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Agilent Technologies

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# Service Guide

Publication Number 54720-90908  
First Edition, November 1992

This manual applies directly to instruments  
with serial numbers having the following prefixes.

HP 54710A - 3237A, 3249A  
HP 54720A - 3220A, 3237A, 3249A  
HP 54717A - 3209A  
HP 54718A - 3238A

For additional information about serial numbers, see  
"Instruments Covered by this Service Guide" in  
chapter 1.

For Safety information, Warranties, and Regulatory  
information, see the pages at the back of this book.

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## HP 54710A and 54720A Oscilloscope Mainframes

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# The HP 54710A and 54720A Oscilloscopes

These instruments are high-performance digitizing oscilloscope mainframes. The architecture of the instruments is designed to allow versatile use of the high sample rates of its digitizing channels.

The HP 54720A has four digitizing channels and the HP 54710A has two. Both instruments have four trigger inputs in the plug-in slots.

## Features

These instruments have a wide range of high-performance features:

- The HP 54720A has four slots for vertical signal conditioning plug-ins. Each slot feeds a 2 GSa/s digitizer for the vertical signal and an input for a trigger signal. The HP 54710A has only two slots with digitizers but can trigger on all four slots.
- A digital timebase with a 2 GHz reference frequency.
- Triggering functions that include edge, state, and pattern triggering, depending on the plug-in configuration.
- A color display that shows the captured signal, measurement results, and the selections for a set of softkeys.
- A 3.5 inch disk drive.
- A port for HP-IB and a parallel printer output.
- Instrument firmware that includes self calibration and failure diagnostics.

## Architecture

The four slots for signal conditioning plug-ins provide the user with a variety of options. Single-slot plug-ins provide 2 GSa/s sample rate. A two-slot plug-in provides 4 GSa/s sample rate. Plug-ins include:

| Model     | Slots | Bandwidth | Channel                     | Sensitivity         | Trigger                      |
|-----------|-------|-----------|-----------------------------|---------------------|------------------------------|
| HP 54711A | 1     | 1.5 GHz   | 50 $\Omega$                 | 2 mV/div to 1 V/div | 2.5 GHz, external            |
| HP 54712A | 1     | 1.1 GHz   | 50 $\Omega$                 | 1 mV/div to 1 V/div | 1 GHz, internal              |
| HP 54713A | 1     | 500 MHz   | 50 $\Omega$ or 1 M $\Omega$ | 1 mV/div to 5 V/div | 500 MHz, internal            |
| HP 54721A | 2     | 1.1 GHz   | 50 $\Omega$                 | 1 mV/div to 1 V/div | 1 GHz, internal and external |

In addition, the HP 54718A Trigger plug-in can be used in the trigger-only slots of the HP 54710A. It can also be used in any slot of the HP 54720A mainframe.

The HP 54717A plug-in is used to calibrate the HP 54710A and 54720A mainframes.

## Service Policy

The service policy of this instrument is the replacement of defective assemblies. Some assemblies can be replaced on an exchange basis.

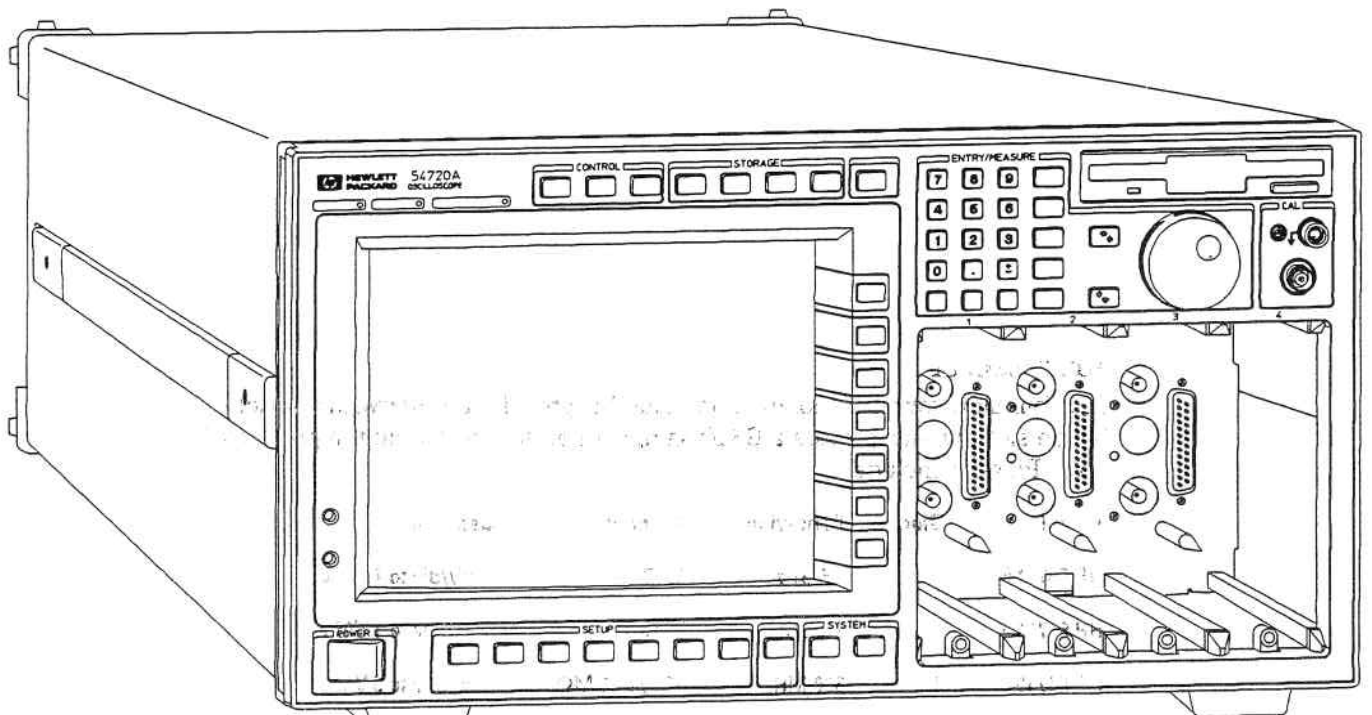
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This book provides the service documentation for the HP 54710A and 54720A Oscilloscopes. It is divided into eight chapters.

Chapter 1 provides general information and specifications.

Chapter 2 shows you how to prepare the oscilloscope for use and gives a brief overview of operation.

Chapter 3 gives performance tests.

Chapter 4 covers calibration and adjustment procedures, how to do them and how often they need to be done.

Chapter 5 provides troubleshooting information.

Chapter 6 gives the procedures and techniques for replacing assemblies and other parts.

Chapter 7 includes a list of exchange assemblies and other replaceable parts, part ordering information, and shipping information.

Chapter 8 briefly covers the internal operation of the oscilloscope.

Chapter 9 provides service information for the HP 54717A Calibration plug-in.

Chapter 10 provides service information for the HP 54718A Trigger plug-in.

At the back of the book you will find Safety information, Warranties, and Regulatory information.

## 1 General Information

- Instruments Covered by this Service Guide 1-2
- Accessories Supplied 1-3
- Accessories Available 1-3
- Options Available 1-3
- Specifications 1-4
- Characteristics 1-4
- Product Support 1-6
- General Characteristics 1-6
- Recommended Test Equipment 1-8

## 2 Preparing for Use

- Setting Up the Oscilloscope 2-3
  - To inspect the instrument 2-3
  - To check power requirements 2-3
  - To set the line voltage selection 2-3
  - To install a plug-in 2-4
  - To clean the instrument 2-5
- Operating the Oscilloscope 2-6
  - A Quick Tour of the Front Panel 2-6
  - Operating Your Oscilloscope in Five Easy Steps 2-12
  - In Case of Difficulty 2-21



## 3 Testing Performance

- Testing Interval 3-2
- Equipment Required 3-2
- Test Record 3-2
- Keystroke Conventions 3-2
- Operating Hints 3-3
  - To test the front panel CAL signal 3-4
  - To test time interval accuracy 3-6

## 4 Calibrating and Adjusting

- Equipment Required 4-2
- Keystroke Conventions 4-2
- Calibrating the Oscilloscope 4-3
  - Calibration Overview 4-3
  - Calibration Interval 4-5
  - Calibration Status Displays 4-6
  - To calibrate the mainframe 4-9
  - To calibrate the plug-ins 4-11
  - To calibrate for best accuracy 4-12



## 4 Calibrating and Adjusting (cont'd)

- Adjusting the Color CRT Module 4-14
- Equipment Required 4-14
- To prepare the instrument 4-14
- To adjust geometry 4-16
- To adjust focus, landing, and convergence 4-17
- To adjust white balance 4-24

## 5 Troubleshooting

- Safety 5-2
- ESD Precautions 5-2
- Keystroke Conventions 5-2
- Default Setup 5-2
  
- Trouble Isolation 5-3
- Tools Required 5-3
- 1, Primary Trouble Isolation 5-5
- 2, No-Display Trouble Isolation 5-11
- 3, Keyboard Trouble Isolation 5-19
- Missing Board Checks 5-22
- Interpreting Internal Self-tests 5-23
- Power Supply Distribution 5-25
  
- Utility Menu 5-27
- HP-IB Setup 5-27
- System Configuration 5-27
- Calibrate 5-29
- Self-test 5-30
- Firmware Support 5-30
- Service 5-31

## 6 Replacing Assemblies

- ESD Precautions 6-2
- Tools Required 6-2
- Instrument Structure 6-2
- To return the instrument to HP for service 6-3
- A Brief Order of Procedures 6-4
- To remove and replace
  - Front panel 6-5
  - Keyboard 6-6
  - RPG 6-7
  - Front fan 6-8
  - Disk drive assembly 6-9
  - Disk drive 6-9
  - Disk drive control 6-10

## 6 Replacing Assemblies (cont'd)

To remove and replace  
 Rear panel 6-11  
 Power supply 6-11  
 CPU and display assemblies 6-12  
 Time base assembly 6-12  
 Clock assembly 6-14  
 Acquisition assemblies 6-16  
 Color CRT module 6-17  
 Motherboard 6-20  
 Rear fan 6-22



## 7 Replaceable Parts

Ordering Replaceable Parts 3-2  
 Exploded Views 3-3  
 Replaceable Parts List 3-6

## 8 Theory of Operation

Mainframe Block-level Theory 3-3  
 Acquisition System 3-7

## 9 HP 54717A Plug-In Service

General Information 10-3  
 Accessories Supplied 10-3  
 Specifications 10-3  
 Characteristics 10-3  
 General Characteristics 10-3



Periodic Maintenance 10-4  
 Functional Test 10-4  
 Calibration and Adjustment 10-5

Troubleshooting 10-6  
 ESD Precautions 10-6  
 Equipment Required 10-6  
 Trouble Isolation 10-6

### Replacing Assemblies 10-8

Tools Required 10-8  
 To remove and replace  
 Covers 10-9  
 Front panel 10-9  
 Limiter 10-9  
 Output cable 10-10  
 PC board 10-11  
 Bus cable 10-11

## 9 HP 54717A Plug-In Service (cont'd)

Replaceable Parts 10-12  
Mechanical View 10-12  
Parts List 10-12

Theory of Operation 10-14  
Signal Paths 10-14  
Digital Interface 10-14  
Power Supplies 10-15

## 10 HP 54718A Plug-In Service

General Information 10-3  
Accessories Available 10-3  
Specifications 10-3  
Characteristics 10-4  
General Characteristics 10-4

Periodic Maintenance 10-5  
Performance Test 10-5  
Calibration and Adjustment 10-8

Troubleshooting 10-9  
ESD Precautions 10-9  
Equipment Required 10-9  
Trouble Isolation 10-9

Replacing Assemblies 10-11  
Tools Required 10-11  
To remove and replace  
Covers 10-11  
Input cable 10-11  
Limiter and attenuator 10-12  
Output cable 10-12  
Bus cable 10-13  
PC board 10-13

Replaceable Parts 10-14  
Mechanical View 10-14  
Parts List 10-14

Theory of Operation 10-16  
Passive Trigger Path 10-16  
Digital Interface 10-17  
Probe Power 10-17  
Power Supplies 10-17



Instruments Covered By this Service Guide 1-2  
Accessories Supplied 1-3  
Accessories Available 1-3  
Options Available 1-3  
Specifications 1-4  
Characteristics 1-4  
Product Support 1-6  
General Characteristics 1-6  
Recommended Test Equipment 1-8

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# General Information

This chapter of the Hewlett-Packard 54710A and 54720A Oscilloscope service guide gives you general information about the instrument. The following topics are covered in this chapter.

- Instrument identification
- Accessories
- Options
- Specifications and characteristics
- Test equipment requirements

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## Instruments Covered by this Service Guide

On the left side of the plug-in compartment of the instrument is a serial number sticker. The serial number is in the form: 0000A00000. It is composed of two parts: the first four digits and letter are the serial prefix, while the last five digits are the suffix. The prefix is the same for all identical instruments and changes only when a change has been made to the instrument. The suffix however, is assigned sequentially and is different for each instrument. The contents of this guide apply to instruments with the serial number prefixes listed under SERIAL NUMBERS on the title page.

An instrument manufactured after the printing of this guide may have a serial number prefix different than those listed on the title page. This unlisted serial number prefix indicates the instrument is different from those described in this guide. The service guide for this instrument is accompanied by a manual changes supplement. This supplement contains the necessary "change information" that explains how to adapt this guide to the newer instrument. In addition to change information, the supplement may contain information for correcting errors in this guide.

For information concerning a serial prefix number not listed on the title page or in the manual changes supplement, contact your nearest HP office.

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## Accessories Supplied

The following accessories are supplied with the HP 54710A and 54720A oscilloscopes.

- One 2.3 meter (7.5 feet) power cord (See chapter 7 for available power cords)
  - One Operating and Programming Guide Set
  - One Service Guide
- 

## Accessories Available

The following accessories are available for use with the HP 54710A and 54720A.

- HP 10087A HP 54710A to HP 54720A upgrade service
  
  - HP 2225A ThinkJet Printer (HP-IB) or HP 2225C ThinkJet (Centronics)
  - HP 3630A PaintJet Printer option 002 (HP-IB) or HP 3630A PaintJet option 004 (Centronics)
  - HP C2106A DeskJet Printer (Centronics)
  - HP 2228A QuietJet Printer (Centronics)
  - HP 2227A QuietJet Plus (Centronics) or HP 2227B QuietJet Plus (HP-IB)
  
  - HP 1181A system testmobile
  - HP 35181A top-mounted printer stand for HP 1181A
  - HP 35181C 3.5-inch drawer for HP 1181A
  - HP 35181D work surface for HP 1181A
- 

## Options Available

The following options are available for the HP 54710A and 54720A.

Option 002 - Training kit including a PC board, demo guide, and power supply.

Option 907 - Rackmount kit (handles only)(HP 54710-68703) includes special long screws

Option 908 - HP Rack-mount Kit (ears only)(HP 54710-68704) includes special long screws

Option 909 - HP Rack-mount Kit (with handles)(HP 54710-68705) includes special long screws

Option 0B1 - additional Service Guide and Operating and Programming Guide Set

Other options are available. See your HP sales representative.



## Specifications

The following are specifications used to test the HP 54710A and 54720A oscilloscopes. Specifications are valid after a 20 minute warm-up period.

### Time base

#### Time-Interval Measurement Accuracy<sup>1</sup>

**Real Time**  $\pm[(0.2)(\text{sample interval}) + 0.007\% \text{ of delta-time marker reading}]$ .  
**Equivalent Time (16 averages)**  $\pm(30 \text{ ps} + 0.007\% \text{ of delta time marker reading})$

### Front Panel Calibrator

#### dc Output

**Adjustable output range**  $-2.5 \text{ V}$  to  $+2.5 \text{ V}$  when terminated into  $50 \Omega$ .  
**Output Delta Voltage Accuracy**  $\pm(0.2\% \text{ of delta voltage output})$

1) Time interval measurement accuracy includes error sources such as time base inaccuracy, aperture uncertainty/sample clock phase jitter, reconstruction filter uncertainty (real-time only), trigger interpolation jitter, and channel-to-channel skew. Real-time time-interval accuracy applies for input rise times greater than 1.4 multiplied by the sample interval.

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## Characteristics

The following characteristics are typical for the HP 54710A and 54720A oscilloscopes.

### Channel

#### ADC Input Sources (simultaneous acquisition)

**HP 54720A mainframe** 4, each plug-in slot has its own 2 GSa/s ADC and 16,384 point acquisition memory.

**HP 54710A mainframe** 2, each plug-in slot has its own 2 GSa/s ADC and 16,384 point acquisition memory.

**Best Accuracy Calibration** Performing the Best Accuracy Cal on a channel just prior to a series of critical measurements will ensure the most accurate results. This calibration adjusts the channel's gain, offset, and linearity and requires a specific plug-in to stay installed in a specific mainframe slot.

**Channel Skew Adjustment** The time skew between channels can be manually eliminated all the way to the probe tip to 1-ps resolution.

**Probe Calibration** A probe calibration routine automatically computes the offset and the attenuation created by the probe attached to the channel input.

### Time base

**Time Base Scale** 100 ps/div to 1 s/div (in 1-2-5 or fine steps)

#### Time Base Position Range (auto sample rate and record length)

**Pretrigger** 0 to  $-1 \text{ s}$  or one full screen width, whichever is larger.

**Posttrigger** 0 to  $1 \text{ s}$  or one full screen width, whichever is larger.

**Time Interval Measurement and Trigger Interpolator Resolution** 1 ps

#### Time Base Window

**Scale:** 1 ps/div to the main time base scale factor.

**Position:** The window must always stay in the time window defined by the main sweep.

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**Trigger**

**Sources** All four input plug-in slots can be used for triggering. See plug-in specifications for more details.

**Edge Slope** Positive/negative

**Holdoff Range** 60 ns to 320 ms

**Pattern Trigger** A pattern can be specified using any channel or external trigger input (up to four bits wide). Each of the inputs can be specified as high, low, or don't care with respect to the trigger level setting for that source. Trigger occurs when that pattern is entered or exited.

**Glitch Trigger** This mode makes it easy to look for glitches on a single source. The user can distinguish glitches down to 3 ns ± 1 ns in width and can capture glitches as narrow as 500 ps in width, depending on the plug-in.

**Time-Qualified Pattern Trigger** A trigger will occur on the first edge to exit a pattern only if it meets one of these criteria: pattern present <[time], pattern present >[time], pattern present in range >[time1] and <[time2]. The time settings are adjustable from 20 ns to 160 ms [ $\pm(3\% + 2 \text{ ns})$ ] with 10 ns resolution. Filter recovery time is ≤ 12 ns.

**State Trigger** A pattern is specified on any three of the four inputs, with the fourth input used as a clock. Trigger occurs on the rising or falling edge of the input specified as the clock, and when the pattern is present or is not present. Setup time for the pattern with respect to the clock is 10 ns or less; hold time is zero.

**Event-Delayed Trigger** The trigger is qualified by an edge. The delay can be specified as a number of occurrences of a rising or falling edge of any input. After the delay, an occurrence of a rising or falling edge of any input will generate the trigger. The trigger occurrence value is selectable from 1 to 16,000,000. The maximum edge counting rate is 70 MHz. Edges occurring <30 ns after the qualifying edge may not be detected.

**Time-Delayed Trigger** The trigger is qualified by an edge. The delay is selectable from 30 ns to 160 ms. After the delay, an occurrence of a rising or falling edge on any one selected input will generate the trigger.

**Display Update**

**Maximum Display Update Rate:** 550 Kpixels/s

**HP-IB Transfer**

**Maximum HP-IB Transfer Rate:** 500 Kbytes/s

**Throughput**

This throughput data was taken in the real-time sampling mode (250 MSa/s) with 512-point records onscreen, no measurements (waveforms/s only), no interpolation, fast draw mode, infinite persistence, markers off, math off, and one channel acquisition. Vp-p does not require threshold detection, but period does.

| Throughput                            | Waveforms/second | Measurements/second |        |
|---------------------------------------|------------------|---------------------|--------|
|                                       |                  | Vp-p                | Period |
| Measurement                           |                  |                     |        |
| Front-Panel Capture and Transfer Rate | >170             | >44                 | >39    |
| HP-IB Capture and Transfer Rate       | >50              | >33                 | >31    |

**Front Panel  
Calibrator**

**ac Output** A 2 kHz or 500 kHz square wave with approximately 1.6 ns transitions can be used for probe compensation and system calibration. The waveform levels are 0 V and 1 V when terminated into 50  $\Omega$ .

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## Product Support

### Calibration

All instrument calibration is executed with built-in calibration routines. The mainframe calibration and plug-in calibration should be performed yearly. These calibrations are valid only if performed between 15°C and 35°C. Specifications are valid  $\pm 5^\circ\text{C}$  from the calibration temperature. Perform probe calibration and best-accuracy calibration to assure the highest level of performance at the time of measurement.

### Low Cost of Ownership

The HP 54720A series, including plug-ins and probes, include a one year, return to HP warranty. To minimize the mean time to repair and the calibration time, the series was designed with no periodic hardware adjustments. HP's board exchange program assures economical and timely repair of units, reducing the cost-of-ownership.

### Reliability

Under normal use, estimated mean time between failures (MTBF) for the HP 54710A is 10,000 hours. The estimated MTBF of the HP 54720A is 9,000 hours.

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## General Characteristics

These general characteristics apply to the HP 54710A and 54720A oscilloscopes.

**Environmental  
Conditions**

The instruments meet Hewlett-Packard's environmental specifications (section 750) for class B-1 products with exceptions as described for temperature and condensation. Contact your local HP field engineer for complete details.

### Temperature

**Operating** 10°C to +40°C (50°F to +104°F)

**Non-operating** -40°C to +70°C (-40°F to +158°F)

### Humidity

**Operating** up to 95% relative humidity (non-condensing) at +40°C (+104°F)

**Non-operating** up to 90% relative humidity at +65°C (+149°F)

### Altitude

**Operating** up to 4,600 meters (15,000 ft)

**Non-operating** up to 15,300 meters (50,000 ft).

### Vibration

**Operating** Random vibration 5-500 Hz, 10 minutes per axis, 0.3 gr<sub>rms</sub>

**Non-operating** Random vibration 5-500 Hz, 10 minute per axis, 2.41 gr<sub>rms</sub>; Resonant search, 5 to 500 Hz swept sine, 1 Octave/minute sweep rate, 0.75g, 5 minute resonant dwell at 4 resonances per axis.

**Power Requirements Voltage** 90 to 132 or 198 to 264 Vac, 48-66 Hz.

**Power** 1200 VA; 650 W

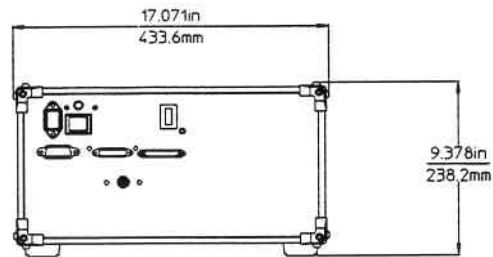
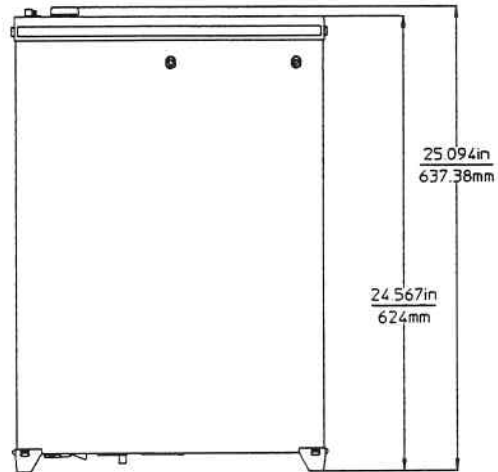
| Weight<br>(approximate) | HP 54710A       | HP 54720A       |
|-------------------------|-----------------|-----------------|
|                         | <b>Net</b>      | 24.5 kg (54 lb) |
| <b>Shipping</b>         | 31.8 kg (70 lb) | 33.6 kg (74 lb) |

**Dimensions** Refer to the outline drawings to the right.

**Notes**

1. Dimensions are for general information only. If dimensions are required for building special enclosures, contact your HP field engineer.

2. Dimensions are in millimeters and (inches).



54720E07

|                            |                  |   |
|----------------------------|------------------|---|
| <b>Product Regulations</b> | <b>Safety</b>    | IEC 348<br>UL 1244<br>CSA Standard C22.2 No.231 (Series M-89)                                 |
|                            | <b>EMC</b>       | This product meets the requirement of the European Communities (EC) EMC Directive 89/336/EEC. |
|                            | <b>Emissions</b> | EN55011/CISPR 11 (ISM, Group 1, Class A equipment)<br>SABS RAA Act No. 24 (1990)              |
|                            | <b>Immunity</b>  | EN50082-1   |
|                            |                  | Code <sup>1</sup> Notes <sup>2</sup>  |
|                            |                  | IEC 801-2 (ESD) 4kV CD, 8kV AD 1  |
|                            |                  | IEC 801-3 (Rad.) 3 V/m 2  |
|                            |                  | IEC 801-4 (EFT) 1kV 1   |

<sup>1</sup> Performance Codes:

- 1 PASS - Normal operation, no effect.
- 2 PASS - Temporary degradation, self recoverable.
- 3 PASS - Temporary degradation, operator intervention required.
- 4 FAIL - Not recoverable, component damage.

<sup>2</sup> Notes:  
(None)

## Recommended Test Equipment

Table 1-1 shows a list of the test equipment required to test performance, calibrate and adjust, and troubleshoot this instrument. The table indicates the critical specification of the test equipment and for which procedure the equipment is necessary. Equipment other than the recommended model may be used if it satisfies the critical specification listed in the table.

**Table 1-1**

**Recommended Test Equipment**

| Equipment Required        | Critical Specifications  | Recommended Model  | Use *   |
|---------------------------|--|--|---------|
| Signal Generator          | 40 and 300 MHz, sine wave<br>amplitude -12 to 2 dB<br>frequency accuracy $\pm 0.1\%$                   | HP 8664A   | P       |
| RF Amplifier              | 40 MHz to 1 GHz, 26 dB gain  | HP 8447D   | P       |
| DMM                       | 5 1/2 digit resolution<br>dc voltage accuracy $\pm 0.025\%$<br>4-wire resistance accuracy $\pm 0.25\%$ | HP 34401A  | P, T    |
| Oscilloscope              | 1 GHz bandwidth  | HP 54720A with<br>HP 54711A, 12A, or 21A                   | P, T    |
| Calibration plug-in       | No substitute  | HP 54717A  | C       |
| Attenuator                | 20 dB $\pm 1$ dB, BNC  | HP 8490 series Opt.20<br>with adapters<br>or Narda 755B-20 | C       |
| Power Splitter            | >500 MHz bandwidth   | HP 11667A  | P       |
| Termination<br>(optional) | BNC 50 $\Omega$  | HP 10100C  | C       |
| Cable (2)                 | BNC - 3 foot   | HP 10503A  | P, C, T |
| Cable (3)                 | BNC - 9 inch   | HP 10502A  | P, C, T |
| Adapter (3)               | N (m) to BNC (f)   | HP 1250-0780   | P       |
| Adapter                   | BNC tee (m)(f)(f)  | HP 1250-0781   | P, C, T |
| Adapter                   | BNC to dual banana   | HP 1251-2277   | P       |

\* P = Performance Tests, C = Calibration and adjustment, T = Troubleshooting



|  |      |
|--|------|
| Setting up the Oscilloscope                    | 2-3  |
| To inspect the instrument                      | 2-3  |
| To check power requirements                    | 2-3  |
| To set the line voltage selection              | 2-3  |
| To install a plug-in                           | 2-4  |
| To clean the instrument                        | 2-5  |
| Operating the Oscilloscope                     | 2-6  |
| A Quick Tour of the Front Panel                | 2-6  |
| Entry Devices                                  | 2-6  |
| Disk Drive                                     | 2-6  |
| CAL Signal                                     | 2-6  |
| Hardkeys                                       | 2-7  |
| Display  | 2-8  |
| Softkeys                                       | 2-9  |
| Operating Your Oscilloscope in Five Easy Steps | 2-12 |
| Writing Conventions                            | 2-12 |
| Equipment Used                                 | 2-12 |
| Step 1. Connect a signal to the oscilloscope   | 2-13 |
| Step 2. Let the oscilloscope find your signal  | 2-14 |
| Step 3. Modify the setup of the oscilloscope   | 2-15 |
| Step 4. Make measurements on the signal        | 2-18 |
| Step 5. Use the help menu                      | 2-20 |
| In Case of Difficulty                          | 2-21 |
| If the oscilloscope does not power up          | 2-21 |
| If autoscale does not find the CAL signal      | 2-21 |

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## Preparing for Use

This chapter shows you how to prepare the HP 54710A and 54720A for use. It references the routines necessary to establish calibration levels.

Following instrument set-up is a brief section covering oscilloscope operation. If you are unfamiliar with this oscilloscope's operation and do not have the operator's manuals, this section will help you.

The following areas are covered in this chapter.

- Inspection
- Setup
- Cleaning
- Operating

---

# Setting Up the Oscilloscope

When ordered as a system, the HP 54710A and 54720A are shipped from the factory ready to use, with the plug-ins installed and normal-accuracy calibrations done. However, if you ordered additional plug-ins and you want to change the instrument configuration, this section will help you get the instrument ready to use.

---

## To inspect the instrument

- Inspect the shipping container for damage.

Keep a damaged shipping container or cushioning material until the contents of the shipment have been checked for completeness and the instrument has been checked mechanically and electrically.

- Check the accessories.

Accessories supplied are listed in chapter 1 of this service guide.

- If the contents are incomplete or damaged notify your HP sales office.

- Inspect the instrument.

- If there is mechanical damage or defect, or if the instrument does not operate properly or pass performance tests, notify your HP sales office.
- If the shipping container is damaged, or the cushioning materials show signs of stress, notify the carrier as well as your HP sales office. Keep the shipping materials for the carrier's inspection. The HP office will arrange for repair or replacement at Hewlett-Packard's option without waiting for claim settlement.

---

## To check power requirements

The instrument requires a power source of 90 to 132 Vac or 198 to 264 Vac, 48 to 66 Hz, 1200 VA or 650 W maximum.

---

### CAUTION

**BEFORE CONNECTING POWER TO THIS INSTRUMENT**, be sure the line voltage switch on the rear panel of the instrument is set properly. Applying a voltage excessive to the setting may open the protective fuse.

---

## To set the line voltage selection

Before applying power, verify the setting of the LINE SELECT switch on the rear panel.

- If the switch is set incorrectly, set it to either 115 V or 230 V, whichever is appropriate for the voltage in your area.

To change the selection, remove the line voltage switch cover, turn it 180 degrees and reinstall it. The switch will change when the cover is installed.



---

**CAUTION**

The fuse requirement is different for 100 V, 115 V, and 230 V operation. The instrument was shipped with the line voltage selection and fuse appropriate for the country of destination. If you change the line voltage selection, you will need to change the fuse or the fuse may not protect the instrument properly.



For size, type, and part number of the fuse, see the parts list in chapter 7, "Replaceable Parts."

---

**WARNING**

**SHOCK HAZARD!**

**BEFORE YOU CONNECT THIS INSTRUMENT TO MAINS POWER OR LIVE MEASURING CIRCUITS**, you must provide a protective earth ground.

The Mains plug must be inserted in a socket outlet provided with a protective earth contact. Do not use an extension cord (power cable) without a protective conductor (grounding). Grounding one conductor of a two-conductor outlet does not provide an instrument ground.

Failure to provide a protective earth ground could result in a shock hazard if there is a failure in this instrument or equipment connected to it.

---

**CAUTION**

For shipments to Japan, this instrument is supplied with a heavy duty mains power cable. At lower mains voltages (approximately 90 to 100 Vac) the increased mains current will cause increased loss in the standard power cable. In such cases, be sure to use the heavy duty cable provided with this instrument.

This instrument is provided 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.

---

## To install a plug-in

There are a few things to consider when using plug-ins:

- Plug-ins may be removed and installed without turning off instrument power.
  - A plug-in calibrated to normal accuracy in a calibrated mainframe will have normal accuracy in any slot of any other calibrated mainframe.
- 1 Install the plug-in in any empty slot of the mainframe.  
Some plug-ins use more than one slot.
  - 2 If the plug-in needs calibration, see "To calibrate the plug-ins" in chapter 4 of this service guide.
  - 3 If Best Accuracy is desired, see "To calibrate for Best Accuracy" in chapter 4 of this service guide.
  - 4 If you are using a probe or other attenuation device with your plug-in, you may perform the probe calibration.
    - Press  , then press **Probe . . .** , then press **Probe cal Execute** , and follow the instructions on the screen.

**See Also**

"Calibration Overview" in chapter 4 of this service guide.

## To clean the instrument

To clean the instrument, use a soft cloth, damp with a mild soap and water solution.

---

# Operating the Oscilloscope

Following is a quick introduction to the oscilloscope. It is not intended as a comprehensive guide, but rather as help for people who need only a brief overview.

**A Quick Tour of the Front Panel** This section gives you a quick tour of the front panel in a descriptive format with examples that help to illustrate the text.

**Five Easy Steps to Operating the Oscilloscope** This section gives you five exercises that show you how to get the oscilloscope up and running, how to scale a waveform vertically and horizontally, and how to use the help menu.

**In Case of Difficulty** This section contains a few simple hints in case you are experiencing difficulty in either getting the oscilloscope to power up or to display a signal.

---

## A Quick Tour of the Front Panel

This section describes how to use the front panel. You will find that this information will help you to gain the full use of your oscilloscope in the shortest possible time. This section divides the front panel into six areas: entry devices, disk drive, CAL signal, hardkeys, display, and softkeys.

### Entry Devices

The entry devices include the knob, arrow keys, and keypad. The knob provides continuous control, while the arrow keys are step controls. The keypad allows you to enter a specific value.

### Disk Drive

The disk drive is a 3-1/2 inch, high-density, MS-DOS<sup>®</sup> compatible drive. You can use the disk drive for loading applications, storing and loading waveforms, storing and loading instrument setups, printing waveforms to a file, or loading new system firmware.

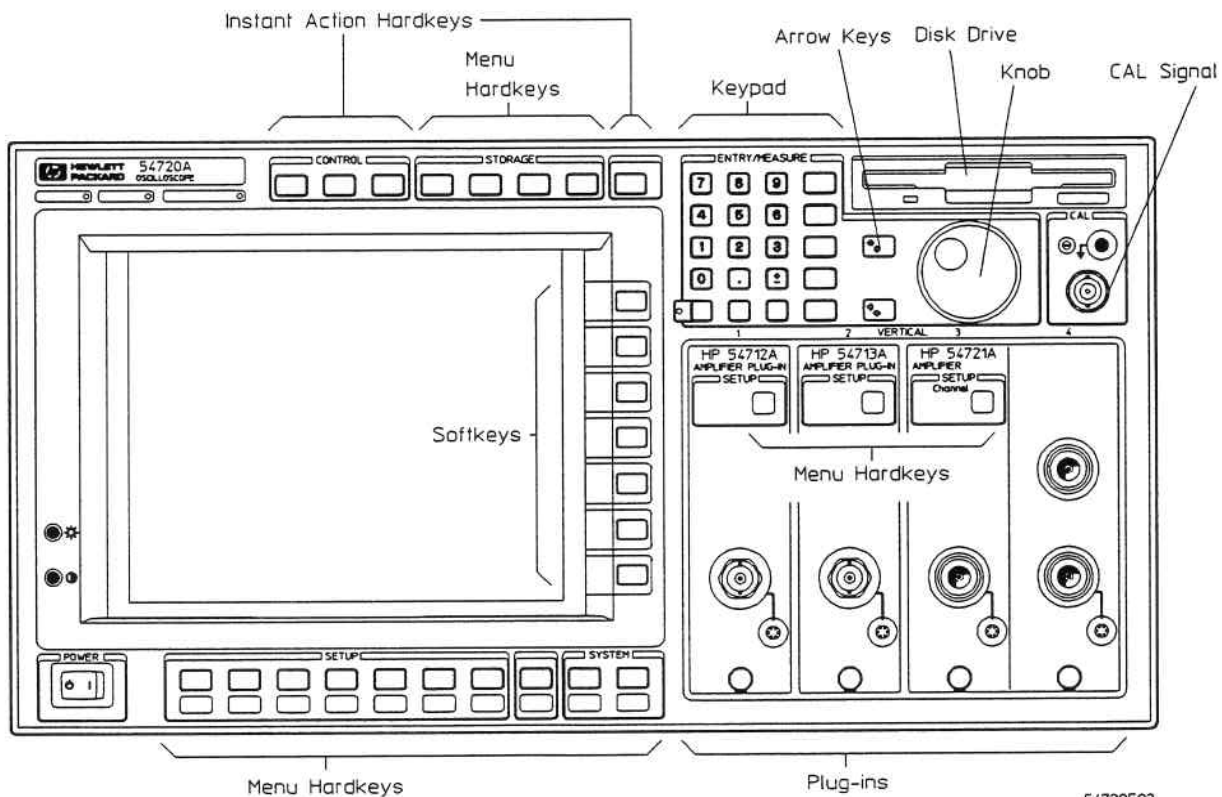
### CAL Signal

The three CAL signal choices are dc, 2-kHz square wave, and 500-kHz square wave. The CAL signal is used for mainframe calibration, plug-in calibration, probe calibration, best accuracy calibration, skew calibration, and demonstration signals. The dc output is  $\pm 2.5$  V into 50  $\Omega$ . The 2-kHz and 500-kHz square waves are 1 V into 50  $\Omega$  with about 1.6-ns edges.

MS-DOS<sup>®</sup> is a U.S. registered trademark of Microsoft Corporation.

### Hardkeys

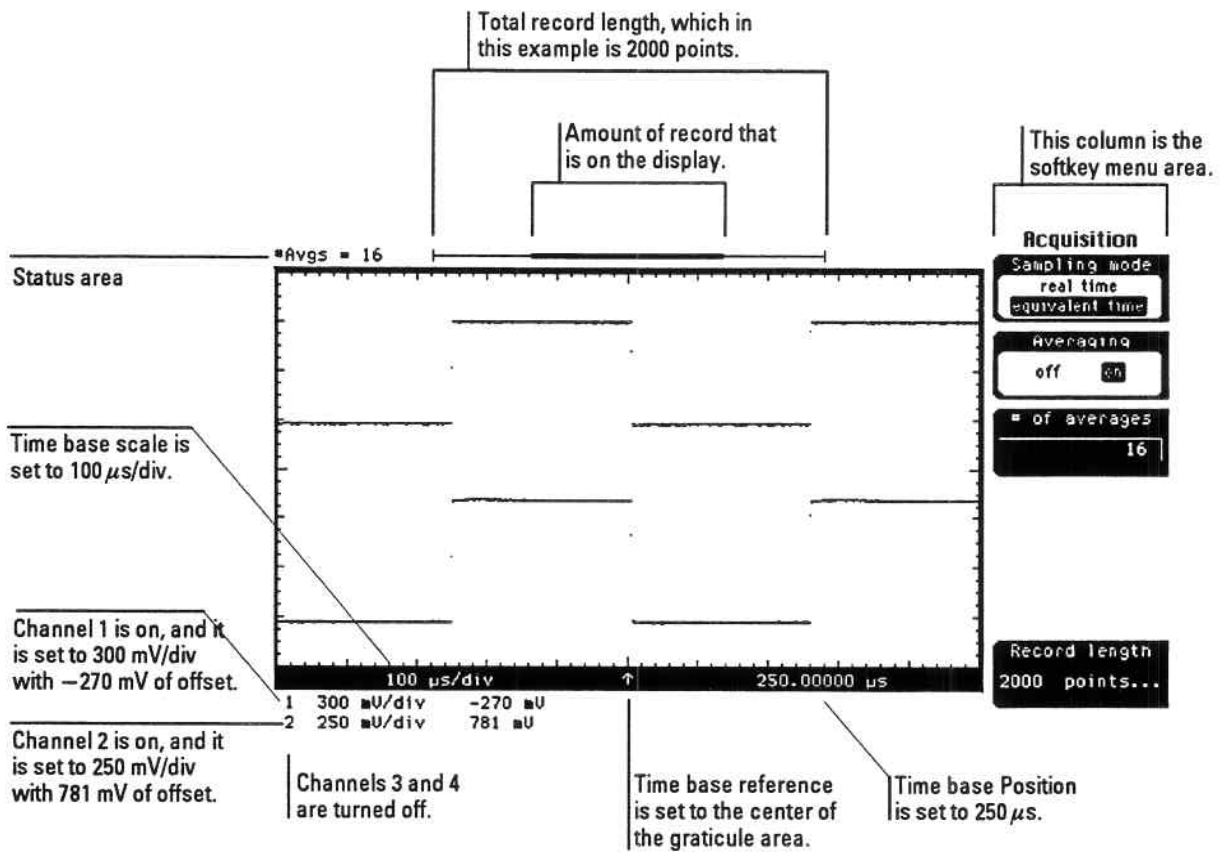
The two types of hardkeys are instant action and menu. Clear display and Run are examples of instant action keys because as soon as you press them, the oscilloscope changes operating states. Time base and Trigger are examples of the menu keys because pressing them causes softkey menus to come up on the right side of the display.



54720E02

**Display**

The figure below shows the main areas of the display, and how you can interpret some of the oscilloscope's settings from the display.



### Softkeys

The softkeys are to the right of the display, and instead of placing a label on the softkey itself, the label is actually located on the display next to the softkey. These labels on the display are called menus, and which menu is on the display depends on which hardkey you press. For example, pressing Time base brings up one menu while pressing Trigger brings up a different menu.

There are five types of softkeys, and there are some differences on how each type of softkey operates. The five types of softkeys are toggle, list, continuous, menu, and single choice. Because the trigger menu contains all five types of softkeys, it is used over the next few pages to demonstrate the differences among the softkeys.

When you press the Trigger hardkey, the Trigger softkey menu comes up on the right side of the display.



**Toggle softkeys** A typical example of the toggle softkeys is Sweep. It allows you to choose between two or three selections, and you change selections by pressing that same softkey. Sweep has choices of either triggered or auto. The highlighted choice is the selection that is currently active. In the example at the left, auto is highlighted, which indicates that the oscilloscope is set to auto sweep.

**List softkeys** A typical example of the list softkeys is Mode. It has several stacked rectangles that represents a list of choices you can choose from. The top rectangle shows the selection that is currently active. In the example at the left, edge is the current selection.



You change selections by pressing the Mode softkey which brings up a second level softkey menu on the display. Then, you use the softkeys, arrow keys, or knob to change selections. To activate that selection simply press the Enter softkey, then the display returns to the previous softkey menu. If you press the Cancel softkey, the oscilloscope returns to the previous selection.



Pressing the mode softkey brings this second level menu up on the display.

**Continuous softkeys** A typical example of the continuous softkeys is Level. It has a range of values that you change with the keypad, arrow keys, or knob. In the example at the left, Level (trigger level) is set to 480 mV.



Because the trigger menu only has one of this type of softkey, it is active when the menu comes up on the display. You do not need to press the Level softkey when you want to change the trigger level. However, the Time base menu has two of this type softkey, Scale and Position. In this case only one of the softkeys is active at a time, and to make the other softkey active you must press the corresponding softkey. You can tell which softkey is currently active because it has a different colored background from the rest of the softkeys. When using the time base scale or channel scale, the knob and arrow keys operate in two modes. One mode is a 1-2-5 sequence, while the other mode is a fine mode that allows you to make smaller incremental changes. You activate the fine mode by pressing the blue shift key on the keypad, followed by pressing the arrow key with the word "Fine" written in blue above that key. When the fine mode is active, you'll see the word FINE at the top-right corner of the graticule area. You get out of the fine mode by simply pressing the blue shift key on the keypad, followed by pressing the arrow key with the word "Fine" written above it.

### Menu softkeys

Holdoff and  
conditioning...

A typical example of the menu softkeys is Holdoff and conditioning... The ellipses after the word "conditioning" indicate that when you press this softkey, a new softkey menu comes up on the display that allows you to make several additional choices. To exit this menu simply press the Done softkey, then the display returns to the previous menu.



Pressing the Holdoff  
and conditioning  
softkey brings this  
second level menu  
up on the display.

### Single choice softkeys

Enter

A typical example of the single-choice softkeys is Enter. There are several variations of this type softkey throughout the many softkey menus. When you press the softkey, the oscilloscope executes that softkey command.



## Operating Your Oscilloscope in Five Easy Steps

This section provides five easy steps to use to familiarize you with the operation of the oscilloscope.

You will find it easier to perform these exercises if you are at least a little familiar with how to use the front panel. The best way to learn how to use the front panel is by reading "A Quick Tour of the Front Panel." If you have not already read this, you will probably find it helpful to do so before continuing.

### Keystroke Conventions

To guide you while setting up the oscilloscope the following conventions are used to represent keystrokes and other interactions with the instrument:

Text in a box, such as `Utility` or `Time base`, represents hardkeys, those defined by text on the front panel.

Bold text in a typewriter font, such as **Display** or **Calibrate...**, represents text on the CRT screen and may be a softkey you should press or a message to consider.

The blue key that has no writing on it is a shift key. It allows you to access the functions written in blue above some of the hardkeys. In this manual it is represented by a box with the word "blue" in it, like this: `(blue)`.

### Equipment used in these exercises

All the pictures of the display in this book were generated using an HP 54712A Amplifier plug-in, and using the 2-kHz CAL signal from the mainframe as a signal source. If you are using a different plug-in or a different signal source, your display and oscilloscope settings may vary slightly from the pictures in this book.

For example, the HP 54712A plug-in has an internal trigger, whereas the HP 54711A plug-in has an external trigger. If you connect the signal to the HP 54711A by using a BNC Tee or power splitter to split the signal between the channel and trigger inputs, the signal on the channel connector of the plug-in will have a lower amplitude. Therefore, your channel settings and display pictures may vary slightly from what follows.

**Step 1. Connect a signal to the oscilloscope**

- 1 Connect a BNC cable between the CAL output BNC on the mainframe and channel 1.**

If you are using a plug-in that uses external triggering instead of internal triggering, use a power splitter or BNC Tee to split the signal between the channel and trigger inputs. However, a power splitter maintains the signal's integrity better than a BNC Tee. Also, a BNC Tee or power splitter attenuates the signal's amplitude substantially, which may make your display results different from the pictures in this book.

- 2 Press .**

When you press the Setup hardkey, the Setup softkey menu is displayed.

- 3 Press **Default setup** (a softkey).**

The default setups put the oscilloscope in a particular operating condition. This gives you a known starting point for the following exercises. The default conditions are listed in the "Setup" chapter in the User's Reference book.

### Step 2. Let the oscilloscope find your signal

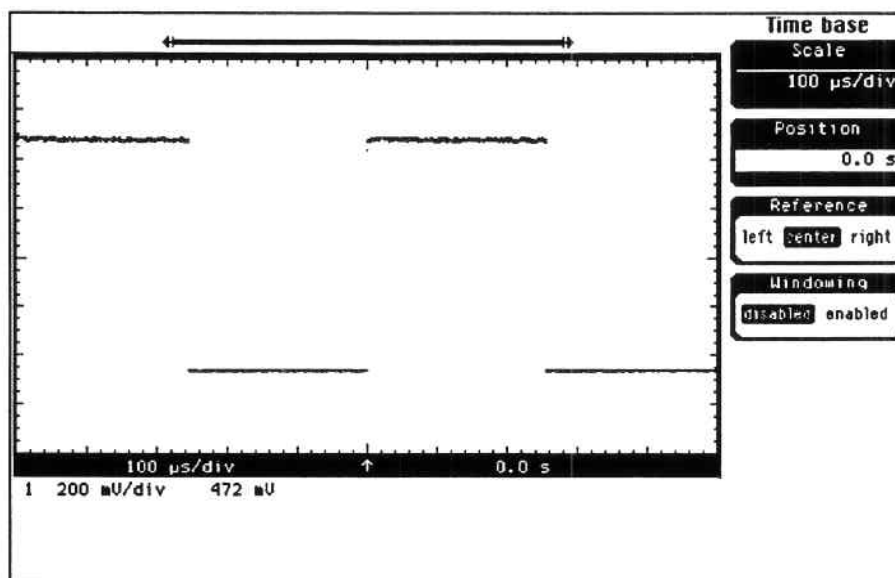
The purpose of this exercise is to demonstrate a feature that automatically sets up the oscilloscope to display most input signals. This feature is called Autoscale.

The pictures of the display in this book were generated using an HP 54712A Amplifier plug-in. If you are using a different plug-in, the display on your oscilloscope may vary slightly from the pictures in this book.

Also, the pictures were made with the graticule set to the frame mode. This was done to make it easier for you to see the waveform in the picture without interference from the graticule lines. However, the graticule lines on your display are dimmer than the waveform, which makes it easier for you to see the waveform on your display even though the graticule lines are also displayed.

- Press **Autoscale** .

Pressing the Autoscale key causes the oscilloscope to quickly analyze the signal. Then, it



sets up the vertical, horizontal, and trigger to best display the signal. Autoscale can find repetitive signals with a frequency greater than or equal to 50 Hz, a duty cycle greater than one percent, and an amplitude greater than 50 mV p-p.

You may find situations where you pressed the Autoscale key unintentionally. When this happens, you can use the Undo Autoscale key to return the oscilloscope to the settings prior to pressing the Autoscale key.

- To undo an Autoscale, press **(blue)** , then press **Autoscale** again.

### Step 3. Modify the setup of the oscilloscope

The purpose of this exercise is to show you the channel, time base, and trigger menus. This is done by having you expand the signal vertically and horizontally until it almost fills the display. You are expanding the signal because in the next exercise you will visually set markers on the signal, and it is easier to set these markers visually when the signal is expanded.

**1** Press **Channel** (located on the plug-in).

**2** Press **Scale**, then change the scaling so the vertical height of the signal is about eight divisions.

When the knob and arrow keys are not in the fine mode, they change the scaling in a 1-2-5 sequence. Changing the scaling in this sequence actually changes an attenuator setting in the plug-in. However, you can change the scaling in 1-mV increments by using the keypad, or by setting the knob and arrow keys to the fine mode.

- To set the oscilloscope to the fine mode, press **(blue)**, then press the arrow key with the word "Fine" written in blue above it.

You can tell when the fine mode is activate because you'll see the word "FINE" at the top-right corner of graticule area.

For example, when using the HP 54712A plug-in, the knob or arrow keys changes the scaling from 100 mV/div to 200 mV/div in one attenuator step. At 100 mV/div the signal is clipped, and at 200 mV/div the signal is not expanded enough to take advantage of the full vertical size of the display. However, you can use the keypad to set the scaling to 155 mV/div. The attenuator in the plug-in is still set to 200 mV/div, but the mainframe does a software expansion so that the signal is displayed at 155 mV/div.

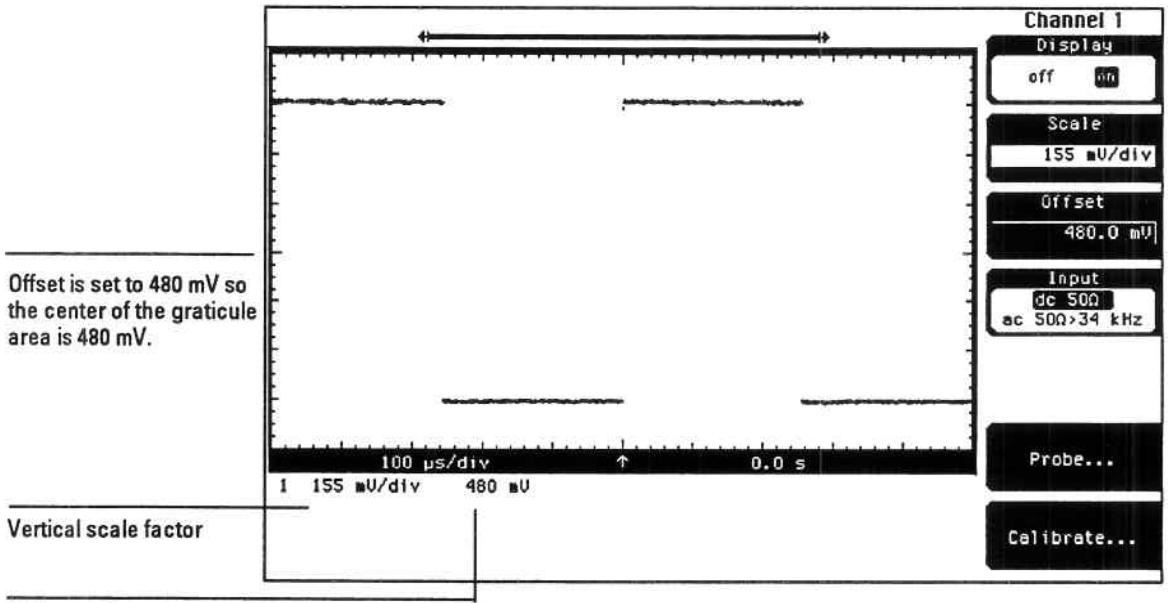
- To set the scaling to 155 mV with the keypad, type the number **155** on the keypad. Then press **milli** for millivolts to select the unit of measure.

When you select a key with a unit of measure written on it, you do not need to press the enter key. You only press the enter key if you are entering numbers that do not require a unit of measure or that are in volts or seconds. Also, depending on the value you enter with the keypad, the oscilloscope may round the value up or down. If you tried to enter 155.5 mV/div, the oscilloscope automatically rounds the entry to 156 mV/div because 1 mV/div is the smallest increment that is allowed for vertical scaling.

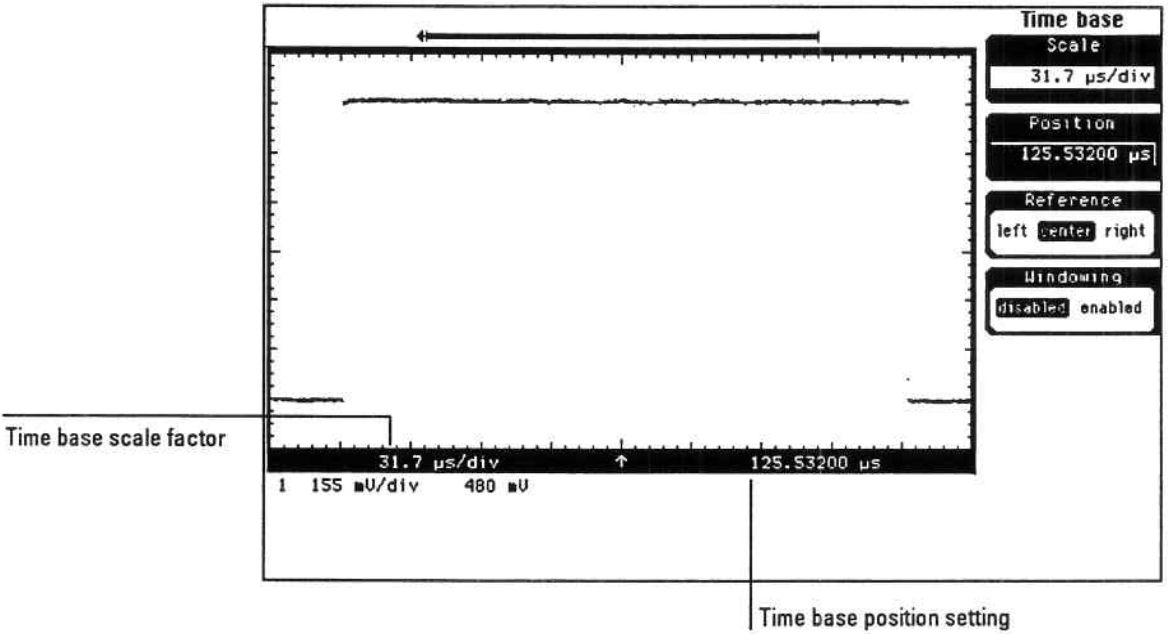
**3** Press **Offset**, then vertically center the signal on the display.

Offset moves the waveform vertically on the display. Offset is similar to the vertical position on analog oscilloscopes, except that offset is calibrated. If offset is set to 480 mV, then you know that the vertical center of the graticule area is 480 mV.

You may need to readjust the scaling and offset until the signal is expanded vertically and is centered on the display.



- Offset setting
- 4 Press **Time base**.
  - 5 Press **Scale**, then change the scaling so that the horizontal width of the positive portion of the signal is about eight divisions.  
 Again, when the knob and arrow keys are not in the fine mode, they operate in a 1-2-5 sequence, changing the scale from 20 μs/div to 50 μs/div in one large step. However, you can use the keypad to enter smaller values, like 31.7 μs/div, or you can use the fine mode so that you can adjust the knob and arrow keys in smaller increments.
  - 6 Press **Position**, then horizontally center the signal on the display.

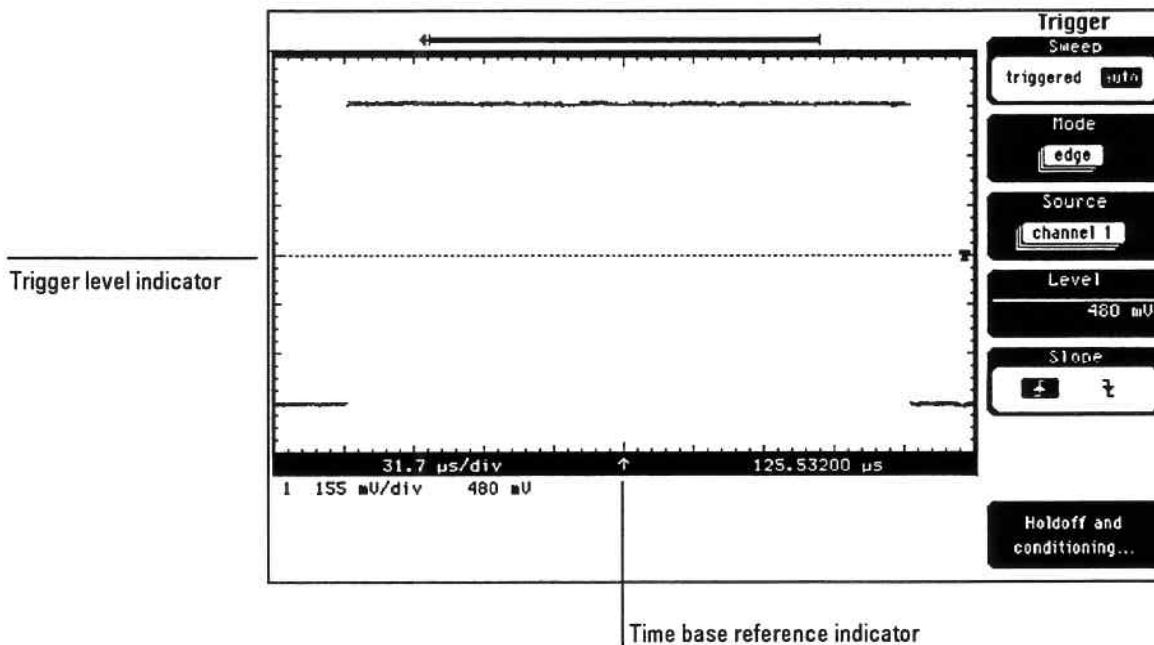


Position moves the waveform horizontally on the display. (Position is sometimes referred to as delay on other oscilloscopes.) When Position is set to 0, then the trigger event occurs at the reference point. The reference point is indicated at the bottom of the display by an arrow. You can set the reference to the left, center, or right side of the graticule area by using the Reference softkey. A positive position value is the amount of time after the trigger event (posttrigger), while a negative value is the amount time before the trigger event (pretrigger). Pretrigger information is an important feature because you can see what led up to the trigger event.

7 Press **Trigger**.

8 Press **Level**, then set the trigger level near the center of the signal.

On plug-ins that have internal triggering, there is a horizontal line on the display and there is a "T" on the right side of that line. This line moves vertically as you change the trigger level and gives you a visual indicator of where the trigger level is in relation to the signal.



**Step 4. Make measurements on the signal**

The purpose of this exercise is to familiarize you with the marker menu and the automatic measurement features of the oscilloscope. You will begin by using the manual markers to make a pulse width and an amplitude measurement on channel 1. After that, you will make the same measurements by using the automatic measurement features.

- 1 Press **Marker**, then press **mode**.
- 2 Select **manual**, then press **Enter**.

In the manual marker mode, there are two X markers and two Y markers. You can position the X markers horizontally and the Y markers vertically on the display. You use the X markers to make timing measurements and the Y markers to make voltage measurements.

- To change the mode selection, use the knob, arrow keys, or softkeys.

- 3 Set **X1, Y1 Source** to channel 1.

- a Press **X1, Y1 Source**.
- b Select **channel 1**.
- c Press **Enter**.

- 4 Set **X2, Y2 Source** to channel 1.

- a Press **X2, Y2 Source**.
- b Select **channel 1**.
- c Press **Enter**.

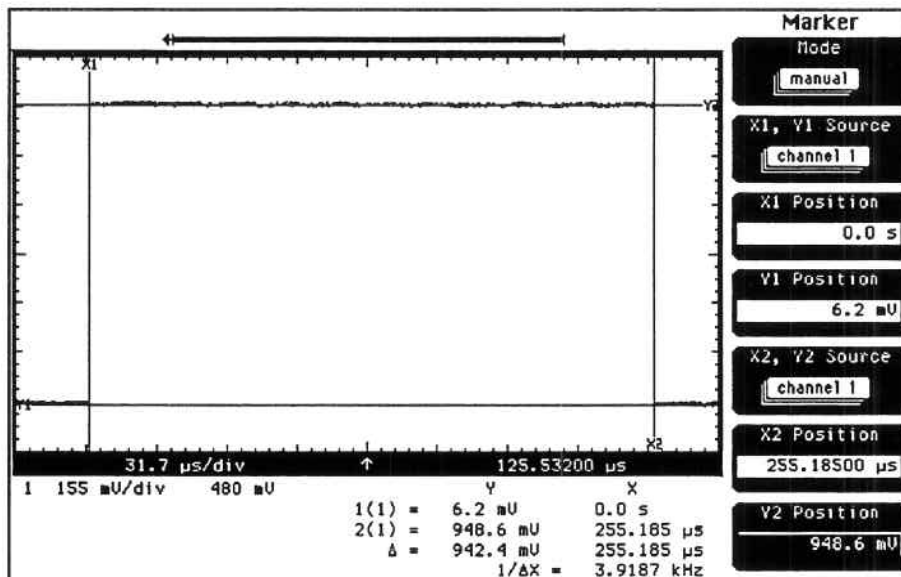
- 5 Press **X1 Position**, then set the X1 marker to the left edge of the pulse.

- 6 Press **X2 Position**, then set the X2 marker to the right edge of the pulse.

- 7 Press **Y1 Position**, then set the Y1 marker to the bottom of the pulse.

- 8 Press **Y2 Position**, then set the Y2 marker to the top of the pulse.

Notice the  $\Delta X$  and  $\Delta Y$  at the bottom of the display. The  $\Delta X$  value is the width measurement, and the  $\Delta Y$  value is the amplitude measurement. The markers allow you to make custom measurements on signals. But, remember that they are not tied directly to the waveform data stored in memory; they are just positions on the display.



**9 Make an automatic +width measurement on channel 1.**

- a Press .
- b Press .
- c Select **channel 1**.
- d Press **Enter**.

The automatic measurement results are displayed at the bottom left of the screen.

**10 Make an automatic amplitude measurement on channel 1.**

- a Press .
- b Press .
- c Select **channel 1**.
- d Press **Enter**.

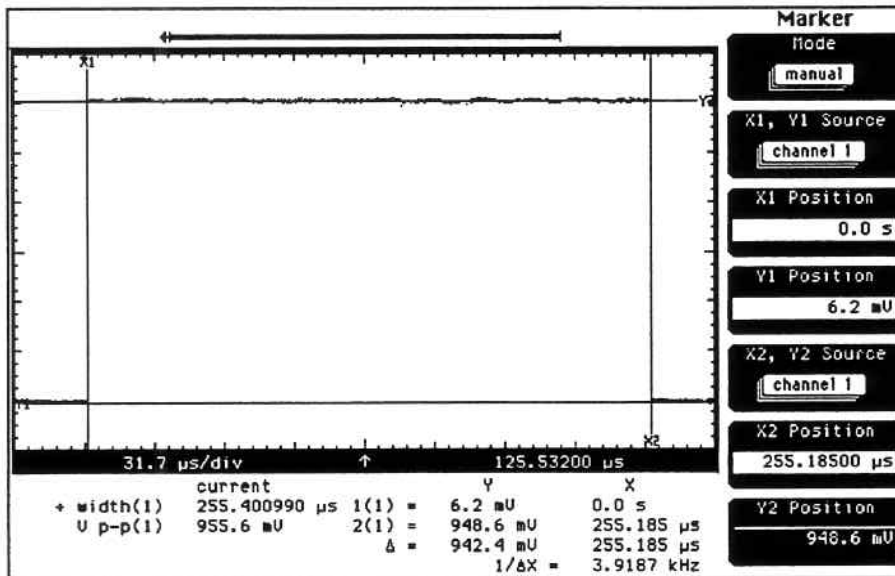
The IEEE pulse parameter standards are used for all of the automatic measurements, unless you make changes in the define measure menu.

Automatic measurements are the preferred measurement choice because they are faster and more repeatable than the manual marker measurements. The automatic measurements use the waveform data stored in memory for all calculations, and the waveform data in memory has a higher resolution than the resolution of the display. In comparison, the manual markers are not tied to the waveform data in memory; they are just positions on the display.

Notice that the automatic measurement results are placed on the display where the vertical scale and offset values are normally displayed.

- To redisplay the vertical scale and offset values, press . Then press .

The automatic measurement results are replaced by the vertical scale and offset values.





Chapter 2: Preparing for Use  
**Operating Your Oscilloscope in Five Easy Steps**

**Step 5. Use the help menu**

- Press **Help** .

A three-column index appears on the display. The left column lists the features of the oscilloscope, while the middle column lists the front-panel key, and (if needed) the right column lists the softkey you press to find that feature. You can use either the knob or arrow keys to scroll through the help menu.

| Feature                          | Hardkey       | Softkey         | Help    |
|----------------------------------|---------------|-----------------|---------|
| BW limit, digital (real time)    | Acquisition   | Digital BW lim  |         |
| CAL output control, mainframe    | Utility       | Calibrate...    |         |
| CAL signal control, mainframe    | Utility       | Calibrate...    |         |
| Calibrate plug-in                | Utility       | Calibrate...    |         |
| Calibrate probe                  | Channel       | Probe...        |         |
| Calibration status               | Utility       | Calibrate...    |         |
| Calibration status, channel      | Channel       | Calibrate...    |         |
| Centronics printer selection     | SHIFT Print   | Destination     |         |
| Channel best accuracy cal.       | Channel       | Calibrate...    |         |
| Channel calibration status       | Channel       | Calibrate...    |         |
| Channel display                  | Channel       | Display         | Line    |
| Channel skew adjustment          | Channel       | Calibrate       | Channel |
| Channel vertical position        | Channel       | Offset          |         |
| Channel vertical units, U, A, M  | Channel       | Probe...        |         |
| Channel view                     | Channel       | Display         |         |
| Channel, magnify                 | Math          | Define Function |         |
| Clear measurements from screen   | SHIFT Clear   |                 |         |
| Clear non-volatile memory        | Utility       | System config.. |         |
| Clear stored pixel memory        | Waveform      | Clear memory    |         |
| Clear waveforms (from display)   | Clear display |                 |         |
| cm/s                             | Time base     | Scale           |         |
| Colors, changing display         | Display       | Color...        |         |
| Colors, Default display          | Display       | Color...        |         |
| Connect waveform dots (linear)   | Display       | Draw waveform   | Exit    |
| Coupling, vertical input (AC,DC) | Channel       | Input           |         |

---

## In Case of Difficulty

This section gives you a few helpful hints in case you are having trouble getting the oscilloscope to power up or display a signal. Complete service information is located in the Service Guide that is supplied with the oscilloscope.

### If the oscilloscope does not power up

- Check that the line voltage switch on the rear panel is set to the correct voltage selection for your voltage source.
- Check that the outlet the power cord is plugged into has power and that the power cord is plugged into the oscilloscope.
- Check that the rear panel line switch is set to the "On" position.
- Check that the front panel power switch is set to the "On" position.

If the oscilloscope still does not power up, refer to chapter 5, "Troubleshooting" in this service guide.

### If autoscale does not find the CAL signal

- Check that the CAL signal is set to 2 kHz.
  - 1 Press **Utility**.
  - 2 Press **Calibrate**....
  - 3 Press **Output**.
  - 4 Use the softkeys, arrow keys, or knob to set the output to **2 kHz**.
  - 5 Press **Enter**.
- Check that a BNC cable is connected between the channel connector and the CAL connector on the mainframe, rather than connected to a Calibration connector on a plug-in.
- If your plug-in requires an external trigger, check that the CAL signal is split between the channel connector and the trigger connector.
- Check that the plug-in is securely seated in the mainframe and that the knurled screw is finger-tightened.
- Check that the BNC cables you are using are good cables.
- Try using a different plug-in.

If the oscilloscope still cannot find a signal, refer to chapter 5, "Troubleshooting" in this service guide.



Testing Interval 3-2  
Equipment Required 3-2  
Test Record 3-2  
Keystroke Conventions 3-2  
Operating Hints 3-3  
To test the front panel CAL signal 3-4  
To test time interval accuracy 3-6

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# Testing Performance

The procedures in this chapter test the instrument's electrical performance using performance specifications given in chapter 1 as performance standards. Specifications applicable to individual tests are noted at the test for reference.

## Testing Interval

The performance test procedures may be performed for incoming inspection of the instrument and should be performed periodically thereafter to ensure and maintain peak performance. The recommended test interval is yearly or every 2,000 hours of operation. Amount of use, environmental conditions, and the user's experience concerning need for testing will contribute to verification requirements.

The calibration interval is covered in chapter 4 "Calibrating and Adjusting."

## Equipment Required

A complete list of equipment required for the performance tests is in the Recommended Test Equipment table in chapter 1. Equipment required for individual tests is listed in the test. Any equipment satisfying the critical specifications listed may be substituted for the recommended model.

## Test Record

The results of the performance tests may be tabulated on the Test Record provided at the end of this chapter. The Test Record lists the performance tests and provides an area to mark test results. The results recorded in the table at incoming inspection may be used for later comparisons of the tests during periodic maintenance, troubleshooting, and after repairs or adjustments.

## Keystroke Conventions

To guide you while setting up the oscilloscope the following conventions are used to represent keystrokes and other interactions with the instrument:

Text in a box, such as `Utility` or `Time base`, represents hardkeys, those defined by text on the front panel.

Bold text in a typewriter font, such as **Display** or **Calibrate...**, represents text on the CRT screen and may be a softkey you should press or a message to consider.

The blue key that has no writing on it is a shift key. It allows you to access the functions written in blue above some of the hardkeys. In this manual it is represented by a box with the word "blue" in it, like this: `(blue)`.

### **Operating Hints**

Some knowledge of operation of the HP 54720A is helpful; however, procedures are written so that little experience is necessary. The following two hints will speed progress of the testing.

#### **Clear Display**

When using many averages, it often takes awhile for a waveform display to stabilize after a change. When a control on the HP 54720A is changed, averaging automatically restarts. When just the input signal is changed, the instrument must average new data with the old so it takes a long time for the waveform to stabilize. If you press CLEAR DISPLAY while changing input signals, the instrument will restart averaging and give a quick indication of the result of the signal change.

#### **Averaging**

Averaging is used to assure a stable signal for measurements. It is not necessary to wait for complete stability of the signal (averaging complete) as long as the measurement is well within the limits of the test.

---

**CAUTION**

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Allow the instrument to warm up for at least 20 minutes prior to beginning performance tests.

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## To test the front panel CAL signal

This procedure is used to test the accuracy of the front-panel calibration signal. This signal is used to perform all calibration of the instrument.

### Specification

**Output delta voltage accuracy** -2.5 V to +2.5 V (into 50  $\Omega$ ), Accuracy  $\pm 0.2\%$  of delta voltage output

**AC Output** (all parameters are approximate), 2 kHz and 500 kHz, rise & fall times: 1.6ns, amplitude: 1 Vp-p (into 50 ohms)

NOTE: The ac output does not have specified parameters, but since its edges are used in calibration it should be checked.

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### Equipment Required:

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| Equipment    | Critical Specifications                                    | Recommended Model/Part                      |
|--------------|--|---|
| DMM          | 6 1/2 digit, 0.1mV resolution, dc accuracy 0.05% or better | HP 34401A                                   |
| Oscilloscope | approximately 1 GHz bandwidth                              | HP 54720A with HP 54711A, 54712A, or 54721A |
| Cable        | BNC  | HP 10503A                                   |
| Adapter      | BNC (f) to dual banana (m)                                 | HP 1251-2277                                |

### Check the dc accuracy

- 1 Set up the DMM to measure DC volts and use the cable and adapter to connect the DMM to the front-panel CAL output.
- 2 Press  , then **Calibrate...**, then **output**.
- 3 Select **DC** and press **Enter**.
- 4 Using either the Entry keypad or RPG knob, enter 2.5 V and record the reading.  
\_\_\_\_\_ Vdc
- 5 Using either the Entry keypad or RPG knob, enter -2.5 V and record the reading.  
\_\_\_\_\_ Vdc
- 6 Subtract the second reading from the first, and divide the result by 5.

Example:

(first reading, +2.498 V) - (second reading, -2.497 V) = 4.995 V

4.995 V  $\div$  5 V = 0.999 (within specifications)

The final result should be between 0.998 and 1.002. Record the result in the Performance Test Record.

**Check the ac characteristics**

The following measurements are for approximate parameters. The normal accuracy vertical characteristics of the HP 54720 family are 3% and timing accuracies are much better. You can use an HP 54720A (with an HP 54711A, 54712A, or 54721A plug-in) to check the parameters of its own ac CAL signal.

If you use an HP 54711A plug-in, connect the CAL signal to both the channel and trigger inputs with short BNC cables and a BNC tee. Because the CAL signal is loaded by two 50  $\Omega$  loads, the signal amplitude will be about 67% of that shown in the test.

- 1 Press  , then press **Calibrate...**, and then press **output**.
- 2 Select **2 kHz**, and press **Enter**.
- 3 Connect the CAL output to a channel of the HP 54720A or the input of another oscilloscope.
- 4 Press  , then measure the amplitude and frequency.
  - For amplitude, press  , then  , select the channel to be measured, and press **Enter**.
  - For frequency, press  , then  , select the channel to be measured, and press **Enter**.

Read the values below the graticule. The frequency should be about 2 kHz, and amplitude should be approximately 1 V, when terminated into 50 ohms.
- 5 Change output from 2 kHz to 500 kHz.
  - a Press  , then press **Calibrate...**, and then press **output**.
  - b Select **500 kHz** and press **Enter**.
- 6 Read the frequency and amplitude below the graticule.
 

The frequency should be approximately 500 kHz and amplitude should be approximately 1 V, when terminated into 50 ohms.
- 7 Press  and change the **Scale** to **5.00 ns/div** and **Position** to **0.0 s**.
- 8 Measure the rise time. It should be approximately 1.6 ns.
  - Press  then  , select the channel to be measured, then **Enter**.
- 9 Measure the fall time. It should be approximately 1.6 ns also.
  - a Press  , then press **Slope** to set it to the negative edge.
  - b Press  then  , select the channel to be measured, then **Enter**.



---

## To test time interval accuracy

This test checks the accuracy of the timing measurements of the HP 54710A and 54720A.

### Specification

Real Time:  $\pm[(0.2)(\text{sample interval}) + 0.007\% \text{ of } \Delta\text{time marker reading}]$

Equivalent Time (16 averages):  $\pm(30 \text{ ps} + 0.007\% \text{ of } \Delta\text{time marker reading})$

---

### Equipment Required:

| Equipment            | Critical Specifications  | Recommended Model/Part               |
|----------------------|--|--------------------------------------|
| Signal Generator     | 40 Mhz and 300 Mhz, frequency accuracy $\pm 0.1\%$   | HP 8664A                             |
| RF Amplifier         | 40 MHz to 1 GHz, 26 dB gain, output rise time varies as a function of signal input amplitude | HP Model 8447D                       |
| Oscilloscope plug-in | for HP 54710, 54720 mainframe  | HP 54711A, 54712A, 54713A, or 54721A |
| Adapter (2)          | N (m) to BNC (f)   | HP 1250-0780                         |
| Cable (2)            | BNC, 36-inch   | HP 10503A                            |

This additional equipment is needed if you are using a 54711A plug-in

|                |                    |              |
|----------------|--------------------|--------------|
| Power Splitter | >500 MHz bandwidth | HP 11667A    |
| Cable (2)      | BNC, 9-inch        | HP 10502A    |
| Adapter (3)    | N (m) to BNC (f)   | HP 1250-0780 |

### Procedure

This test uses an RF signal generator with an accurate frequency specification to test timing accuracy. The signal generator overdrives an RF amplifier to give a faster edge to the signal.

If the test is made using the HP 54721A the real time results are different because the sample rate is double on that plug-in. Two result requirements are given for real time tests. Use the requirement for the plug-in you are using.

- 1 Connect the equipment.
  - a Put the plug-in into mainframe slot 1.
  - b Connect the signal generator output to the RF Amplifier input.
  - c Connect the output of the amplifier to the channel 1 input.
  - d If the plug-in is a 54711A, use the power splitter and other cables to connect the signal to the external trigger input as well.
- 2 Set the signal generator for 40 Mhz with a + 2dBm output amplitude.

- 3 Press **Setup** , then **Default setup**, then **Autoscale** , then change the oscilloscope parameters as follows:

| Menu (hardkey) | Parameter                 | Setting                        |
|----------------|---------------------------|--------------------------------|
| Channel        | Scale                     | 500 mV/div                     |
|                | Input (54713A)            | dc 50Ω                         |
| Time base      | Scale                     | 5.00 ns/div                    |
|                | Position                  | -5.000 ns                      |
| Trigger        | Level                     | as required for stable trigger |
| Acquisition    | Averaging                 | On                             |
|                | Number of averages        | 16                             |
|                | Record length             | manual, 4096 points            |
|                | Press <b>Done</b>         |                                |
| Define meas    | Press <b>Define Δtime</b> |                                |
|                | Stop edge                 | rising                         |
|                | Edge number               | 2                              |
|                | Press <b>Done</b>         |                                |

You should have about 2 cycles of a square wave signal.

- 4 Measure the rise time of the signal to check its quality.

Press **(blue)** then **Rise** , then **Enter**.

The rise time should be between 700 ps and 900 ps. If not, vary the signal generator output amplitude to achieve this. This is a critical parameter for this test.

- 5 Measure the period of the signal.

Press **(blue)** , then **Δtime** , then **Enter**.

- 6 Read the **Δtime(1)-(1)** at the bottom of the display and record the reading in the Performance Test Record. \_\_\_\_\_ ns

The time should be 25.000 ns ±32 ps, 24.968 ns to 25.032 ns.

- 7 Press **Acquisition** then select **real time**.

- 8 Press **Stop/Single** to stop acquisition.

- 9 Read and record the **Δtime** in the Performance Test Record. \_\_\_\_\_ ns

With the HP 54711A/12A/13A plug-ins it should be 25.000 ns ±102 ps, 24.898 ns to 25.102 ns.

With the HP 54721A plug-in it should be 25.000 ns ±52 ps, 24.948 ns to 25.052 ns.

- 10 Press **Time base** and change the scale to 50.0 ns/div.

- 11 Press **Define meas** , then **define Δtime**.

- 12 Change the **stop edge number** from 2 to 19 and press **Done** .


- 13 Read and record the **Δtime** in the Performance Test Record. \_\_\_\_\_ ns

With the HP 54711A/12A/13A plug-ins it should be 450.000 ns ±132 ps, 449.868 ns to 450.132 ns.

With the HP 54721A plug-in it should be 450.000 ns ±82 ps, 449.918 ns to 450.082 ns.

- 14 Press Run.
- 15 Press  , then select **Equivalent Time** and turn **Averaging ON**.
- 16 Read and record the  $\Delta$ time in the Performance Test Record. \_\_\_\_\_ ns  
It should be 450.000 ns  $\pm$ 62 ps, 449.938 ns to 450.062 ns.
- 17 Press  and change the **scale** to **1.00 ns/div**.
- 18 Set up the signal generator.
  - a Change the frequency to 300 Mhz (3.333 ns period).
  - b Change the output level to -12 dBm.
  - c Press  and readjust the trigger level for a stable display.
  - d Check the rise time of the signal. It is shown at the bottom of the display. If it is not shown, see step 4.  
The rise time should be between 750 ps and 900 ps. If not, vary the signal generator amplitude to achieve this.
- 19 Press  , then **define  $\Delta$ time**.
- 20 Change the **stop edge number** to **2** and press **Done** .
- 21 Read and record the  $\Delta$ time in the Performance Test Record. \_\_\_\_\_ ns  
It should be 3.333 ns  $\pm$ 30 ps, 3.303 ns to 3.363 ns.
- 22 Press  then select **real time**.
- 23 Press  to stop acquisitions.
- 24 Read and record the  $\Delta$ time in the Performance Test Record. \_\_\_\_\_ ns  
With the HP 54711A/12A/13A plug-ins it should be 3.333 ns  $\pm$ 100 ps, 3.233 ns to 3.433 ns.  
With the HP 54721A plug-in it should be 3.333 ns  $\pm$ 50 ps, 3.283 ns to 3.383 ns.
- 25 Press Run
- 26 Press  and change the **scale** to **10.0 ns/div**.
- 27 Press  , then select **Equivalent Time** and turn **Averaging ON**.
- 28 Press  , then **define  $\Delta$ time**.
- 29 Change the **stop edge number** to **26** and press **Done** .
- 30 Read and record the  $\Delta$ time in the Performance Test Record. \_\_\_\_\_ ns  
It should be 83.332 ns  $\pm$ 36 ps, 83.296 ns to 83.368 ns.

**Table 3-1. Performance Test Record**

|  |   |
|--|---|
|  <b>HEWLETT<br/>PACKARD</b> | <p style="text-align: right;"><b>HP 54710A, 54720A Oscilloscope</b></p> <p>Tested by _____</p> <p>Work Order No. _____</p> <p>Date _____</p> <p>Temperature _____</p> |
| Serial No. _____   |   |
| Recommended Test Interval - 1 Year/2000 hours  |   |
| Recommended next testing _____   |   |

| Test   | Limits   | Results |
|--|--|---------|
| CAL<br>Accuracy  | 1.000 ± 0.002      0.998 to 1.002                        | _____   |
| Time Interval<br>Accuracy  | 25.000 ns ± 32 ps      24.968 ns to 25.032 ns            | _____   |
|  | 25.000 ns ± 102 ps      24.898 ns to 25.102 ns           | _____   |
|  | or *<br>25.000 ns ± 52 ps      24.948 ns to 25.052 ns    | _____   |
|  | 450.000 ns ± 132 ps      449.868 ns to 450.132 ns        | _____   |
|  | or *<br>450.000 ns ± 82 ps      449.918 ns to 450.082 ns | _____   |
|  | 450.000 ns ± 62 ps      449.938 ns to 450.062 ns         | _____   |
|  | 3.333 ns ± 30 ps      3.303 ns to 3.363 ns               | _____   |
|  | 3.333 ns ± 100 ps      3.233 ns to 3.433 ns              | _____   |
|  | or *<br>3.333 ns ± 50 ps      3.283 ns to 3.383 ns       | _____   |
|  | 83.332 ns ± 36 ps      83.296 ns to 83.368 ns            | _____   |
| * The first result of this pair is for tests using the HP 54711A, 54712A, or 54713A plug-ins. The second is for tests using the HP 54721A plug-in. |  |         |
|  |  |         |



Equipment Required 4-2  
Keystroke Conventions 4-2

Calibrating the Oscilloscope 4-3

Calibration Overview 4-3

Calibration Interval 4-5

Calibration Status Displays 4-6

To calibrate the mainframe 4-9

To calibrate the plug-ins 4-11

To calibrate for best accuracy 4-12



Adjusting the Color CRT Module 4-14

Equipment Required 4-14

To prepare the instrument 4-14

To adjust geometry 4-16

To adjust focus, landing, and convergence 4-17

To adjust white balance 4-24

---

# Calibrating and Adjusting

Calibration of the HP 54700 family is done with internally generated signals. The only other equipment required is an HP 54717A calibration module, general purpose attenuators and terminations, and cables. There is no need to remove covers for mainframe calibration. Plug-in covers must be removed for plug-in calibration (normal accuracy).

There are no adjustments in the acquisition systems of the HP 54710A and 54720A oscilloscopes. There are adjustment procedures for the color display, but these need to be done only if the display needs correction.

## Equipment Required

Equipment required for these procedures is listed in the Recommended Test Equipment table in chapter 1 of this manual. Any equipment that satisfies the critical specification listed in the table may be substituted for the recommended model. Equipment for individual procedures is listed at the procedure.

## Keystroke Conventions

To guide you while setting up the oscilloscope the following conventions are used to represent keystrokes and other interactions with the instrument:

Text in a box, such as `Utility` or `Time base`, represents hardkeys, those defined by text on the front panel.

Bold text in a typewriter font, such as **Display** or **Calibrate...**, represents text on the CRT screen and may be a softkey you should press or a message to consider.

The blue key that has no writing on it is a shift key. It allows you to access the functions written in blue above some of the hardkeys. In this manual it is represented by a box with the word "blue" in it, like this: `(blue)`.

With any exceptions noted where they apply, this section includes all procedures needed to calibrate the HP 54720A and 54710A mainframes with plug-ins. Plug-In calibration is part of the service guide for each specific plug-in. However, the prompts on the display direct the calibration details, so the procedures in this section apply to all plug-ins.

Some plug-ins, however, may require adjustment after certain repairs. See the plug-in service guide for the procedures necessary after repair.

---

## Calibration Overview

This section briefly explains the calibration of the HP 54710A and 54720A oscilloscopes. It is intended to provide an understanding of calibration levels available and how they should be used.

The levels of accuracy provided by calibration procedures are given in the specifications and characteristics in chapter 1. Unless otherwise specified, characteristics given in the following paragraphs are typical and approximate.

There are three calibration levels:

- Normal accuracy
- Best accuracy
- Probe cal

These are accomplished by using four calibration procedures:

- Frame calibration
- Plug-In calibration
- Best-accuracy calibration
- Probe calibration

### Normal accuracy

Normal accuracy is achieved by performing only the frame calibration and plug-in calibration. This is the basic level of accuracy, which provides typical vertical accuracies of  $\pm 3\%$  with any calibrated plug-in installed in any front-panel slot in any calibrated mainframe. These characteristics hold for the standard calibration interval and over a  $\pm 5^\circ\text{C}$  temperature range.

For instruments that use more than one mainframe slot, such as the HP 54721A, interleaving of the two slots is done during the best-accuracy calibration. Typically therefore, a real time display from these plug-ins will not be useful when only a normal accuracy calibration has been done. A Best-accuracy calibration must be done to use multiple-slot plug-ins in the real time mode.

**Frame Calibration** Frame calibration allows the oscilloscope to establish calibration factors for each slot, independent of plug-ins. These factors are stored in non-volatile RAM in the mainframe. These calibration factors are protected by a switch that allows calibration to be enabled or disabled. This switch can be accessed through a hole in the rear panel. The hole can be covered by a sticker if frame calibration is to be denied.



**Plug-In Calibration** Plug-In calibration allows the oscilloscope to establish the calibration factors for a particular plug-in independent of the frame in which it is calibrated. These calibration factors are stored in EEPROM in the plug-in, so the factors stay with the plug-in, not with the frame the plug-in was calibrated in.

Since the intent is for the oscilloscope to determine the calibration factors for the plug-in only, plug-in calibration should be done right after a frame calibration so that any drift in the frame calibration (due to time or temperature) doesn't cause drift in the calibration factors of the plug-in.

A switch in the plug-in is used to enable or disable plug-in calibration. The cover of the plug-in must be removed to gain access to the switch. A sticker can be placed over the edge of the cover to deny access to the switch.

### **Best Accuracy**

Best-accuracy specifications require an additional calibration operation. Best-accuracy specifications are valid for a given plug-in in the same slot, for a set period of time, and for a certain temperature range. A plug-in can be best-accuracy calibrated in more than one slot but a given slot can be best-accuracy calibrated to only one plug-in.

The intention is that to insure the best measurement results, a best-accuracy calibration should be done just before critical measurements are made. The calibration is quick and easy, and requires only a short BNC cable.

The oscilloscope establishes best-accuracy calibration factors by calibrating the plug-in and the frame slot as a system. These calibration factors are stored in non-volatile RAM in the mainframe. The oscilloscope will keep these calibration factors for a plug-in/slot combination until a plug-in with a different serial number is best-accuracy calibrated in that slot. This means a plug-in that has been calibrated to best accuracy in a particular frame slot can be removed for a time, then re-installed later. The best-accuracy calibration will still be valid as long as no other plug-in was best-accuracy calibrated in that slot in the meantime, and the calibration has not been invalidated by time or a temperature difference.

A best-accuracy calibration provides the best vertical measurement results for a given channel (plug-in/slot combination). Also, plug-ins that use more than one slot must be calibrated for best accuracy to be useful in realtime mode.

Like frame calibration, best-accuracy calibration is limited by a  $\pm 5^{\circ}\text{C}$  temperature range. The temperature difference since the last calibration is shown in the calibration status displays. In order for a channel to meet the best-accuracy specifications, both the Current Frame  $\Delta\text{Temp}$  and the Best Accuracy  $\Delta\text{Temp}$  must be between  $\pm 5^{\circ}\text{C}$ . In other words, the temperature of the oscilloscope must be within  $5^{\circ}\text{C}$  of the frame calibration temperature and the best-accuracy calibration temperature.

To check the instrument temperature change, see "Calibration Status Displays" in this chapter.

### **Probe Calibration**

Probe calibration allows the oscilloscope to establish the gain and offset of a probe and apply those factors to the calibration of the channel that probe is connected to.

To achieve the most accuracy, the probe should be calibrated to a channel with a valid best-accuracy calibration. The typical vertical accuracy in this case is  $\pm 2\%$ . A probe calibrated to a channel with a valid normal accuracy calibration will provide typically  $\pm 4\%$  vertical accuracy.

For active probes that the oscilloscope can identify through the probe power connector, such as the 54701A, the oscilloscope will automatically adjust the vertical scale factors for that channel even if a probe calibration is not done. For passive probes or other unidentified

probes, the scope will adjust the vertical scale factors only if a probe calibration is done. Without a probe calibration, the probe attenuation factor can be entered manually, through the menus.

If a probe being calibrated has an attenuation that will allow the oscilloscope to adjust its gain (in hardware) to produce even steps in the vertical scale factors, the oscilloscope will do so. If the probe being calibrated has a unusual attenuation (such as 3.75, etc) the oscilloscope may have to adjust the vertical scale factors to an unusual number (3.75V/div, etc.). Typically probes have standard attenuation factors such as  $\div 10$ ,  $\div 20$ , or  $\div 100$ .

## Calibration Interval

Calibration interval varies with the type of calibration involved.

### Mainframe and Plug-In Calibration

Mainframe and plug-in calibration should be done under either of the following conditions:

- Yearly or every 2,000 hours of operation.
- If the instrument temperature is more than 5°C different than the temperature when the last calibration was done.
- If you are going to use it to calibrate plug-ins.
- If you have replaced one of the following assemblies.
  - CPU assembly (calibration factors are stored on the CPU assembly)
  - Time base assembly
  - Clock assembly
  - Acquisition assembly

### Best-Accuracy Calibration

Best-accuracy calibration should be done under any of the following conditions:

- When the most accurate vertical measurements are necessary.
- If the instrument temperature is more than 5°C different than the temperature when the last calibration was done.
- If the best-accuracy time limit has expired.

For further information see "Calibration Overview" and "To calibrate for best accuracy" in this chapter.

---

### Caution

For temperature stability, all calibration must be done with the rear panel installed. An instrument warm-up of 20 minutes is recommended before starting these procedures.

## Calibration Status Displays

The calibration status displays show the current calibration status of the mainframe and plug-ins for normal accuracy and best accuracy. There are two displays, one through the Utility menu and one, specifically for each plug-in, through the channel setup menu.

The status of Calibration Memory and Best Accuracy Memory protection, and the Current Frame and plug-in  $\Delta$ Temp, update only when the Cal status display is entered.

### Frame Calibration Status

The following figure shows the display, and the table explains the features. This display also shows an abbreviated version of the plug-in status.

To enter this display press **Utility**, then **Calibrate...**, then press **Cal status** to turn it on.

Figure 4-1

The screenshot shows a terminal-style interface for the Frame Calibration Status. On the right side, there is a vertical column of buttons: 'Calibrate', 'Calibrate plug-in...', 'Calibrate frame', 'Cal status' (with 'off' and 'on' indicators), 'Output' (with '2 kHz' indicator), and 'Exit'.

The main display area contains the following information:

```

Current Frame ΔTemp : 1 °C
Frame
Calibration Status : Calibrated
Last Calibration   : 12 JUN 92 16:47
Calibration Memory : Protected
Best Accuracy Memory : Unprotected

Slot  Vertical  Failure Code  Trigger  Failure Code
----  -
1     Passed
2     Passed
3     Passed
4     Passed
Other Calibration Status : Passed
Comments:

Plug-ins
Slot  Model  Memory  Date  Time  Accuracy  ΔTemp
----  -
1     S4711A Protected 5 JUL 92 16:34 Best Normal 0 °C
2     S4713A Protected 5 JUL 92 16:36 Best Normal 0 °C
3     S4721A Protected 5 JUL 92 16:39 Best Normal 0 °C
4
    
```

Frame Calibration Status

Table 4-1

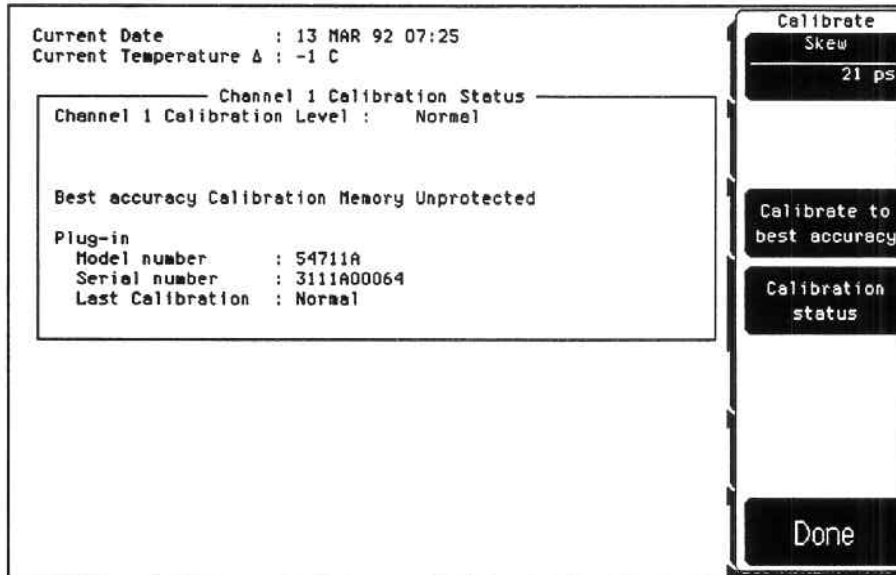
| Frame Calibration Status                     |  |
|--|--|
| <b>Frame</b>                                 |  |
| <b>Current Frame <math>\Delta</math>Temp</b> | Displays the current internal temperature of the instrument compared to the temperature at which the frame was calibrated, in increments of one degree centigrade.   |
| <b>Calibration Status</b>                    | Calibrated or Uncalibrated.  |
| <b>Last Calibration</b>                      | Displays the date and time of the last frame calibration.  |
| <b>Calibration Memory</b>                    | Shows the setting of the Frame cal memory protect switch.  |
| <b>Best Accuracy Memory</b>                  | Shows the setting of the Best cal memory protect switch.   |
| <b>Slot</b>                                  | All front panel slots are calibrated during one calibration procedure  |
| <b>Vertical and Trigger</b>                  | The pass/fail status of each section of the slot input. During calibration it shows Calibrating.   |
| <b>Failure Code</b>                          | An eight digit code showing the reason for failure. These are for factory use.   |
| <b>Other Calibration Status</b>              | Passed, Failed, or Calibrating   |
| <b>Comments</b>                              | This area is for text which can be programmed over the HP-IB. See "Calibrate Subsystem" in the HP 54710A and 54720A Programmer's Reference.  |
| <b>Plug-ins</b>                              |  |
| <b>Slot</b>                                  | The front panel plug-in position. A plug-in occupying more than one slot registers as the lowest numbered slot.  |
| <b>Model</b>                                 | The model number of the plug-in currently in the slot. Unfilled slots register "empty." If the mainframe does not recognize the plug-in, "~known" is displayed instead of the model number. If "~known" is displayed, refer to the User's Reference for the plug-in.                   |
| <b>Memory</b>                                | This shows the status of the calibration switch in the plug-in. It does not reflect the protection status of best-accuracy calibration. See "Plug-In Calibration Status".<br>When calibration is disabled this shows Protected.<br>When calibration is enabled this shows Unprotected. |
| <b>Date</b>                                  | The date the plug-in was calibrated. This shows the date of the plug-in calibration (normal accuracy) or the date of the best-accuracy calibration.  |
| <b>Time</b>                                  | The time the plug-in was calibrated. This shows the time of the plug-in calibration (normal accuracy) or the date of the best-accuracy calibration.  |
| <b>Accuracy</b>                              | This shows the plug-in calibration status, Uncalibrated, Normal (normal accuracy), or Best (best accuracy).  |
| <b><math>\Delta</math> Temp</b>              | The change in temperature since the best-accuracy calibration.   |

**Plug-In Calibration Status**

The following figure shows the plug-in calibration status display and the table explains the features.

To enter this display press **Channel** , then **Calibrate**....

**Figure 4-2**



**Plug-In Calibration Status**

**Table 4-2**

**Plug-In Calibration Status**

|   |  |
|---|--|
| <b>Current Date</b>                     | Date and time reflected by the internal clock.   |
| <b>Current Frame ΔTemp</b>              | The current internal temperature of the instrument compared to the temperature at which the frame was calibrated, in increments of one degree centigrade.  |
| <b>Channel X Calibration Level</b>      | Uncalibrated, Best, or Normal  |
| <b>Best Accuracy Calibration Memory</b> | Protected or Unprotected. The Best Accuracy Calibration Memory is protected by a switch in the mainframe. See "To calibrate for best accuracy."  |
| <b>Plug-in</b>                          | This shows other relevant plug-in data.<br>The model number is derived from a hardware ID on the PC board<br>The serial number is set through the Utility Service menu.<br>Last Calibration is the date and time of the relevant calibration level.<br>Best Accuracy ΔTemp is the change in temperature since a best-accuracy calibration. |

## To calibrate the mainframe

Calibration by the instrument firmware is done using the front panel CAL output. The CAL output must be performance tested before an accurate calibration can be assured.

### Equipment Required

| Equipment              | Critical Specifications    | Recommended Model/Part                                      |
|------------------------|----------------------------|---|
| Calibration module     | no substitution            | HP 54717A   |
| Attenuator             | 20 dB, BNC                 | HP 8490 Series Opt 20,<br>with adapters<br>or Narda 755B-20 |
| Cables (3)             | BNC, 9-inch (equal length) | HP 10502A   |
| Adapter                | BNC Tee (m)(f)(f)          | HP 1250-0781  |
| Adapter (2)            | Type N(m) to BNC(f)        | HP 1250-0780  |
| Termination (optional) | BNC 50 $\Omega$            | HP 10100C   |

### Procedure

If calibration is canceled during the process, the previous calibration factors will be retained.

### CAUTION

The rear panel and all rear-panel hardware must be installed when calibrating the instrument. The instrument must have warmed up for 20 minutes.

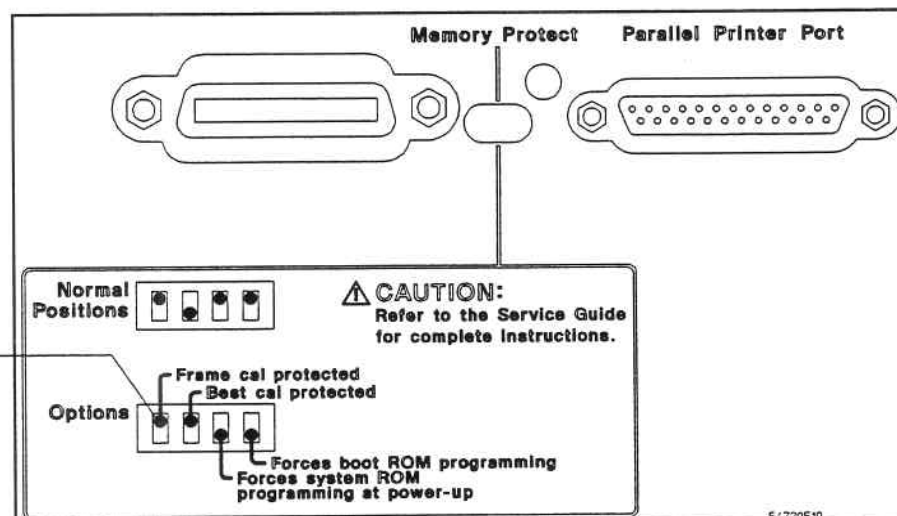
- 1 Set the mainframe calibration protect switch to the unprotected position.

- a Find the cal protect switches on the rear panel. See the figure below.
- b Set the left-most switch to the down position.

The protection status displayed on screen will not change unless the calibration status display is exited and re-entered.



Figure 4-3



Mainframe Calibration Protect Switch down to allow calibration.

Rear-Panel Calibration Protect Switches

- 2 Press **Utility** , then **Calibrate...**, then **Calibrate frame**.
- 3 Follow the prompt on the display.
  - Remove all plug-ins.
  - Disconnect everything from the CAL output.
- 4 Press **Continue**. Monitor the calibration status bar.
- 5 When calibration is complete, follow the prompt on the display.
  - Install the HP 54717A calibration plug-in in slot 1.
- 6 Follow the prompt on the display.
  - Connect the CAL output to the plug-in Channel input.
  - Connect a termination to the Trigger input.
  - Use either the 20 dB pad or the 50  $\Omega$  feedthrough as a termination.
- 7 Press **Continue** and wait for the next prompt.
- 8 Follow the prompt on the display.
  - Connect the CAL output to the plug-in Trigger input.
  - Connect the termination to the Channel input.
- 9 Press **Continue** and wait for the next prompt.
- 10 Follow the prompt on the display.
  - Connect the CAL output through a 20 dB pad to both the Channel and Trigger inputs using a BNC tee and two short cables of equal length.
- 11 Press **Continue** and wait for the next prompt.
  - When the calibration is complete, whether passed or failed, the instrument will prompt you to calibrate the next slot.
- 12 Following the prompts on the display, calibrate the other three slots in the oscilloscope.
- 13 Return the mainframe calibration protect switch to the "protected" position.

## To calibrate the plug-ins

Though plug-in calibration is not strictly part of the mainframe procedures, it is included here as a convenience to the service person.

You can calibrate any plug-in in any slot and in any mainframe. It will have normal accuracy in any other slot or mainframe. Of course, a mainframe that has just been calibrated will provide the optimal basis for a plug-in calibration. A mainframe that has drifted since its last calibration (even though it is still calibrated) may introduce skew into the plug-in calibration and provide less than optimum results. You should calibrate the mainframe just before calibrating plug-ins.

For the vertical accuracies valid after plug-in calibration, see the specifications and characteristics in chapter 1 of the plug-in service guide.

### Equipment Required

| Equipment     | Critical Specifications | Recommended Model/Part |
|---------------|-------------------------|------------------------|
| Cable         | BNC, 12-inch            | HP 8120-1838           |
| Adapter (1) * | Type N(m) to BNC(f)     | HP 1250-0780           |

\* Adapter needed for calibrating HP 54711A only.

### Procedure

#### CAUTION

The rear panel and all rear-panel hardware must be installed when calibrating the instrument. The instrument must have warmed up for 20 minutes.

- 1 Enable plug-in calibration.
  - a Remove the plug-in from the mainframe.
  - b With a small flat tool, remove the right-side plug-in cover by prying gently at the rear corners, lifting, and sliding it back.
  - c Set the calibration switch to the ENABLE position.
  - d Replace the cover and put the plug-in back into the mainframe.
- 2 Press **Utility**, then **Calibrate...**, then **Calibrate plug-in...**
- 3 Press **Plug-in** to select the plug-in to be calibrated.
- 4 Press **Start cal** and follow the instructions on the display.
- 5 After the instructions have been followed, press **Continue**.  
The status bar will show the progress of calibration.  
When calibration is complete, the display will show **Calibration completed**.
- 6 Disconnect the BNC cable, remove the plug-in, and return the calibration switch to the DISABLE position.
- 7 If desired, select the next channel to be calibrated and repeat the procedure.



---

## To calibrate for best accuracy

The best-accuracy calibration is not part of mainframe calibration. Because of its 24-hour time limitation it is typically a user calibration. It is given here as a convenience to the service person.

A best-accuracy calibration improves the vertical characteristics of gain, offset, and linearity. For the parameters affected, see the specifications and characteristics in chapter 1 of the plug-in service guide.

Perform the best-accuracy calibration under the following circumstances:

- When you need the more accurate vertical specifications and
- When the current best-accuracy calibration is voided for one of the following reasons.
  - The 24 hour time limit on a best-accuracy calibration has expired.
  - The instrument Current Temperature  $\Delta$  is more than  $\pm 5^{\circ}\text{C}$ .
  - In this case all of the mainframe and plug-in calibrations are void and a complete recalibration at the new temperature is necessary.
  - The temperature change since the current best-accuracy calibration is more than  $\pm 5^{\circ}\text{C}$ .
  - The plug-in has been moved to a mainframe slot where it does not have a valid best-accuracy calibration.

A plug-in may be best-accuracy calibrated in one or more mainframe slots. However, only one plug-in can be best-accuracy calibrated in a given slot. This last factor is dependent on the serial number of the plug-in rather than the model number.

Best-accuracy calibration factors are stored in memory in the mainframe. Calibration factors are protected by a separate switch next to the frame calibration protect switch behind the rear panel.

---

### Equipment Required

| Equipment     | Critical Specifications | Recommended Model/Part |
|---------------|-------------------------|------------------------|
| Cable         | BNC, 12-inch            | HP 8120-1838           |
| Adapter (1) * | Type N(m) to BNC(f)     | HP 1250-0780           |

\* Adapter needed for calibrating HP 54711A only.

### Procedure

---

**CAUTION**

---

The rear panel and all rear-panel hardware must be installed when calibrating the instrument. The instrument must have warmed up for 20 minutes.

- 1 On the channel to be calibrated, press  , then **Calibrate** . . . .
- 2 Check the status of the Best Accuracy Calibration Memory.
  - If it is Protected, go to the next step.
  - If it is Unprotected, skip the next step.

- 3 Set the Best cal protect switch to the unprotected position.
  - a Find the cal protect switches on the rear panel. See figure 4-3 on page 4-9.
  - b Set the second from the left switch to the down position.

The protection status displayed on screen will not change unless the calibration status display is exited and re-entered.
- 4 Press **Calibrate to best accuracy**.
- 5 Follow the instructions at the top of the display. Instructions may vary depending on the plug-in being calibrated.

To reach the channel input in slot 1 with a 9-inch cable, you must extend the cable slightly with a BNC tee or right-angle adapter.
- 6 After the instructions have been followed, press **Continue**.

The status bar will show the progress of calibration. The calibration time will vary with different models but will typically take only a few minutes.

When calibration is complete the display will show Calibration completed, the Channel X Last Calibration as Best, and the Last Calibration as the date and time reflected by the setting of the clock in the mainframe.
- 7 To calibrate other channels, press  on that plug-in, then **Calibrate...**, then repeat steps 4 through 6.

---

## Adjusting the Color CRT Module

Use these procedures to adjust the Color CRT Module to compensate for magnetic influences causing mis-convergence.

---

### **WARNING**

---

Read the Safety Considerations at the beginning of this manual before performing adjustment procedures.

DO NOT PERFORM THESE ADJUSTMENTS AS A PART OF ROUTINE CALIBRATIONS. The following procedures are provided only for the few extreme cases where either the earth's magnetic field or the user's environment cause an unusable display due to mis-convergence which cannot be corrected by degaussing the entire CRT screen.

DO NOT continue this procedure before first degaussing the CRT screen using the rear panel degaussing switch. In extreme cases of magnetism, it may be necessary to degauss the CRT using a conventional external television-type degaussing coil.

It is recommended that these adjustments be performed only by qualified personnel who are familiar with color CRT convergence procedures.

Before starting the adjustments, mark the position where the potentiometers are set. This helps in returning the adjustments to their original positions if it becomes necessary to restart the procedure.

### **Equipment Required**

The instrument firmware supplies the display patterns necessary for adjustment. The only tool required is a non-metallic adjustment tool:

- Sony Part Number 4-367-065-01
- HP Part Number 8710-1355

After the shields are removed, you can operate the instrument with the module connected and sitting at the front of the frame. However, the cables will be very short. You can make up a longer ribbon cable (4 feet) using the following parts.

- Ribbon cable (use 4 feet), HP Part Number 8120-1613, 3M Part Number 3365-40
- Cable connector (2 each), HP Part Number 1252-3124, 3M Part Number 3417-7600

---

### **To prepare the instrument**

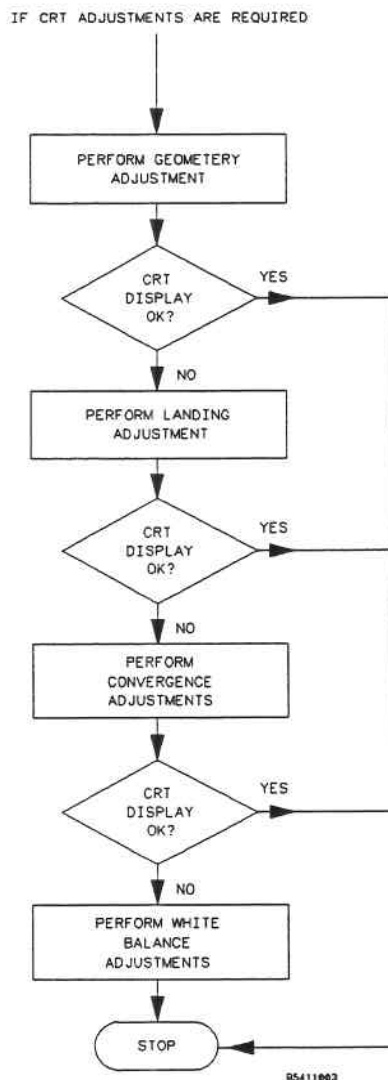
Note the original routing of all cabling for proper routing when the module is re-installed in the instrument. Then, re-route the cables from inside the module to the outside (left side) of the module for reconnection to the power supply for adjustments.

- 1 Remove the Color CRT Module from the instrument (see chapter 6 of this service guide).
- 2 Reconnect the instrument front panel and re-install the front panel (use two screws to temporarily hold the front panel in place).

- 3 Remove the right shield.
  - a Disconnect the display power cable from the connection in the shield.
  - b Remove the screws and slide the shield off of the module.
  - c Remove the power connector from the shield and reconnect it to the power cable from the instrument.
- 4 With the Color CRT Module placed in front of the mainframe, reconnect the module. During any of the following adjustments, the CRT module must face west.
- 5 Use the following chart to guide the procedure.

The following adjustments are broken down into adjustment groups. The adjustment group sequence must be followed in order because of interaction and dependency. The adjustment group sequence is shown in the adjustment flow diagram below. There will be cases where not all of the adjustments groups will be used. For example, if the Geometry Adjustment Group corrects the problem, this will be the only group used.

Figure 4-4



Color CRT Module Adjustment Flow Diagram

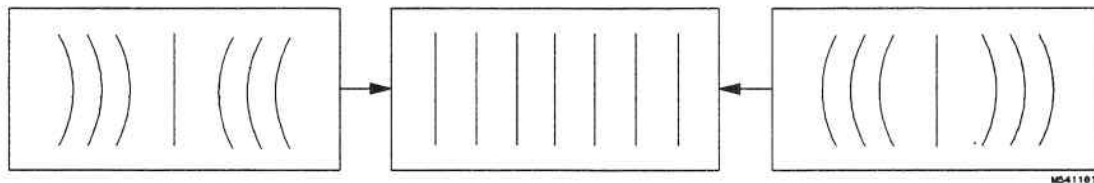
---

## To adjust geometry

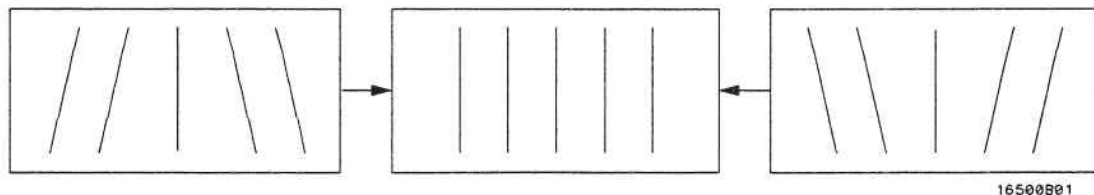
- 1 Display the white cross-hatch pattern on the CRT.  
Press **Utility**, **Service**, **CRT Setup...**, then **CRT pattern on** keys to display the white cross-hatch pattern.
- 2 Preset front panel brightness control (top of the two controls to the left of the display) maximum clockwise.
- 3 Preset front panel contrast control (bottom of the two controls to the left of the display) to the mechanical center.
- 4 Preset H.SUB SHIFT (RV006) and V.SUB SHIFT (RV008), located on the bottom PC board, to the mechanical centers.

All of the following adjustment potentiometers are located on the PC board on the left side of the display.

- 5 Adjust the display size. Measure with a flexible ruler.
  - Adjust H.SIZE (RV504) for a 161 mm (6.34 in.) width.
  - Adjust V.HEIGHT (RV50) for a 120.5 mm (4.74 in.) height.
- 6 Center the pattern.
  - Adjust V.CENT (RV510) for vertical centering.
  - Adjust H.CENT (RV503) for horizontal centering.
- 7 Adjust PIN AMP (RV506) to eliminate pincushion distortion in the vertical lines of the cross-hatch pattern as shown in the next figure.



- 8 Adjust PIN PHASE (RV505) to eliminate pin phase distortion in the vertical lines of the cross-hatch pattern as shown in the next figure.



- 9 Adjust TOP PIN (RV511) so that the top horizontal line is parallel with the center horizontal line.
- 10 Adjust BOTTOM PIN (RV512) so that the bottom horizontal line is parallel with the center horizontal line.

## To adjust focus, landing, and convergence

Once you have started, you will have to do all three of the procedures in this group.

### Initial Preparation

- 1 Loosen the deflection yoke clamp screw.
- 2 Apply power and allow the instrument to thermally re-stabilize for 20 minutes.

### Focus Adjustment

Geometry adjustments must be performed before making the focus adjustment.

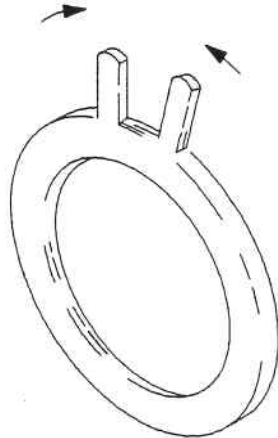
- 1 Display the white cross-hatch pattern on the display.  
Press **Utility**, **Service**, **CRT Setup . . .**, then **CRT pattern** keys to display the white cross-hatch pattern.
- 2 Adjust FOCUS (RV701), located on the rear PC board, for best overall focus.

### Landing Adjustment

- 1 Turn the front panel BRIGHTNESS control fully clockwise.
- 2 Degauss the CRT by momentarily pressing the DEGAUSS switch located on the instrument rear panel.

In some cases, the user's environment or shipping environment may have caused high levels of magnetization in the CRT. In this case, to completely degauss the CRT it may be necessary to use a conventional television-type degaussing coil.

- 3 Set the purity magnet tabs to the mechanical center (see next figure).



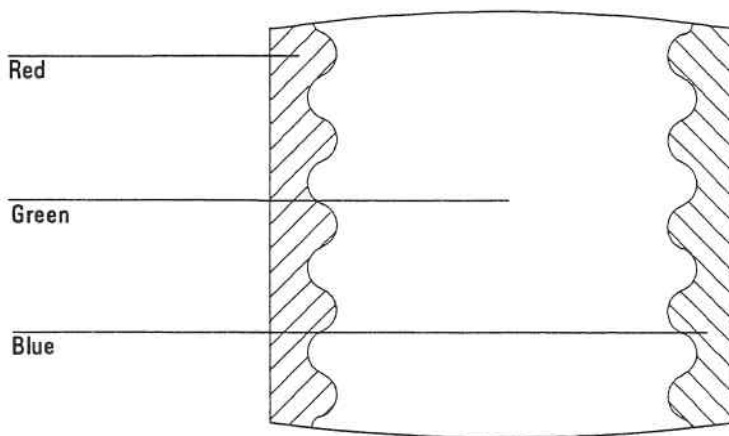
54720MB6

- 4 Display a green raster on the display.

Press **Utility**, **Service, CRT Setup . . .**, press **Color purity** until green is highlighted then press **Enter**.

In the next steps, while moving the deflection yoke forward and rearward, rotate the yoke as necessary to keep the edges of the raster parallel to the sides of the display.

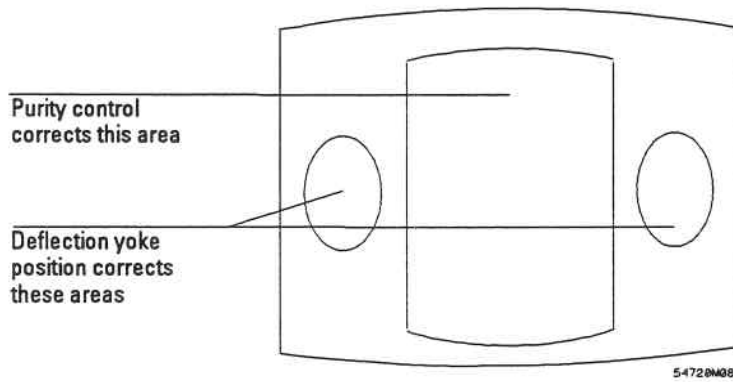
- 5 Move the deflection yoke rearward until the left edge of the raster turns red and the right side of the raster turns blue (see figure below).



54720MB7

- 6 Adjust the purity magnets until green is in the center of the raster with red and blue bands evenly distributed on the sides (see above figure).

- 7 Move the deflection yoke forward until the entire raster is green.  
Landing adjustment is easier if the yoke is moved all the way forward and then moved back until the raster is completely green.
- 8 Using the Color Purity key, replace the green raster with red and then blue raster, each time checking for proper landing adjustment (color purity of each).
- 9 If the landing is not correct in step 9, repeat steps 6 through 9 for best compromise



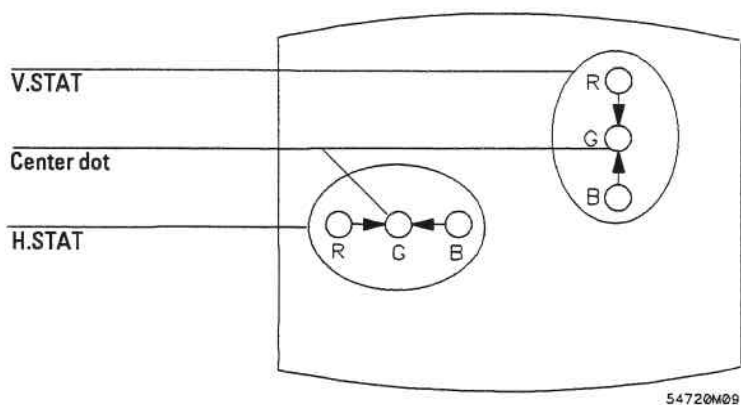
(see next figure).

- 10 If the landing is not correct in step 10, readjust purity magnets for best landing of each color.
- 11 When the landing adjustment is complete, tighten the deflection yoke clamp screw just enough to keep the yoke from moving. DO NOT over tighten.



### Static Convergence

- 1 Temporarily disconnect the power from the instrument.
- 2 Remove the PC board shield cover from the rear of the Color CRT Module by prying evenly on all four sides.
- 3 Re-apply power.
- 4 Display the white cross-hatch pattern on the CRT.  
Press **Utility**, **Service**, **CRT Setup . . .**, then **CRT pattern** keys to display the white cross-hatch pattern.
- 5 Preset front panel brightness control (top of the two controls to the left of the display) maximum clockwise.
- 6 Preset front panel contrast control (bottom of the two controls to the left of the display) to the mechanical center.
- 7 Check the four dots which are located around the center intersection of the cross-hatch pattern for coincidence of the blue, red and green dots.  
If the dots are not coincident, adjust H.STAT (RV703) located on the rear PC board to obtain horizontal coincidence and V.STAT (RV803) located on the bottom PC board to obtain



vertical coincidence (see figure below).

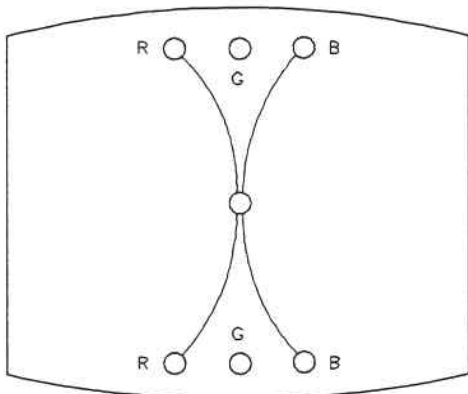
Due to interaction, the BEAM LANDING will need to be re-adjusted if either the H.STAT or V.STAT adjustments are made. Once the BEAM LANDING is re-adjusted, repeat step 7 above if necessary to obtain the center screen coincidence of the dots.

### Dynamic Convergence

- 1 Display the white cross-hatch pattern on the CRT.

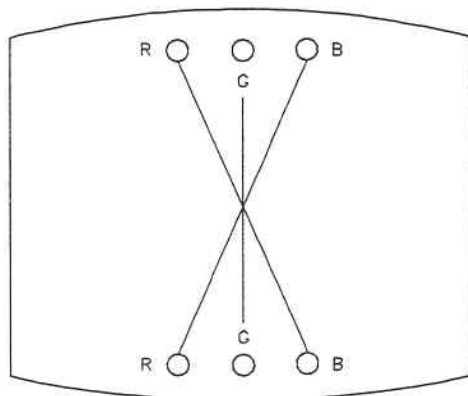
Press **Utility**, **Service**, **CRT Setup . . .**, then **CRT pattern** keys to display the white cross-hatch pattern.

- 2 Adjust Y BOW (RV805) located on the bottom PC board to eliminate red, green and blue bowing at the top and bottom of the center vertical line (see next figure).



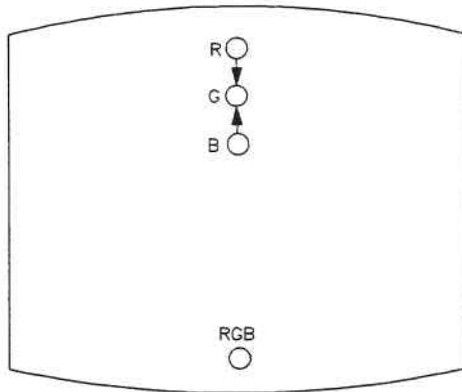
M5-411005

- 3 Adjust Y CROSS (RV804) located on the bottom PC board to eliminate red green and blue orthogonal mis-alignment at the top and bottom of the center vertical line (see next figure).

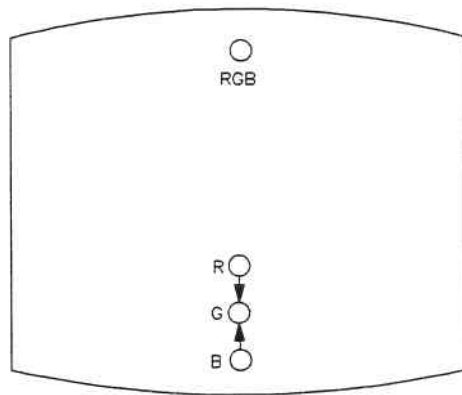
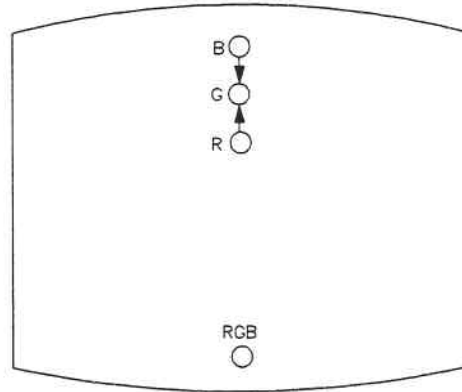


M5-411006

- 4 Adjust V TOP (RV801) and V BOTTOM (RV802) located on the bottom PC board to obtain coincidence of the red, blue and green at the intersection of the top and bottom horizontal lines with the center vertical line. Use the next two figures for V TOP and V BOTTOM respectively.

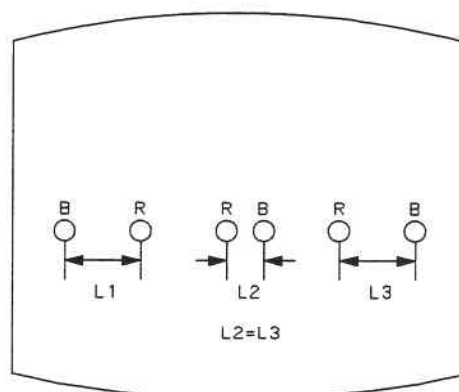
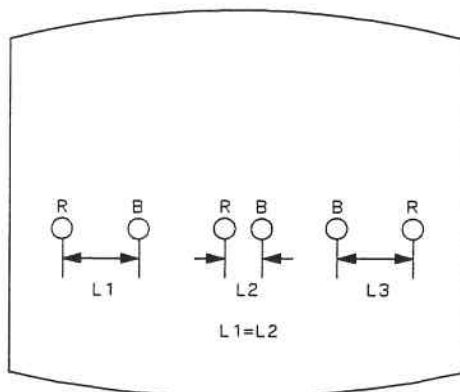


M5411007



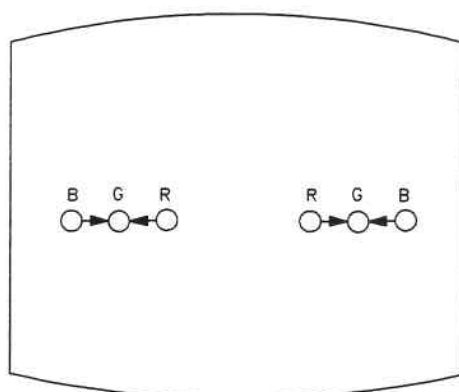
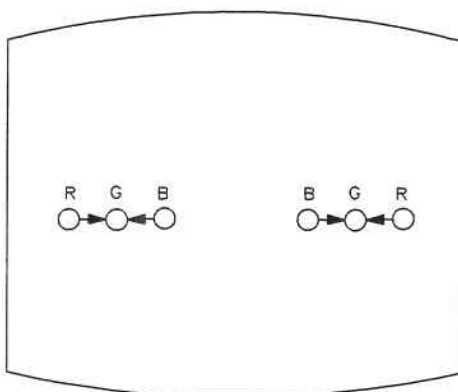
M5411008

- 5 Adjust H.AMP (RV807) located on the bottom PC board for equal amounts of mis-convergence at the right and left sides of the screen (see next figure).



MS411009

- 6 Adjust H.TILT (RV806) located on the bottom PC board for coincidence of red, green and blue at the right and left sides of the screen (see next figure).



MS411018

## To adjust white balance

**1 Provide a blank display on the CRT.**

Press **Utility**, **Service, CRT Setup . . .**, then **Color purity** key to display the black screen.

The completely blanked raster will contain the text for the function keys on the right side of the display, however, this will not affect the adjustment.

**2 Preset front panel brightness and contrast controls to their mechanical centers.**

**3 On the bottom PC board, set the following adjustments to their mechanical centers.**

- SUB BRT (RV901)
- SUB CONT (RV902)

**4 On the bottom PC board, set the following adjustments to their mechanical centers.**

- G. DRIVE (RV921)
- B. DRIVE (RV931)
- R. DRIVE (RV911)

**5 On the rear PC board, set the following adjustments ) fully counterclockwise (CCW).**

- G. BKG (RV721)
- B. BKG (RV731)
- R. BKG (RV711)

**6 Adjust SCREEN (RV702) located on the rear PC board until either the red, green or blue raster just starts to become visible. Note which color becomes visible first and do not adjust the background control (BKG) for that color in the next step.**

**7 Adjust the other two background controls for the best white balance.**

**8 Press Color Purity key as necessary to obtain the white raster.**

**9 Set the front panel brightness control to maximum.**

**10 On the bottom PC board, adjust the DRIVE controls (RV921, RV931 and RV911) for the best white balance.**

For a white balance reference, use an average piece of white photocopy paper and compare the white on the CRT to the paper.

**11 Repeat steps 1-3 and 6-10 until satisfied with the white balance.**

Essentially, from this point the procedure is:

- With a blank screen, the front panel brightness set to center, and SCREEN (RV702) set for minimum background, adjust the BKG controls (G.-RV721, B.-RV731, and R.-RV711) for the best white balance.
- With a white raster and the front panel brightness set to maximum, adjust the DRIVE controls (G.-RV921, B.-RV931, and R.-RV911) for best white balance.
- Repeat until satisfied with the white balance.

|                                  |      |
|----------------------------------|------|
| Safety                           | 5-2  |
| ESD Precautions                  | 5-2  |
| Keystroke Conventions            | 5-2  |
| Default Setup                    | 5-2  |
| <br>                             |      |
| Trouble Isolation                | 5-3  |
| Tools Required                   | 5-3  |
| 1, Primary Trouble Isolation     | 5-5  |
| 2, No-Display Trouble Isolation  | 5-11 |
| 3, Keyboard Trouble Isolation    | 5-19 |
| Missing Board Checks             | 5-22 |
| Interpreting Internal Self-tests | 5-23 |
| Clock                            | 5-23 |
| Acquisition 1                    | 5-23 |
| Acquisition 2                    | 5-23 |
| CPU                              | 5-24 |
| Display                          | 5-24 |
| Time Base                        | 5-24 |
| Floppy Disk                      | 5-24 |
| Front Panel                      | 5-24 |
| Power Supply Distribution        | 5-25 |
| General Supply Distribution      | 5-25 |
| Fan Supply                       | 5-25 |
| Color CRT Module Supply          | 5-25 |
| Power Standby Switch             | 5-25 |
| <br>                             |      |
| Utility Menu                     | 5-27 |
| HP-IB Setup                      | 5-27 |
| System Configuration             | 5-27 |
| Time and Date                    | 5-28 |
| Declassify frame memory          | 5-29 |
| Update system firmware           | 5-29 |
| Calibrate                        | 5-29 |
| Self-test                        | 5-30 |
| Firmware Support                 | 5-30 |
| Problem report                   | 5-30 |
| Firmware request                 | 5-30 |
| Service                          | 5-31 |
| Plug-in                          | 5-31 |
| Frame                            | 5-32 |
| CRT setup                        | 5-32 |

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# Troubleshooting

This section provides troubleshooting and other non-periodic maintenance information for the HP 54710A and 54720A Oscilloscopes. The service strategy of this instrument is replacement of defective assemblies. Some assemblies can be replaced on an exchange basis.

This chapter is divided into two sections.

- The Trouble Isolation section helps you find a defective assembly when the instrument fails.
- The Utility Menu section describes the various features of that menu and how to use them.

## Safety

Read the Safety Summary at the front of this manual before servicing the instrument. Before performing any procedure, review it for cautions and warnings.

---

### WARNING

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Maintenance should be performed by trained service personnel aware of the hazards involved (for example, fire and electric shock). When maintenance can be performed without power applied, the power cord should be removed from the instrument.

## ESD Precautions

When using any of the procedures in this chapter you should use proper ESD precautions. As a minimum you should place the instrument on a properly grounded ESD mat and wear a properly grounded ESD wrist strap.

## Keystroke Conventions

To guide you while setting up the oscilloscope, the following conventions are used to represent keystrokes and other interactions with the instrument:

Text in a box, such as `Utility` or `Time base`, represents hardkeys, those defined by text on the front panel.

Bold text in a typewriter font, such as **Display** or **Calibrate...**, represents text on the CRT screen and may be a softkey you should press or a message to consider.

## Default Setup

A Default Setup is provided to assure the instrument is in a known default state. The default setup prevents previous setups from interfering with the next test. The default setup also simplifies the instrument set up procedure.

To set the HP 54710A/54720A in the default state:

- 1 At the top of the instrument, press `Setup`.
- 2 At the bottom of the screen, press **Default Setup**.

The trouble isolation information is provided to isolate a problem to a faulty assembly. When the faulty assembly has been located, the disassembly/assembly procedures in chapter 6 help direct replacement of the assembly.

The primary procedural tool in this section is the flowchart. The flowchart contains the entire troubleshooting path from failed instrument to working one. Reference letters on the flowcharts point to sections of reference text that expand on the brief prompts in the flowchart.

The flowcharts will direct you in an orderly manner through the possible failure symptoms. You will have problems if you try to troubleshoot by following only the reference text because the text is not in the correct order for troubleshooting. The flowcharts have the correct order of steps.

If you are unfamiliar with the HP 54710 and 54720, start with the Primary Trouble Isolation Flow chart on the next page.

## Tools Required

Just the normal tools used when troubleshooting electronic equipment are needed. A good digital multimeter and an oscilloscope with about a 100 MHz bandwidth should be sufficient.

If you need to troubleshoot the color CRT module or plug-ins you can build extender cables using the parts listed below.

### Color CRT module extender cable

This is a 40-conductor ribbon cable with 40-pin female connectors on each end. The cable should be about 4 feet long.

|                    | Connector | Cable     |
|--------------------|-----------|-----------|
| <b>3M Part No.</b> | 3417-6640 | 3365-40   |
| <b>HP Part No.</b> | 1251-8231 | 8120-1613 |

### Plug-in extender cable

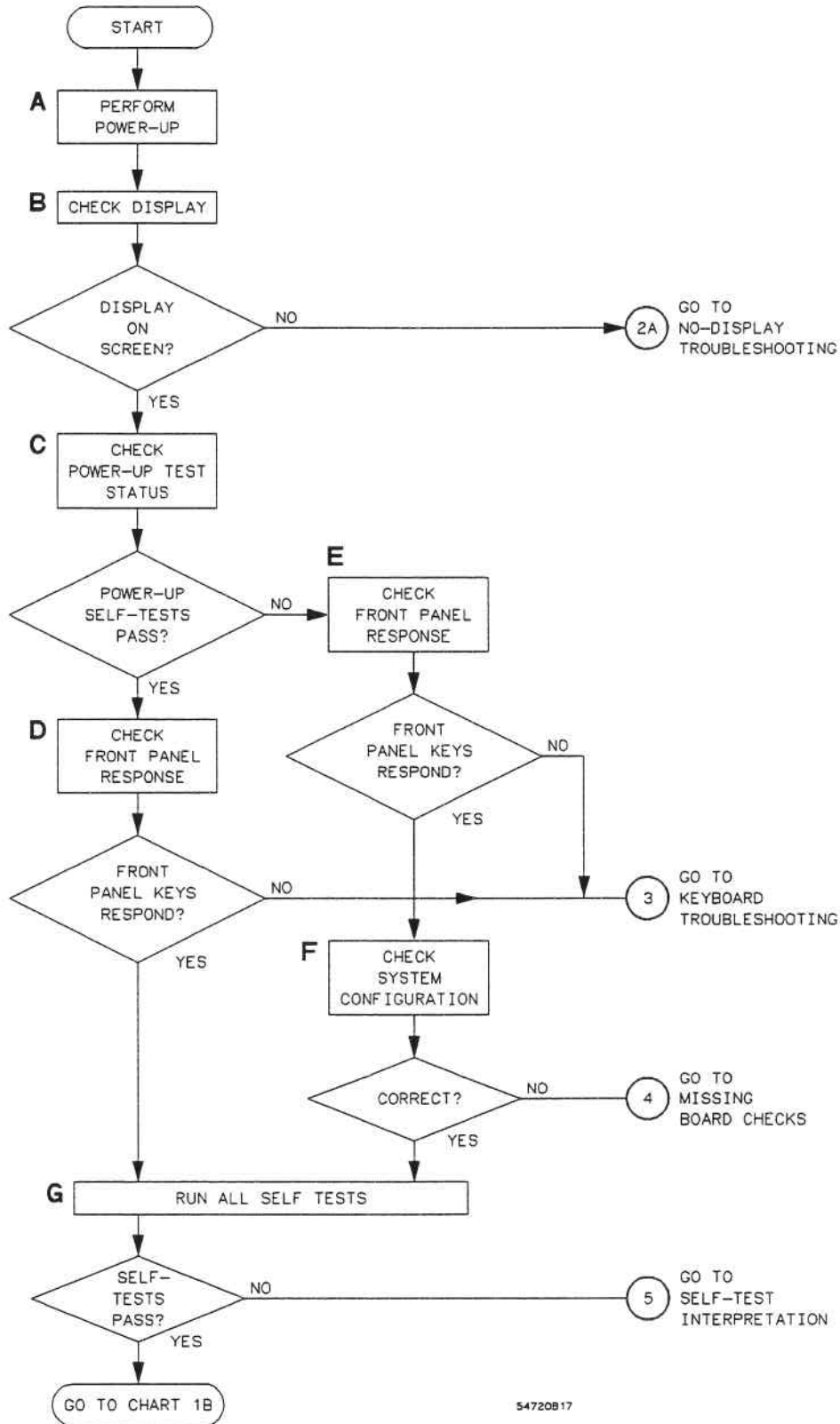
This is a 25 conductor cable with a 25-pin female sub-D on one end and a 25-pin male sub-D on the other. The cable should be about 2 feet long. You need to remove one conductor from the cable noted below.

|                    | Female Connector | Male Connector | Cable     |
|--------------------|------------------|----------------|-----------|
| <b>3M Part No.</b> | 8325-6000        | 8225-6000      | 3365-26   |
| <b>HP Part No.</b> | 1252-0048        | 1251-8352      | 8120-1506 |

If you need to remove and replace assemblies, you may need some of the hand tools listed in chapter 6 "Replacing Assemblies."



Figure 5-1



54720B17

Primary Trouble Isolation Flowchart 1A

## 1, Primary Trouble Isolation

Except for moving the plug-ins between slots in the mainframe, the actions in the Primary Trouble Isolation Flowchart, figure 5-1, are performed without disassembling the instrument. Interaction of the front panel and other indications are used to help identify the problem area.

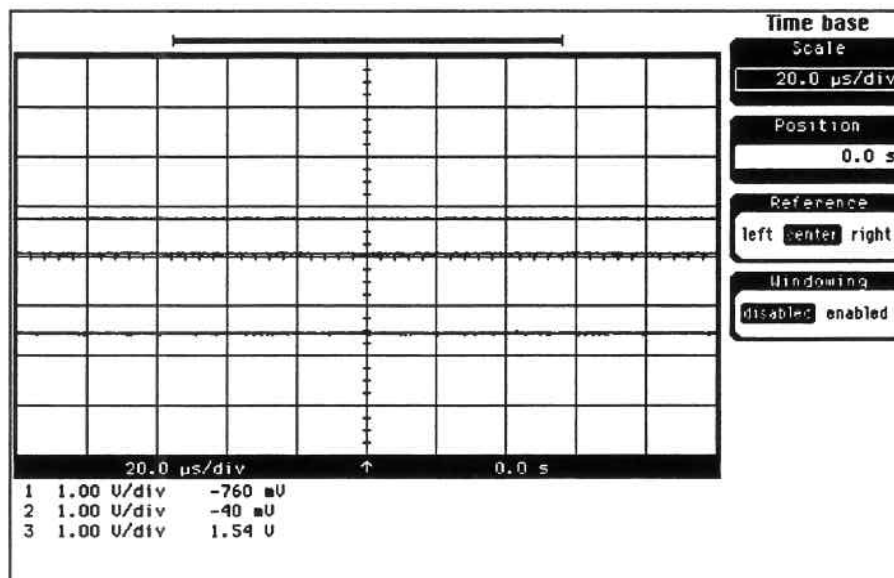
A letter is assigned to boxes in the flowchart. The letter corresponds to a specific section in the reference text. Be sure to use the flowchart itself for your troubleshooting path.

### A Perform powerup

#### 1 Turn on the instrument.

A few seconds after the instrument is turned on, the graticule and a function menu is displayed on the screen. The screen should look similar to Figure 5-2. Items in the softkey area will vary depending to the setup selected before the instrument was turned off.

Figure 5-2



#### Power-Up Display, Timebase Menu

If a fault occurs on power up, the screen will display "**Power-On Test FAILED!**".

The power-on test just runs a few essential self-tests.

#### 2 In the Storage keys, press **Setup** , then **Default Setup**, then **Time base** .

### B Check the display.

The display on screen should be similar to Figure 5-2. If there is no display on the CRT screen after power up, go to the No-Display Trouble Isolation flowchart for further troubleshooting.

**C Check power-on test status.**

When the instrument is turned on the Power On Tests are performed. If the tests fail, a power-on test FAIL message will appear at the top of the CRT screen. It will stay on screen until a key is pressed. If the tests pass, no message is displayed. The Power On Test status is shown in the system configuration menu.

**D/E Check the front panel response.**

- Try pressing the different menu keys such as **Timebase** or **Trigger**, and the **Channel** keys on the plug-ins. Each of these keys should change the set of function keys on the right side of the screen.

**F Check the system configuration**

For more information about the system configuration menu, see "Utility Menus" in this chapter.

- 1 In the System keys, press **Utility** then press **System Config...**
- 2 Verify that the slots show that all the boards are installed, as in the figure below.
- 3 If the System Configuration is not showing a board in a slot, go to the "Missing Board Checks" for further trouble isolation procedures.

Figure 5-3

The screenshot shows the 'System config' menu with several sections:

- System info:** Model: 54720A, Serial Number: 3207A00101, Calibration Memory: Protected, Power On Test: Passed, Firmware Revision: 1.0, Boot Revision: 1.0.
- Power Statistics:** Total Pon Time: 27.67 hrs, Length Last Poff: 0.0 hrs, Time Since Pon: 0.44 hrs, Power Cycles: 45.
- Board Installation Table:**

| Slot | Board       |
|------|-------------|
| 6    | CPU         |
| 5    | Display     |
| 4    | Time base   |
| 3    | Clock       |
| 2    | Acquisition |
| 1    | Acquisition |
- Plug-ins Table:**

| Slot | Model  | Serial #   | Analog BW | Calibration Memory |
|------|--------|------------|-----------|--------------------|
| 1    | 54711A | 3207A00101 | 1.5 GHz   | Protected          |
| 2    | 54713A | 3207A00101 | 500 MHz   | Protected          |
| 3    | 54721A | 3207A00101 | 1.1 GHz   | Protected          |
| 4    |        |            |           |                    |
- System config menu options (right side):** Time (11:12:57), Date (15 JUL 1992), Declassify frame memory, Update system firmware, Exit.

This assembly is not installed in the HP 54710A mainframe.

**System Configuration**

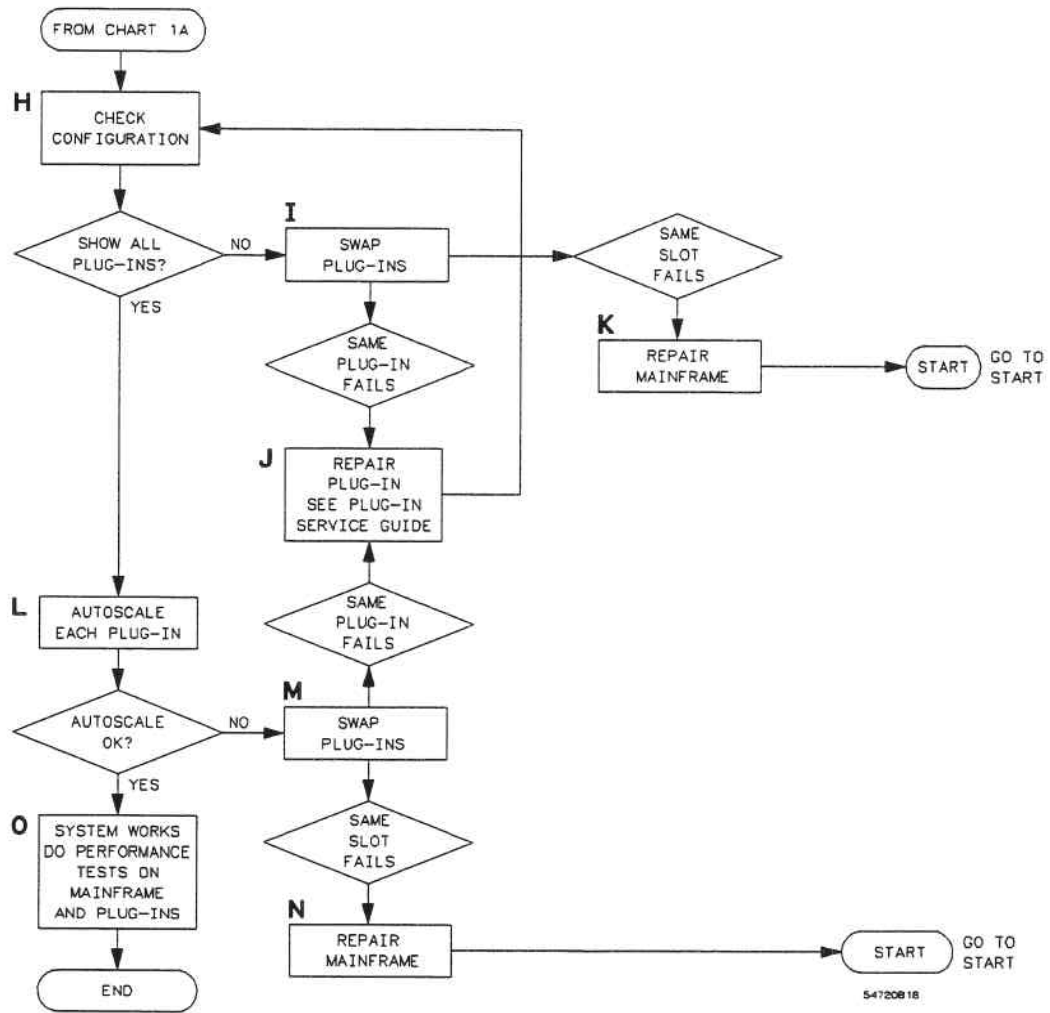
**G Run all of the self-tests**

- 1 In the System keys press **Utility**, then press **Self test...**
- 2 Toggle the **Board** softkey until **Test all boards** is highlighted, then press **Enter**.
- 3 Press **Start** and allow the instrument to run the tests.
- 4 If any of the self-tests fail, go to "Interpreting Internal Self-tests" for further information.

**NOTES**

Figure 5-4

1B



Primary Trouble Isolation Flowchart 1B

**H Check instrument configuration.**

- Press **Utility** , then press **System Config...**

The plug-ins are listed at the bottom of the screen. If a plug-in is not listed, it has not been recognized by the mainframe.

**I Swap plug-ins.**

If the mainframe does not show all of the plug-ins, swap plug-ins between a slot that recognizes a plug-in and the slot that does not.

- If the failure follows the plug-in, the plug-in needs repair.
- If the failure is in the same slot as before, there is a problem with the mainframe.

**J Repair the plug-in.**

- 1 Use the trouble isolation procedures in the service guide for the failed plug-in.
- 2 Reinstall the repaired plug-in and resume troubleshooting at block H of this chart.

**K Repair the mainframe.**

For this type of mainframe problem, first try replacing the CPU board. If that does not correct the problem, replace the motherboard.

**L Autoscale test each channel.**

- Connect the CAL signal to each plug in turn and press **Autoscale** .

If a plug-in is an HP 54711A, you will have to connect the signal to both the channel and trigger inputs.

**M Swap the plug-ins.**

If the autoscale for a plug-in is not successful, swap it with a plug-in that does autoscale and retry autoscale of both plug-ins.

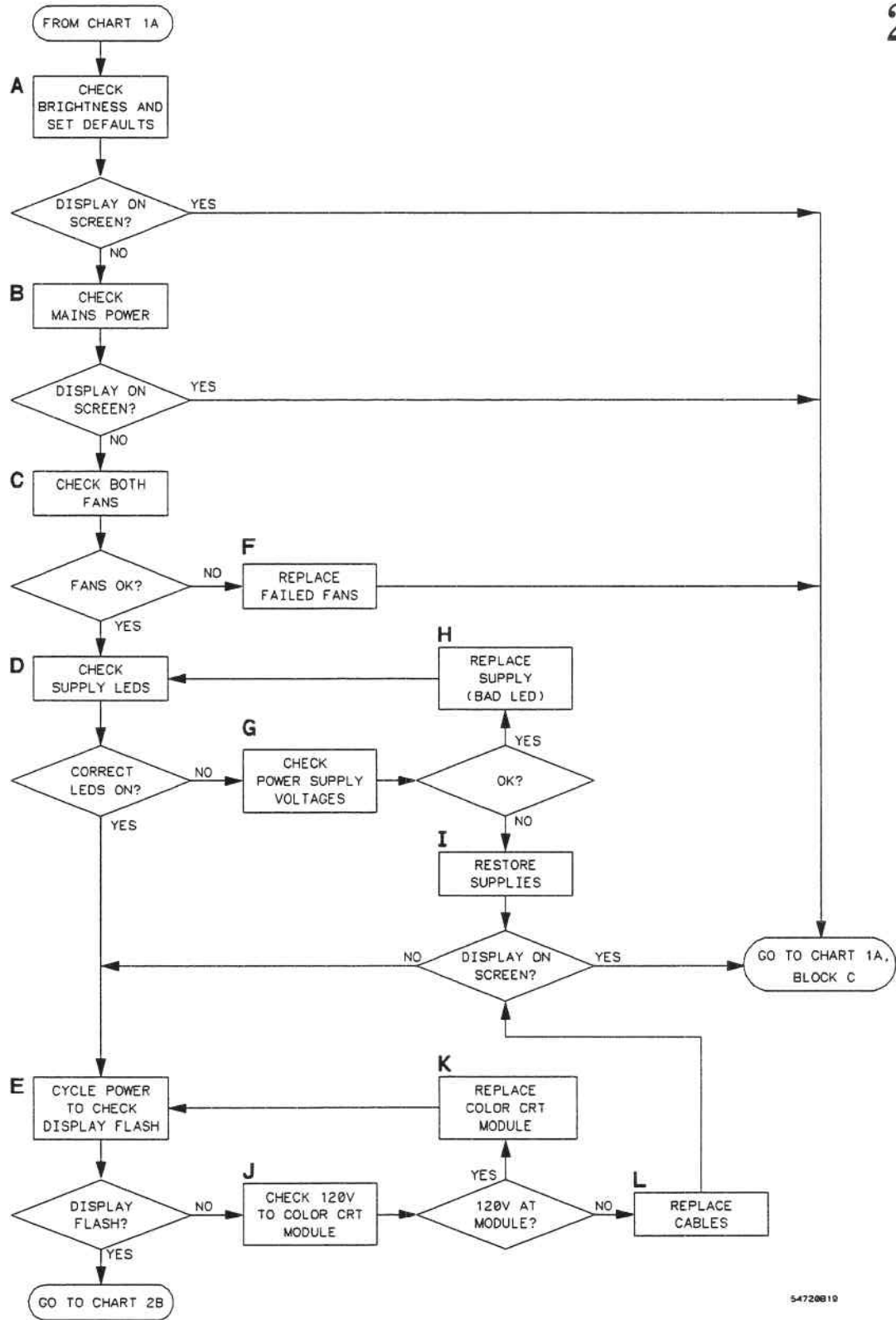
**N Repair the mainframe.**

In this case the mainframe failure is most likely in the Acquisition assembly for that slot. Use the self-tests to determine the failure. Slots 1 and 2 are Acquisition 2 and slots 3 and 4 are Acquisition 1.

- **O The system is operational. Performance test the mainframe and each plug-in according to the procedures in chapter 3 of the service guides.**

Figure 5-5

2A



54720010

No-Display, Trouble Isolation Flowchart, 2A

## 2, No-Display Trouble Isolation

These trouble isolation details help isolate a problem to the assembly level when there is no display on the color module screen.

### A Check brightness and set defaults.

- 1 Check that the front panel brightness control (top adjustment) is set fully clockwise.
- 2 Set up the instrument defaults. Press **Setup**, then the bottom softkey.

### B Check mains power.

- Verify that the 54710A/54720A power cable is connected.
- Verify the rear panel line select switch is set to the proper line voltage, 115V or 230V.
- Check that the rear panel circuit breaker and the front panel Power switch are both ON.

### C Check both fans.

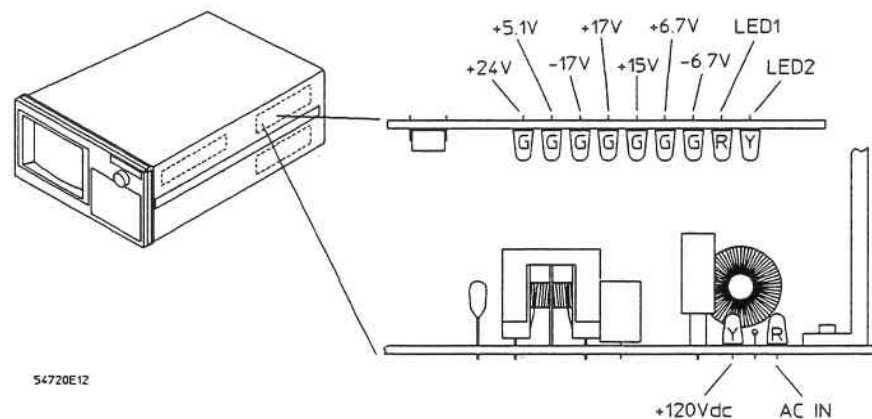
Check that both the rear and the front fans are operating.

- The rear fan is located in the compartment directly behind the color CRT module.
- The front fan is located above the plug-in slots, behind the disk drive. To view the front fan, remove plug-ins from slots 3 and 4 and look into the area above the plug-in slots.

The power supply Remote Shut Down (RSD) circuit will shut the supply down if either fan is not connected or a fan does not start rotating immediately when power is turned on. One symptom of an inoperative fan is a particular sequence of LED indications on power-up.

- 1 Use the figure below to establish the location of the power supply LEDs. They can be viewed through the ventilation holes in the side of the instrument.

**Figure 5-6**



### Power Supply LED Location

- 2 Cycle the power while watching the LEDs.
  - a The seven green LEDs and 120 V yellow LED light for 1-5 seconds, then go off.
  - b Then LED1 (red) and LED2 (yellow) come on.
- 3 Cycle the power while watching the fans.

If the LED sequence happens as noted in step 2, cycle the power while watching each fan in turn. A good fan should start to run as the power comes up, then stop when remote shutdown occurs. A faulty fan probably will not run at all.



**D Check supply LEDs.**

Verify that the correct supply LED indicators are lit. Use the figure on the previous page. An unlit LED indicates that the respective power supply voltage is missing.

- The red AC IN LED is on.
- All seven green LEDs are on.
- The yellow LED for +120 Vdc is on.

Both LED1 and LED2 are normally off and when on indicate supply failure or shutdown.

**Table 5-1**

**Failure LED Indications**

|                          |   |
|--------------------------|---|
| <b>LED1 on, LED2 off</b> | The power supply is in either Over-Load-Protection or in Over-Temperature- Protection condition. In this case, verify the vent holes are clear and allow instrument to cool if necessary. If the instrument is cool and the condition persists, suspect a short circuit on one of the supplies.   |
| <b>LED1 on, LED2 on</b>  | The power supply is in the Over-Voltage-Protection or the Remote-Shut-Down mode. A disconnected or non-working fan will cause the power supply to go into Remote-Shut-Down mode. See paragraph C above. The Over-Voltage-Protection condition indicates the power supply is not properly loaded or is not maintaining regulation and needs to be replaced . |

**E Cycle the power to check for display flash.**

When there is no display, try cycling the power off, then on. If the screen flashes, the +120 Vdc supply voltage is reaching the color CRT module.

**F Replace failed fan.**

Replace a fan that will not attempt to run.

**G Check the power supply voltages.**

- 1 Five of the seven supply voltages can be checked on any of the bus connectors in the plug-in compartment. See the following figure.

**Figure 5-7**

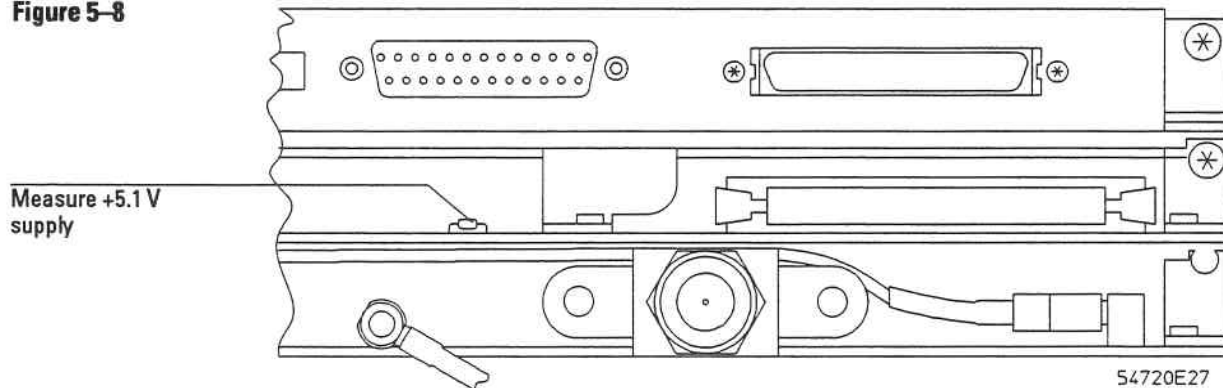
|  |              |                           |                           |
|--|--------------|---------------------------|---------------------------|
|  | <b>Pin #</b> | <b>Voltage</b>            | <b>Approx. Resistance</b> |
|  | 6            | +17 V (17 V to 18 V)      | 200 Ω                     |
|  | 7            | -17 V (-17 V to -18 V)    | 200 Ω                     |
|  | 18           | +15 V (14.5 V to 16 V)    | 500 Ω                     |
|  | 19           | +6.7 V (6.7 V to 7.7 V)   | 50 Ω                      |
|  | 20           | -6.7 V (-6.7 V to -7.7 V) | 50 Ω                      |

**Voltages Accessible on Plug-in Connectors**

- 2 Set Power to Standby and measure the supply line resistance (with respect to ground) at the pins shown in the above figure. If the supply voltages are down, it can be caused by a short on an assembly.
- 3 Check the +5.1 V supply.
  - a Remove the rear panel and find the display assembly. It is the second assembly below the power supply.

- b Apply power and measure the 5.1 V supply voltage at the decoupling capacitor visible just to left of the center of the board.

**Figure 5-8**



**+5-V Supply Measurement Point**

- c Set Power to Standby, allow the supplies to discharge, and measure the resistance of the supply line. It should be about 20  $\Omega$ .

**H Replace the supply.**

Apparently the supply works but an LED is not lit. Replace the supply to correct the problem.

**I Restore the supplies.**

Either the power supply is faulty or an assembly is overloading the supply. Use the "Power Supply Distribution" section and other isolation techniques, removing assemblies etc., to isolate the excessive load on the supply.

**J Check for 120 Vdc at the module.**

If the screen does not flash when the power is cycled, extend the color CRT module (see "To remove and replace the color CRT module" in chapter 6) and check for 120 Vdc at the module. There is an intermediate cable between the module shield and the module circuitry. You will have to remove the shield to check further.

While the module shield is off, check the ribbon cable connection.

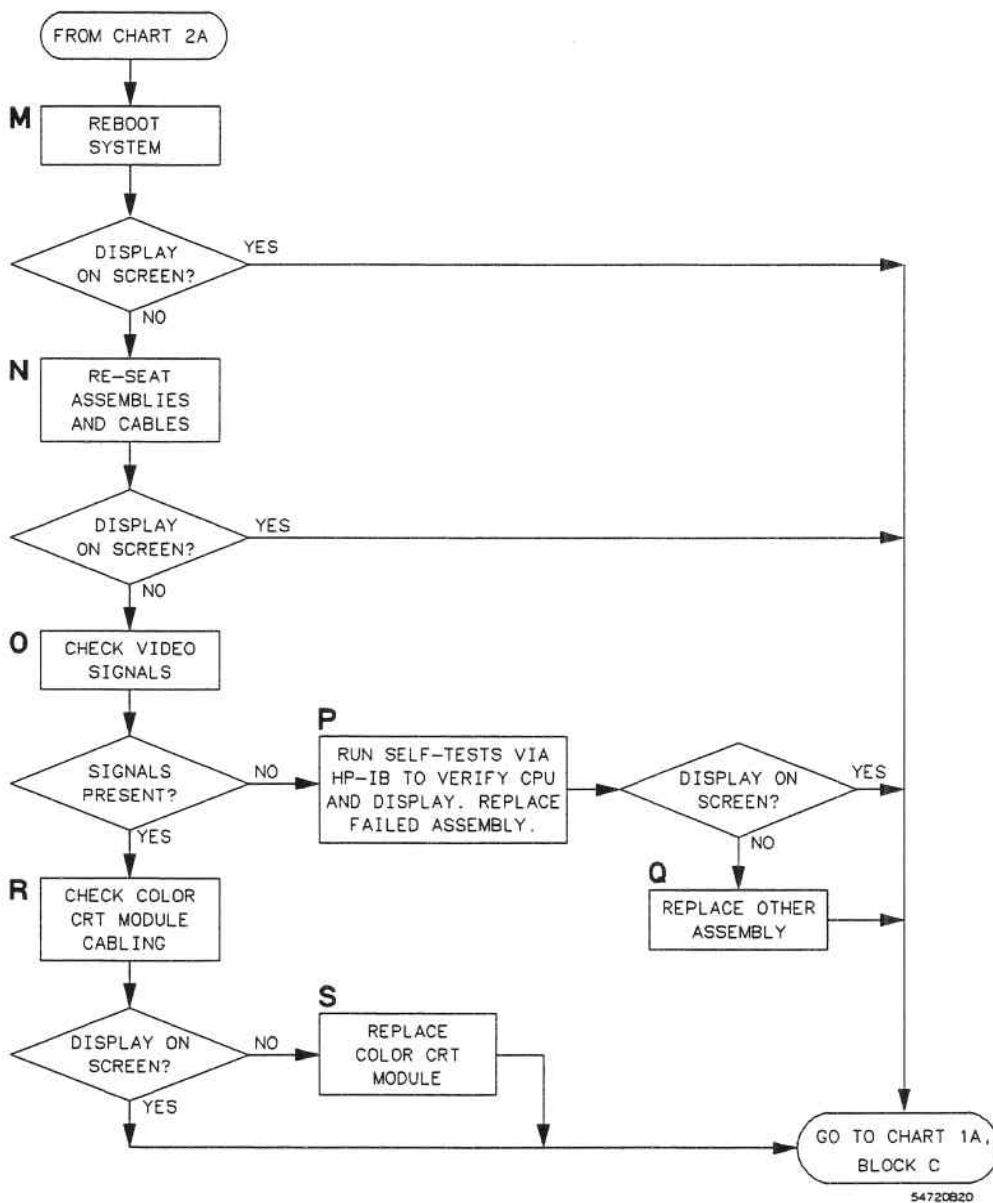
**K Replace the module.**

If the +120 Vdc is reaching the color CRT module but it does not flash when the power is cycled, replace it with a different one. (See "To remove and replace the color CRT module" in chapter 6).

**L Replace cables.**

The most likely cause of the lack of power is a bad cable. However, the 120 V comes through the motherboard. Check for 120 V at the motherboard connector. If there is no 120 V there, there is a problem on the motherboard or with the power supply connection to the motherboard.

Figure 5-9



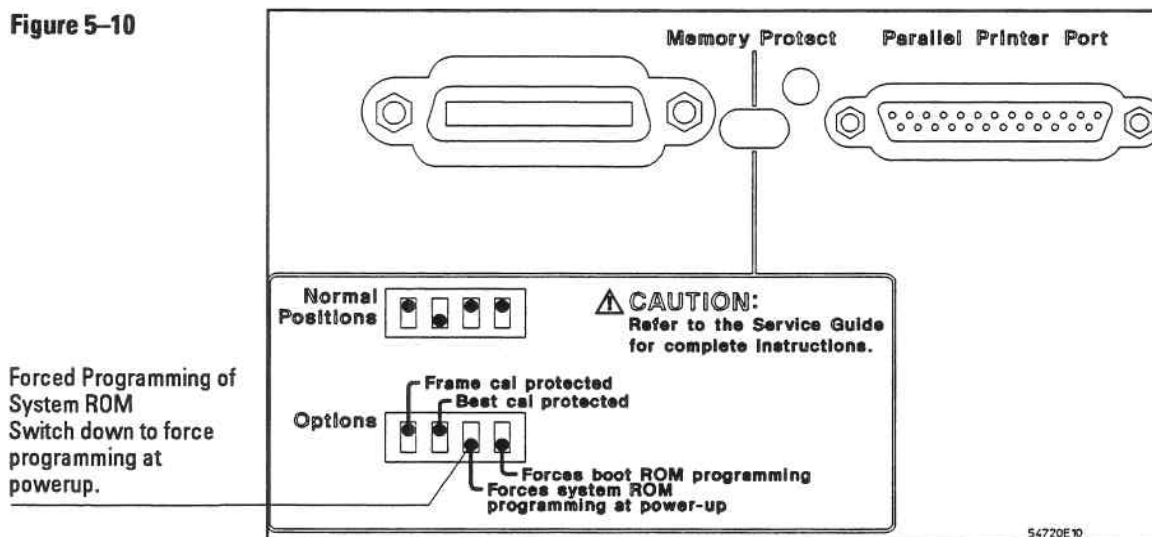
No-Display, Trouble Isolation Flowchart, 2B

**M Re-boot the system.**

There are three ways to force the system to load firmware when you cannot see the display.

- If the disk drive light comes on when power is applied, the instrument knows the firmware is corrupted. To load the operating system, insert the system disk and cycle the power.
- If the disk drive light does not come on, the firmware may be corrupt but the instrument is not aware of that and will not try to load new firmware. Use the following procedure.
  - a Set the rear panel system ROM switch down, as shown in the figure below.

**Figure 5-10**



**ROM Programming at Powerup**

- b Install a system disk and apply power.  
 The operating system loading operation takes a few minutes. When finished, the disk drive light will go out.
  - c Cycle the power. The display should come up on the screen.
- If the system is operating but has no display, you can load the firmware using the front panel even if you cannot see the display.
    - a Insert the system disk.
    - b Press, in order, Utility, second softkey from the top, then the third softkey from the bottom.
  - If the oscilloscope loses its operating system when power is turned off, the battery on the CPU may be low.

**N Re-seat assemblies and cables.**

A no-display condition can be caused by disconnected or improperly seated connectors. Try the following:

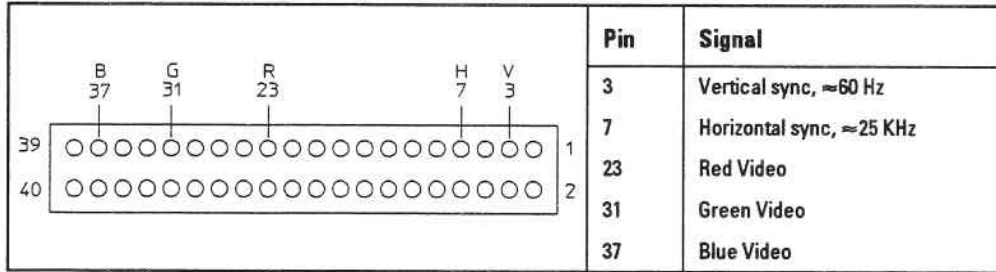
- Check the ribbon cable connection between the display board and the color CRT module.
- Check the ribbon cable between the CPU board and the display board.
- Re-seat the CPU board and Display boards

**O Check the video signals.**

The video signals are conducted from the display board to the color CRT module via a wide ribbon cable. To remove parts and assemblies, refer to procedures in chapter 6.

- 1** Remove the ribbon cable from the rear of the display board. The display board is the second assembly below the power supply.
- 2** Use the following figure to locate the video signals on the PC board connector.

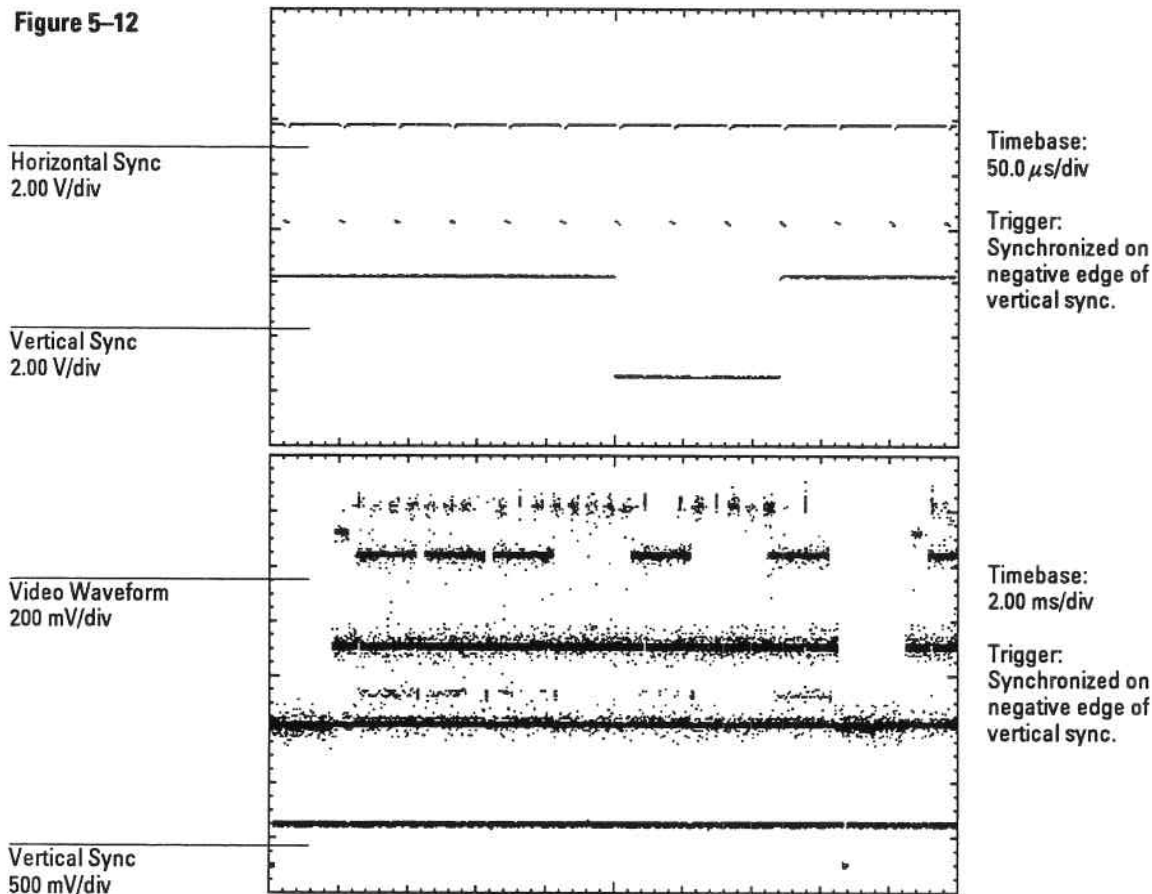
**Figure 5-11**



**Video Signal Locations**

- 3** Use another oscilloscope to check for video signals similar to the following figure.

**Figure 5-12**



**Video Signals**

**P Run self-tests via HP-IB.**

If all the power supplies are running and there is no display, the problem may be caused by the CPU board or Display boards. Run the internal self-tests via the HP-IB to verify the CPU board and Display boards are running. The procedure gives an example program.

**1** Connect an HP series 200/300 controller.

**2** Set the HP-IB address on the oscilloscope.

For the following program to run, the oscilloscope address must be set to 7. Since the display is blank, you will have to do it without seeing the softkey names on the screen.

**a** Press Utility.

**b** Press the top softkey.

**c** Press 7 then Enter.

**3** Run this program for a CPU self-test. The test takes about 3 minutes; much longer indicates the test is failing.

```

10  !This program runs 54720 self-tests via the HP-IB
20  !and prints the pass/fail result.
30  !
40  DIM Test$[100]
50  CLEAR 707                                !Clears HP-IB interface.
60  !
70  OUTPUT 707;"SELFTEST:CPU? ALL"           !Commands 54720 to run a
80                                          !self-test.
90  !
100 ENTER 707;Test$                          !Returns results of self-test.
110 PRINT Test$
120 END
:SELFTEST: CPU PASSED

```

**4** To run a Display self-test, change the program.

**a** Change line 70 so that it will run the display test. Change "CPU?" to "DISP?".

```

70  OUTPUT 707;"SELFTEST:DISP? ALL"         !Commands 54720 to run a
80                                          !self-test.

```

**b** When the test is finished the instrument will return to the controller:

```

:SELFTEST: DISPLAY PASSED

```

**5** Replace the failed assembly.

**Q** If the display does not show after block O, replace the assembly not replaced in block O.

**R** Check color CRT module cabling.

If video signals are present at the display PC board connector but there is no display, check the cabling to the module. To remove parts and assemblies, refer to procedures in chapter 6.

**1** Remove the module from the instrument.

**2** Remove the shields from the module.

**3** Check the ribbon cable connection.

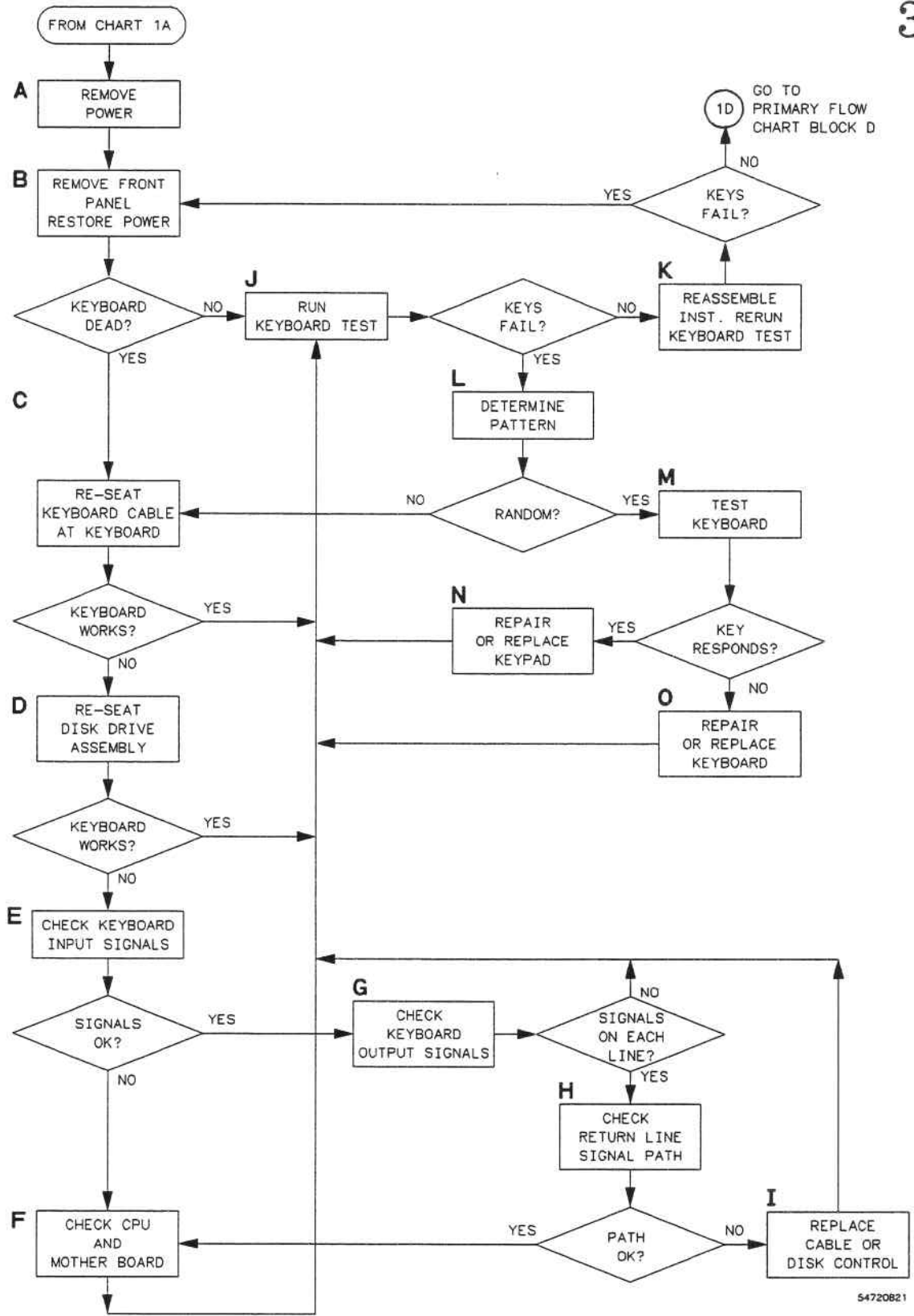
**4** Connect the module cables and apply power.

**5** If there is still no display, check for the video signals at the module end of the ribbon cable. Use the figures on the previous page.

**6** If there are no video signals, replace the cable. If there are, replace the module.

**S** Replace the color CRT module.

Figure 5-13



Keyboard Troubleshooting Flowchart

54720821

### 3, Keyboard Trouble Isolation

Use this section to isolate keyboard problems. Such problems can usually be isolated into two groups, those that indicate complete keyboard failure and those that indicate random key failures. However, electrically the keys on the front panel are in a six by eight array, so multiple key failures may have a pattern which is masked by the layout of the keyboard.

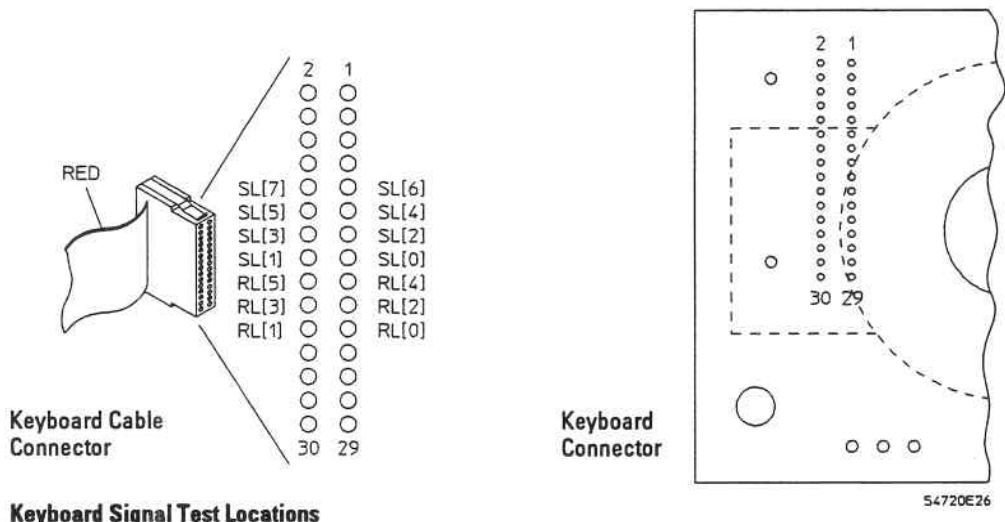
Refer to the instrument block diagram in chapter 8 and the exploded views in chapter 7 for cable interconnect information. Notice that the front panel keyboard is connected via cable to the disk control board. The disk control board plugs into the mother board. The problem can be a disconnected cable or connector in the keyboard signal path.

**CAUTION**

Always remove power before removing and replacing assemblies.

- A Turn off the power and remove the power cord.**
- B Remove the front panel.**  
 Refer to the disassembly procedure in chapter 6.
- C Re-seat the keyboard cable in the front panel board connector and retry instrument operation.**  
 To remove this connector, push in the metal clips on both ends of the connector and pull the connector out.
- D Re-seat the disk drive assembly.**
  - 1 Remove power.**
  - 2 Remove the disk drive and disk control board as a unit and re-seat all connectors.**  
 To remove this assembly remove the one screw that holds the disk drive assembly at the front of the plug-in enclosure.
  - 3 Re-install the disk drive assembly and retry instrument operation.**
- E Check the keyboard input signals.**  
 Refer to the figure below and the table on the next page. The keyboard input signals consist of eight strobe lines, SL[0] through SL[7]. Each line should show a negative TTL pulse 1 ms wide at about 126 Hz (7.9 ms period).
  - 1 Check the strobe signals on the keyboard connector. If the signals are good, go to block G.**

**Figure 5-14**

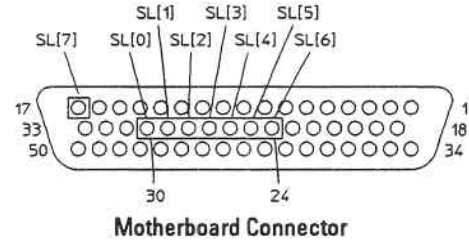


**Keyboard Signal Test Locations**



**2** Check the strobe signals at the motherboard connector where the disk control board plugs in.

- a** Remove the disk drive assembly.  
 To remove this assembly remove the one screw that holds the disk drive assembly at the front of the plug-in enclosure.
- b** Apply power and check the signals.  
 When power is applied the signals should be present. However, the display will not come up because the front panel is disconnected.



- If the signals are correct the CPU and mother board are functioning and the problem is between the motherboard and the front panel board connector. Check for continuity through the disk control assembly and keyboard cable.
- If the signals are not correct, the problem is with the CPU or mother board.

**F** Check the CPU and motherboard.

Try the following, in this order. Use the disassembly procedures in chapter 6.

- 1** Remove and reseat the CPU board.
- 2** Replace the CPU board.
- 3** Replace the motherboard.

**Table 5–2**

**Keyboard Signal Lines**

| Return Lines (out) | Strobe Lines (input) |              |                    |           |           |             |           |             |
|--------------------|----------------------|--------------|--------------------|-----------|-----------|-------------|-----------|-------------|
|                    | SL[7]                | SL[6]        | SL[5]              | SL[4]     | SL[3]     | SL[2]       | SL[1]     | SL[0]       |
| RL[0]              | Time base            | Trigger      | Acquisition        | Display   | Marker    | Define meas | Math      | Application |
| RL[1]              | Help                 | Utility      | Softkey 6 (bottom) | Softkey 5 | Softkey 4 | Softkey 3   | Softkey 2 | Softkey 1   |
| RL[2]              | Clear display        | Run          | Stop Single        | Disk      | Waveform  | Setup       | Print     | Auto-scale  |
| RL[3]              | Softkey 0 (top)      | Shift (blue) | 0                  | 1         | 4         | 7           | 8         | 5           |
| RL[4]              | 2                    | .            | Clr                | Eex       | ±         | 3           | 6         | 9           |
| RL[5]              | ---                  | pico         | nano               | micro     | milli     | Enter       | ← ↓       | ↑ ⇒         |

**G** Check the keyboard output signals.

- 1** Use the figure on the previous page and the table above.
- 2** While monitoring each output line in turn, (RL[0]–RL[5]) press a key on that line.  
 You should get the same signal as the input lines, a negative TTL pulse 1 ms wide at about 126 Hz.

**H** Check the return line signal path (RL[0]–RL[5]).

- 1** Use the figure on the previous page, the table above, and the table on the next page.
- 2** Use an ohmmeter to check continuity between the keyboard and the disk control connector that plugs into the motherboard.

Table 5-3

Keyboard Signal Locations

| Keyboard Connector Pin | Signal          | Disk Control Connector Pin | Keyboard Connector Pin | Signal        | Disk Control Connector Pin |
|------------------------|-----------------|----------------------------|------------------------|---------------|----------------------------|
| 1                      | Trig LED        | 8                          | 16                     | SL[1]         | 29                         |
| 2                      | Armed LED       | 9                          | 17                     | SL[0]         | 30                         |
| 3                      | A Trig LED      | 10                         | 18                     | RL[5]         | 31                         |
| 4                      | SW LED0 (Shift) | 11                         | 19                     | RL[4]         | 32                         |
| 5                      | --              | 12                         | 20                     | RL[3]         | 33                         |
| 6                      | --              | 13                         | 21                     | RL[2]         | 41                         |
| 7                      | RPG A           | 14                         | 22                     | RL[1]         | 42                         |
| 8                      | RPG B           | 15                         | 23                     | RL[0]         | 43                         |
| 9                      | Grd             | 16                         | 24                     | VCC +5.1      | 44                         |
| 10                     | SL[7]           | 17                         | 25                     | REMOTE ON/OFF | 45                         |
| 11                     | SL[6]           | 24                         | 26                     | GND           | 21                         |
| 12                     | SL[5]           | 25                         | 27                     | +12V          | 47                         |
| 13                     | SL[4]           | 26                         | 28                     | +12 RTN       | 48                         |
| 14                     | SL[3]           | 27                         | 29                     | Background    | 49                         |
| 15                     | SL[2]           | 28                         | 30                     | Brightness    | 50                         |

**I** Replace the keyboard cable or disk control, whichever is faulty.

**J** Run the Front Panel test.

1 In the SYSTEM keys press **Utility**, then press **Self test**.

2 Toggle the **Board** key until **Front Panel** is selected.

3 Press **Enter**, then press **Start**.

This brings up a diagram of the HP 54720A front panel. The individual keys will highlight as they are pressed.

4 Press all the keys to determine if keys or groups of keys are not functioning.

**K** Re-assemble the instrument and re-run the keyboard test.

**L** Determine the key failure pattern.

Use the previous table to determine whether there is a pattern to the key failures.

- If failures are grouped on a specific strobe line (SL[0]–SL[7]) or return line (RL[0]–RL[5]), the failure is likely to be off the keyboard. Go to block C.

- If failures are unrelated to a specific strobe or return line, the failure is probably on the keyboard. Note which keys have failed and go to block M.

**M** Test the keyboard.

On the back side of the keyboard (the side opposite the keys) at each key position is a pair of PC pads. Each pair of pads is in a small open area of the ground pattern. These PC pads, one square and one round, are connected to the key contacts on the opposite side.

- At the failed key, use a short wire or paper clip to carefully short the square and round PC pads.

**N** Repair or replace the keypad.

Check for contamination on the PC traces or keypads. The keypads are very simple.

Contamination may prevent contact between the black contact on the pad and the board.

**O** Repair or replace the keyboard.

The failure may be a broken trace.

## Missing Board Checks

The HP 54710A and 54720A mainframes have the following system configurations. Note that the HP 54710A mainframe uses only one Acquisition board.

Figure 5-15

| Frame                          |             | System config                 |           |                    |
|--------------------------------|-------------|-------------------------------|-----------|--------------------|
| Model : 54720A                 |             | Time<br>11:12:57              |           |                    |
| Serial Number : 3207A00101     |             | Date<br>15 JUL 1992           |           |                    |
| Calibration Memory : Protected |             | Declassify<br>frame<br>memory |           |                    |
| Power On Test : Passed         |             | Update<br>system<br>firmware  |           |                    |
| Firmware Revision : 1.0        |             | Exit                          |           |                    |
| Boot Revision : 1.0            |             |                               |           |                    |
| Slot                           | Board       | Power Statistics              |           |                    |
| 6                              | CPU         | Total Pon Time : 27.67 hrs    |           |                    |
| 5                              | Display     | Length Last Poff : 0.0 hrs    |           |                    |
| 4                              | Time base   | Time Since Pon : 0.44 hrs     |           |                    |
| 3                              | Clock       | Power Cycles : 45             |           |                    |
| 2                              | Acquisition |                               |           |                    |
| 1                              | Acquisition |                               |           |                    |
| Plug-ins                       |             |                               |           |                    |
| Slot                           | Model       | Serial #                      | Analog BW | Calibration Memory |
| 1                              | 54711A      | 3207A00101                    | 1.5 GHz   | Protected          |
| 2                              | 54713A      | 3207A00101                    | 500 MHz   | Protected          |
| 3                              | 54721A      | 3207A00101                    | 1.1 GHz   | Protected          |
| 4                              |             |                               |           |                    |

This assembly is not installed in the HP 54710A mainframe.

### HP 54710A, 54720A System Configuration

#### CAUTION

Do not remove or replace PC assemblies when the instrument is powered. Doing so may cause circuit failures. Plug-ins can be removed and installed with power applied.

Use the procedures in chapter 6 for removing and replacing assemblies.

- 1 In the System keys, press **Utility** then press **System Config...** You should have the display shown above.
- 2 If the instrument appears to be missing a board in one or more slots, turn off the power and re-seat the board/assembly that is not showing.
- 3 Reapply power and check the configuration (step 1).
- 4 If there is still a missing board repeat the procedure, making the next one of the following changes at step 2 each time.
  - Re-seat the Microprocessor assembly.
  - Replace the board/assembly that is not showing.
  - Replace the Microprocessor assembly.
  - Replace the motherboard assembly.

---

## Interpreting Internal Self-tests

The internal self-tests exercise the internal circuitry on the respective mainframe assemblies. Some of the tests require that some associated circuitry on interfacing boards is working also. These tests do not test the the plug-ins. The plug-ins are checked by checking plug-in operation in different mainframe slots and by attempting plug-in calibration.

### **Clock**

The Clock self-test looks for the existence of the board, then checks for the presence of each required clock signal. If the self-test fails, reseal the board, then try the test again. If it still fails, replace the board.

---

### **CAUTION**

Do not over-tighten the SMA semi-rigid cables! The maximum recommended torque is 5 inch-pounds. Damage to the acquisition hybrids can result from over-tightening these connectors.

Hewlett-Packard offers a special wrench socket for use on the SMA connectors in the HP 54700 family. Refer to the procedures in chapter 6 if you need to check cables or remove and replace the clock assembly. The procedures provide special instructions and cautions.

### **Acquisition 1**

Acquisition 1 digitizes plug-in slots 3 & 4 in the HP 54720A. The HP54710A does not have Acquisition 1. The explanation of the tests and troubleshooting for Acquisition 1 is the same as for Acquisition 2 that follows. Acquisition assemblies are replaced as a set so failure of one assembly requires replacement of both.

### **Acquisition 2**

Acquisition 2 digitizes plug-in slots 1 & 2 in the HP 54720A and 54710A. The acquisition tests check circuit groups on the acquisition board. If any test fails, check the cabling. The cabling is located in the instrument rear between the acquisition boards and the clock board. Mis-cabling and/or loose connectors can give test failures.

---

### **CAUTION**

Do not over-tighten the SMA semi-rigid cables! The maximum recommended torque is 5 inch-pounds. Damage to the acquisition hybrids can result from over-tightening these connectors.

Hewlett-Packard offers a special wrench socket for use on the SMA connectors in the HP 54700 family. Refer to the procedures in chapter 6 if you need to check cables or remove and replace the acquisition assemblies. The procedures provide special instructions and cautions.

If the self-tests continue to fail, reseal the assemblies in the motherboard connectors and retry the tests. If the tests still fail, replace the acquisition assembly set.

### CPU

If the CPU self-tests pass and one Display self-test passes, the CPU is tested to the 95% level. The only circuitry not tested with these tests are the interface/port drivers. These self-tests can also be run via HP-IB if the color CRT module is not functioning. See "Run self-tests via HP-IB" in the "No-Display Trouble Isolation" section.

If the self-tests fail:

- 1 Remove the CPU and Display board as a unit.
- 2 Reseat the ribbon cable between the two assemblies.
- 3 Re-install the assemblies in the mainframe.
- 4 Retry the self-test.
- 5 If the self-tests continue to fail, replace the CPU assembly.

### Display

The Display self-tests check the display board circuitry to a 90% confidence level. If any of the tests fail, try re-seating the display and CPU assemblies as given in "CPU" above and re-run the tests. If the any test continues to fail, replace the display assembly.

### Time Base

The Time Base tests check various circuit groups in the time base and trigger circuitry to a 85% confidence level. If any of these tests fail, try re-seating the assembly and check the rear panel cabling. If the tests continue to fail, replace the assembly.

### Floppy Disk

The Floppy Disk test checks that the disk drive can be accessed by the CPU. The self-test verifies operation of the disk drive to a 90% confidence level. To check the disk drive to 100% confidence level, run the self-test and format a disk. To format a disk:

- 1 Press  .
- 2 Press **Operation** to select **Format** and press **Enter**.
- 3 Press **Execute**.

### Front Panel

The Front Panel test checks operation of the front panel keys and the RPG (knob). If there is a problem, check which keys are operating and refer to "Keyboard Trouble Isolation" for further procedures.

Though the front panel test is part of the list of the other self-tests, it does not run when **test all boards** is run. To run the front panel test:

- 1 Press  , then **Self test...**, then press **Board** to select **front panel**.
- 2 Press **Enter** then **Start** to start the test.
- 3 Press each key and turn the knob.

If they function, each key will highlight when it is pressed and the knob symbol on the display will rotate.

- 4 When you see that everything works, press **Stop/Single** until the test is exited.

## Power Supply Distribution

The following discussion can be used if the power supplies are being loaded excessively and you need to know which supplies are used on each assembly.

### General Supply Distribution

Power supplies are distributed through the motherboard to the assemblies shown in the table below; shading indicates use. Two other supplies are noted in following paragraphs.

Table 5-4

Power Supply Distribution

| Assembly<br>( ) Motherboard conn. | Supplies <sup>1</sup> |        |        |        |      |        |     |        |
|-----------------------------------|-----------------------|--------|--------|--------|------|--------|-----|--------|
|                                   | -17                   | -6.7   | DGND   | AGND   | +5.1 | +6.7   | +15 | +17    |
| (J0) Acquisition 1                | Shaded                | Shaded | Shaded | Shaded |      | Shaded |     | Shaded |
| (J1) Acquisition 2                | Shaded                | Shaded | Shaded | Shaded |      | Shaded |     | Shaded |
| (J2) Clock                        | Shaded                | Shaded | Shaded | Shaded |      | Shaded |     | Shaded |
| (J3) Timebase                     | Shaded                | Shaded | Shaded | Shaded |      | Shaded |     | Shaded |
| (J4) Display                      | Shaded                | Shaded | Shaded | Shaded |      | Shaded |     | Shaded |
| (J5) CPU                          | Shaded                | Shaded | Shaded | Shaded |      | Shaded |     | Shaded |
| (J9) Disk Control                 | Shaded                | Shaded | Shaded | Shaded |      | Shaded |     | Shaded |
| (J10-J13) Plug-ins                | Shaded                | Shaded | Shaded | Shaded |      | Shaded |     | Shaded |
| Disk Drive <sup>2</sup>           | Shaded                | Shaded | Shaded | Shaded |      | Shaded |     | Shaded |
| Front Panel <sup>2,3</sup>        | Shaded                | Shaded | Shaded | Shaded |      | Shaded |     | Shaded |

<sup>1</sup> All supplies listed in the table come from the Power Supply assembly (see note 2).

<sup>2</sup> The supply for this assembly comes through the Disk Control assembly.

<sup>3</sup> A +12-Vdc supply, used exclusively for the Background and Brightness controls, comes from the Color CRT Module through the motherboard and goes to the Front Panel assembly.

### Fan Supply

The rear fan is connected directly to the power supply assembly. The front fan is connected to the same supply but through the motherboard. The power supply detects fan rotation so if a fan is not connected, the power supply will not be allowed to come up and the instrument will not function. The fans are connected to a +24-V supply, which can vary between +11 V and +27.5 V depending on the temperature within the instrument.

### Color CRT Module Supply

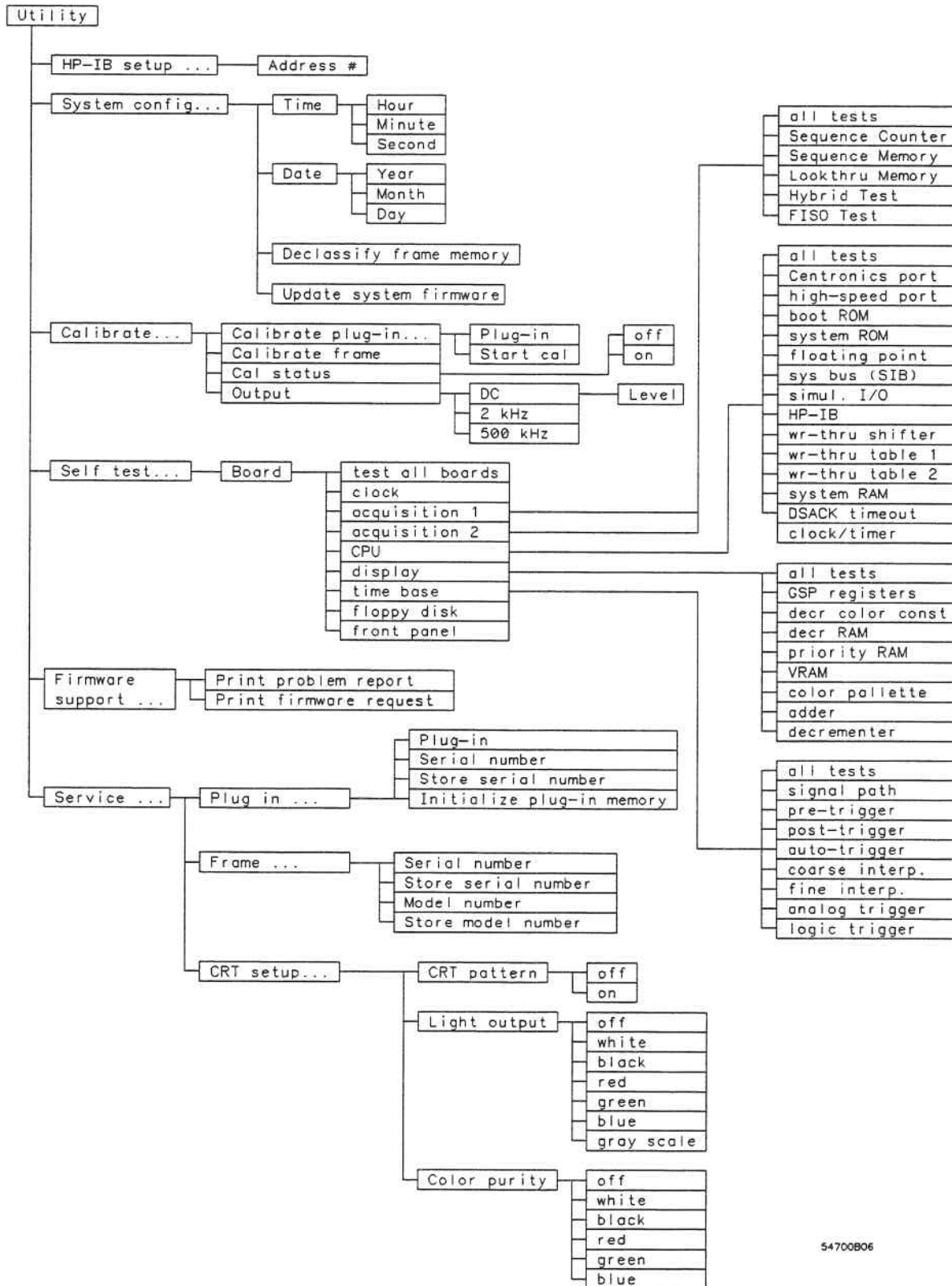
The Color CRT Module is powered by a separate supply from the power supply assembly. This +120-Vdc supply is not distributed to any other assemblies. The +120-V supply is distributed through the motherboard.

### Power Standby Switch

The front panel power switch operates as a remote control for the regulators in the power supply. To shut the supplies Off, the switch grounds a control line from the supply.

With the rear panel switch on and the front panel switch set to Standby, mains power is still applied to the power supply. The AC IN LED (red) should be lit. Power supply status LEDs are visible near the top-middle of the right side of the instrument. See figure 5-6, page 5-11.

Figure 5-16



54700B06



# Utility Menu

The utility menu, as shown in the figure on the previous page, gives you six additional softkey menus: HP-IB setup, System configuration, Calibrate, Self test, Firmware support, and Service.

## HP-IB Setup

You may have several instruments connected by a common bus to a computer or controller. Each instrument on the bus has a separate identifying address, so that the computer or controller can communicate with only one instrument at a time. The HP-IB setup menu lets you select an address from 0 to 31. The address number you select is the address that a computer or controller uses to communicate with the oscilloscope. The default HP-IB address for oscilloscopes is 7.

## System Configuration

The system configuration menu gives you information about the mainframe and plug-ins. It allows you to set the date and time on the instrument clock. It also allows you to update the system firmware and to declassify the memory in the mainframe.

Figure 5-17

This assembly is not installed in the HP 54710A mainframe.

The screenshot shows the 'System config' menu with several sections and softkey options.

**System config**

Time: 11:12:57

Date: 15 JUL 1992

Declassify frame memory

Update system firmware

Exit

**Frame**

Model : 54720A  
Serial Number : 3207A00101  
Calibration Memory : Protected  
Power On Test : Passed  
Firmware Revision : 1.0  
Boot Revision : 1.0

| Slot | Board       | Power Statistics           |
|------|-------------|----------------------------|
| 6    | CPU         | Total Pon Time : 27.67 hrs |
| 5    | Display     | Length Last Poff : 0.0 hrs |
| 4    | Time base   | Time Since Pon : 0.44 hrs  |
| 3    | Clock       | Power Cycles : 45          |
| 2    | Acquisition |                            |
| 1    | Acquisition |                            |

**Plug-ins**

| Slot | Model  | Serial #   | Analog BW | Calibration Memory |
|------|--------|------------|-----------|--------------------|
| 1    | 54711A | 3207A00101 | 1.5 GHz   | Protected          |
| 2    | 54713A | 3207A00101 | 500 MHz   | Protected          |
| 3    | 54721A | 3207A00101 | 1.1 GHz   | Protected          |
| 4    |        |            |           |                    |

System Configuration



Table 5-1

**System Configuration**

**Frame**

|                           |   |
|---------------------------|---|
| <b>Model Number</b>       | Shows the model number of the mainframe.  |
| <b>Serial Number</b>      | Shows the serial number of the mainframe.   |
| <b>Calibration Memory</b> | Shows the position of the Frame cal switch on the rear panel. This switch is for the memory in the mainframe that contains the calibration factors. This switch is normally set to the protected position.  |
| <b>Power On Test</b>      | Shows if the power-on self-tests passed or failed. These power-on tests verify that the six boards are in the mainframe (five boards in the HP 54710 mainframe). A "Failed" message indicates that at least one board is loose or defective. The power-up routine is kept simple to enable the oscilloscope to power up quickly. You can execute a more complete set of self-tests from the self-test menu. |
| <b>Software Revision</b>  | Shows the revision number of the installed system firmware.   |
| <b>Boot Revision</b>      | Shows the boot ROM version in the mainframe. The boot ROM uncompresses files and loads new system firmware from the disk drive.   |
| <b>Slot and Board</b>     | Shows the rear slot number and the board (assembly) in each slot.   |
| <b>Power Statistics *</b> |   |
| <b>Total Pon time</b>     | The total time that the oscilloscope has run since it was manufactured.   |
| <b>Length Last Poff</b>   | The total time that the oscilloscope was off the last time it was unpowered (On Standby or no mains power).   |
| <b>Time Since Pon</b>     | The total time that the oscilloscope has run since the last time it was turned on.  |
| <b>Power Cycles</b>       | The number of times that the oscilloscope has been turned on since manufacture.   |

**Plug-ins**

|                           |   |
|---------------------------|---|
| <b>Slot</b>               | Shows the slot that the plug-in is installed in.  |
| <b>Model</b>              | Shows the model number of the plug-in. If there is no plug-in in a slot it reads "empty." |
| <b>Serial number</b>      | Shows the serial number stored in the plug-in's nonvolatile memory.                       |
| <b>Analog BW</b>          | Shows the maximum analog bandwidth of the plug-in/ mainframe combination.                 |
| <b>Calibration Memory</b> | Shows the position of the memory protect switch in the plug-in.                           |

\* Power statistics are stored in battery-backed RAM on the CPU assembly. Loss of battery power or replacement of the CPU will cause loss of the statistics.

**Time and Date**

The oscilloscope has a 24-hour clock and a calendar that it uses for all time references. It stamps the time and date on:

- Waveforms when they are acquired.
- Files stored to the disk drive.
- Waveforms transferred over the HP-IB.
- Waveforms that are printed. The print lists both the acquired time and the print time.
- Calibration events.
- To change the time or date, press the **Time** or **Date** softkey, then change the entry fields with the knob, arrow keys, or keypad and press  , then press **Done**.

**Declassify frame memory**

Declassify the mainframe in situations when you are concerned about the security of your work. When you declassify the memory, no one can determine what you are working on by browsing through saved setups, waveforms, and displays . Declassifying places zeros in the RAM memory. This clears:

- Setup memories
- Waveform memories
- Pixel memories
- Front-panel setups
- Channel memories
- Function memories

The following memory is not affected.

- Normal mainframe calibration
- Normal plug-in calibration (located in the plug-in)
- Best accuracy calibration
- Boot and system common variables
- Clock memory
- The part of display RAM that holds the firmware for the graphics processor

**See Also**

The HP 54710A and 54720A *Users Reference* for further information.

**Update system firmware**

The operating system is located in the system ROM. The oscilloscope does not need a disk in the disk drive in order to operate. The Update system firmware softkey loads new firmware.

To install system firmware:

- 1 Install the system disk in the disk drive.
- 2 Press, in order,  , **System config...**, and **Update System firmware**.

---

**CAUTION**

Check the display for any messages about the firmware or any special considerations before you continue.

- 3 Press **Continue**.

**See Also**

To re-boot the system firmware when there is a problem with the mainframe, see the "No Display Troubleshooting," specifically block L on page 5-15.

---

## Calibrate

Calibration is covered in chapter 4 in this service guide.

## Self-test

The Self-test menu is used for troubleshooting failures. With the self-test menus you can test all boards, test all of one board, or individual tests on a board. Since this instrument is repaired by replacing entire boards (assemblies), failure of any board test requires replacement of the board.

Use of self-tests is covered where applicable in the "Trouble Isolation" section.

### See Also

"Interpreting Internal Self-Tests" in "Trouble Isolation" in this chapter.

---

## Firmware Support

If you press **Firmware support . . .**, the instrument displays an information screen and a choice of two forms. These forms are your way of communicating directly with the factory. Because both forms are stored in memory, you can print a copy of either form whenever you like.

To print one of the forms from the oscilloscope:

**1 Connect a printer to the oscilloscope.**

You can connect it to the Centronics port or the HP-IB port, depending on your printer.

**2 Set up the print.**

**a** Press  then  .

**b** Press each softkey in turn and make the appropriate selections.

**3 Press  then **Firmware support . . .**, then the **Print** softkey for the desired form.**

The instrument will automatically include the configuration information.

If a printer is not available, there are similar versions of the forms at the end of this chapter. Make a copy of the appropriate pages. The Problem Report Form is one page and the Firmware Notification Request Form is two pages.

- To display the instrument configuration information, press  then **System config . . .**

Mail (or FAX) the form to the address (or phone number) on the firmware support display.

### Problem report

The problem report can be used if you encounter a problem while using this oscilloscope.

### Firmware request

The firmware request form is designed for those who did not sign up for the firmware notification service (option +NA0) for this oscilloscope and who would like to be notified of all future software and hardware upgrades. If you signed up for option +NA0, you do not need to fill out this form because you will automatically receive future firmware upgrades. Keep in mind that this form provides notification of upgrades only. If an upgrade has already occurred and you want a copy of the latest upgrade, you can purchase a firmware upgrade kit. Contact your nearest Hewlett-Packard Sales Office.

---

## Service

The Service menu provides several service functions for the oscilloscope. When you press the Service softkey, the display shows the instrument configuration (the same as in the system config. menu) and several new softkeys.

### Plug-in . . .

When you press **Plug-in . . .** you can program the serial number of the plug-in or initialize the plug-in memory. The plug-in data is stored in flash EEPROM in the plug-in

**Store the plug-in serial number** You need to re-store the plug-in serial number if:

- It is not shown in the configuration.
  - You replace the plug-in PC assembly.
  - To store the plug-in serial number:
    - 1 Remove the plug-in cover and set the protect switch to ENABLE.
    - 2 Press **Utility**, **Service . . .**, then **Plug-in . . .** to select the desired plug-in.
    - 3 Press **Serial number** to display the alpha-numeric list.
    - 4 Enter the serial number.
      - With the knob, highlight each character in turn and enter it by pressing the top softkey.
      - or
      - Enter numbers directly with the keypad but highlight letters with the knob and enter them by pressing the top softkey. (There is usually one letter in the serial number.)
- Use **Backspace** and **Delete** to help edit the number. You cannot insert a character.
- 5 Press **Done** to return to the previous menu.
  - 6 Press **Store serial number** to store the number in the plug-in.
  - 7 If you do not have to recalibrate the plug-in, set the protect switch to DISABLE and replace the cover.

**Initialize the plug-in** You need to initialize the plug-in if you replace the plug-in PC assembly.

- To initialize the plug-in.

Plug-in calibration will be lost when you initialize the plug-in.

---

### CAUTION

---

- 1 Remove the plug-in cover and set the protect switch to ENABLE.
- 2 Press **Utility**, **Service . . .**, then **Plug-in . . .** then **Plug-in** again to select the desired plug-in.
- 3 Press **Initialize plug-in memory**.
- 4 Recalibrate the plug-in.
- 5 Set the protect switch to DISABLE and replace the cover.

### Frame . . .

When you press **Frame . . .** you can enter the mainframe serial number and model number.

**Store the mainframe serial number** The mainframe serial number has the same status as the calibration factors. You need to re-store the mainframe serial number if:

- You replace the CPU assembly.
- The battery fails.
- To store the mainframe serial number:
  - 1 Go to the instrument rear panel and set the frame cal protect switch to the Unprotected position.
  - 2 Press  , **Service . . .**, then **Frame . . .**.
  - 3 Press **Serial number** to display the alpha-numeric list.
  - 4 Enter the serial number.
    - With the knob, highlight each character in turn and enter it by pressing the top softkey.
    - or
    - Enter numbers directly with the keypad but highlight letters with the knob and enter them by pressing the top softkey. (There is usually one letter in the serial number.)Use **Backspace** and **Delete** to edit the number. You cannot insert a number.
  - 5 Press **Done** to return to the previous menu.
  - 6 Press **Store serial number** to store the number.
  - 7 If you do not have to recalibrate the mainframe, set the protect switch to the Protected position.

**Store the mainframe model number** The mainframe model number has the same status as the calibration factors. You need to re-store the mainframe model number if:

- You upgrade an HP 54710A to a 54720A.
- You replace the CPU assembly.
- The battery fails.
- To store the mainframe model number:
  - 1 Go to the instrument rear panel and set the frame cal protect switch to the Unprotected position.
  - 2 Press  , **Service . . .**, then **Frame . . .**.
  - 3 Press **Model number** to select the desired model.
  - 4 Press **Store model number** to store the number.
  - 5 If you do not have to recalibrate the mainframe, set the protect switch to the Protected position.

### CRT setup . . .

When you press **CRT setup . . .** you are given several choices of special displays. These displays are used to adjust the Color CRT Module and check color purity. Use of these displays is covered in "Adjusting the Color CRT Module" in chapter 4 "Calibrating and Adjusting."

HP 54700-Series Oscilloscope  
Problem Report Form

Your Name \_\_\_\_\_ Job Title \_\_\_\_\_  
Company Name \_\_\_\_\_ Division \_\_\_\_\_  
Telephone:Area/Country Code \_\_\_\_\_ Phone Number \_\_\_\_\_  
Street Address \_\_\_\_\_ FAX Number \_\_\_\_\_  
City \_\_\_\_\_ Prov/State \_\_\_\_\_ Mail Stop \_\_\_\_\_  
Postal/Zip Code \_\_\_\_\_ Country \_\_\_\_\_ Department \_\_\_\_\_  
Date \_\_\_\_\_

Problem Report Classification

\_\_\_\_\_ Hardware/Mechanical Problem      \_\_\_\_\_ Documentation Problem  
\_\_\_\_\_ Software/Firmware Problem      \_\_\_\_\_ Remote Programming Problem  
\_\_\_\_\_ Suggested Enhancement

Problem Description \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

System Description (Remote controller, Software, Printer, Cables) \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Your current configuration is:

Mainframe model no. \_\_\_\_\_ Serial no. \_\_\_\_\_ Software revision \_\_\_\_\_  
Plug-in 1 model no. \_\_\_\_\_ Serial no. \_\_\_\_\_  
Plug-in 2 model no. \_\_\_\_\_ Serial no. \_\_\_\_\_  
Plug-in 3 model no. \_\_\_\_\_ Serial no. \_\_\_\_\_  
Plug-in 4 model no. \_\_\_\_\_ Serial no. \_\_\_\_\_

How would you prefer to be contacted?

\_\_\_\_\_ Mail      \_\_\_\_\_ FAX      \_\_\_\_\_ Phone      \_\_\_\_\_ Your local HP sales representative

Return this form to Hewlett-Packard

By Mail:      By FAX  
Hewlett-Packard Company      (719) 590-3505  
Colorado Springs Division  
Software Notification Manager  
P.O. Box 2197  
Colorado Springs, Colorado, 80901-2197 USA



HP 54700-Series Oscilloscope  
Firmware Notification Request Form

Please complete this form and FAX or MAIL it to Hewlett-Packard to ensure that HP can contact you when firmware upgrades or new product information becomes available. If you have already signed up for the firmware notification service (option +NA0) for this product, you are already registered and you do not need to fill out this form.

Anyone responsible for the maintenance of this product, as well as the end user, may return this form. Please feel free to return the form even if you are not the original purchaser. This form may also be used to initiate a dialogue on your product needs and expectations.

Please provide as much information as possible so we will be able to contact you.

Your Name \_\_\_\_\_ Job Title \_\_\_\_\_  
Company Name \_\_\_\_\_ Division \_\_\_\_\_  
Telephone: Area/Country Code \_\_\_\_\_ Phone Number \_\_\_\_\_  
Street Address \_\_\_\_\_ FAX Number \_\_\_\_\_  
City \_\_\_\_\_ Prov/State \_\_\_\_\_ Mail Stop \_\_\_\_\_  
Postal/Zip Code \_\_\_\_\_ Country \_\_\_\_\_ Department \_\_\_\_\_  
Date \_\_\_\_\_

How would you prefer to be contacted?

Mail  FAX  Phone  Your local HP sales representative

Has this product already been registered for Software Update Service?

Yes  No  Not Sure

Your current configuration is:

Mainframe model no. \_\_\_\_\_ Serial no. \_\_\_\_\_ Software revision \_\_\_\_\_  
Plug-in 1 model no. \_\_\_\_\_ Serial no. \_\_\_\_\_  
Plug-in 2 model no. \_\_\_\_\_ Serial no. \_\_\_\_\_  
Plug-in 3 model no. \_\_\_\_\_ Serial no. \_\_\_\_\_  
Plug-in 4 model no. \_\_\_\_\_ Serial no. \_\_\_\_\_

Return this form to Hewlett-Packard

By Mail:

Hewlett-Packard Company  
Colorado Springs Division  
Software Notification Manager  
P.O. Box 2197

By FAX

(719) 590-3505

Colorado Springs, Colorado, 80901-2197 USA



Optional Information

What are the most critical decisions that this oscilloscope will help you make?

---

---

---

---

What critical information do you need from the oscilloscope to make these decisions?

---

---

---

---

With the built-in disk drive and flash EPROM memory, it is possible to customize this oscilloscope to specific applications. Is this capability of interest to you?

Yes  No

If you answered yes, what is the application and how could we customize the scope to the application?

---

---

What are you making measurements on?

- |  |  |
|--|--|
| <input type="checkbox"/> Computers                 | <input type="checkbox"/> Disk Drives                 |
| <input type="checkbox"/> Tape Drives               | <input type="checkbox"/> ICs                         |
| <input type="checkbox"/> Lasers                    | <input type="checkbox"/> Fiber Optics                |
| <input type="checkbox"/> Instrumentation           | <input type="checkbox"/> Video                       |
| <input type="checkbox"/> Datacomm                  | <input type="checkbox"/> Telecomm                    |
| <input type="checkbox"/> Microprocessors (# _____) | <input type="checkbox"/> RF/Microwave Communications |
| <input type="checkbox"/> High-Energy Research      | <input type="checkbox"/> TV                          |
| <input type="checkbox"/> Other (Please describe)   |  |

What is the primary application for this product?

- |   |   |
|---|---|
| <input type="checkbox"/> General Troubleshooting      | <input type="checkbox"/> Computer Aided Test          |
| <input type="checkbox"/> Digital Design and Debug     | <input type="checkbox"/> Data Acquisition             |
| <input type="checkbox"/> Analog Design Verification   | <input type="checkbox"/> Go/No Go Measure Limit Tests |
| <input type="checkbox"/> Device Characterization/Test | <input type="checkbox"/> Go/No Go Wave Compare Tests  |
| <input type="checkbox"/> Transient Waveform Capture   | <input type="checkbox"/> Other (Please describe)      |

---

ESD Precautions 6-2  
Tools Required 6-2  
Instrument Structure 6-2  
To return the instrument to HP for service 6-3  
A Brief Order of Procedures 6-4  
To remove and replace  
  Front panel 6-5  
  Keyboard 6-6  
  RPG 6-7  
  Front fan 6-8  
  Disk drive assembly 6-9  
  Disk drive 6-9  
  Disk drive control 6-10  
  Rear panel 6-11  
  Power supply 6-11  
  CPU and display assemblies 6-12  
  Time base assembly 6-12  
  Clock assembly 6-14  
  Acquisition assemblies 6-16  
  Color CRT module 6-17  
  Motherboard 6-20  
  Rear fan 6-22



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# Replacing Assemblies

Procedures in this chapter should be used when removing and replacing assemblies and parts in the HP 54710A and 54720A oscilloscopes.

## ESD Precautions

When using any of the procedures in this chapter you should use proper ESD precautions. As a minimum you should place the instrument on a properly grounded ESD mat and wear a properly grounded ESD wrist strap.

## Tools Required

The following tools are required for these procedures. This instrument uses SMC connectors that require either a 6-mm or 1/4-inch wrench. Both connector types may be used in the instrument.

- Torx drivers: T10, T15, T20
- Nut Drivers: 5/16, 7/16
- Pozidrive screwdriver: #1
- Torque wrench, 0.565 Nm (5 in-lbs), 8 mm (5/16-inch) open end
- Torque wrench, 0.565 Nm (5 in-lbs), 1/4-inch open-end – for SMC connectors
- Torque wrench, 0.565 Nm (5 in-lbs), 6-mm (15/64-inch) open-end – for SMC connectors
- Torque driver, 0.565 Nm (5 in-lbs), 1/4-inch square male drive
- Special socket, HP part number 5081-7718 (part of HP 54717A plug-in)

## Instrument Structure

The HP 54710A and 54720A are built from a welded steel cabinet with four closed sides. All assemblies are inserted from the front or the rear. At the front, behind the front panel, there are separate internal compartments for the plug-ins, color CRT module, and the front fan and disk drive. At the rear, behind the rear panel, one compartment encloses the rear fan and another comprises the card cage which holds the power supply, digital control system, and acquisition system. A motherboard, located between the plug-ins and card cage, is the main connection between the front and rear of the instrument.

## To return the instrument to HP for service

Before shipping the instrument to Hewlett-Packard, contact your nearest HP sales office for additional details.

**1 Write the following information on a tag and attach it to the instrument.**

- Name and address of owner
- Instrument model numbers
- Instrument serial numbers
- Description of the service required or failure indications

**2 Remove all accessories from the instrument.**

Accessories include all cables. Do not include accessories unless they are associated with the failure symptoms.

**3 Protect the instrument by wrapping it in plastic or heavy paper.**

**4 Pack the instrument in foam or other shock absorbing material and place it in a strong shipping container.**

You can use the original shipping materials or order materials from an HP sales office. If neither are available, place 8 to 10 cm (3 to 4 inches) of shock-absorbing material around the instrument and place it in a box that does not allow movement during shipping.

**5 Seal the shipping container securely.**

**6 Mark the shipping container as FRAGILE.**

In any correspondence, refer to instrument by model number and full serial number.

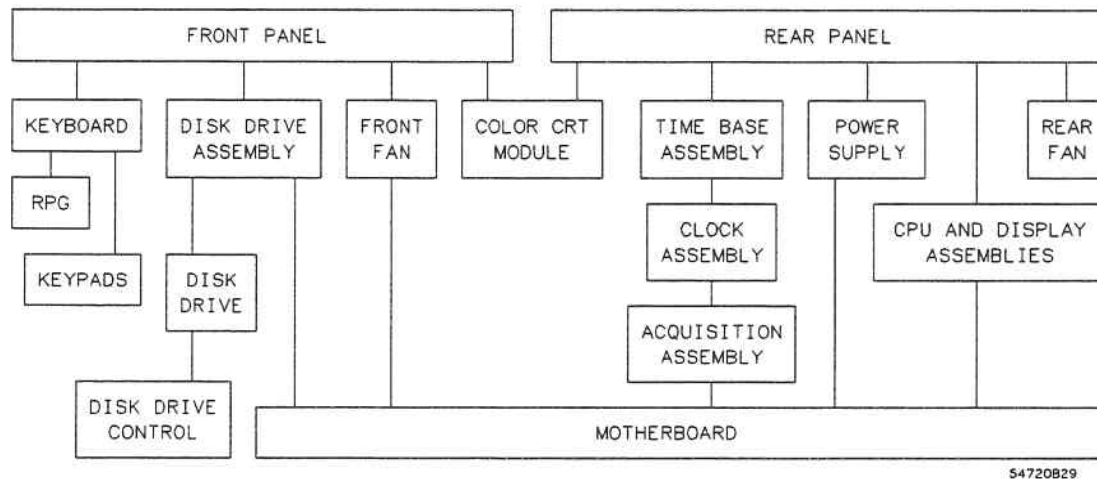
## A Brief Order of Procedures

In general, the procedures that follow have been placed in the order they must be used to remove a particular assembly. That is, given first are the procedures for assemblies that must be removed first. The figure below shows the general flow of procedures (from top to bottom) to remove assemblies.

**CAUTION**

Do not remove or replace any circuit board assemblies in this instrument while power is applied. The assemblies contain components which may be damaged if the assembly is removed or replaced while the instrument is powered.

Figure 6-1



Assembly Removal Flow Diagram

---

## To remove and replace the front panel

Removing the front panel exposes all assemblies located in the front compartments.

### To Remove

Plug-ins may have been calibrated to specific slots. Record which plug-in is in each slot so you can return the instrument to its original calibrated condition.

- 1 Remove the plug-ins.
- 2 Remove all cables from the rear panel.
- 3 Place the instrument on its left side (as viewed from the front).
- 4 On the bottom of the front panel, remove the four 8 mm-long flat-head screws that hold the plug-in latches.  
You may need to temporarily remove the right-front foot to remove the right side screw. Replace the foot after removing the screw.
- 5 Place the instrument in its normal operating position.
- 6 Remove the three 12 mm-long flat-head screws at the trim strips on each side of the front panel.
- 7 Pull the front panel off.

If you don't need to disconnect the panel, you can place it on top of the instrument.

- 8 To remove the keyboard cable, squeeze the metal tabs on the ends of the cable connector and pull the connector out of its receptacle.

When replacing the connector, make sure the metal tabs have latched in the keyboard connector.

### To Replace

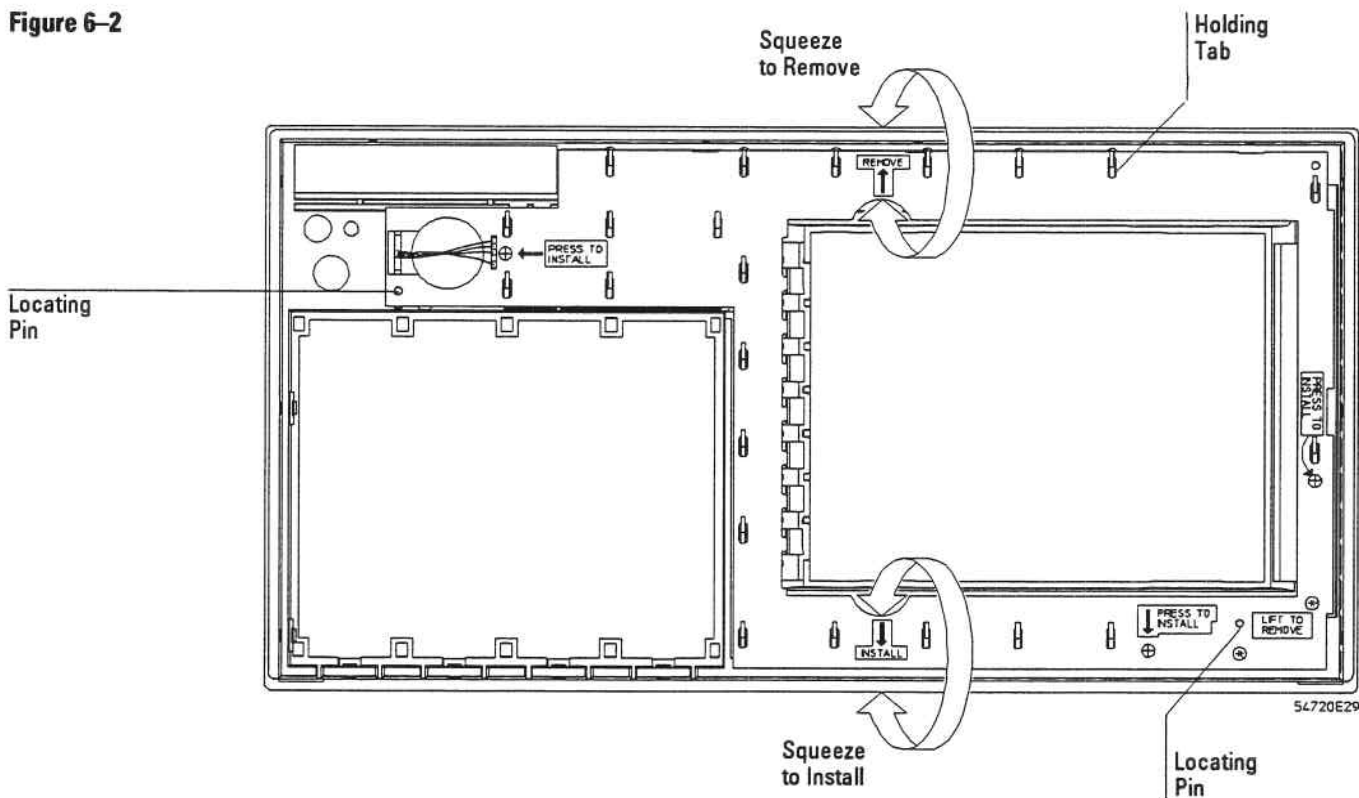
- To reassemble, reverse the above procedure. However, make note of the following:
  - Make sure the metal tabs of the keyboard cable connector have latched in the keyboard connector.
  - The plug-in guides must be inserted into holes in the back of the front panel. It may be helpful to set the instrument on its back feet while aligning the front panel.
  - While tightening the plug-in latches, hold them straight so the plug-in latching screws will align properly.

## To remove and replace the keyboard

The keyboard is fastened by only two screws and the RPG shaft. However, it is held against the rubber keypads by many small tabs. Two locating pins position the PC board in the front panel. To remove the PC board, it must be lifted over the locating pins and then moved from under the tabs.

Several key reference points used during removal are marked on the PC board.

Figure 6-2



### Keyboard Feature Locations

#### To Remove

- 1 Remove the front panel from the instrument.
- 2 Remove the knob by pulling on it firmly.
- 3 Use a 7/16 nut driver to remove the nut from the RPG bushing, then remove the curved lockwasher.
- 4 Remove the two self-tapping screws that hold the PC board at the corner near the switch.
- 5 Remove the PC board.

For this step use the finger recess at the top of the PC board. It may be helpful to turn the front panel assembly so a short side is toward you.

- a Put your thumb in the finger recess and your first finger at the top of the panel.
- b While squeezing the thumb and finger to slide the PC board toward the top of the panel, use the other hand to lift the PC board over the two locating pins. You can alternately push on the power switch and RPG from the front of the panel.

**CAUTION**

- c Lift the PC board off of the holding tabs.

Be careful not to contaminate the key side of the PC board or the keypads. Dust and fingerprints on these parts may cause intermittent key operation.

- 6 Remove the keypads if necessary.

**To Replace**

- 1 Make sure the keypads are clean and in their correct locations. They are positioned by holes in the pad and pins in the front panel.

If they look contaminated, clean them with isopropyl alcohol and a lint-free cloth.

- 2 Make sure the RPG is correctly installed on the keyboard.
- 3 Make sure the key side of the keyboard is clean.

If the key side of the keyboard is dirty, clean it with isopropyl alcohol and a lint-free cloth.

- 4 Check the green LEDs. They should be straight and perpendicular to the PC board.
- 5 Install the PC board.

For these steps use the finger recess at the bottom of the keyboard.

- a Place the keyboard over the holding tabs.
- b Put your thumb in the finger recess and your first finger at the bottom of the panel.
- c To make the PC board slide under the holding tabs, press it gently with your free hand at the points marked "Press to Install". Press first at the power switch and then near the RPG. Simultaneously, squeeze your thumb and finger to slide the PC board toward the bottom of the panel.
- d If the PC board will not slide, make sure it has dropped over all of the holding tabs.
- e Make sure the PC board has dropped over the locating pins.
- f Install the self-tapping screws in the corner of the PC board.
- 6 Place the lockwasher over the RPG bushing.  
Place it on the bushing with the cupped (concave) side toward the panel.
- 7 Install the RPG nut and tighten.
- 8 Install the knob.

**To remove and replace the RPG**

The RPG (rotary pulse generator) is driven by the front-panel knob.

- 1 Remove the front panel from the instrument.
- 2 Remove the keyboard from the front panel.
- 3 Remove the spacer nut from the RPG bushing. It should be only finger tight so the RPG bushing can align with the hole in the panel.
- 4 Disconnect the cable and remove the RPG.
- 5 To install the RPG, reverse the procedure.



---

## To remove and replace the front fan

The front fan is mounted on a bracket above the plug-ins. The fan power cable plugs into the motherboard at the rear of the fan compartment.

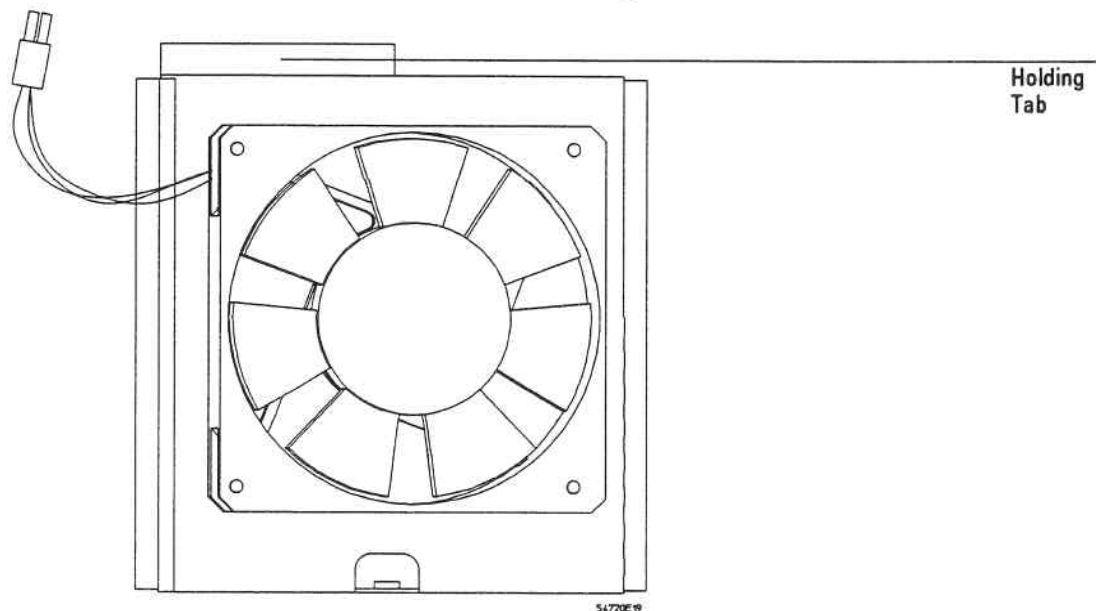
### To Remove

- 1 Remove the front panel but do not disconnect the keyboard cable. Lay the front panel on top of the instrument.
- 2 Remove the top plug-in guide.  
Press up on the large locking tab at the rear of the plug-in guide and pull the guide out.
- 3 Use a T15 driver to remove the screw at the front of the fan bracket.
- 4 Push the fan bracket down at the front and slide the assembly down and out.
- 5 Disconnect the fan cable.  
Squeeze the locking tab on the top of the connector and pull the connector out.
- 6 To remove the fan from the bracket, remove the four 8 mm-long screws.

### To Replace

- 1 Place the fan on the raised side of the bracket so that the airflow is down and the cable is on the left rear corner as shown in the figure.

Figure 6-3



### Front Fan Alignment

- 2 Install the four 8 mm-long screws.
- 3 Place the fan assembly into the plug-in compartment and connect the cable.
- 4 With the assembly sloping up at the back, slide it up and in so the holding tab (see figure) is above the ledge at the back of the compartment.
- 5 Raise the front end of the assembly into place.
- 6 Install the T15 pan-head screw at the front of the bracket.
- 7 Install the plug-in guide.
- 8 Install the front panel.

## To remove and replace the disk drive assembly

The disk drive assembly includes the disk drive, disk drive control board, and the mounting bracket. It plugs into a connector at the rear of the fan compartment. The keyboard cable plugs into the disk drive control board.

### To Remove

- 1 Remove the front panel, but do not disconnect the keyboard cable. Lay the front panel on top of the instrument.
- 2 Remove one screw that fastens the front strut of the disk drive bracket to the cabinet.
- 3 With a slight side-to-side motion, pull on the disk drive bracket strut and pull the assembly out.
- 4 Disconnect the keyboard cable at the disk drive control board.

### To Replace

- 1 Connect the keyboard cable.  
You must squeeze the metal locking tabs on the side of the connector while inserting it.
- 2 Slide the assembly most of the way into the cabinet.
- 3 Lift the back of the assembly to locate the connector into the motherboard connector.
- 4 Push on the strut or sides of the disk drive assembly to seat the connector.
- 5 Install the screw at the strut.
- 6 Install the front panel.

---

## To remove and replace the disk drive

The disk drive is held by four screws.

- 1 Remove the disk drive assembly.
- 2 Remove four screws on the bottom of the disk drive assembly.
- 3 Separate the disk drive from the bracket slightly, and disconnect the cable from the disk drive.

The cable is soldered to the disk drive control board.

- 4 To install the disk drive, reverse the procedure.

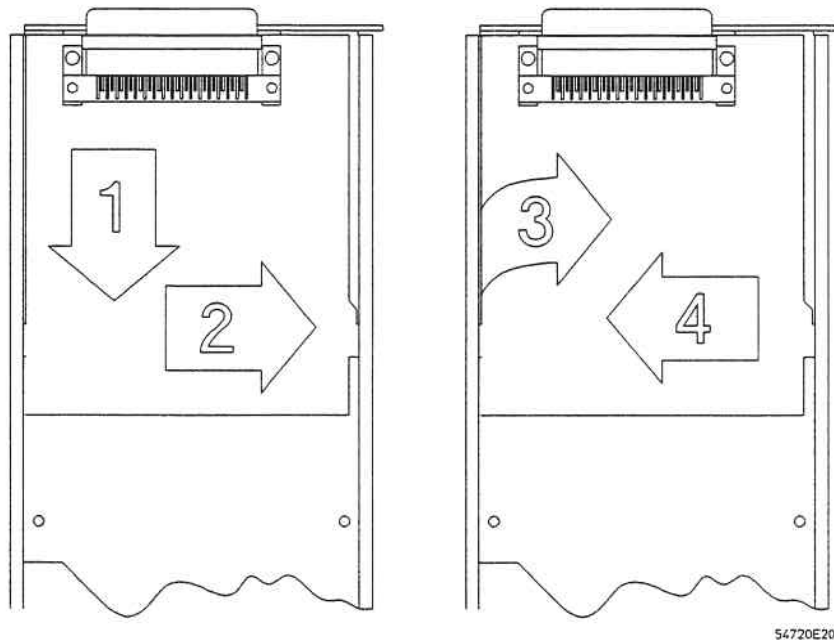
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## To remove and replace the disk drive control

The disk drive control is secured to the disk drive assembly by two tabs at the end near the disk drive and two screws at the connector.

- 1 Remove the disk drive assembly from the cabinet and the disk drive from the assembly.
- 2 Remove the two flathead pozidrive screws at the sides of the large connector.
- 3 Remove the PC board by moving it as shown by the four steps in the picture below.

Figure 6-4



Disk Drive Control Removal

- 4 To install the board, reverse the procedure.

---

## To remove and replace the rear panel

Removing the rear panel provides access to the digital system, acquisition system, and rear fan.

- 1 Remove the power cord and other cables.
- 2 Remove the four rear feet. Each has a screw and flat washer.
- 3 Remove the two screws that hold the cover over the fuse.
- 4 Remove the two large screws just above and on either side of the parallel printer port.  
Do not confuse these screws with the hex standoffs used to secure a printer cable.
- 5 Remove the two screws on either side of the trigger output connector.
- 6 To remove the cover, use a flat tool to gently pry at the corners.
- 7 To install the cover, reverse the procedure.

---

## To remove and replace the power supply

---

### CAUTION

The fuse requirement is different for 100 V, 115 V, and 230 V operation. If you will be installing a new supply you must check that the fuse on the new supply is appropriate for the line voltage that you will be using. Refer to the Replaceable Parts list for the correct fuse rating and part numbers. The wrong fuse may not protect the instrument properly.

#### To Remove

- 1 Remove the rear panel.
- 2 Disconnect the rear fan cable from the connector at the side of the power supply.  
Consult the illustration on the inside of the rear panel.
- 3 Remove the two screws at the lower corners of the supply.

---

### WARNING

**SHOCK HAZZARD!** The charge on capacitors can be lethal even after power has been disconnected. Do not touch the PC board or components until you are sure there is no danger.

- 4 Slide the supply out of the frame.  
Grip the supply at the recesses on each side of the rear panel of the supply.

#### To Replace

- 1 To reinstall the supply, reverse the above procedure.  
Slide the supply in gently to make the connection with the motherboard without bending connector pins.
- 2 If you have installed a new supply, make the following checks.
  - Check that the line voltage selection is set properly.  
To change the selection, remove the line voltage switch cover, turn it 180 degrees and reinstall it. The switch will change when the cover is re-installed.
  - Check that the correct fuse is installed.

The fuse requirement is dependent on the line voltage being used; 100 V, 115 V, or 230 V. Refer to the Replaceable Parts list for the correct fuse rating and part numbers.

## To remove and replace the CPU and display assemblies

The CPU and display assemblies are in the rear card cage, the second and third assemblies from the top. The display assembly is just below the CPU.

The CPU and display assemblies are connected by a short cable near the rear of the assemblies. Both assemblies must be partially removed before they can be separated.

---

**CAUTION**

---

Use proper ESD safety precautions.

### To Remove

- 1 Remove the rear panel.
- 2 Disconnect the display cable (large ribbon cable) at the display assembly.  
Push to the side the clamps on either side of the cable connector and the connector will slide out of the socket.  
To get it out of the way, temporarily tuck the cable into the area beside the fan.
- 3 Remove four screws, two at either side of the CPU and display assemblies.
- 4 One at a time, and with a slight side-to-side motion, slide each assembly out until they just release at the front connector.
- 5 Slide the assemblies out together about 7 cm (3 inches).
- 6 Disconnect the ribbon cable at the center rear of the CPU.  
Push to the side the clamps on either side of the cable connector and the connector will slide out of the socket.
- 7 Push the cable through the opening in the CPU assembly and remove the desired assembly.

### To Replace

- 1 To reinstall the assemblies, reverse the procedure.  
Slide the assemblies in gently to make the connection with the motherboard without bending connector pins.
- 2 If you have installed a new CPU or have had a battery problem, recalibrate the mainframe. The calibration factors are stored on the CPU assembly.

---

## To remove and replace the time base assembly

The time base assembly is in the rear card cage, the fourth assembly from the top.

---

**CAUTION**

---

Use proper ESD safety precautions.

---

**CAUTION**

---

This instrument uses SMC connectors that require either a 6-mm (15/64-inch) or 1/4-inch wrench. Use the correct wrench. Using a wrench that is too large may damage the connector.

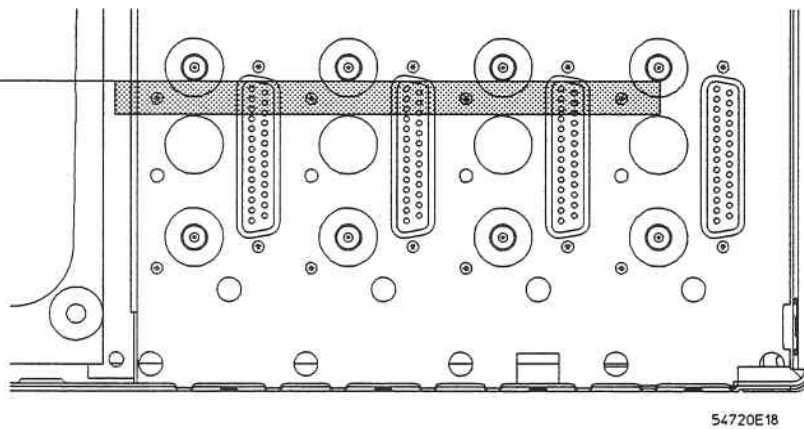
### To Remove

- 1 Remove the plug-ins.
- 2 Remove the rear panel.

- 3 Disconnect the display cable (large ribbon cable) at the display assembly.  
Push to the side the clamps on either side of the cable connector and it will slide out of the socket. To get the cable out of the way, temporarily tuck it into the area beside the fan.
- 4 Disconnect the CAL cable.  
Use a 6-mm (15/64-inch) or 1/4-inch (as required) open-end wrench to disconnect the SMC connector and long-nose pliers to disconnect the wire connectors.
- 5 Remove 4 screws that hold the front of the time base assembly in the mainframe.  
These screws are accessible through the plug-in compartment. See the figure below.  
These screws have a plastic "patch lock" that comes off the threads when the screws are removed. If you use new screws when you replace the assemblies, it ensures the assemblies stay secure. For the part number, see the parts views and replaceable parts list in chapter 7.

Figure 6-5

Remove these four screws



#### Time base Mounting Screws

- 6 Slide the time base assembly about 2.5 cm (1 inch) out of the instrument.
- 7 Disconnect the clock cable at the time base assembly.  
This is the short cable that connects to the clock assembly. This is an SMC connector; use a 6-mm (15/64-inch) or 1/4-inch (as required) wrench.
- 8 Disconnect the two other SMC connectors and the two SMB connectors from the time base assembly.
- 9 Note the routing of the CAL cable in the opening in the rear bracket. Slide the cable out of the opening.
- 10 Remove the time base assembly from the instrument.

#### CAUTION

Be sure that all cables are out of the way so that the time base assembly and cables do not get damaged.

#### To Replace

The clock assembly must already be installed.

- 1 To install the time base assembly, reverse the removal procedure. However, make note of the following:
  - Tighten the SMC connectors to 0.34 Nm (3 in-lbs). Use an open-end torque wrench.
  - Slide the assemblies in gently, to make the connection with the motherboard without bending connector pins.
- 2 Recalibrate the mainframe.

---

## To remove and replace the clock assembly

The clock assembly is in the rear card cage, the fifth assembly from the top.

---

**CAUTION**

---

Use proper ESD safety precautions.

---

**CAUTION**

---

This procedure requires removing and replacing cables in very mechanically sensitive locations. Use caution and a light touch when working with the semi-rigid cabling. Follow the procedures carefully to avoid breaking expensive parts. Careless handling may result in a broken hybrid which will be very expensive to repair.

You will need the following special tools.

- Torque screwdriver handle set to 0.565 Nm (5 in-lbs) with a 1/4-inch male drive
- Special cut-away 5/16-inch socket, 1/4-inch drive. This is a standard 5/16-inch deep socket, cut away to fit around the cables while turning. This socket is supplied with the HP 54717A calibration plug-in.

---

**CAUTION**

---

If you do not have these tools, do not attempt these procedures.

### To Remove

Read each step completely before performing it. Refer to the appropriate procedures in this chapter for the first three steps.

- 1 Remove the plug-ins.
- 2 Remove the rear panel.
- 3 Remove the time base assembly.
- 4 Loosen the clock cable at the clock assembly so it can be moved out of the way.

This is an SMA connector; use an 8-mm (5/16-inch) open-end wrench.

---

**CAUTION**

---

While removing the cables in the next step you want to avoid stress to the hybrids on the acquisition assemblies. This is most easily done by just loosening the connectors with the cut-away socket and torque driver, then removing the cables the rest of the way by using just the cut-away socket held in your fingers.

The socket will only rotate part of a turn before interfering with the cable. Be sure to position it with allowance for rotation.

If the instrument is an HP 54720A there will be eight semi-rigid cables and if the instrument is an HP 54710A there will be four. The procedure is the same for both. On the HP 54710A, terminations are connected to four of the clock assembly outputs. Unless you are installing a new assembly they do not need to be removed.

- 5 With the special socket wrench and driver, loosen the semi-rigid connectors at the acquisition assemblies.
- 6 With the special socket wrench and driver, loosen the semi-rigid connectors at the clock assembly.
- 7 Working from right to left (as viewed from the rear of the instrument), remove each semi-rigid cable using your fingers or the special socket held in your fingers.  
If you remove the cables in order, and set them aside in the same order, you can more easily install them in the required order.
- 8 Remove two screws that secure the clock assembly rear bracket to the acquisition assembly rear bracket.



- 9 Remove the clock assembly from the instrument.
- 10 If you are installing a new clock assembly in an HP 54710A, remove the four terminations on the unused outputs of the old assembly and install them on the same outputs of the new one.

**To Replace**

The acquisition assemblies must already be installed.

- 1 Slide the clock assembly into the instrument in the slot just above the acquisition assemblies.

Slide the assemblies in gently, to make the connection with the motherboard without bending connector pins.

- 2 Install two screws that secure the clock assembly rear bracket to the acquisition assembly rear bracket.
- 3 Using the drawing below, install the semi-rigid cables from left to right. Tighten the connectors gently using your fingers or the special socket held in your fingers.
- 4 Only at the clock assembly, tighten the semi-rigid coax connectors to 0.565 Nm (5 in-lbs). Use the special socket and torque driver.



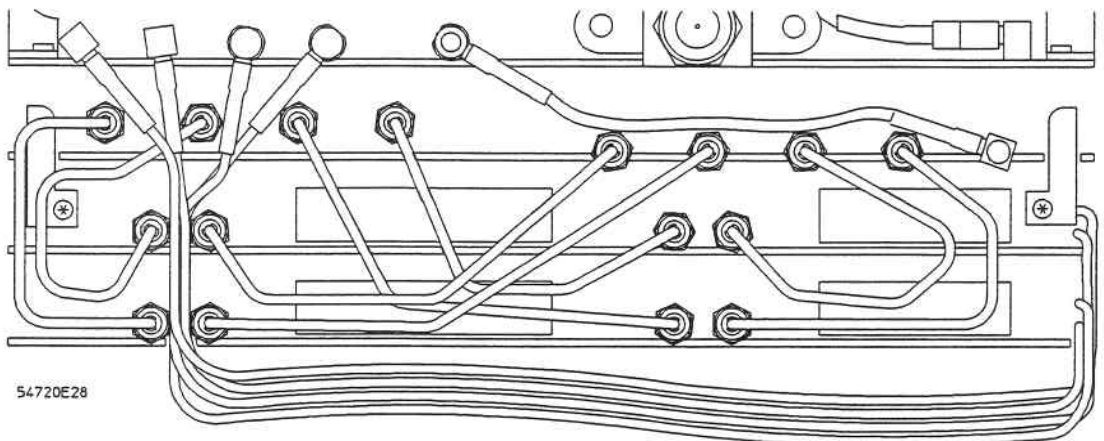
**CAUTION**

When tightening the cables on the acquisition assemblies in the next step, be sure not to apply side stresses to the connectors on the hybrids. Unusual stress may break the hybrid.



- 5 On the acquisition assemblies, tighten the semi-rigid coax connectors to 0.565 Nm (5 in-lbs). Again, use the special socket and torque driver, and remember, the socket will only rotate part of a turn before interfering with the cable. Be sure to position it with allowance for rotation.
- 6 Tighten the clock cable at the clock assembly.  
Be sure to position it so that the time base assembly can slide over it without damage.
- 7 Install the time base assembly, rear panel, and plug-ins.
- 8 Recalibrate the mainframe.

Figure 6-6



Acquisition Assembly Cabling



## To remove and replace the acquisition assemblies

The acquisition assemblies are the two bottom assemblies in the rear card cage. In the HP 54710A there is only one acquisition assembly, but the procedures for removal and installation are essentially the same.

**CAUTION**

The ceramic hybrids to which the semi-rigid cables attach are very susceptible to breakage. Be sure to follow the procedures very carefully.

**CAUTION**

Use proper ESD safety precautions.

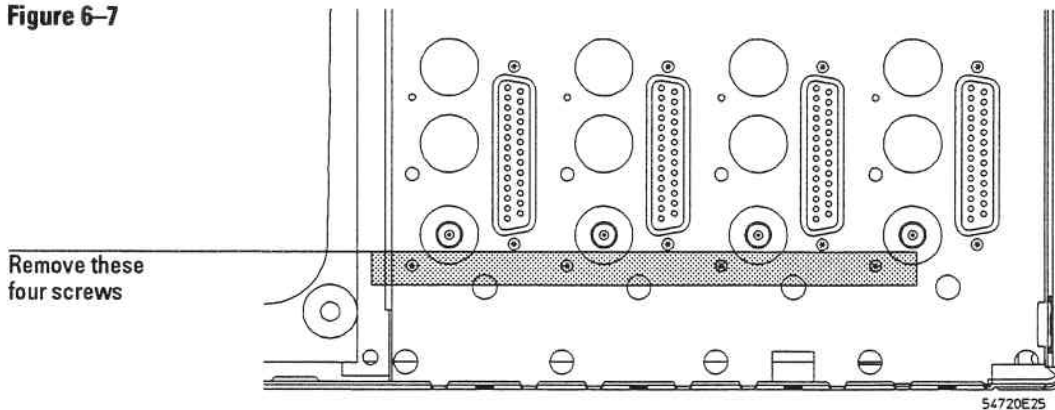
### To Remove

Read each step completely before performing it. Refer to the appropriate procedures in this chapter for the first four steps.

- 1 Remove the plug-ins.
- 2 Remove the rear panel.
- 3 Remove the time base assembly and clock assembly.
- 4 Loosen the stop bars.  
These hold the rear of the acquisition assemblies at each side.
- 5 Remove 4 screws that hold the front of the acquisition assemblies in the mainframe.

These screws are accessible through the plug-in compartment. See the figure below. These screws have a plastic "patch lock" that comes off the threads when the screws are removed. If you use new screws when you replace the assemblies, it ensures the assemblies stay secure. For the part number, see the parts views and replaceable parts list in chapter 7.

Figure 6-7



### Acquisition Assembly Mounting Screws

- 6 Remove the stop bars and slide the acquisition assemblies out of the cabinet.

### To Replace

- 1 To install the acquisition assemblies, reverse the removal procedure. However, make note of the following:
  - Slide the assemblies in gently to make the connection with the motherboard without bending connector pins.
- 2 Recalibrate the mainframe.

---

## To remove and replace the color CRT module

The color CRT module is in a compartment by itself and does not need to be removed to replace any other assembly.

If you are replacing a failed color CRT module, you will have to move several parts from the failed module to the new one.

### To Remove the Module

When necessary, use other procedures in this chapter to help remove the various assemblies.

- 1 Remove the rear panel.
- 2 Disconnect the ribbon cable from the display assembly.
- 3 Remove the ribbon cable from the clips that hold it in the rear fan compartment.
- 4 Remove the front panel and disconnect the keyboard cable at the keyboard.
- 5 Turn the instrument onto its left side (same side as the color CRT module).
- 6 Remove the two pan-head screws and washers, about half way back on the bottom of the cabinet.  
These screws secure the color CRT module rear bracket.
- 7 Remove the two pan-head screws on the bottom of the cabinet, near the front.
- 8 Turn the instrument so that it is again right side up.
- 9 Remove the two pan-head screws on the top of the cabinet, near the front.
- 10 Slide the module part way out of the cabinet, until you can reach the power cable on the right side of the module.
- 11 Disconnect the cable at the module and remove the module from the instrument.

### To Exchange Parts Between Modules

If you are installing a new or rebuilt module, you need to move several parts from the old module to the new one.

The shields and rear bracket are attached to the module with self-tapping screws. If your replacement module is a new one, the screws will tap the holes when they are installed. If the replacement module is a rebuilt one, the holes may be already tapped. Start the screws carefully so they do not cross thread the holes.

#### 1 Move the shields.

The left shield fits around the top, left, and bottom of the module. The right shield is angled and covers the right side of the module.

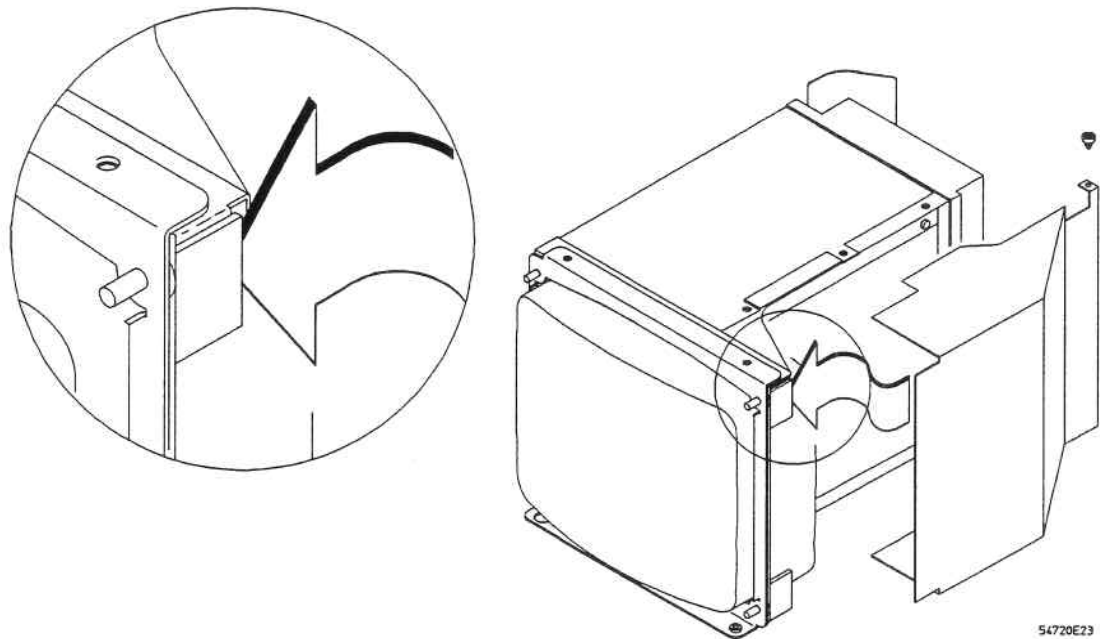
- a Remove one screw from the upper-right rear of the module.

Note how tabs on the shield tuck into the front of the module frame and how the shields overlap each other at the top and bottom joints.

- b Swing the rear of the right shield away from the module and slide the front tabs out of the module frame.
- c Disconnect the cable from the module at the two places on the PC board.
- d Remove five screws from the left shield.
- e Remove the left shield and place it around the new module.  
Overlap the joint between the shields as they were on the old module.
- f Install the five screws but do not tighten them at this time.

- g Take the right shield and connect the cables to the proper places on the PC board. One connector has four pins and the other has five.
- h Hold the shield at an angle and slide the front tabs of the shield about 15 mm (9/16 in) into the two slots on the module frame. (See the figure below. The bottom is the same as the top.)

Figure 6-8



#### Installing Right CRT Module Shield

- i As you swing the rear of the shield toward the module, make sure the cables do not get caught between the shield and frame.
  - j Install the screw. Reposition the shield if the screw hole does not line up properly.
  - k Tighten the five screws of the left shield.
- 2 Move the front mounting bracket.**
- a Remove four 5/16 nuts from the studs at the front of the replacement module.
  - b Remove the two angle rails; one is between the left pair of studs and one is between the right pair. Set the rails aside.
  - c Note the position of the front bracket on the failed module.
  - d Remove the four 5/16 nuts from the front of the failed module.
  - e Transfer the front bracket to the same position on the replacement module.
  - f Install four 5/16 nuts on the replacement module and tighten them.
  - g Install and tighten the two angle rails and 5/16 nuts on the failed module.
- 3 Note the position of the rear mounting bracket on the failed module, then remove it.**
- 4 Remove the ribbon cable from the failed module (push the connector clamps to the side), and install it on the replacement module.**
- 5 With the two screws and washers, install the rear bracket loosely on the replacement module.**
- The bracket should be able to move only slightly. It will be tightened when the module is installed in the instrument.

### To Replace the Module

- 1 Set the oscilloscope frame in its normal operating position.
- 2 Position the module in front of the mainframe and thread the ribbon cable into the slot at the bottom rear of the compartment. Make sure that it is not twisted.
- 3 Slide the module part way into the mainframe and connect the power cable to the connector on the right side of the module.
- 4 Slide the module into the mainframe. Pull the ribbon cable through the mainframe as the module slides in.

Take care not to get the ribbon cable or power cable caught between the module and mainframe. If the power cable connector gets caught between the module and frame the module may not get positioned correctly.
- 5 Install, but do not tighten, two screws in the oblong holes in the depressions at the top-front of the instrument cabinet.
- 6 Connect the keyboard cable to the front panel and install the front panel on the mainframe.
- 7 Place the instrument face down on the table with the left side (color CRT module side) toward you.

Use a couple of books under the left and right sides of the front panel so the instrument is stable and does not sit on the knob or the calibrator connectors.

In the next steps, the object is for the weight of the color CRT module to push it against the back of the front panel so there is a minimal gap between the CRT and the panel.
- 8 Install, but do not tighten, two screws in the oblong holes in the depressions at the bottom-front of the instrument cabinet.
- 9 At the module rear bracket and on the cabinet bottom are two rectangular holes with a large round hole between them. Install, but do not tighten, two screws with washers at the rectangular holes.

There is a small hole in the rear bracket, aligned with the large round hole. A pointed device can be used in the small hole to move the module bracket to insert the screws or position the module so it rests properly in the cabinet.
- 10 Tighten all of the hardware in the following sequence.
  - a Tighten the screws at the front of the instrument, those that fasten the front bracket of the module.
  - b Ensure that the rear module bracket is flush with the inside bottom of the cabinet (bottom screws are still loose).
  - c Through the two holes in the left side of the cabinet, tighten the screws that fasten the rear bracket to the module.
  - d Tighten the two rear bracket screws on the bottom of the cabinet.
- 11 Set the instrument on its bottom, look at the front, and ensure that the CRT is flush with the front panel.

If the CRT is not flush, put the instrument back on its front panel, loosen the hardware, use the access holes (side and bottom) to reposition the module, then re-tighten the hardware in the sequence in step 10.

## To remove and replace the motherboard

The motherboard is located between the plug-in compartment and the card cage. It connects the card cage assemblies and the plug-ins.

- 1 Disassemble the instrument.
  - a Remove the power cord and plug-ins.
  - b Remove the front panel but leave the keyboard cable connected.
  - c Remove the disk drive assembly and carefully set it on top of the front panel. You do not need to disconnect the keyboard cable.
  - d Remove the front fan assembly.
  - e Remove the following assemblies in order. When you start with the power supply procedure, the other procedures follow in sequence in this chapter.
    - Power supply
    - CPU and display assemblies
    - Time base assembly
    - Clock assembly
    - Acquisition assemblies

- 2 Remove and replace the motherboard.

The cable that provides power to the color CRT module is connected to the front of the motherboard. You must move the motherboard carefully until you can disconnect this cable from the rear. This is preferable to having to remove the color CRT module as well. Read all of the following steps before proceeding.

- a Remove the screws that hold the motherboard. See the figures on the next page.

Three things have to be considered as the motherboard is removed.

  - Three tabs on the right side of the motherboard (as viewed from the rear of the instrument) fit in slots in the cabinet.
  - Eight plug-in locating pins protrude from the motherboard through the bulkhead panel.
  - The color CRT module power connector also protrudes through the bulkhead panel.
- b Swing the left side of the motherboard toward the rear until the locating pins clear the bulkhead panel.
- c As the locating pins clear, you will be able to move the motherboard to the left slightly to clear the tabs from the slots.
- d When the tabs are free, pull the motherboard back until the connector clears the bulkhead panel, then swing the motherboard against the right side of the card cage.
- e Squeeze the connector locking tab at the top, and disconnect the color CRT module power cable from the upper corner of the motherboard. Do not allow the cable to fall through the opening in the bulkhead panel.
- f If you are installing a new motherboard, use the following steps to move the torroidal springs to the new board.

---

### CAUTION

The effect of these grounding springs is very significant, and they require care in installation. Handle the springs carefully and follow the instructions. Improper installation may cause poor operation of the oscilloscope.

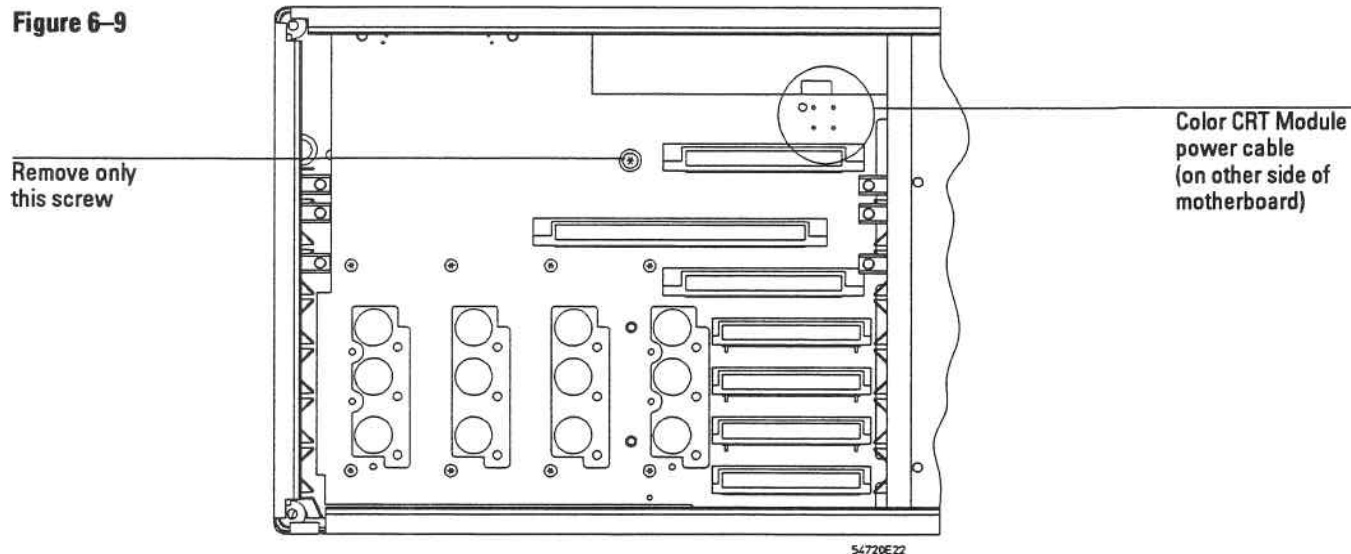
- 1 One at a time, carefully remove the springs from the posts on the old motherboard and slide them half way down the posts on the new motherboard.

**CAUTION**

If you try to push the springs all of the way on with your fingers, they will roll and may be out of position when they come to rest on the shoulder of the pin. If they are out of position they may be crushed when the motherboard is installed or may make insufficient contact between the motherboard and the bulkhead panel.

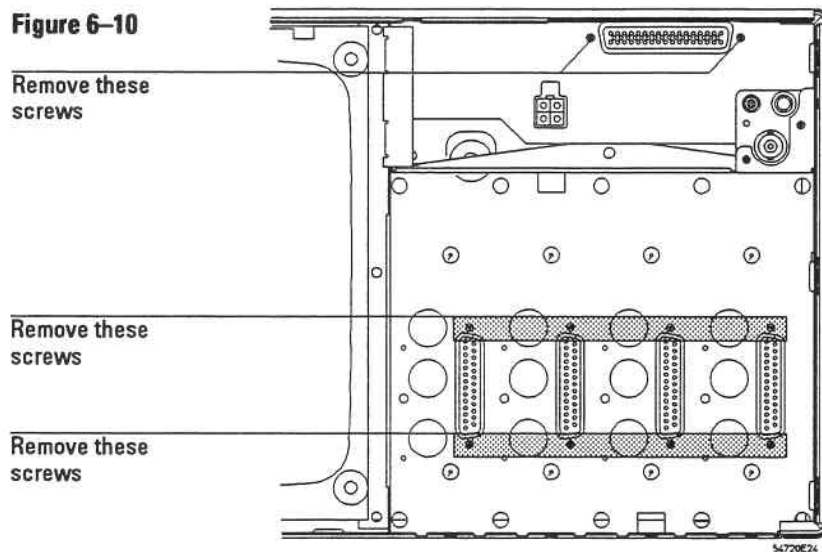
- 2 Use the rear end of a plug-in as a tool to slide the springs down the posts. Fit the plug-in over a pair of posts, as if you were going to plug it into the motherboard, and push it until the bus connector fully mates in the motherboard.
- 3 To reassemble the instrument, reverse the procedure.  
Follow the appropriate steps in all procedures.

Figure 6-9



Rear Motherboard Mounting Screws

Figure 6-10



Front Motherboard Mounting Screws



## To remove and replace the rear fan

The rear fan does not need to be removed to remove any other assemblies.

### To Remove

The fan bracket is held in the cabinet by two pins at the front and by two screws at the rear mounting tabs.

- 1 Remove the rear panel.
- 2 Disconnect the rear fan cable from the connector at the side of the power supply.  
Consult the label on the inside of the rear panel. Note the routing of the fan cable.
- 3 Remove the two screws that hold the fan bracket at the top and bottom.
- 4 Pull the fan assembly straight back about 1 cm (3/8 in) until it clears the pins at the front of the fan compartment.
- 5 Rotate the fan assembly counter-clockwise until it clears the rear mounting tabs and you can remove it completely.
- 6 Remove three screws to remove the fan from the bracket.

### To Replace

- 1 Mount the fan on the bracket.
  - a Place the fan bracket on the table with the largest right-angle bend down and on the left.
  - b Place the fan on the bracket with the cable at the lower left and take note of the following:
    - Fan rotation is clockwise
    - Air flow is downAirflow and rotation are marked on the side of the fan.
  - c Install three screws.
    - left side
    - upper right
    - lower right
  - d Check that the temperature sensor is tied at the right-side hole, away from the fan bracket.
- 2 Install the fan in the instrument.
  - a Slide the fan and bracket into the cabinet with the fan to the right of the bracket.  
Tilt the fan and bracket counterclockwise so that it clears the top mounting tab to the left and the bottom mounting tab to the right (as viewed from the rear).
  - b When the assembly is about 1 cm (3/8 inch) out of the cabinet, rotate it clockwise to line up with the front pins and rear tabs, then slide it the rest of the way into the cabinet.
  - c Install two screws at the rear mounting tabs.
  - d Connect the fan cable to the power supply.
- 3 When you turn on the instrument, check that the airflow is from the outside, into the cabinet.
- 4 Install the rear panel.

|                            |     |
|----------------------------|-----|
| Ordering Replaceable Parts | 7-2 |
| Listed Parts               | 7-2 |
| Unlisted Parts             | 7-2 |
| Direct Mail Order System   | 7-2 |
| Exchange Assemblies        | 7-2 |
| Exploded Views             | 7-3 |
| Replaceable Parts List     | 7-6 |



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# Replaceable Parts

This chapter of the Hewlett-Packard 54720A Oscilloscope service guide includes information for ordering parts. Service support for this instrument is replacement of parts to the assembly level. The replaceable parts include assemblies and chassis parts.

---

## Ordering Replaceable Parts

### Listed Parts

To order a part in the parts list, quote the HP part number, indicate the quantity desired, and address the order to the nearest HP Sales/Service Office.

### Unlisted Parts

To order a part not listed in the parts list, include the instrument part number, instrument serial number, a description of the part (including its function), and the number of parts required. Address the 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. There are several advantages to this system:

- Direct ordering and shipment from the HP parts center in California, USA.
- No maximum or minimum on any mail order. (There is a minimum amount for parts ordered through a local HP sales office when the orders require billing and invoicing.)
- Prepaid transportation. (There is a small handling charge for each order.)
- No invoices.

In order for Hewlett-Packard to provide these advantages, please send a check or money order with each order.

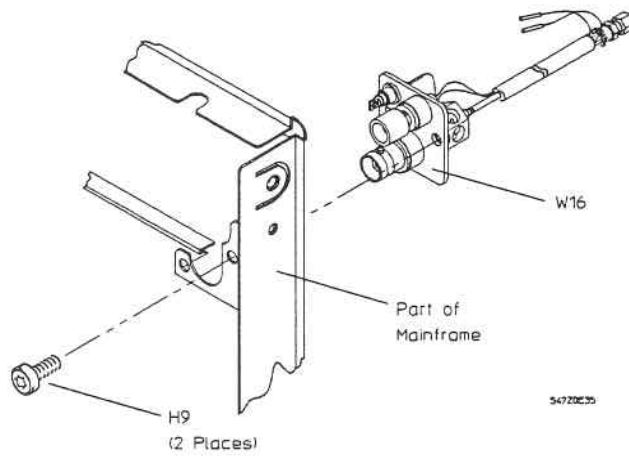
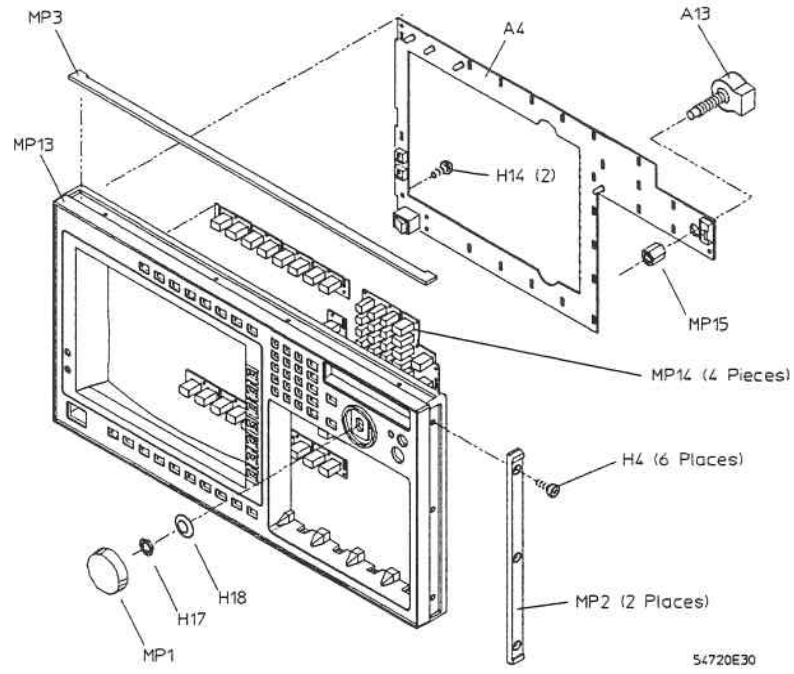
Mail order forms and specific ordering information are available through your local HP sales office. Addresses and telephone numbers are located in a separate document shipped with the manuals.

### Exchange Assemblies

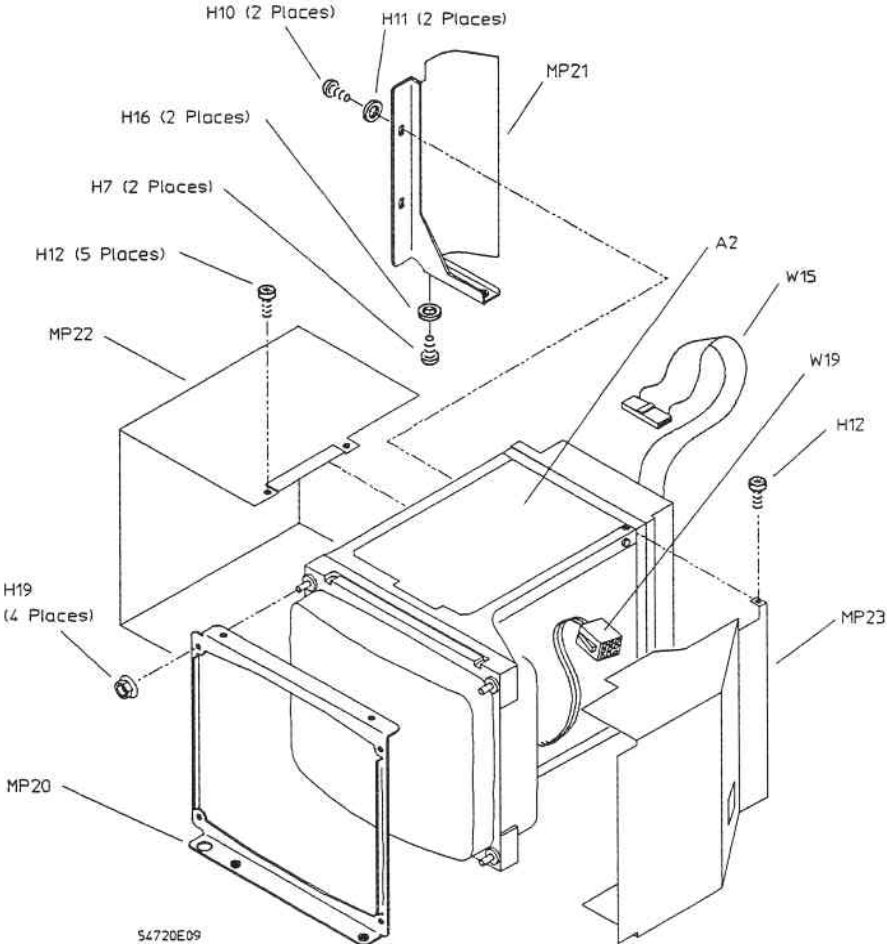
Some parts used in this instrument have been set up for an exchange program. This program allows the customer to exchange a faulty assembly with one that has been repaired, calibrated, and performance-verified by the factory. The cost is significantly less than that of a new part. The exchange parts have a part number in the form XXXXX-695XX.

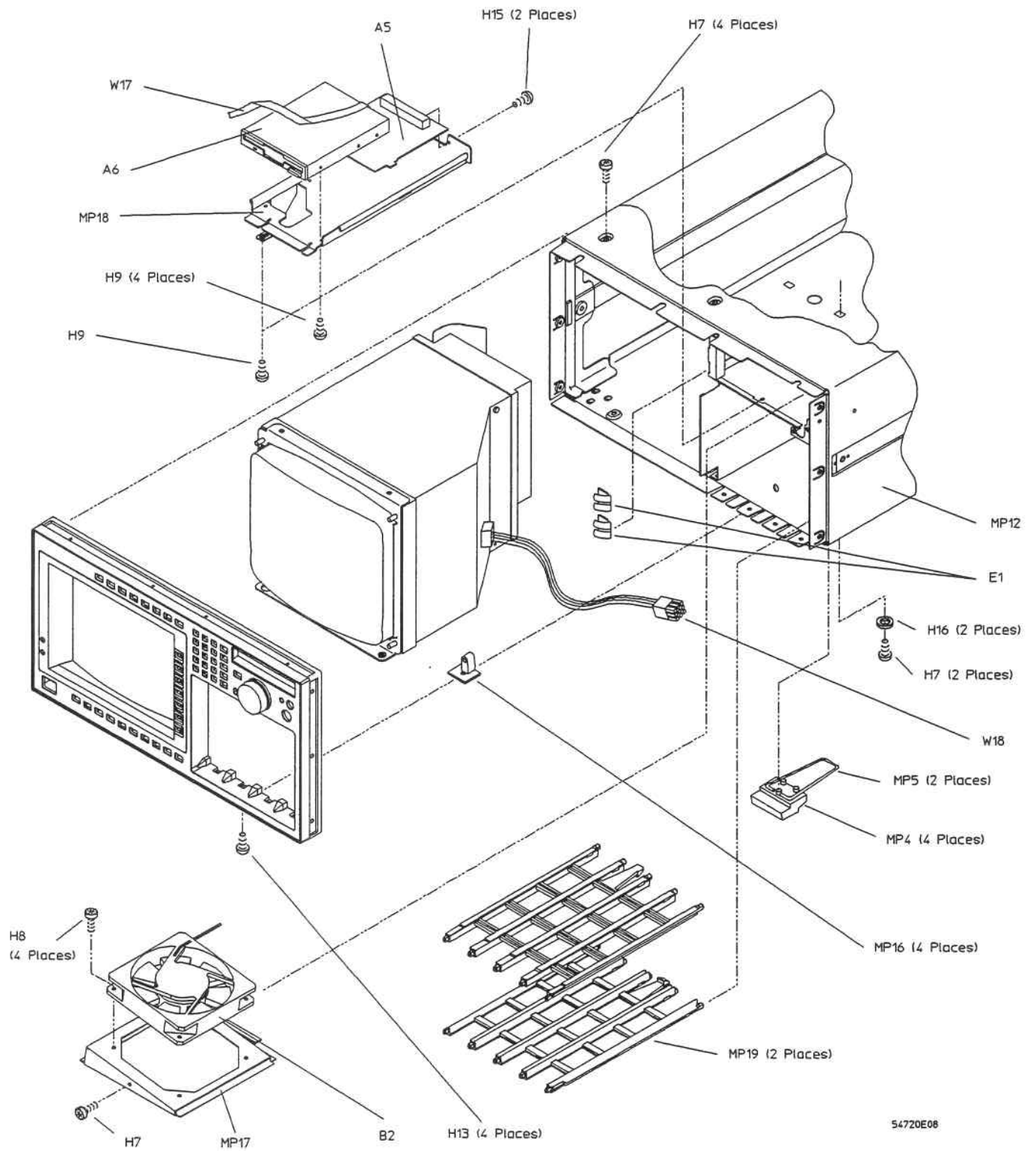
After receiving the repaired exchange part from Hewlett-Packard, a United States customer has 30 days to return the faulty assembly. For orders not originating in the United States, contact the local HP service organization. If the faulty assembly is not returned within the warranty time limit, the customer 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.

Exploded Views

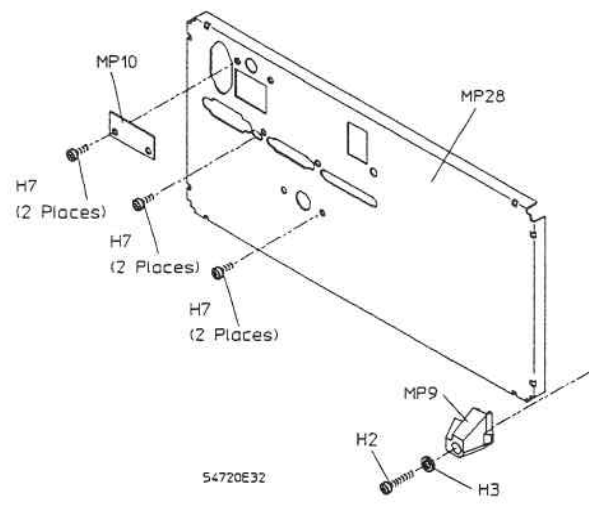
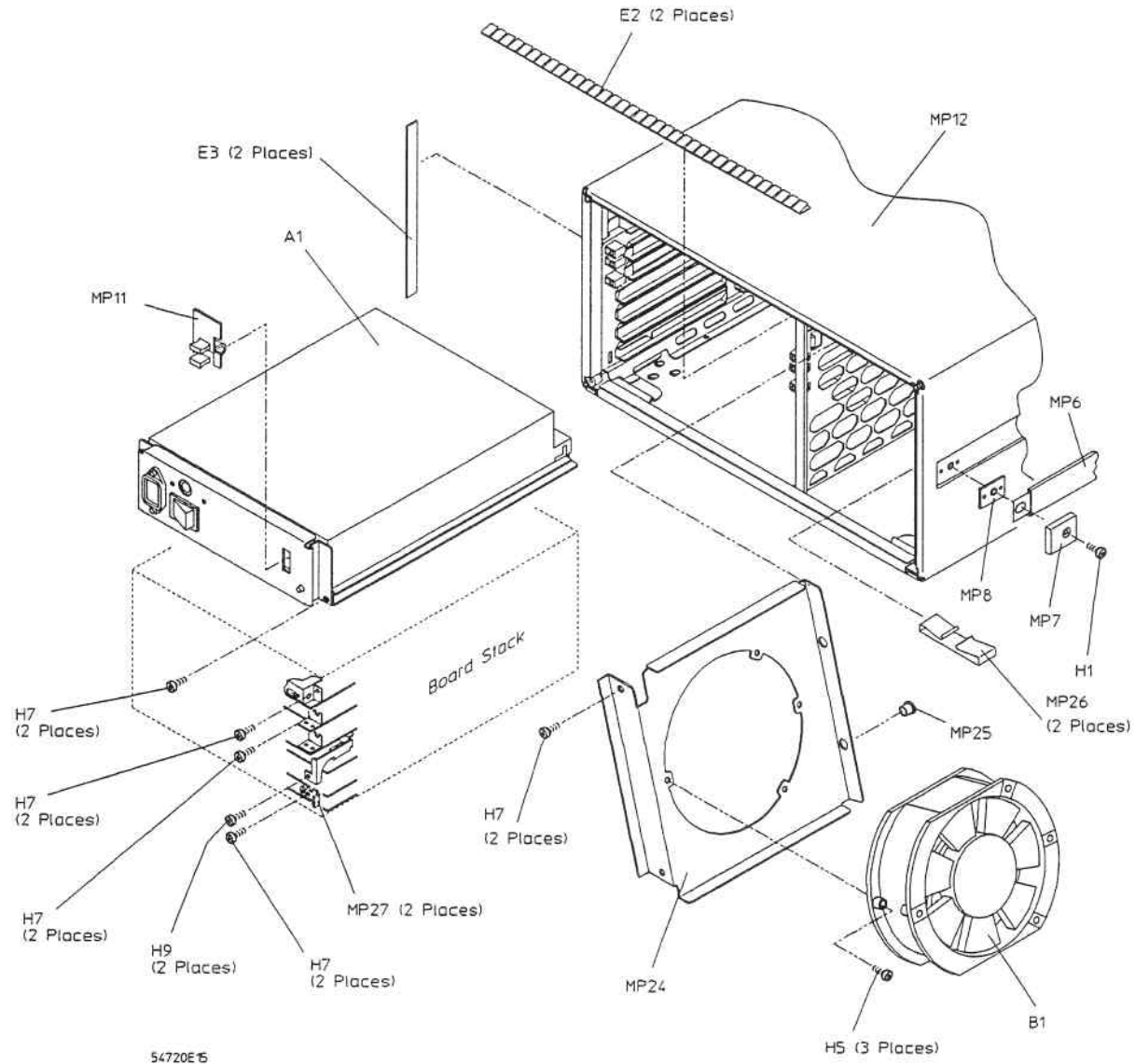


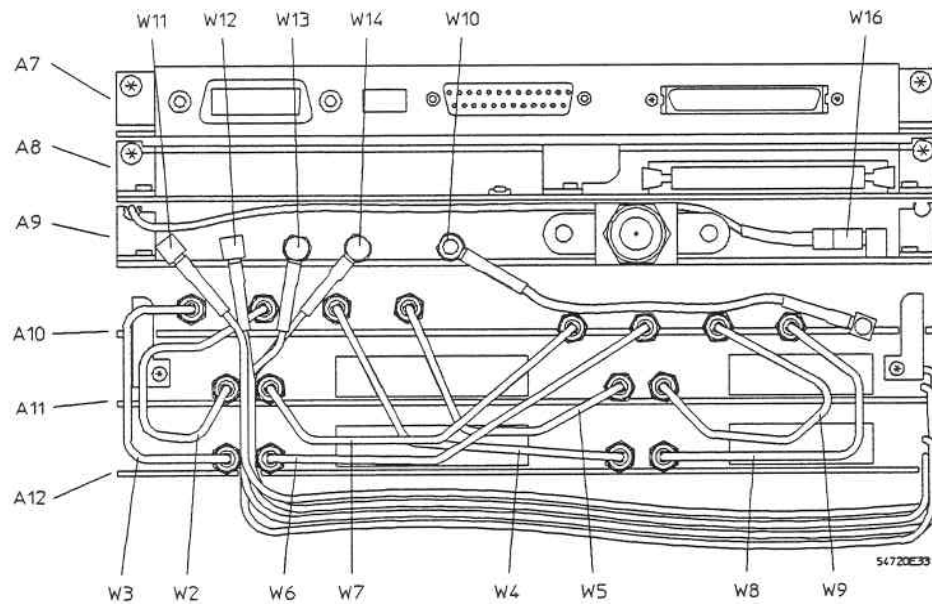
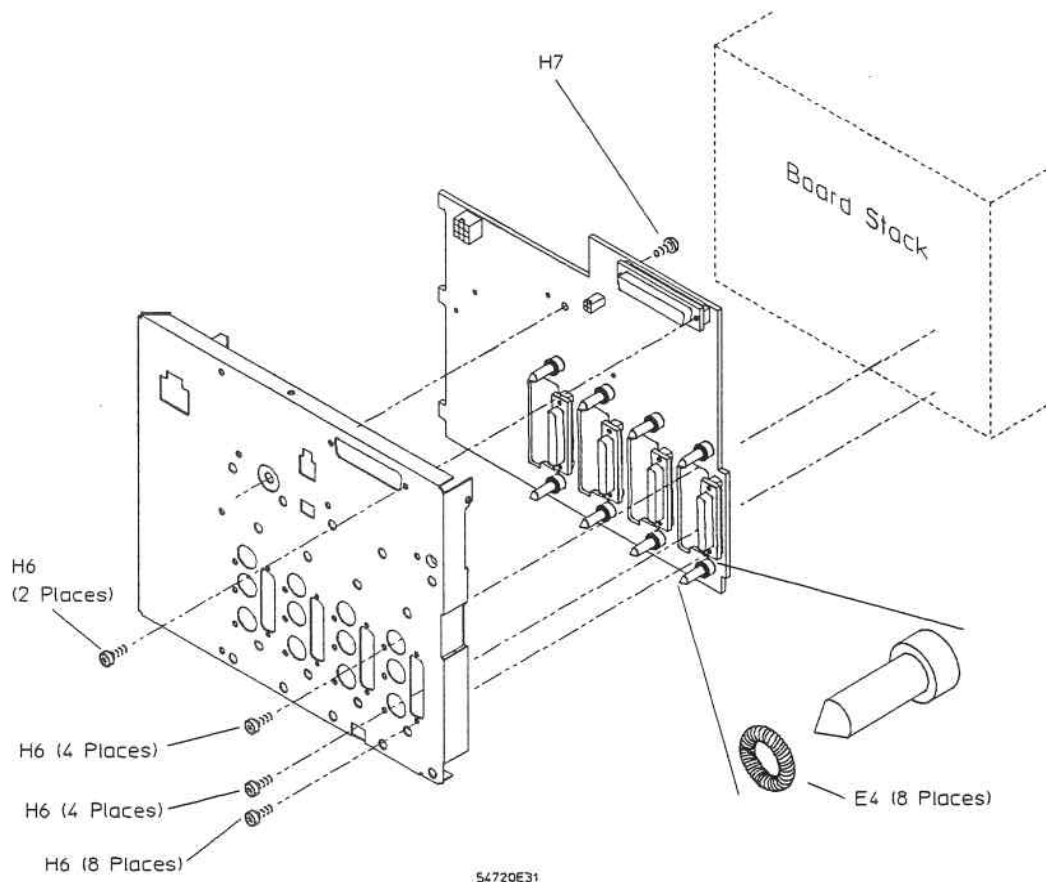
Chapter 7: Replaceable Parts  
Exploded Views





Chapter 7: Replaceable Parts  
Exploded Views





## Replaceable Parts List

Table 7–1 is a list of replaceable parts and is organized as follows:

- Exchange assemblies in alphanumerical order by reference designation.
- External parts in alphanumerical order by reference designation. These parts are generally those that take the physical wear and tear of use.
- Internal parts in alphanumerical order by reference designation. Replacing these parts generally requires opening the cabinet.

The information given for each part consists of the following:

- Reference designation.
- HP part number.
- Total quantity (QTY) in instrument or on assembly. The total quantity is given once and at the first appearance of the part number in the list.
- Description of the part.

Table 7-1

## HP 54720A Replaceable Parts

| Ref. Des.           | HP Part Number | QTY | Description   |
|---------------------|----------------|-----|---|
| EXCHANGE ASSEMBLIES |                |     |   |
| A2                  | 2095-0001      | 1   | COLOR CRT MODULE  |
| A7                  | 54710-69520    | 1   | PC ASSEMBLY - CPU   |
| A8                  | 54710-69518    | 1   | PC ASSEMBLY - DISPLAY   |
| A9                  | 54720-69509    | 1   | PC ASSEMBLY - TIME BASE   |
| A10                 | 54720-69507    | 1   | PC ASSEMBLY - CLOCK   |
| A11                 | 54720-69703    | 1   | PC ASSEMBLY - ACQUISITION - 54710A ONLY (one acquisition assembly)    |
| A11/A12             | 54720-69702    | 1   | PC ASSEMBLY - ACQUISITION - 54720A ONLY (both acquisition assemblies) |
| EXTERNAL PARTS      |                |     |   |
| F1                  | 2110-0342      | 1   | FUSE 8A 250V (for 230 V operation)                                    |
| F1                  | 2110-0249      | 1   | FUSE 12A 250V (for 115 V operation)                                   |
| F1                  | 2110-0342      | 1   | FUSE 15A 250V (for 100 V operation)                                   |
| H1                  | 0515-2048      | 4   | MS M5 X 0.8 12MM-LG FLAT-HD T20 (handles)                             |
| H2                  | 0515-0383      | 4   | MS M4 X 0.7 16MM-LG PAN-HD T10 (rear feet)                            |
| H3                  | 3050-0065      | 4   | WASHER - FLAT 0.203-IN-ID 0.375-IN-OD (rear feet)                     |
| H4                  | 0515-2227      | 6   | MS M4 X 0.7 12MM-LG FLAT-HD T15                                       |
| MP1                 | 01650-47401    | 1   | KNOB - RPG  |
| MP2                 | 54710-41002    | 2   | TRIM STRIP - SIDE   |
| MP3                 | 5041-8802      | 1   | TRIM STRIP - TOP  |
| MP4                 | 5041-8801      | 4   | FOOT - BOTTOM   |
| MP5                 | 1460-1345      | 2   | TILT STAND  |
| MP6                 | 5062-3705      | 2   | HANDLE - STRAP  |
| MP7                 | 54710-62501    | 4   | CAP - HANDLE  |
| MP8                 | 54710-01211    | 4   | SPACER - HANDLE   |
| MP9                 | 54710-41001    | 4   | FOOT - REAR   |
| MP10                | 54710-04101    | 1   | COVER - LINE FUSE   |
| MP11                | 64120-48101    | 1   | COVER - LINE VOLTAGE SWITCH   |
| W1                  | 8120-1378      | 1   | CABLE - POWER   |
| W1                  | 8120-1351      | 1   | CABLE - POWER (Option 900-UK)   |
| W1                  | 8120-1369      | 1   | CABLE - POWER (Option 901-AUSTL)                                      |
| W1                  | 8120-1689      | 1   | CABLE - POWER (Option 902-EUR)  |
| W1                  | 8120-0698      | 1   | CABLE - POWER (Option 904-250V USA/CANADA)                            |
| W1                  | 8120-2104      | 1   | CABLE - POWER (Option 906-SWIT)                                       |
| W1                  | 8120-2956      | 1   | CABLE - POWER (Option 912-DEN)  |
| W1                  | 8120-4211      | 1   | CABLE - POWER (Option 917-AFRICA)                                     |
| W1                  | 8120-4755      | 1   | CABLE - POWER (Option 918-JAPAN)                                      |



Chapter 7: Replaceable Parts  
**Replaceable Parts List**

Table 7-1

**HP 54720A Replaceable Parts (cont'd)**

| Ref. Des.      | HP Part Number | QTY | Description   |
|----------------|----------------|-----|---|
| INTERNAL PARTS |                |     |   |
| A1             | 0950-2211      | 1   | POWER SUPPLY ASSEMBLY                                 |
| A2             | 2090-0251      | 1   | COLOR CRT MODULE                                      |
| A3             | 54710-66513    | 1   | PC ASSEMBLY - MOTHER BOARD                            |
| A4             | 54710-66516    | 1   | PC ASSEMBLY - FRONT PANEL                             |
| A5             | 54710-66515    | 1   | PC ASSEMBLY - DISK DRIVE CONTROL                      |
| A6             | 0950-2169      | 1   | DISK DRIVE  |
| A7             | 54710-66520    | 1   | PC ASSEMBLY - CPU                                     |
| A8             | 54710-66518    | 1   | PC ASSEMBLY - DISPLAY                                 |
| A9             | 54720-66509    | 1   | PC ASSEMBLY - TIME BASE                               |
| A10            | 54720-66507    | 1   | PC ASSEMBLY - CLOCK                                   |
| A11            |                |     | PC ASSEMBLY - ACQUISITION 2 (see parts below)         |
| A12            |                |     | PC ASSEMBLY - ACQUISITION 1 (see parts below)         |
|                | 54720-68703    | 1   | PC ASSEMBLY - ACQUISITION - 54710A ONLY (A11 only)    |
|                | 54720-68702    | 1   | PC ASSEMBLY - ACQUISITION - 54720A ONLY (A11 and A12) |
| A13            | 0960-0852      | 1   | ROTARY PULSE GENERATOR (RPG)                          |
| B1             | 3160-0643      | 1   | FAN - TUBEAXIAL (rear fan)                            |
| B2             | 3160-0804      | 1   | FAN - TUBEAXIAL (front fan)                           |
| E1             | 8160-0718      | 2   | GASKET - RFI FINGER STRIP (front)                     |
| E2             | 54710-07101    | 2   | GASKET - RFI FINGER STRIP (rear top and bottom)       |
| E3             | 54710-07102    | 2   | GASKET - RFI FINGER STRIP (rear sides)                |
| E4             | 1460-2337      | 8   | SPRING - RFI (motherboard)                            |
| E5             | 54710-47601    | 4   | TERMINATION 54710A ONLY                               |
| H5             | 0515-0383      | 3   | MS M4 X 0.7 16MM-LG PAN-HD T10                        |
| H6             | 0515-2305      | 18  | MS M3 X 0.5 14MM-LG PAN-HD T10                        |
| H7             | 0515-0433      | 24  | MS M4 X 0.7 8MM-LG PAN-HD T15                         |
| H8             | 0515-0372      | 4   | MS M3 X 0.5 8MM-LG PAN-HD T10                         |
| H9             | 0515-0430      | 9   | MS M3 X 0.5 6MM-LG PAN-HD T10                         |
| H10            | 0515-0641      | 2   | SCREW - THREAD-ROLLING M4 X0.7 10MM-LG PAN-HD T15     |
| H11            | 3050-0065      | 2   | WASHER - FLAT 0.203-IN-ID 0.375-IN-OD                 |
| H12            | 0515-1958      | 6   | SCREW - THREAD-ROLLING M3 X 0.5 6MM-LG PAN-HD T10     |
| H13            | 0515-2043      | 4   | MS M4 X 0.7 8MM-LG FLAT-HD T15                        |
| H14            | 0624-0600      | 2   | SCREW - TAPPING 4-20                                  |
| H15            | 2200-0140      | 2   | MS 4-40 0.27-IN-LG PAN=HD-POZI                        |
| H16            | 3050-0071      | 2   | WASHER - FLAT XXXXX-IN-ID XXXXX-IN-OD                 |
| H17            | 2950-0043      | 1   | NUT - HEX DBL-CHAM 3/8-32 THD .093-IN-THK             |
| H18            | 3050-0188      | 1   | WASHER - CURVED LOCK (rpg)                            |
| H19            | 2950-0043      |     | NUT - HEX (part of A2, color CRT module)              |
| MP12           | 54710-04401    | 1   | CABINET   |
| MP13           | 54710-60202    | 1   | FRONT PANEL 54710A ONLY (with label)                  |
| MP13           | 54720-60202    | 1   | FRONT PANEL 54720A ONLY (with label)                  |
| MP14           | 54710-68701    | 1   | KEYPAD KIT (four pieces)                              |
| MP15           | 54710-05701    | 1   | NUT - SPACER (for RPG)                                |
| MP16           | 54710-25001    | 4   | BRACKET - PLUG-IN LATCH                               |
| MP17           | 54710-01220    | 1   | BRACKET - FRONT FAN                                   |
| MP18           | 54710-01221    | 1   | BRACKET - DISK DRIVE                                  |
| MP19           | 54710-43101    | 2   | GUIDE - PLUG-IN                                       |
| MP20           | 54710-01215    | 1   | BRACKET - FRONT (color CRT module)                    |

Table 7-1

## HP 54720A Replaceable Parts (cont'd)

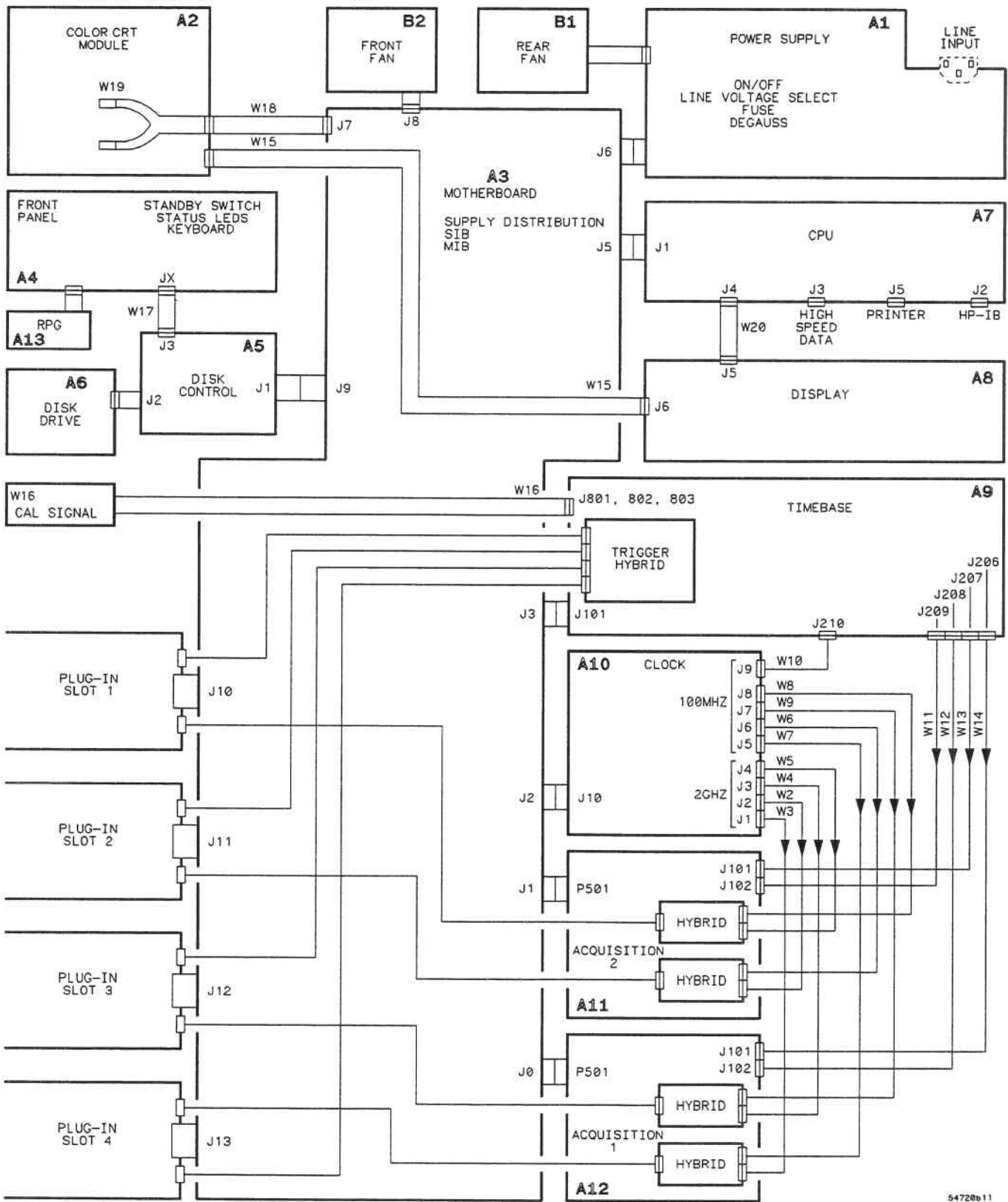
| Ref. Des. | HP Part Number | QTY | Description  |
|-----------|----------------|-----|--|
| MP21      | 54710-01216    | 1   | BRACKET - REAR (color CRT module)                        |
| MP22      | 5061-6197      | 1   | SHIELD - LEFT (color CRT module)                         |
| MP23      | 54710-00601    | 1   | SHIELD - RIGHT (color CRT module)                        |
| MP24      | 54710-01219    | 1   | BRACKET - REAR FAN (includes plastic bushings)           |
| MP25      | 0400-0269      | 2   | BUSHING - PLASTIC (part of MP 24)                        |
| MP26      | 1400-1331      | 2   | CLAMP - CABLE  |
| MP27      | 54720-03701    | 2   | STOP BAR   |
| MP28      | 54710-00201    | 1   | REAR PANEL   |
| W2        | 54720-61606    | 1   | CABLE - SEMI RIGID - 2GHZ CHAN 2                         |
| W3        | 54720-61605    | 1   | CABLE - SEMI RIGID - 2GHZ CHAN 4 (54720A only)           |
| W4        | 54720-61607    | 1   | CABLE - SEMI RIGID - 2GHZ CHAN 3 (54720A only)           |
| W5        | 54720-61608    | 1   | CABLE - SEMI RIGID - 2GHZ CHAN 1                         |
| W6        | 54720-61610    | 1   | CABLE - SEMI RIGID - 100MHZ CHAN 4 (54720A only)         |
| W7        | 54720-61609    | 1   | CABLE - SEMI RIGID - 100MHZ CHAN 2                       |
| W8        | 54720-61612    | 1   | CABLE - SEMI RIGID - 100MHZ CHAN 3 (54720A only)         |
| W9        | 54720-61611    | 1   | CABLE - SEMI RIGID - 100MHZ CHAN 1                       |
| W10       | 54720-61614    | 1   | CABLE - COAXIAL (clock to time base)                     |
| W11       | 54720-61615    | 4   | CABLE - COAXIAL (time base to acquisition 1)             |
| W12       | 54720-61615    |     | CABLE - COAXIAL (time base to acquisition 2)             |
| W13       | 54720-61615    |     | CABLE - COAXIAL (time base to acquisition 1)             |
| W14       | 54720-61615    |     | CABLE - COAXIAL (time base to acquisition 2)             |
| W15       | 54710-61601    | 1   | CABLE - RIBBON (display PC assembly to color CRT module) |
| W16       | 54710-61613    | 1   | CABLE ASSEMBLY (calibration signal)                      |
| W17       | 54710-61603    | 1   | CABLE - RIBBON (keyboard)                                |
| W18       | 54710-61604    | 1   | CABLE (color CRT module, outside)                        |
| W19       | 54710-61609    | 1   | CABLE (color CRT module, inside)                         |
| W20       | 54710-61611    | 1   | CABLE - RIBBON (CPU to display PC assembly)              |



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|                              |     |
|------------------------------|-----|
| Mainframe Block-Level Theory | 8-3 |
| Acquisition                  | 8-3 |
| Motherboard                  | 8-3 |
| Power Supply                 | 8-3 |
| Fans                         | 8-4 |
| CPU                          | 8-4 |
| Display Assembly             | 8-4 |
| Color CRT Module             | 8-4 |
| Disk Drive and Control       | 8-5 |
| Front Panel                  | 8-5 |
| Acquisition System           | 8-7 |
| Acquisition Assemblies       | 8-7 |
| Clock                        | 8-8 |
| Time Base                    | 8-8 |
| Acquisition System Signals   | 8-8 |

Figure 8-1



54720b-11

Instrument Block Diagram

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# Theory of Operation

The HP 54710A and 54720A mainframes contain the sampling, digital processing, and display for a digitizing oscilloscope. Four front-panel slots accept an assortment of signal conditioning plug-ins. Seven rear-panel slots accept major assemblies of the mainframe, including the power supply and acquisition assemblies. The color CRT module (display) is a separate assembly. The front panel consists of hard and soft keys, a knob RPG (rotary pulse generator), a 3.5-inch disk drive, and the calibrator output.

The HP 54710A mainframe is identical to the HP 54720A except that it has only one acquisition assembly, acquisition 2 for plug-in slots 1 and 2. Acquisition 1 is not installed. The following theory is written to cover the HP 54720A but with minor considerations it can be applied to the HP 54710A.

---

## Mainframe Block-Level Theory

Use the main block diagram on the previous page for the following discussion.

### Acquisition

The acquisition system consist of the time base, clock, and two acquisition assemblies. They accept the conditioned vertical and trigger signals from the plug-ins in the front-panel slots.

- The plug-ins condition the input signals and provide one or more channel and/or trigger signals to the mainframe.
- The clock assembly provides 2 GHz and 100 MHz sample rates.
- The time base starts the acquisition according to the trigger conditions and trigger signals.
- The acquisition assemblies sample, digitize, and store the input signals.

Acquisition operation is covered in more detail in "Acquisition System" later in this chapter.

### Motherboard

The motherboard provides most of the common connections in the mainframe. The digital interface, some acquisition control lines, and power supplies are routed through the motherboard. The vertical plug-ins, disk controller, and front fan connect to the motherboard from the front of the instrument and the other mainframe assemblies plug in from the rear.

### Power Supply

The 650 W switching power supply provides eight dc voltages to the instrument. A rear-panel power switch switches both sides of the ac power input. When the rear panel power switch is on, the power supply primary circuits are energized.

The front-panel power switch is a remote control for the regulators in the supply. When the front-panel switch is set to Standby, with the rear-panel switch on, the regulators are shut down and most instrument circuitry is off.

On the rear panel is a fuse as well as a switch for changing the ac voltage input range, nominally 115 Vac or 230 Vac. The rear panel of the power supply also carries the degauss push-button switch for the CRT.

One output of the power supply is a power-on-reset signal which is distributed on the bus. This is used to initialize circuitry after all of the supplies are operating.

### **Fans**

Fans are powered by a 24 V supply provided by the power supply assembly. The fan voltage, therefore the fan speed, varies with the internal temperature of the instrument. The power supply monitors a signal line from each fan and shuts down the supply if fan rotation stops.

### **CPU**

The CPU assembly controls all digital functions of the instrument other than the display. It uses an MC68020 microprocessor and an MC68882 floating-point math coprocessor. A 32 MHz oscillator output is divided by two to get a 16 MHz processor clock.

The system ROM is 2 M-byte of flash ROM which can be programmed from the disk drive. One ROM IC is partitioned as a boot ROM. It is protected by a write protect switch. After power-up, pointers are set and the rest of ROM runs the instrument. The system RAM is 4M-byte of static RAM. All of the RAM has battery back-up.

The CPU assembly provides two ports to the user: an HP-IB port for instrument control and data handling, and a parallel port for a direct printer connection. Also, the hardware is present for a high-speed data port, which may be implemented with future firmware.

The CPU assembly provides separate digital interfaces to several internal functions:

- The processor sections of the system interface bus (SIB).
- The keyboard and other front panel functions.
- The display assembly.
- The digital functions of the front panel plug-ins, the module interface bus (MIB).

The CPU assembly uses a set of four switches to control firmware. One switch protects boot ROM, one protects system ROM, and two switches protect calibration factors. Use of these switches is covered wherever it is appropriate.

### **Display Assembly**

The display assembly handles the graphics functions of the instrument. It organizes pixel-level data for the display. Special interface circuitry on the CPU assembly connects the microprocessor to a TMS34010 graphics microprocessor on the display assembly. The main display memory is 1 MByte of dynamic RAM. A 4K by 12-bit static RAM is used for variable persistence and a 16K by 8-bit static RAM is used for color mapping. Out of a possible 256K different colors, up to 256 main colors and 15 overlay colors are available at one time.

The connection to the CPU assembly is through a dedicated ribbon cable connected between the two assemblies. the connection between the display assembly and the motherboard is not used.

### **Color CRT Module**

The color CRT module includes the color CRT and its associated driving circuitry. It uses vertical and horizontal sync and red, green, and blue video signals from the display processor. It gets power from a separate 120 Vdc supply in the power supply assembly. A switch to degauss the CRT is located on the rear panel of the power supply.

**Disk Drive and Control**

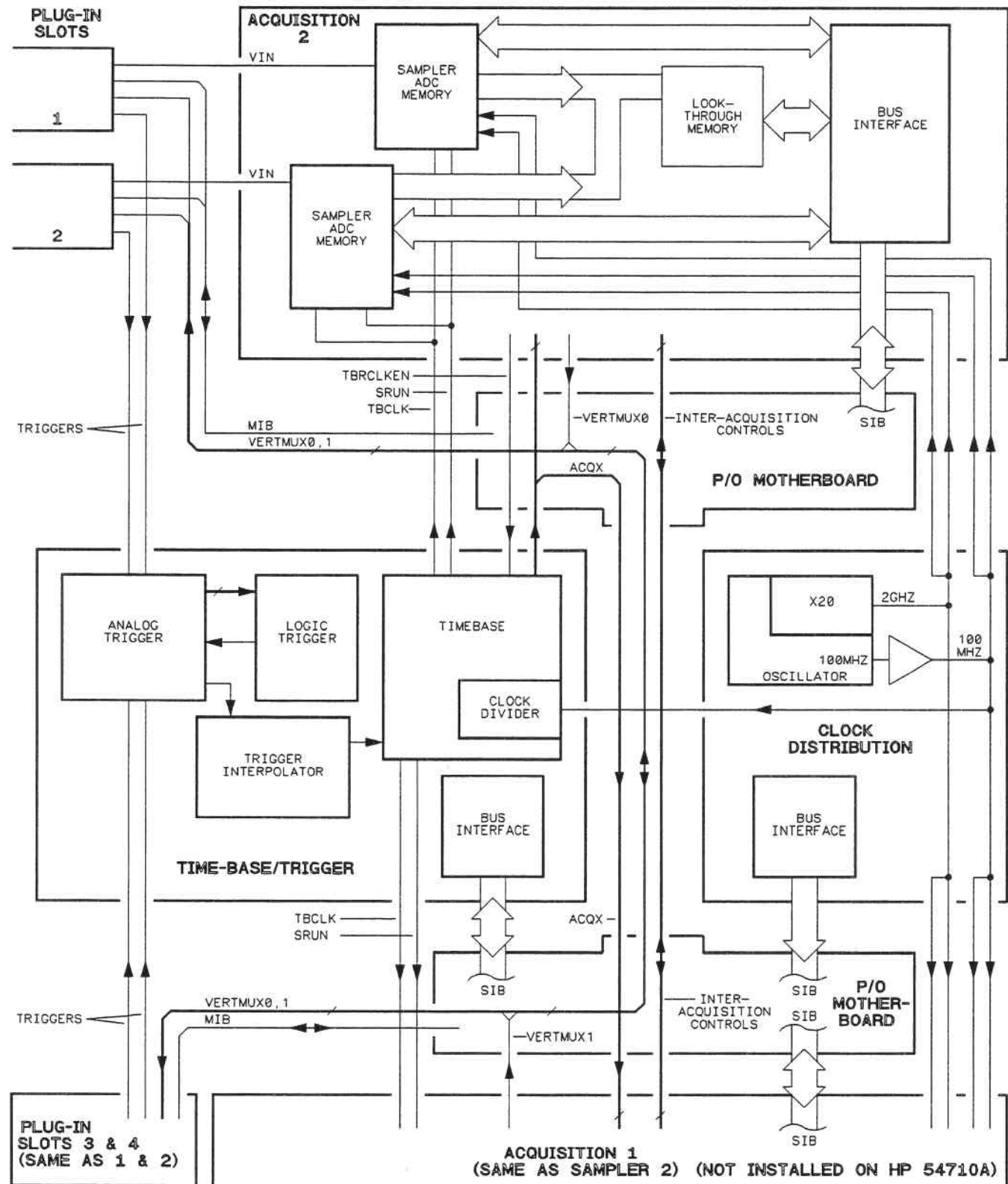
The disk drive is in the front panel of the instrument. Electronically however, it is not part of the front panel. The disk drive connects to the disk control, and the disk control connects to the SIB through the motherboard. The disk control assembly also passes the keyboard interface connections from the motherboard to the keyboard.

**Front Panel**

The front panel includes the hard keys, soft keys, knob, status LEDs, display controls, and a power switch. The knob is attached to a rotary pulse generator (RPG). The microprocessor communicates with the keyboard through a separate interface on the CPU assembly. Electrical connection between the CPU assembly and keyboard is made through the disk controller assembly and the motherboard.



Figure 8-2



54720b12

Acquisition Block Diagram

---

## Acquisition System

The acquisition system samples and stores the vertical input signals and establishes a time reference between the input trigger and the stored signal. There are four assemblies in the acquisition system: a time-base assembly which includes trigger functions, a clock assembly, and two acquisition assemblies. These assemblies occupy the four lower slots in the rear-panel card cage. They connect to each other with coaxial cables. They connect to the motherboard and SIB when installed in the mainframe. In addition, the time base and acquisition assemblies provide coaxial connectors which mate directly with plug-ins installed in the front panel slots.

In the acquisition block diagram on the previous page only two channels are shown in full. The other two are identical. To accommodate the slot they are in, the samplers are programmed differently of course.

### Acquisition Assemblies

Two identical acquisition assemblies receive the conditioned vertical signals from the four plug-in slots (channels) in the front panel. Two front-panel slots feed each acquisition assembly. The acquisition assemblies occupy the two lower slots in the instrument rear panel. The two acquisition assemblies are mechanically connected at the front so that all four vertical inputs can be aligned in one horizontal plane.

Each acquisition assembly holds two acquisition hybrids, one for each vertical channel. An acquisition hybrid accepts a signal of  $\pm 80$  mV and digitizes at a maximum of 2 Gsamples/s. Each acquisition hybrid consists of four groups of the three acquisition functions: sampler, analog-to-digital converter (ADC), and memory.

The four groups in one acquisition hybrid can be configured to optimize sample rate or vertical resolution. In addition, the acquisitions of two or four acquisition hybrids (in both acquisition assemblies) can be interleaved to obtain sample rates greater than 2 Gsamples/s or paralleled to obtain greater vertical resolution. This can be done when a vertical plug-in occupies two or more front-panel slots and provides the same vertical signal to more than one acquisition hybrid.

The 2 GHz sample clock is distributed from the clock assembly directly to each acquisition hybrid. Also distributed directly to each acquisition hybrid is a 100 MHz reference clock. A delay-locked-loop is used to adjust the phase relationship between the 2 GHz sample clock and the 100 MHz reference clock. This is used to eliminate phase noise and skew the sample clocks for interleaving the sample intervals.

The acquisition assemblies include the following major support functions for the acquisition hybrids:

- a look-through memory
- circuitry for interleaving acquisition data
- self test circuitry
- an interface to the SIB on the motherboard

The look-through memory serves two purposes. It maps the gray-code output of the acquisition memories to twos complement binary values. It also corrects for linearity errors in the analog path from the vertical plug-in input to the ADCs. The linearity correction is part of the self-calibration features of the instrument. During self calibration known signals are applied to the input of the plug-in. Errors in the digitized output are noted and the look-through memory is programmed to provide the correct code when the uncorrected data is read from the acquisition memory.

### Clock

The clock assembly generates the 2 GHz and 100 MHz clocks. A 100 MHz oscillator generates the reference clock. In the oscillator assembly the 100 MHz frequency is multiplied by 20 to get the 2 GHz sample clock. Both clocks are distributed by semi-rigid coax directly to the acquisition hybrids on the acquisition assemblies. An additional 100 MHz signal is sent to the time base assembly where it is divided for the lower-frequency sample rates.

### Time Base

The time base assembly performs several functions in the acquisition system:

- It provides analog trigger functions such as trigger level and slope.
- It provides logic trigger functions, combining the triggers of the channels.
- It determines the relationship between the trigger and acquisition memory (trigger interpolator).
- It starts and stops the acquisition process.
- It develops the sample clock for rates below 100 MHz.
- It provides clocking for reading the contents of acquisition memory.
- It provides the front-panel calibrator signals.

All triggering functions up to a frequency of 1 GHz can be provided by the time base assembly. For plug-ins requiring triggering above 1 GHz, the high-speed triggering is implemented in the plug-in. Logic triggering is not available on channels where the trigger is implemented in the plug-in.

The time base assembly occupies the fourth slot from the bottom in the rear panel card cage. The interface with the front panel plug-in slots is at the front of the assembly. Coaxial cables connect the trigger signals from the plug-ins to the trigger hybrid.

In the HP 54710A, the trigger functions are still available for plug-in slots 3 and 4 even though there is no acquisition assembly for these slots. Plug-ins in slots 3 and 4 will function only as trigger sources.

### Acquisition System Signals

Signals within the acquisition system control timing between the several separate assemblies. Some are connected directly between assemblies. Others are connected through the motherboard though they are not part of the SIB. Refer to the acquisition block diagram for signals in the following table:

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#### Acquisition System Signals

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| Signal                     | Description   |
|----------------------------|---|
| ACQX                       | These three signals from the time base are used for acquisition control. They are connected to the acquisition assemblies through the motherboard.  |
| Inter-Acquisition Controls | These are five signals that are used to control the readout of data from the acquisition memories. One line is used by acquisition 1 to tell acquisition 2 it has valid data to put on the SIB. the other four lines control interleaving of data. The signal at the assembly interface can be an input or output, depending on whether the board is acquisition 2 or acquisition 1. They connect the acquisition assemblies through the motherboard. |

| Signal   | Description   |
|--|---|
| MIB<br>(Module Interface Bus)                  | This bus provides the connection between the CPU and the digital functions of the plug-ins. It includes two serial address/data lines (data in and data out), address/data select, and several other control and handshake lines.   |
| SIB<br>(System Interface Bus)                  | This is the primary bus between the CPU and the acquisition system. It includes bits 1 to 13 of microprocessor address, bits 16 to 31 of microprocessor data, and various status, control, and interrupt lines.   |
| SRUN<br>(Synchronized Run)                     | This is an ECL signal that gates the clocks to the FIFO memories. It signals the actual start of data acquisition. It is synchronized to the 100 MHz reference clock and is conducted from the time base to the acquisition assemblies through coaxial cables.  |
| TBCLK<br>(Time Base Clock)                     | This is the acquisition write signal for sample rates 100 MHz and below. In this mode it is referenced to the 100 MHz reference clock. It is also used to increment acquisition memory when it is being read. It is conducted from the time base assembly to the acquisition assemblies by coaxial cables.                        |
| TBRCLKEN<br>(Time Base Read Clock Enable)      | This signal is used by the time base to enable the memory read clock from the microprocessor. The time base will then strobe TBCLK to advance to the next memory position. This signal is distributed through the SIB.  |
| Triggers                                       | These are the analog trigger signals from the plug-in slots. They are conditioned in the plug-ins and conducted from the plug-in interface directly to the analog trigger hybrid through coaxial cables. If a plug-in has its own high-speed triggering circuitry, the edge of this signal represents the selected trigger point. |
| VERTMUX0<br>VERTMUX1<br>(Vertical Multiplexer) | These signals are used to multiplex the channels in multi-channel plug-ins. VERTMUX0 is generated on acquisition 2 and VERTMUX1 is generated on acquisition 1. Both signals are conducted to each front panel slot through the motherboard.   |
| VIN<br>Vertical Input                          | This is the conditioned vertical signal from the plug-in. It provides $\pm 80$ mV for a full-screen vertical display. It is conducted from the plug-in interface directly to the acquisition hybrid through a "semi-flexible" cable.  |
| 100 MHz<br>(100 MHz Reference Clock)           | This is the reference clock for many of the signals from the time base. All references are to the zero crossing of the rising edge. It is conducted from the clock assembly directly to each acquisition hybrid by semi-rigid coax with SMA connectors.   |
| 2 GHz<br>(2 GHz Sample Clock)                  | This is the base sample clock. It is conducted from the clock assembly directly to each acquisition hybrid by semi-rigid coax with SMA connectors.  |

