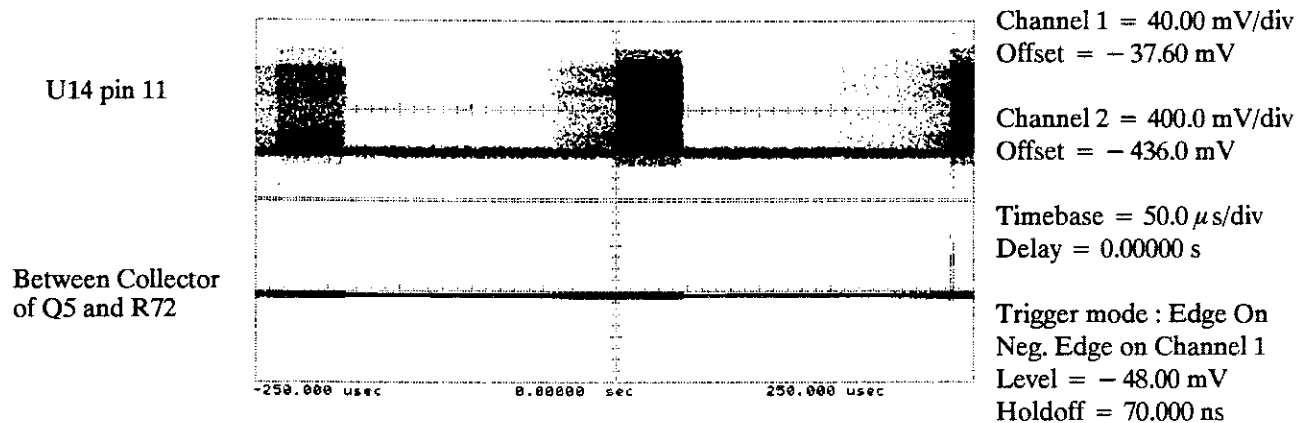


Figure 6C-60. With Pulse Filter Removed from Test Set, on the Horizontal Assembly, 50 μ s/div.

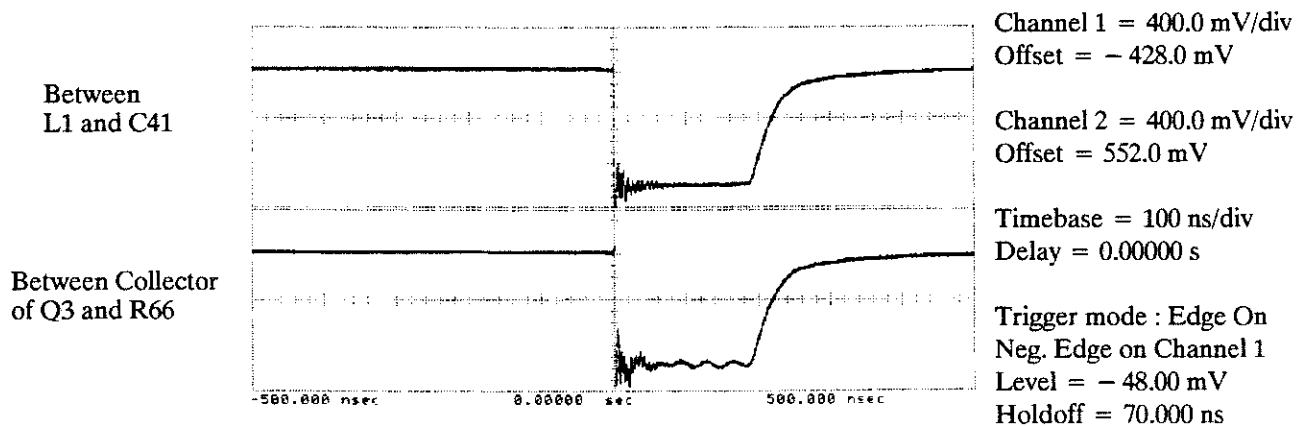


Figure 6C-61. With Pulse Filter Installed in Test Set, on the Horizontal Assembly, 100 ns/div.

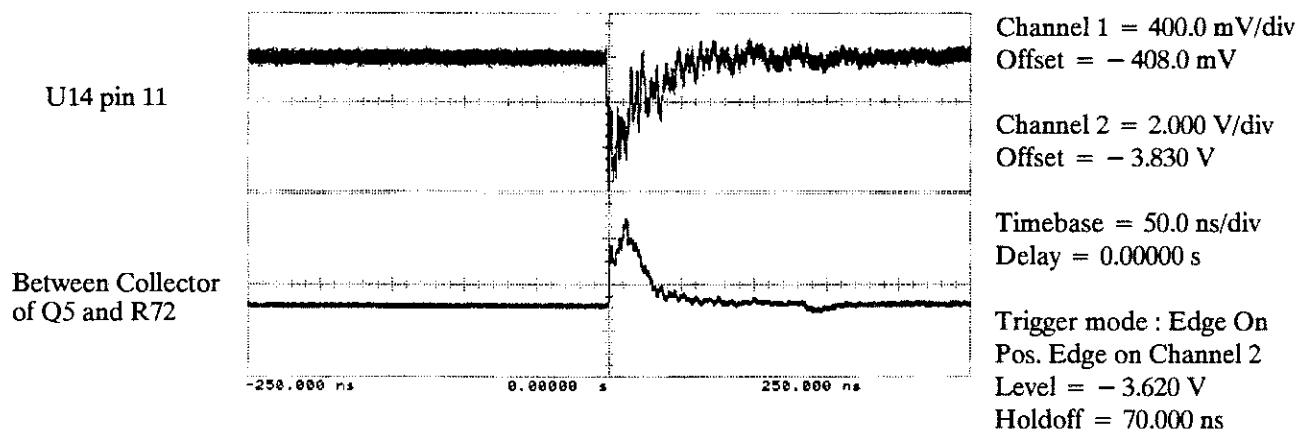


Figure 6C-62. With Pulse Filter Installed in Test Set, on the Horizontal Assembly, 20 ns/div, Trigger Mode Channel 2 Edge.

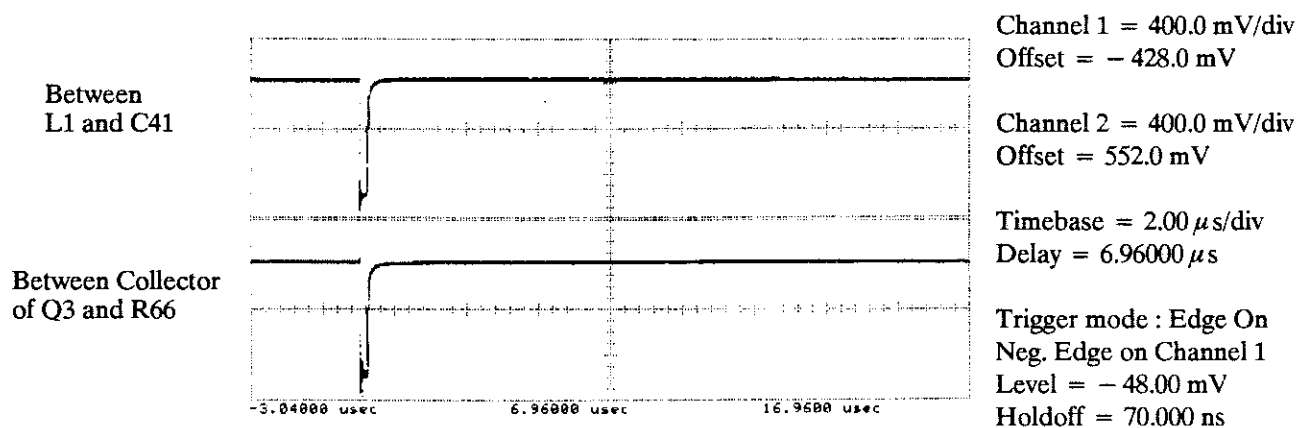


Figure 6C-63. With Pulse Filter Removed from Test Set, on the Horizontal Assembly, 2 μs/div.

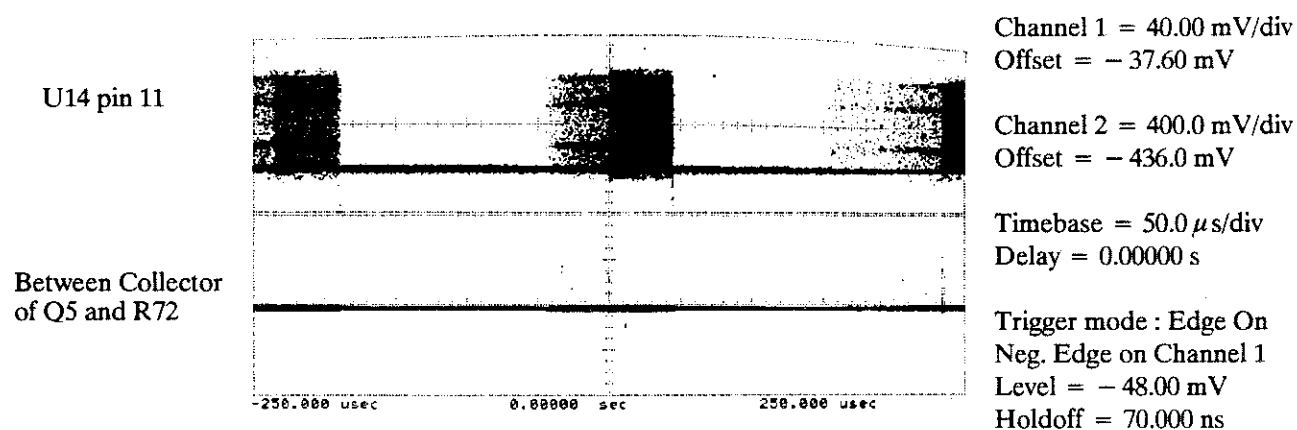


Figure 6C-64. With Pulse Filter Removed from Test Set, on the Horizontal Assembly, 50 μs/div.

TDR Test

This is a front panel test which determines if the TDR system is working properly. For this test to work, it requires at least one good channel other than channel 1. The TDR specifications are checked in channel 1 and the good channel. If either channel fails, suspect a faulty channel. If both channels fail, suspect a faulty TDR system.

1. Perform a one key-down power up. Change display to single screen.
2. Press **Network** menu key and press **Reflect/Trans/Cal** key until **Cal** is highlighted. Press **Preset Reflect Channel** key.
3. Measure the following pulse parameters on channel 1.

| Parameter | Approximate Expected Results |
|-----------|------------------------------|
| Risetime | 45 ps |
| Vtop | 200 mV |
| Vbottom | 0 V |
| Overshoot | 3 % |
| Preshoot | 3 % |

4. If the measured results are within 100% of the expected results, perform the TDR step generator adjustments, than repeat steps 1-4. If the measured results are still off, perform the vertical adjustment, than repeat steps 1-5.
5. If the measured results are still more than 100% off, than this channel fails. Continue with step 7.
6. Connect a semi-rigid S and U cable through an APC 3.5 (f-f) adapter from channel 1 to channel 3 (use a 2.4 mm adapter on channel 3).
7. Turn channel 3 on. Press **Preset Reflect Channel** key.
8. Change sweep speed to 1 ns/div and channel 1 offset to – 500 mV.
9. Measure the following pulse parameters on channel 3.

| Parameter | Approximate Expected Results |
|-----------|------------------------------|
| Risetime | 60 ps |
| Vtop | 200 mV |
| Vbottom | 0 V |
| Overshoot | 4 % |
| Preshoot | 4 % |

10. If the measured results are more than 100% off, this channel fails.
11. Return to the flow diagram.

TDR System Test This test determines which TDR part is faulty: TDR step generator, TDR drive circuitry, or delay line.

1. Perform a one key-down power up.
2. Change display to single screen, and turn channels 2-4 off.
3. Press **Network** menu key, press **Reflect/Trans/Cal** key until **Cal** is highlighted, press **Preset Reflect Channel** key.
4. If a pulse appears on channel 1, go to step 5; otherwise go to step 8.
5. Perform TDR step adjustments in section 4.
6. If the TDR step adjustments do not work properly, replace the TDR generator. Repeat the TDR step adjustment. If the adjustments still do not work properly, replace the horizontal assembly.
7. Return to flow diagrams.
8. Remove the test set's top and bottom covers.
9. Probe the following points. If they are good, the TDR system is probably good. If they are bad, the timebase or trigger system is bad; return to the flow diagram.

| | |
|----------|--------------|
| U4 pin 6 | Figure 6C-65 |
| U4 pin 8 | |

| | |
|---------------------------|--------------|
| Junction of R173 – R31 | Figure 6C-66 |
| U4 pin 4 | |

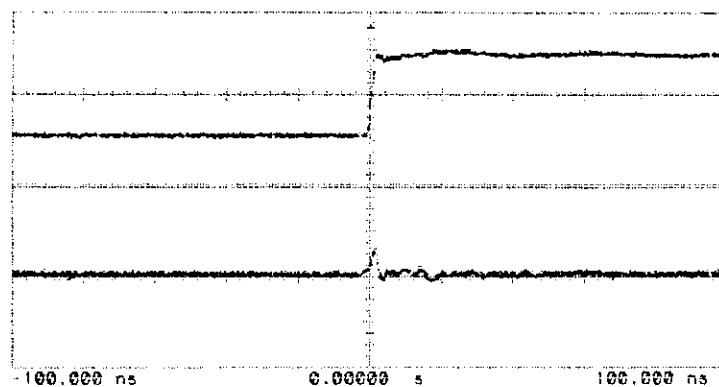
10. Disconnect TDR delay line (W15) from horizontal assembly.
11. Probe the following points. If they are good, replace the TDR step generator; otherwise replace the horizontal assembly.

| | |
|----------|--------------|
| U4 pin 6 | Figure 6C-67 |
| U4 pin 8 | |

| | |
|--------------------------|--------------|
| Junction of R173 – R3 | Figure 6C-68 |
| U4 pin 4 | |

U4 pin 6

U4 pin 8



Channel 1 = 400.0 mV/div
Offset = - 388.0 mV

Channel 2 = 200.0 mV/div
Offset = - 756.0 mV

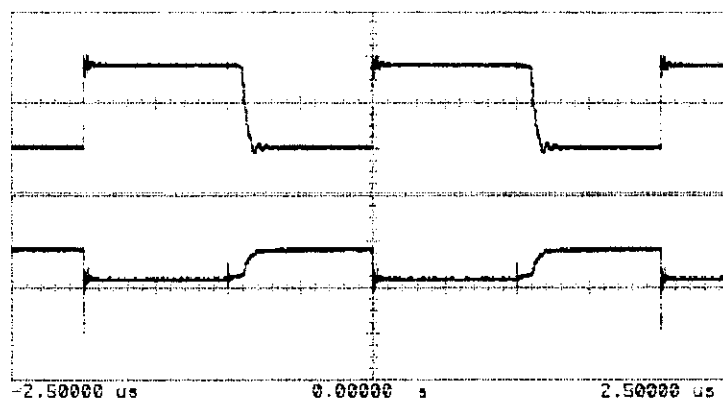
Timebase = 20.0 ns/div
Delay = 0.00000 s

Trigger mode : Edge On
Pos. Edge on Channel 1
Level = - 388.0 mV
Holdoff = 70.000 ns

Figure 6C-65. On the Horizontal Assembly.

Junction of
R173 and C56

U4 pin 4



Channel 1 = 2.000 V/div
Offset = 720.0 mV

Channel 2 = 1.000 V/div
Offset = 1.360 V

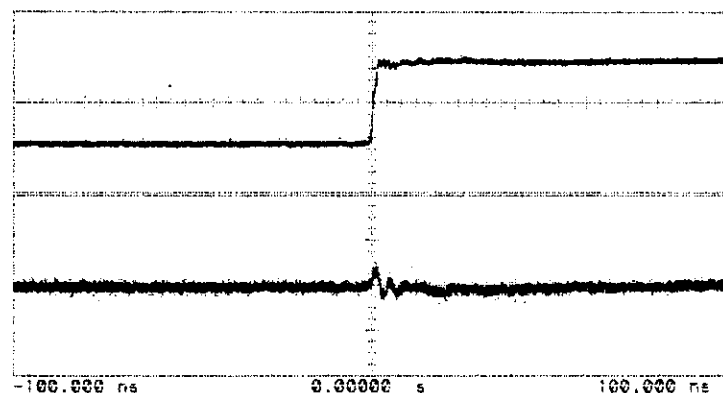
Timebase = 500 ns/div
Delay = 0.00000 s

Trigger mode : Edge On
Pos. Edge on Channel 1
Level = 720.0 mV
Holdoff = 70.000 ns

Figure 6C-66. On the Horizontal Assembly.

U4 pin 6

U4 pin 8



Channel 1 = 400.0 mV/div
Offset = - 382.0 mV

Channel 2 = 200.0 V/div
Offset = - 738.0 mV

Timebase = 20.0 ns/div
Delay = 0.00000 s

Trigger mode : Edge On
Pos. Edge on Channel 1
Level = - 382.0 mV
Holdoff = 70.000 ns

Figure 6C-67. On the Horizontal Assembly.

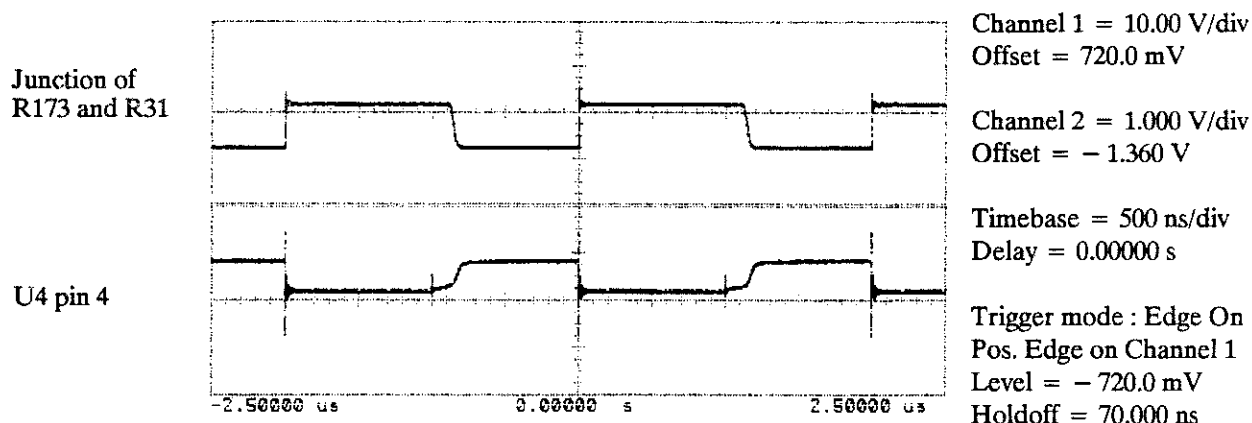


Figure 6C-68. On the Horizontal Assembly.

Trigger Test

This is a quick front panel test to see if the instrument is receiving triggers in both the triggered and freerun modes. The message "Running" on the screen's top left corner DOES NOT indicate the instrument is receiving triggers, it indicates the RUN key has been pressed.

1. Apply a 100 kHz sine wave with an amplitude of 100 mV and offset of 0 V to the external trigger input and press the Autoscale key.
2. Change to trg'd mode and 0 V trigger level, average mode with 2048 averages.
3. Press **Clear Display** key.
4. If the number of averages increases, the instrument is receiving triggers in the trg'd mode.
5. Remove the signal from the external trigger input and attach an SMA short to the external trigger input.
6. Change the timebase mode to freerun and press the Clear Display key.
7. If the number of averages increases, the freerun mode is operational.

Probing Trigger Test

This test verifies the trigger hybrid is functioning properly. External triggers are applied to the instrument and the trigger hybrid's output lines are checked. If this test fails, the timebase/trigger test should be performed to determine if the trigger hybrid is functioning properly. If this test passes, the horizontal test should be performed to find out why the trigger signal is not being received.

1. Remove the test set's top and bottom covers.
2. Apply a 20 MHz sine wave with an amplitude of 300 mV and an offset of 0 V to a power splitter. Connect the power splitter to channel 1 and to the external trigger input.
3. Perform a one key-down power up. Press the **Autoscale** key. Change the display persistence to 300 ms, trigger mode to trg'd.
4. Probe U1 pin 19 and expand the timebase to see the edge with high resolution. When trying to determine if this is a good signal, look for a clear stable trigger. If there are many misplaced dots to the edge's left or right side, or if there appears to be two edges, then the signal is faulty. The jitter test should be executed to determine if the quantity of misplaced dots are within specification.
5. Change the applied signal to 500 MHz. Probe U1 pin 19 Use the same criteria as step 4 to determine if the trigger is operating correctly.
6. If steps 4 and 5 are good, then the trigger circuit's normal triggered mode is good.
7. Remove the signal from the oscilloscope. Change the timebase mode to freerun and set freerun rate to 500 kHz.
8. Probe U1 pin 19 checking for stable signals. Change the freerun rate to each range possible and verify the trigger event rate is correct and the output is stable as defined in step 4. If all the trigger event rates are correct, the trigger circuit's freerun mode is good.
9. If both the triggered and freerun modes are correct, this test passes; otherwise it fails.
10. Return to the flow diagram.

Timebase/Trigger Test

This test verifies the horizontal assembly is applying the proper signals to the trigger hybrid. If this test passes, the probing trigger test should be run to see if the trigger hybrid is good. If this test fails, the umbilical input test should be run to determine the faulty module.

1. Perform a one key-down power up. Perform the umbilical input test for the following points: freerun clock, trig LEN/RESET, trigger slope, trigger hysteresis, and trigger level. If the above points are good proceed to step 3; otherwise this test fails and return to the flow diagrams.
2. Perform the umbilical input test for the following points. Refer to figure 6C-69.

In place of Probe on trigger hybrid
U3 pin 16 U1 pin 22 (level shifted)
U3 pin 8 U1 pin 24 (less gain)

3. If these points are good, the trigger hybrid is receiving good signals and this test passes. Return to the flow diagrams.

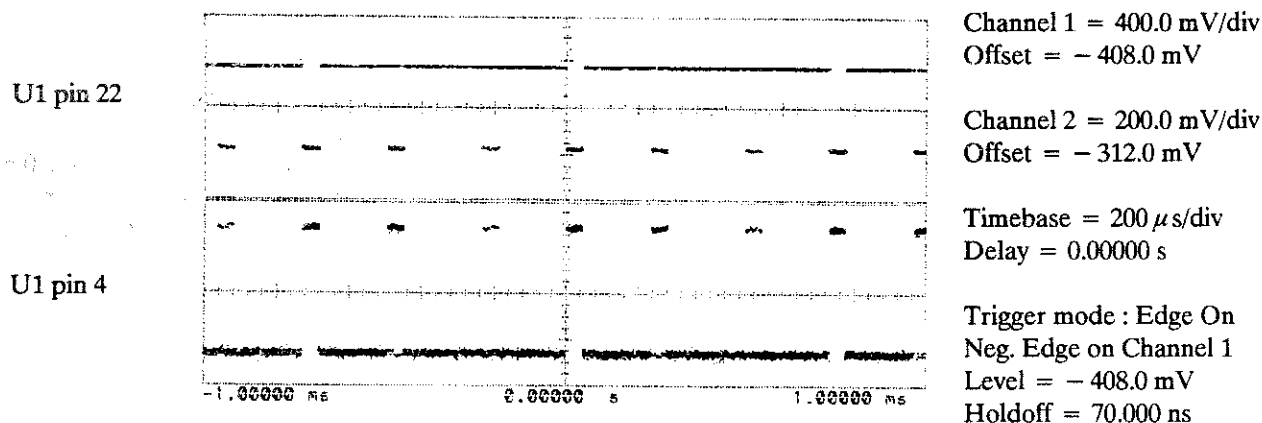


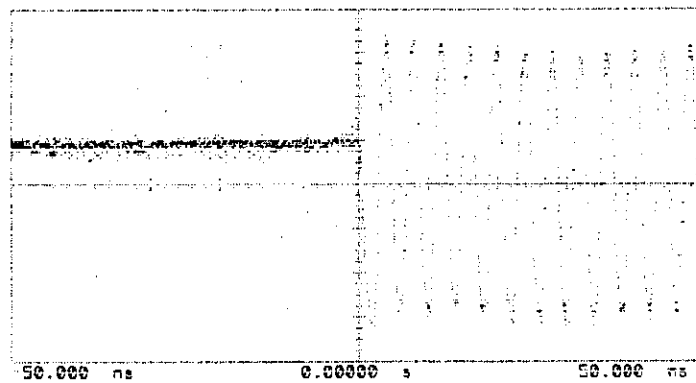
Figure 6C-69. On the Horizontal Assembly.

Horizontal Test

This test checks for a timebase fault in either the horizontal assembly, horizontal control assembly, or interconnect cable. The instrument is setup in a known operating state, and the interface between the two boards is probed.

1. Perform a one key-down power up.
2. Probe the points indicated on figures 6C-70 through 6C-77. If either U22 pin 11 or U3 pin 8 is bad, replace the horizontal control assembly. If J5 pin 11 is bad, go to the pulse filter troubleshooting flow diagram. If any of the remaining points are bad, replace the horizontal assembly.

U14 pin 4



Channel 1 = 100.0 mV/div
Offset = -362.0 mV

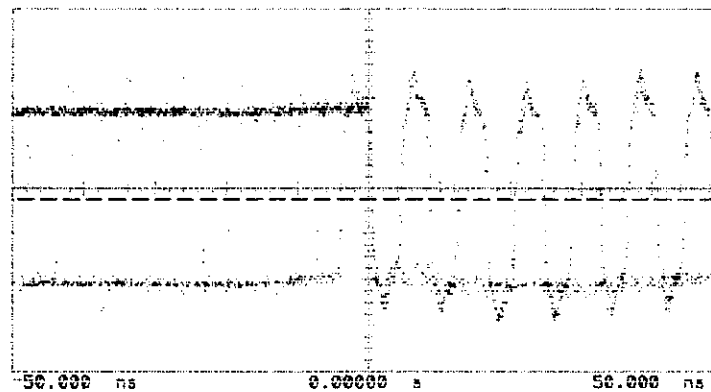
Channel 2 Off

Timebase = 10.0 ns/div
Delay = 0.00000 s

Trigger mode : Edge On
Neg. Edge on Channel 1
Level = -362.0 mV
Holdoff = 70.000 ns

Figure 6C-70. On the Horizontal Assembly, 1KDPU, Freerun

U15 pin 6

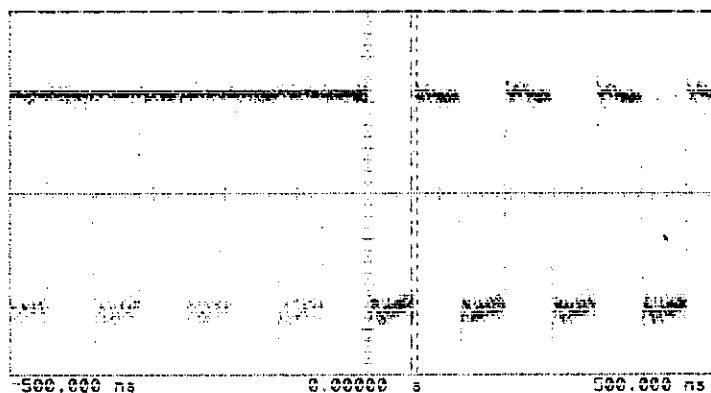


Channel 1 = 200.0 mV/div
Offset = -362.0 mV
Channel 2 Off

Timebase = 10.0 ns/div
Delay = 8.000 ns
Delta T = 8 ns
Start = 80.600 ns
Stop = 88.600 ns
Delta V = 0.000 V
Vmarker 1 & 2 = -412.0 mV
Trigger mode : Edge On
Neg. Edge on Channel 1
Level = -362.0 mV
Holdoff = 70.000 ns

Figure 6C-71. On the Horizontal Assembly.

U16 pin 14

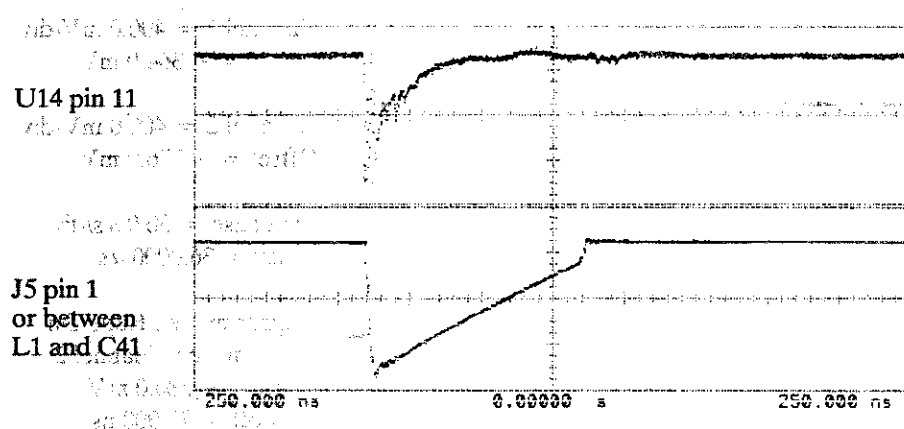


Channel 1 = 200.0 mV/div
Offset = -1.300 V
Channel 2 Off

Timebase = 100 ns/div
Delay = 0.00000 s
Delta T = 8.000 ns
Start & Stop = 88.800 ns
Delta V = 0.000 V
Vmarker 1 & 2 = -412.0 mV

Trigger mode : Edge On
Neg. Edge on Channel 1
Level = -1.300 V
Holdoff = 70.000 ns

Figure 6C-72. On the Horizontal Assembly.



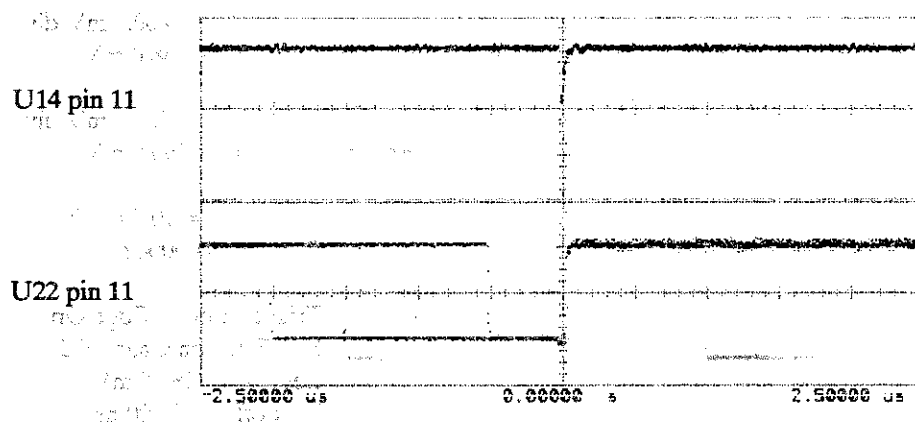
Channel 1 = 400.0 mV/div
Offset = - 544.0 mV

Channel 2 = 4.000 V/div
Offset = - 3.880 V

Timebase = 50.0 ns/div
Delay = 0.00000 s

Trigger mode : Edge On
Pos. Edge on Channel 2
Level = - 2.180 V
Holdoff = 70.000 ns

Figure 6C-73. On the Horizontal Assembly.



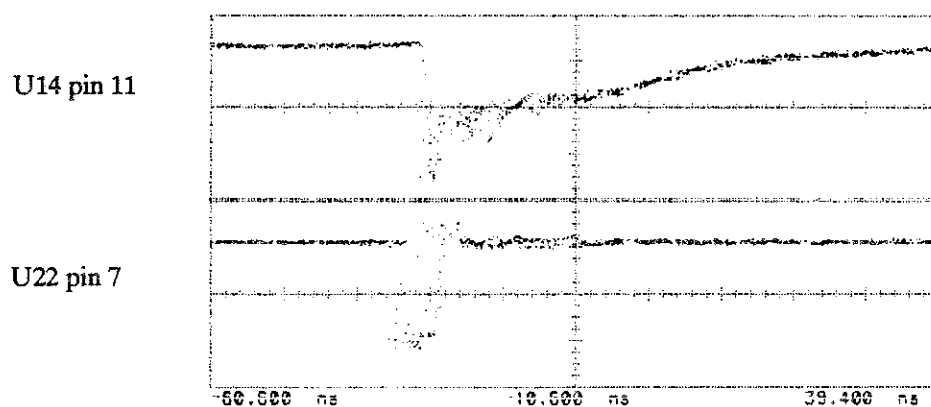
Channel 1 = 400.0 mV/div
Offset = - 544.0 mV

Channel 2 = 400.0 mV/div
Offset = - 1.304 V

Timebase = 500 ns/div
Delay = 0.0000 s

Trigger mode : Edge On
Pos. Edge on Channel 1
Level = - 372.0 mV
Holdoff = 70.000 ns

Figure 6C-74. On the Horizontal Assembly.



Channel 1 = 400.0 mV/div
Offset = - 544.0 mV

Channel 2 = 400.0 mV/div
Offset = - 1.304 V

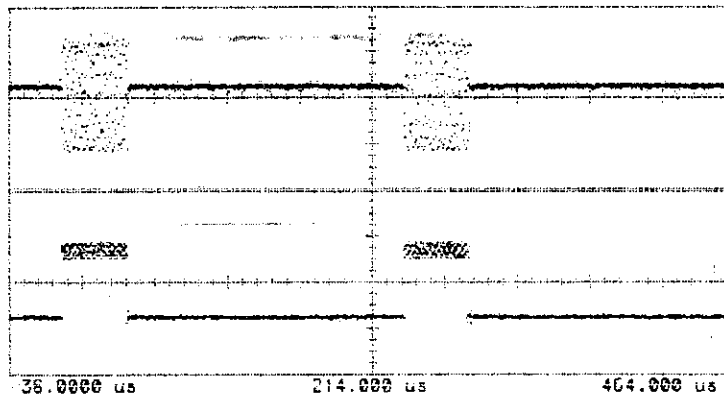
Timebase = 10.0 ns/div
Delay = 10.600 ns

Trigger mode : Edge On
Pos. Edge on Channel 1
Level = - 324.0 mV
Holdoff = 70.000 ns

Figure 6C-75. On the Horizontal Assembly.

U14 pin 14

U1 pin 19



Channel 1 = 400.0 mV/div
Offset = -364.0 mV

Channel 2 = 400.0 mV/div
Offset = -276.0 mV

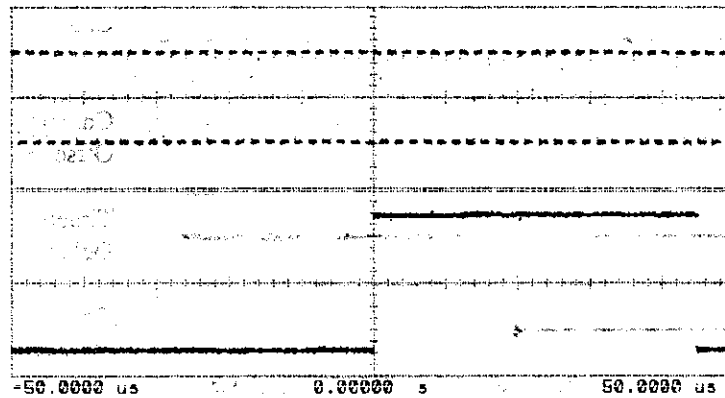
Timebase = 50.0 μ s/div
Delay = 36.0000 μ s

Trigger mode : Edge On
Pos. Edge on Channel 2
Level = -280.0 mV
Holdoff = 70.000 ns

Figure 6C-76. On the Horizontal Assembly.

U3 pin 8

U1 pin 19



Channel 1 = 400.0 mV/div
Offset = -368.0 mV

Channel 2 = 200.0 mV/div
Offset = -290.0 mV

Timebase = 10.0 μ s/div
Delay = 0.00000 s

Trigger mode : Edge On
Pos. Edge on Channel 2
Level = -280.0 mV
Holdoff = 70.000 ns

Figure 6C-77. On the Horizontal Assembly.



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