Errata

Title & Document Type: 54112D Digitizing Oscilloscope Service Manual

Manual Part Number: 54112-90903

Revision Date: December 1987

HP References in this Manual

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

About this Manual

We've added this manual to the Agilent website in an effort to help you support your product. This manual provides the best information we could find. It may be incomplete or contain dated information, and the scan quality may not be ideal. If we find a better copy in the future, we will add it to the Agilent website.

Support for Your Product

Agilent no longer sells or supports this product. You will find any other available product information on the Agilent Test & Measurement website:

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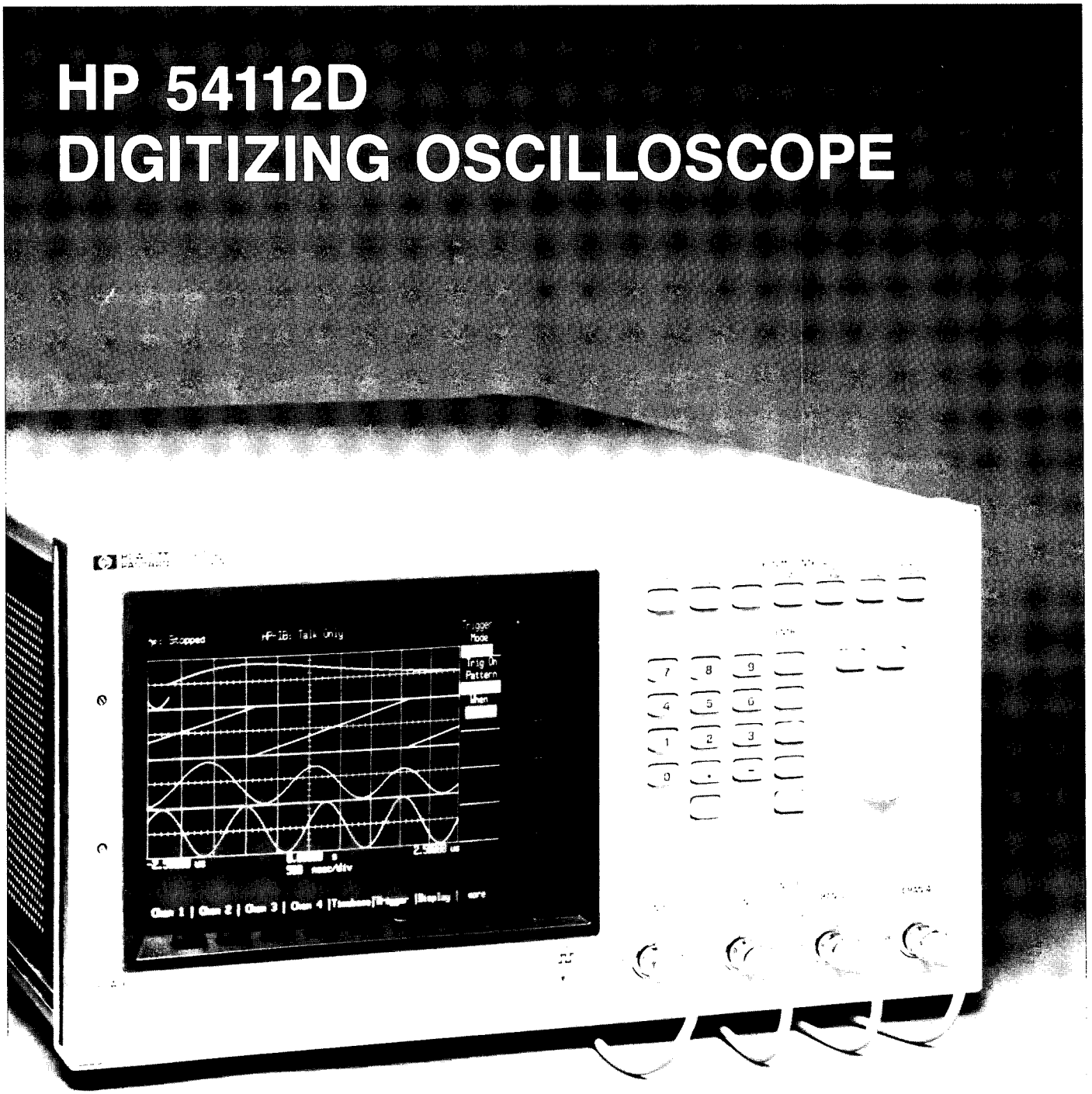
Search for the model number of this product, and the resulting product page will guide you to any available information. Our service centers may be able to perform calibration if no repair parts are needed, but no other support from Agilent is available.

Agilent Technologies

SERVICE MANUAL

HP 54112D
DIGITIZING OSCILLOSCOPE



HEWLETT PACKARD

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SERVICE MANUAL

HP 54112D

DIGITIZING OSCILLOSCOPE

SERIAL NUMBERS

This manual applies directly to instruments with serial numbers prefixed:

2735A

For additional important information about serial numbers, see INSTRUMENTS COVERED BY MANUAL in Section I.

Manual Part No. 54112-90903
Microfiche Part No. 54112-90803

PRINTED: December 1987

GEWERBEAUFSICHTSAMT STUTTGART

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

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Hewlett-Packard GmbH
Herrenberger Straße 110

7030 Böblingen

Stuttgart, den 02.06.1986
Fernsprecher
(07 11) 2 05 01 (Behördenzentrum)
Durchwahl 20 50 - 4798
Aktenzeichen: Z 5108/Hewlett-
(Bitte bei Antwort angeben)
Packard/Ws/Vg

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

Bezug: Ihr Antrag vom 22.05.1986; PSD US-ab

Nachtrag 1

zum Zulassungsschein Nr. BW/218/86/Rö

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

Gegenstand:	Digital-Oszilloskop
Firmenbezeichnung:	HP Typ 54 111 D HP Typ 54 112 D HP Typ 54 120 A
Bauartunterlagen:	Service Manuals Nr. 54 111 - 90 902 vom 21.94.86 Nr. 54 112 - 90 902 vom 24.04.86 Nr. 54 120 - 90 902 vom 26.04.86

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

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

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

Reutter

GEWERBEAUFSICHTSAMT STUTTGART

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

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Colorado Springs
Colorado 80907, USA

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

Firma
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Herrenberger Str. 110/130

7030 Böblingen

Zulassungsschein Nr. BW/218/86/Rö

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

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

Die Bauartzulassung ist befristet bis 16.01.1996.

Für den Strahlenschutz wesentliche Merkmale

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

Auflagen:

1. Die Geräte sind bezüglich der für den Strahlenschutz wesentlichen Merkmale entsprechend den vorgestellten und geprüften Mustern und Antragsunterlagen herzustellen.

2. Die Geräte sind einer Stückprüfung daraufhin zu unterziehen, ob sie bezüglich der für den Strahlenschutz wesentlichen Merkmale der Bauartzulassung entsprechen.

   Die Prüfung muß umfassen:

   a) Kontrolle der Hochspannung an jedem einzelnen Gerät,

   b) Messung und Dosisleistung nach Festlegung im Bauartzulassungsbescheid.

3. Die Herstellung und die Stückprüfung sind durch den von der Zulassungsbehörde bestimmten Sachverständigen überwachen zu lassen.

4. Die Geräte sind deutlich sichtbar und dauerhaft mit dem Kennzeichen

   BW/218/86/Rö

   zu versehen sowie mit einem Hinweis folgenden Mindestinhalts:

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

Hinweis für den Benutzer des Geräts:

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

Reutter

GEWERBEAUFSICHTSAMT STUTTGART

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

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

SAFETY CONSIDERATIONS

GENERAL - This is a Safety Class I instrument (provided with terminal for protective earthing).

OPERATION - BEFORE APPLYING POWER verify that the power transformer primary is matched to the available line voltage, the correct fuse is installed, and Safety Precautions are taken (see the following warnings). In addition, note the instrument's external markings which are described under "Safety Symbols."

WARNING

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

SAFETY SYMBOLS

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

Indicates hazardous voltages.

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

WARNING

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

CAUTION

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

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SECTION 1
GENERAL INFORMATION

1-1. INTRODUCTION

This Service Manual contains information necessary to test, adjust, and service the Hewlett-Packard 54112D Digitizing Oscilloscope. This manual is divided into 6 sections as follows:

1 - General Information

2 - Installation

3 - Performance Tests

4 - Adjustments

5 - Replaceable Parts

6A - Instrument Disassembly

6B - Theory of Operation

6C - Service Menus/Keys

6D - Self-Tests/Troubleshooting

Information for operating, programming, and interfacing the HP 54112D is contained in the *HP 54112D Operating and Programming Manual* supplied with each instrument.

The General Information Section includes a description of the HP 54112D Digitizing Oscilloscope, its specifications, characteristics, options, and available accessories.

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

1-2. DESCRIPTION

The HP 54112D is a fully programmable, real-time digitizing oscilloscope. It uses sample rates up to 400 Megasamples/second, and has a real-time bandwidth of 100 MHz.

The inputs include four vertical signal channels and an external trigger. The channel inputs can be set up for 50 Ohm impedance with dc coupling or 1 MOhm at 6.5 pf with ac or dc coupling. The signals from the vertical channels and external trigger can be used to provide a qualified trigger for the instrument and can be a pattern of levels and/or edges (see table 1-2).

The color display of the HP 54112D provides 16 colors which are mapped to provide specific colors for specific functions. For example, channel 1 is displayed in yellow, channel 2 in green, channel 3 in orange, channel 4 in pink, and error messages are displayed in red.

To ensure proper operation, extensive self-tests have been designed into the instrument, in addition to internal diagnostics which aid in efficient fault locating and repair should a failure occur.

1-3. SPECIFICATIONS

Instrument specifications are listed in table 1-1. These specifications are the performance standards against which the oscilloscope is tested.

1-4. OPERATING CHARACTERISTICS

Table 1-2 is a listing of the instrument's operating characteristics. These are not specifications, but are typical operating characteristics included as additional information for the user.

1-5. GENERAL CHARACTERISTICS

Table 1-3 gives environmental limits, input power requirements, and mechanical dimensions.

1-6. SAFETY CONSIDERATIONS

This product is a Safety Class 1 instrument (provided with a protective earth terminal). Review the instrument and manual for safety markings and instructions before operating. A page, Safety Considerations, covering general safety concerns, is in the front of this manual. Specific warnings, cautions, and instructions are placed wherever applicable throughout the manual. These precautions must be observed during all phases of operation, service, and repair of the instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of this instrument.
Hewlett-Packard assumes no liability for the customer's failure to comply with these requirements.

1-7. INSTRUMENTS COVERED BY MANUAL

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

An oscilloscope manufactured after the printing of this manual may have a serial number prefix that is not listed on the title page. This unlisted serial prefix indicates the oscilloscope is different from those described in this manual. The manual for this newer oscilloscope is accompanied by a Manual Changes supplement. This supplement contains "change information" that explains how to adapt the manual to the newer oscilloscope.

In addition to change information, the supplement may contain information for correcting errors in the manual. To keep this manual as current and accurate as possible, Hewlett-Packard recommends that you periodically request the latest Manual Changes supplement. The supplement for this manual is identified with the manual print date and part number, both of which appear on the manual title page. Complimentary copies of the supplement are available from Hewlett-Packard.

1-8. OPTIONS

In addition to power cord options, the following options are available for the HP 54112D:

- W30: Additional two years "return to HP" service support commencing at the end of the standard warranty.
- 090: Deletion of the four 10:1 divider probes.
- 908: Rack mounting kit.
- 910: Extra manuals, consisting of a set of operating and programming manuals and a service manual.

1-9. ACCESSORIES SUPPLIED.

The following accessories are supplied with the HP 54112D:

- Four 10:1 divider probes, HP Model No. 10033A.
- One power cord.
- One set of operating and programming manuals.
- One service manual.

1-10. RECOMMENDED TEST EQUIPMENT

Equipment recommended to maintain the HP 54112D is listed in table 1-4. The function for which a piece of equipment is needed (Performance Tests, Adjustments, or Troubleshooting), is also given in the table.

Table 1-1. Specifications

VERTICAL (VOLTAGE)

Bandwidth (–3 dB) **dc-coupled** **ac-coupled**	dc to 100 MHz 10 Hz to 100 MHz
Transition Time (10% to 90%)	See "Operating Characteristics"
Deflection Factor (full-scale=8 div)	5 mV/div to 5 V/div continuous
Resolution (% of full scale)	8 bits with averaging to 100 MHz, (0.4%) 6 bits to 100 MHz, (1.6%)
DC Gain Accuracy	±2% of full-scale [1]
DC Offset Accuracy	±1.5% of setting ±0.2 div [2]
DC Measurement Accuracy **single data point** **between data points on same waveform**	±Gain Acc. ±Offset Acc. ±Resolution ±Gain Acc. ±2 × Resolution
DC Offset Range	±1 V (5 mV/div to 49 mV/div) ±10 V (50 mV/div to 499 mV/div) ±40 V (500 mV/div to 5 V/div)
Input Coupling	ac/dc/dc-50 Ω
Input Resistance	1 Megohm nominal, or 50 ohms (dc) ±1%
Maximum Safe Input Voltage	±40 Volts @ 1 MΩ (dc + peak ac), 5 Vrms @ 50 Ω

NOTE: *All voltages in the table correspond to a 1:1 attenuation setting. If a 10:1 probe is attached, multiply all voltages by 10. The HP 10033A has a maximum voltage of ±200 V.*

1 When calibrated to probe tip using the front panel calibration source. Applies to major ranges (5 mV/div, 10 mV/div, 20 mV/div, 50 mV/div, 100 mV/div, 200 mV/div, 500 mV/div, 1 V/div, 2 V/div). All settings other than these ranges are ±3% of full-scale.

2 Increases to ±0.4 divisions at 5 mV/div to 9 mV/div.

Table 1-1. Specifications (cont.)

HORIZONTAL (TIME)

Digitizing Rate	400 MS/s to 50 S/s
Deflection Factor	2 ns/div to 1 s/div
Memory Depth per Channel	64K max (160 μs @ 400 MS/s)
Pre-trigger Delay Range	−160 μs @ timebase settings 249 ns/div and faster, increasing to −1200 s @ 1 s/div.
Post-trigger Delay Range	160 ms @ timebase settings 500 ns/div and faster, increasing to 10,000 s @ 1 s/div.
Measurement Accuracy single channel	2 to 24.9 ns/div - ±500 ps ±0.002% of reading 25 ns/div and slower - ±0.2% of time range[1] ±0.002% of reading
dual channel	2 to 24.9 ns/div - ±1 ns ±0.002% of reading 25 ns/div and slower - ±0.4% of time range[1] ±0.002% of reading

NOTE: *All delta time measurement accuracy specifications include: (1) Timebase accuracy (% of Delta t), (2) Aperture uncertainty and sample clock phase jitter, (3) Reconstruction filter uncertainty, (4) Trigger interpolator jitter (repetitive only), (5) Channel to channel skew (dual channel only).*

1 Time range is TIME/DIV x 10.

TRIGGERING

Sources	**Internal Channels 1,2,3,4**	**External Rear Panel Input**
Sensitivity	0.1 of full-scale, dc to 100 MHz	100 mV p-p (1:1) dc to 50 MHz
Trigger Level Range	±3 × full-scale [1,2]	±5 V (1:1) [3]
Input Resistance	NA	200K ohms (nominal) [4]
Maximum Safe Input Voltage	NA	±40 volts (dc + peak ac)
Input Operating Range	NA	±5 V (1:1) dc + peak ac

1 The trigger level range is centered on the Offset level.

2 Trigger level range is limited to ±600 mV from 25 to 49 mV/div inclusive, ±6 V from 250 to 499 mV/div inclusive, and by the maximum safe input voltages at 2 V/div and above.

3 The ±25 mV of hysterisis in the external trigger is not included in this specification.

4 When the external trigger is used with a 1 Mohm 10:1 probe intended for 1 Mohm inputs (HP 10017A/033A/431A) and instrument menus are set up to reflect the 10:1 probe, the software provides the correct scaling to compensate for the difference in input resistance.

Table 1-2. Operating Characteristics.

VERTICAL

Real-time Mode Transition Time (10% to 90%): 3.5 ns.
Calculated by measuring a 3.5 ns risetime source. In the filter mode, a 3.5 ns input risetime is measured as; 4.95 ns = $\sqrt{(3.5)^2 + (3.5)^2}$.
Input Capacitance: 6.5 pF at 1 MOhm input resistance.
Input Protection: 50 ohm input resistor is protected where input rating is exceeded.
Dynamic Performance (typical):

Input Frequency	1 MHz	10 MHz	40 MHz	100 MHz
Effective Bits of Resolution	5.5	5.5	5.2	5.0

Channel-to-channel Isolation: 60dB at 100MHz.

HORIZONTAL

Delay Between Channels: Difference in delay between channels can be front panel calibrated.
Reference Location: The reference point can be located at the left edge, center, or right edge of the display. The reference point is the trigger plus the delay time.

TRIGGER

Trigger Modes
Edge trigger: on any source.
Pattern trigger: A pattern can be specified for all sources. Each source can be specified as high, low, or don't care. Trigger can occur on the last edge to enter the specified pattern or the first edge to exit the specified pattern.
State trigger: A pattern can be specified for any of the sources. Trigger can be set to occur on an edge of either polarity on the source specified as the clock (not one of the pattern sources) when the pattern is present or not present. Setup time for the pattern to be present prior to the clock edge is <4 ns; hold time is zero.

Delayed Trigger
Events-delayed mode: The trigger can be armed by an edge on any source, then triggered by the nth edge on any other source. The number of events, n, can be set from 1 to 16,000,000. Maximum event counting rate is 35 MHz.
Time-delayed mode: The trigger can be armed by an edge on any source, then triggered by the first edge on any other source after a specified time from 50 ns to 160 ms has elapsed.
External Trigger Filter
High Frequency Reject provides an external trigger bandwidth from dc to approximately 4 KHz.

DISPLAY

Data Display Resolution: 501 points horizontally by 256 points vertically.
Data Display Formats
Quad Screen: Channel displays are two divisions high. Each channel is displayed separately.
Dual screen: Channel displays are four divisions high. Channels 1 and 3 are overlaid on the top display and channels 2 and 4 on the bottom.
Full screen: Channel displays are eight divisions high and all are overlaid.

Table 1-2. Operating Characteristics (cont.)

DISPLAY (cont.)

Display Modes

Variable persistence: The time that each data point is retained on the display can be varied from 200 ms to 10 seconds, or it can be displayed in the infinite persistence mode.

Averaging: The number of averages can be varied from 1 to 64. On each acquisition, 1/n times the new data is added to (n-1)/n of the previous value at each time coordinate. Averaging operates continously; the average does not converge to a final value after n acquisitions, except over HP-IB.

Graticules: Full grid, axes with tic marks, frame with tic marks, or graticule off.

Data Reconstruction: On sweep speeds when less than 500 points are acquired across the screen, a built-in digital filter will automatically reconstruct the data in the real-time acquisition modes (single-shot acquisition). The filter "off" position in the display mode will display raw data.

Display Colors: A default color selection is set up. Different colors are used for display background, channels, functions, background text, highlighted text, advisories, markers, overlapping waveforms, and memories. If desired, colors may be changed either from the front panel or over HP-IB.

HP-IB

Data Transfer Rate: 80k bytes/s

MEASUREMENT AIDS

Markers: Dual voltage markers and dual time markers are available. Voltage markers can be assigned to channels, memories, or functions.

Automatic Edge Finders: The time markers can be assigned automatically to any displayed edge of either polarity on any channel. The voltage markers establish the threshold reference for the time markers in this mode.

Automatic Pulse Parameter Measurements: The following pulse parameter measurements are performed automatically (as defined by IEEE standard 194-1977, "IEEE Standard Pulse Terms and Definitions").

Frequency	Overshoot
Period	Peak-to-peak voltage
Duty Cycle	Average voltage
Pos Pulse Width	RMS voltage
Neg Pulse Width	Top voltage *
Rise time	Base voltage *
Fall time	Maximum voltage
Preshoot	Minimum voltage

* only available over the HP-IB.

Waveform Math: Two independent functions are provided for waveform math. The operations provided are +, −, and invert. The vertical channels or any of the waveform memories can be used as operands for the waveform math.

SETUP AIDS

Presets: Vertical deflection factor, offset, and trigger level can be preset independently on each channel for ECL and TTL levels.

Auto-Scale: Pressing the Auto-Scale button causes the vertical and horizontal deflection factors and the trigger source to be set for a display appropriate to the signals applied to the inputs. Requires a duty cyle greater than 0.1% and frequency greater than 50 Hz. Operative only for relatively stable input signals.

Save/Recall: Ten front panel setups may be saved in non-volatile memory. If Auto-Scale is inadvertently pressed, pressing Recall followed by Auto-Scale, restores the instrument to the state prior to the first Auto-Scale.

Table 1-3. General Characteristics

ENVIRONMENTAL CONDITIONS

Temperature
Operating: 0° C to +45° C (+32° F to +113° F)
Non-operating: −40° C to +75° C (−40° F to +167° 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 4600 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 Grms.
Non-operating: Random vibration 5-500 Hz, 10 minutes per axis, ~2.41 Grms; resonant search 5 to 500 Hz swept sine, one octive/minute sweep rate, 5 minute resonant dwell at 4 resonances per axis.

POWER REQUIREMENTS

Voltage: 115/230 V ac, −25% to + 15%, 48-66 Hz.
Power: 350 watts maximum, 700 VA maximum.

WEIGHT

Net: approximately 25 kg (56 lb).
Shipping: approximately 32 kg (70 lb).

DIMENSIONS

Refer to the outline drawings.

NOTES:

1. *Dimensions are for general information only. If dimensions are required for building special enclosures, contact your HP field engineer.*
2. *Dimensions are in millimetres and (inches).*

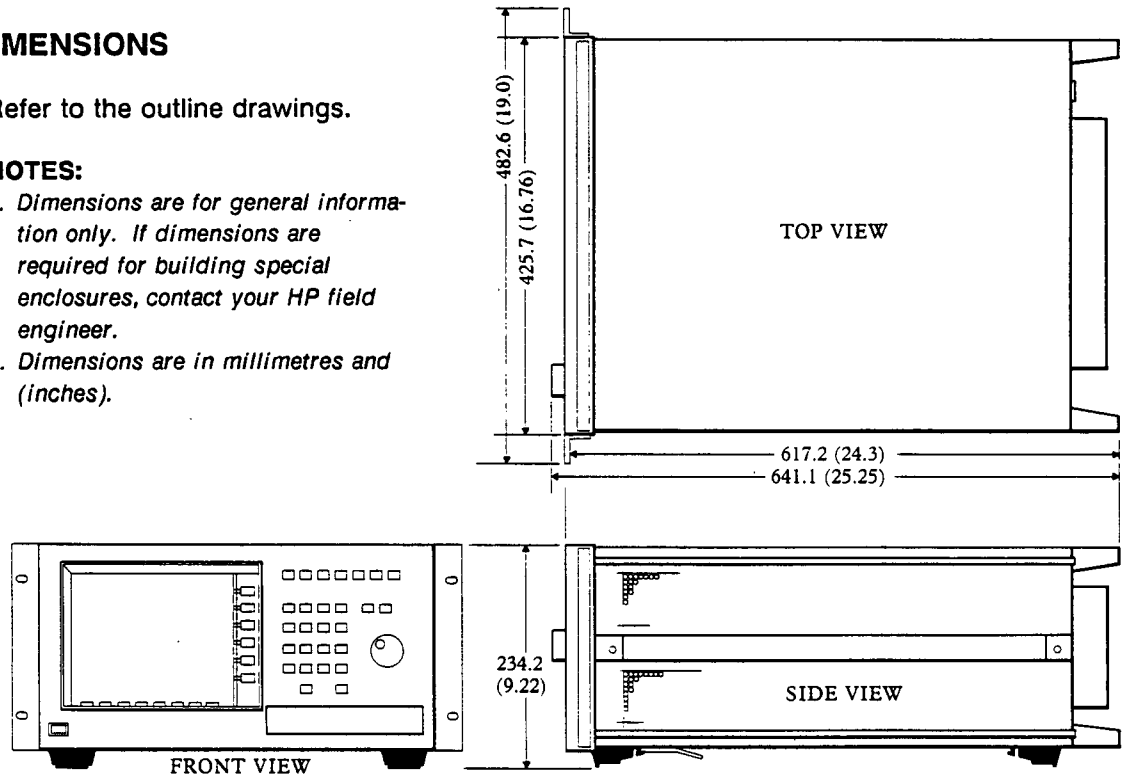


Table 1-4. Recommended Test Equipment.

Equipment Required	Critical Specifications	Recommended Model	Use*
Signal Generator	100 KHz to 100 MHz, <-34 dBm to >+12 dBm, timebase within 5 ppm	HP 8656B check time-base to be within 5 ppm	P
Power Meter and Sensor	100 KHz to 100 MHz, <-28 dBm to >+9 dBm	HP 436A/8482A	P
DC Supply	±175 mV to ± 100V, 0.1 mV resolution	HP 6115A	P,A
Digital Multimeter	Better than ±0.05% accuracy	HP 3468A	P,A,T
Pulse Generator	≤1% perturbation after 10 ns 0 to -300 mV output	Tektronix PG 506	A
Oscilloscope	General purpose 300 Mhz bandwidth	HP 54201A	T
Power Splitter	Outputs differ by <0.15%	HP 11667A	P
Attenuator	10 ±0.6 dB at 50 MHz	HP 8491B	P
Divider Probe	10:1, 1 MΩ	HP 10431A/033A/017A	P,A,T
Termination	BNC 50Ω feedthrough	HP 10100C	P,A
Cables (2)	BNC (m) >36 inch (equal Length)	HP 10503A	P,A
Cable	Type N (m) 24 inch	HP 11500B	P
Adapter (2)	N (m) to BNC (f)	HP 1250-0780	P
Adapter	N (m) to BNC (m)	HP 1250-0082	P
Adapter	N (f) to BNC (m)	HP 1250-0077	P
Adapter (2)	BNC (f) to banana (m)	HP 1251-2277	P
Adapter	BNC tee (m) (f) (f)	HP 1250-0781	P,A
Adjustment tool	Non-metallic (for display)	HP 8710-1355	A
Adjustment tool	(for attenuator)	HP 8710-1515	A
Product Support Kit	No substitute	HP 54100-69006	T

* P = Performance Tests, A = Adjustment Procedures, T = Troubleshooting

Installation

SECTION 2
INSTALLATION

2-1. INTRODUCTION

This section contains the initial operation information for the HP 54112D Digitizing Oscilloscope. Included are power and grounding requirements, operating environment requirements, cleaning methods and storage and shipment requirements.

2-2. PREPARATION FOR USE

POWER REQUIREMENTS. The instrument requires a power source of either 115 or 230 VAC, -25% to +15%; single phase, 48 to 66 Hz; 350 watts, 700 VA maximum.

CAUTION

The instrument may be damaged if the Line Voltage Select Switch is not properly set to match the input line voltage.

LINE VOLTAGE SELECTION. Before turning ON the instrument verify that the Line Voltage Select Switch on the rear panel matches the input line voltage.

POWER CABLE. This instrument is equipped with a three-wire power cable. When connected to an appropriate AC power outlet, this cable grounds the instrument cabinet. The type of power cable plug shipped with the instrument depends on the country of destination. See table 2-1 for option numbers of power cables and plug configurations available. Part numbers for each cable option are also listed in the parts list in Section VI.

2-3. OPERATING ENVIRONMENT

The operating environment is noted in table 1-3. Note should be made of the non-condensing humidity limitation. Condensation within the instrument can cause poor operation or malfunction. Protection should be provided against internal condensation.

2-4. CLEANING REQUIREMENTS

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

CAUTION

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

2-5. STORAGE AND SHIPMENT

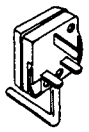
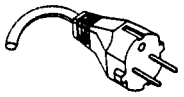
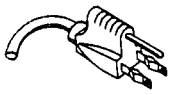
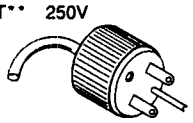
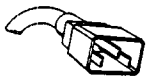
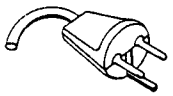
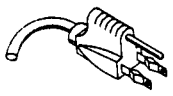
2-6. Environment

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

Temperature: -40 to +75° C (-40 to +167° F)
Humidity: Up to 90% at 65° C (+149° F)
Altitude: Up to 15,300 metres (50,000 feet)

The instrument should also be protected from temperature extremes which cause condensation within the instrument. Condensation within the instrument may cause malfunction if the instrument is operated under these conditions.

Table 2-1. Power Cord Configurations

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

*Part number shown for plug is industry identifier for plug only. Number shown for cable is HP Part Number for complete cable including plug.
**These cords are included in the CSA certification approval of the equipment.
E = Earth Ground
L = Line
N = Neutral

AC.CABLES3

2-7. Packaging

TAGGING FOR SERVICE. If the instrument is to be shipped to a Hewlett-Packard office for service or repair, attach a tag showing owner (with address), complete instrument serial number, and a description of the service required.

ORIGINAL PACKAGING. If the original packing material is not available or is unserviceable, material identical to those used in factory packaging are available through Hewlett-Packard offices. If the instrument is to be shipped to a Hewlett-Packard office for servicing, attach a tag showing owner (with address), model number, complete instrument serial number, and a description of the service required. Mark the container FRAGILE to ensure careful handling. In any correspondence, refer to the instrument by model number and full serial number.

OTHER PACKAGING. The following general instructions should be used for repacking with commercially available materials.

a. Wrap instrument in heavy paper or plastic.

b. Use a strong shipping container. A double-wall carton made of 350 lb. test material is adequate.

c. Use a layer of shock-absorbing material 70 to 100 mm (3 to 4 inch) thick around all sides of the instrument to provide firm cushioning and prevent movement inside container. Protect control panel with cardboard.

d. Seal shipping container securely.

e. Mark shipping container FRAGILE to ensure careful handling.

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

Performance Tests

SECTION 3
PERFORMANCE TESTS

3-1. INTRODUCTION

The procedures in this section test the instrument's electrical performance using specifications in Section I as performance standards. The specification is also listed at the beginning of the test for reference.

3-2. CALIBRATION CYCLE

This instrument requires periodic verification of performance. The instrument should be checked using the following performance tests yearly or every 2000 hours of operation. Amount of use, environmental conditions, and the user's experience concerning need for calibration will contribute to performance verification requirements.

3-3. CALIBRATION REQUIREMENTS

To fully calibrate the HP 54112D, follow these steps:

1. Ensure front panel CAL signal is 800 ±2 mV. Follow the Calibrator Amplitude Adjustment procedure, section 4, but do not adjust unless outside the 2 mV tolerance.

2. Check the Flatness Adjustment, section 4. Do not adjust unless needed.

3. Perform these procedures per section 4:
   - Vertical Cal
   - Probe Tip Cal
   - Offset Cal
   - Trigger Cal
   - Channel Skew Alignment

4. Perform all Performance Test procedures and record the results.

For a MIL STD calibration, do all performance tests first and record results in the performance test record. Then perform the calibration as above.

3-4. TESTS AFTER REPLACEMENTS

Some performance tests may be necessary after replacement of an assembly, though it may not be necessary to test the entire instrument. Table 3-1 (next page) gives the minimum performance testing required after replacement of major assemblies.

3-5. EQUIPMENT REQUIRED

Equipment required for performance tests is listed in table 1-4. Any equipment that satisfies critical specifications given in the table may be substituted.

3-6. PROBES USED DURING TESTS

The HP 54112D uses a ring around the input BNC to sense a grounded contact pin on certain 10:1 probes, such as the HP 10431A, or other probes shipped with the instrument. The HP 54112D scales the input properly when those 10:1 probes are being used.

Some parameters of the HP 54112D are specified with the instrument calibrated through a probe to the front panel CAL signal or a 10 V supply. Therefore, some of the performance tests require the use of a 10:1 divider probe and using the Probe Tip Cal to calibrate the instrument with that probe.

In the event that the probes shipped with the HP 54112D are not available for performance tests, any probe with comparable specifications may be used, whether it has the grounded contact pin or not. Probe Tip Cal assumes that a 10:1 probe is being used so the calibration is properly done. The performance test procedures are written to allow use of unsensed probes, such as the HP 10017A.

Calibration with the probe is a user function. The HP 54112D can be calibrated to other probes once it is returned to the user.

Table 3-1. Performance Tests Required After Assembly Replacement.

PERF. TEST / ASSEMBLY	Calibrator Amplitude	Input Res.	Measurement Accuracy	Offset Accuracy	Band-width	Timebase Accuracy	Trigger Sens.
Acquisition			RCO	RCO	RCO		
Timebase/Trig	#					X	EXT Trig only
Attenuator		RCO	RCO	RCO	RCO		RCO

NOTE: The **Microprocessor, Input/output,** and **Color Display** assemblies, **Color CRT Module**, and **Power Supplies** do not require any performance tests after replacement.

KEY: RCO Replaced Channel Only. Perform the test only on the channel in which the assembly was replaced.

\# Timebase/trigger assembly replacement calls for calibrator amplitude adjustment. Adjustment sets calibrator amplitude with greater accuracy than the performance test requires so the performance test is unnecessary.

X This test must be performed.

3-7. PERFORMANCE TEST RECORD

Results of performance tests may be entered in the Performance Test Record (table 3-2) at the end of the procedures. The Test Record lists the tested specifications and their acceptable limits. The results recorded at incoming inspection can be used for comparison in periodic maintenance and troubleshooting and when testing after repairs or adjustments.

3-8. ONE-KEY POWER UP

A one-key power up is a procedure where any one key is held depressed when the power is turned on. The key is held depressed until the power up cycle completes; "Powerup Self Test Passed!" (or Failed) is displayed. This is done to preset or reset the instrument to default conditions and prevent previous setups from interfering with the next test. It also simplifies the instrument setup procedure.

The one-key power up is a part of many procedures and should be performed like any other procedural step.

You can save some time by performing the first one-key power up then storing the setup. This avoids the wait for actual power up. The procedures however, expect the instrument to be in a certain menu after power up. After recalling the stored setup the instrument will not be in the same menu as it would be after the power up. The next steps in the procedure, if they involve keystrokes, may need to be altered to reflect the different starting point. This method is recommended for experienced users of the instrument.

3-9. PERFORMANCE TEST PROCEDURES

Performance test procedures start with the next paragraph. Any one, or all procedures may be done in any order.

NOTE

Allow instrument to warm up for at least 15 minutes prior to beginning performance tests.

3-10. CALIBRATOR AMPLITUDE

Description:

This procedure checks the amplitude of the front panel calibrator. This signal is used to run calibration routines in the instrument.

When being adjusted, this signal has a tighter specification than that required for passing this test. This is done to maintain the performance specification for the entire calibration cycle (see Calibration Requirements).

Specification:

+0.8 ±0.004 Vdc

Equipment Required:

EQUIPMENT	CRITICAL SPECIFICATIONS	RECOMMENDED MODEL
DC Voltmeter	Better than 0.05% accuracy	HP 3468A

Procedure:

1. Connect the voltmeter input to the front panel calibrator signal. Connect the voltmeter ground to the CHAN 1 input BNC ground.
2. With the softkeys, press ***more, Utility, Test Menu, Extended Tests***, 21 and ENTER, and ***Start Test***.
3. The CAL signal should be +0.8 ±0.004 Vdc; record the value.
4. Press ***Stop Test*** then ***Exit Test Menu*** to return to normal functions.

3-11. INPUT RESISTANCE

Description:

A four-wire resistance measurement is used to verify accuracy of the channel 50Ω input resistance.

Specification:

50Ω ±1%

Equipment Required:

EQUIPMENT	CRITICAL SPECIFICATIONS	RECOMMENDED MODEL
Multimeter	Measure resistance better than 0.25% accuracy	HP 3468A
Cables (2)	BNC	HP 10503A
Adapter	BNC Tee (m)(f)(f)	HP 1250-0781
Adapter (2)	BNC (f) to banana (m)	HP 1251-2277

Procedure:

1. Set up the multimeter to make a 4-wire resistance measurement.
2. Connect the BNC tee to the CHAN 1 BNC of the HP 54112D and connect the BNC cables to the female ends of the BNC tee.
3. Use the BNC-to-banana adapters to connect the free ends of the BNC cables to the 4-wire resistance connectors on the multimeter.
4. Press ***Chan 1*** and verify or set ***Input Impedance*** of **50Ω**. The reading on the multimeter should be 50Ω ±0.5Ω.
5. Repeat steps 2 through 4 for channels 2, 3, and 4.

3-12. VOLTAGE MEASUREMENT ACCURACY

Description:

This test verifies the voltage measurement accuracy of the instrument with a 10:1 probe at the input. Accuracy consists of gain accuracy and resolution. The test uses positive and negative DC levels so that any OFFSET errors are nulled.

If any part of this test fails on a channel, perform the Flatness Adjustment and vertical software cals (Vertical Cal, Probe Tip Cal, Offset Cal, section 4) for that channel and retest.

Specification: [1]

Averaging: ±2.8% of full scale[2] [2% gain + 2 × resolution(0.4%)]
Real-time:[3] ±5.2% of full scale[2] [2% gain + 2 × resolution(1.6%)]

1 - Major ranges only and with a 10:1 probe at the input; 2 - Full scale = 8 div × V/div; 3 - Not tested

Equipment Required:

EQUIPMENT	CRITICAL SPECIFICATIONS	RECOMMENDED MODEL
DC Supply	±175 mV to ±70 Vdc 0.1 mV resolution	HP 6115A
DC Voltmeter	Better than 0.1% accuracy	HP 3468A
Oscilloscope Probe	10:1	HP 10431A/033A/017A

Procedure:

A positive, followed by a negative, voltage is applied at each V/div range. Each voltage is measured and the difference is used to check gain on that range. With a supply like the HP 6115A, polarity is changed by floating the supply and reversing the connection of the probe to get the negative value. If you are using a supply with switchable polarity reversing the probe connection is not necessary.

1. Perform a one-key power up* to set instrument to default conditions, then set the following additional parameters.

   *Power to STBY. Press and hold one key. Power to ON. Release key when "Powerup Self Test Passed!" is displayed.

MENU SELECT	FUNCTION SELECT	SETTING
Chan 1,2,3,4	Display	Chan 1 On/Chan 2,3,4 Off
Timebase	TIME/DIV	2 us/div
Display	NUMBER OF AVERAGES Screen	64 Single
Delta V	V Markers	On

2. Connect the 10:1 divider probe to the CHAN 1 input of the HP 54112D and the front panel CAL signal and press ***more***.

3. If you are using an HP 10431A or 10033A probe, skip this step. Press ***Utility, Probe Menu***, and ***CHAN 1 PROBE ATTN***, then in the ENTRY keys, 10 and ENTER.

4. Calibrate the HP 54112D to the 10:1 probe being used for the test. Press ***Utility, Cal Menu, Probe Tip Cal, Calibrate Probe Tip CHAN 1***, and ***Continue***. When calibration is done press ***Exit, more, Chan 1***, and ***VOLTS/DIV***.

5. Set the power supply to 0.0 V and remove any connection between the output and ground.

6. Use the following table for steps 7 through 17. For the first V/div setting it is necessary to set the supply within ±0.1 mV with the voltmeter.

SCOPE V/div	INPUT VOLTAGE SETTINGS#	Δ	MEASURED Δ VOLTAGE LIMITS TOLERANCE	MIN		MAX
50 mV	±175 mV*	350 mV	±12 mV	338 mV	_____	362 mV
100 mv	±350 mV	700 mV	±24 mV	676 mV	_____	724 mV
200 mv	±700 mV	1.40 V	±50 mV	1.35 V	_____	1.45 V
500 mV	±1.75 V	3.50 V	±120 mV	3.38 V	_____	3.62 V
1 V	±3.5 V	7.00 V	±240 mV	6.76 V	_____	7.24 V
2 V	±7.0 V	14.0 V	±500 mV	13.5 V	_____	14.5 V
5 V	±17.5 V	35.0 V	±1.2 V	33.8 V	_____	36.2 V
10 V	±35.0 V	70.0 V	±2.4 V	67.6 V	_____	72.4 V
20 V	±70.0 V	140 V	±5 V	135 V	_____	145 V

#For a supply without a polarity switch (like the HP 6115A) polarity is changed by switching the probe tip and ground of the 10:1 probe.

*Confirm this setting with the voltmeter.

7. Connect the probe to the output of the supply (probe tip to +, ground clip to –).

8. Press ***Chan 1*** and ENTER the SCOPE V/div range with the ENTRY keypad.

9. Set the supply to the positive value of the voltage in the INPUT VOLTAGE - SETTINGS column of the table and press CLEAR DISPLAY to restart averaging.

10. Press ***more, Delta V***, and ***MARKER 2 POSITION***. When ***#Avgs = 64***, use the knob and cursors to set the marker over the trace. With the marker at best overlap the most overlap color will show.

11. Set the supply to the negative value of the voltage in the INPUT VOLTAGE - SETTINGS column of the table (or reverse the probe connections, probe tip to – and ground clip to +) and press CLEAR DISPLAY.

12. Press ***MARKER 1 POSITION*** and overlap the trace with the marker.

13. Read and record the $\Delta V=$ in the lower right corner of the screen. It should fall within the specified limits in the table above.

14. If you are using a supply with no polarity switch reverse the probe connection (probe tip to +, ground to −).

15. Press ***more*** and repeat steps 7 through 14 with the rest of the V/div rannges in the table.

16. Press ***more, Chan 1, Display (Off), Chan 2***, and ***Display (On)***.

17. Repeat steps 2 through 15 for the remaining channels, substituting channel numbers appropriately.

18. Set the dc power supply to 0.0V.

19. If you are doing the Offset Accuracy tests next, skip this step. If probe attenuation factors (step 3) were entered, set them back to 1.000 to avoid improper results in further tests. Press ***more, Utility, Probe Menu***; then, for all channels, ***CHAN X PROBE ATTN*** and in the ENTRY keys, 1 and ENTER.

3-13. VERTICAL OFFSET ACCURACY

Description:

This test verifies vertical offset accuracy. Resolution is a part of the specification for this test.

Offset Cal, a front panel software cal which can be done by the user, can affect the outcome of the Vertical Offset Accuracy test. If the Offset Cal is done with an inaccurate dc source the instrument may fail this test. If the test fails, for each failed channel perform the Offset Cal (section 4) then repeat the Vertical Offset Accuracy test before troubleshooting the instrument.

Specification:

With a 10:1 probe at the input.

Averaging: ±1.5% of setting ± 0.2 div[1] ±Resolution[0.4% of full scale (8 div.)]
Real-time:[2] ±1.5% of setting ± 0.2 div[1] ±Resolution[1.6% of full scale (8 div.)]

1 - ±0.4 div from 50 to 90 mV/div; 2 - Not tested.

Equipment Required:

EQUIPMENT	CRITICAL SPECIFICATIONS	RECOMMENDED MODEL
DC Supply	±300 mV and ±9.5 V 1.0 mV resolution	HP 6115A
Oscilloscope Probe	10:1	HP 10431A/033A/017A

Procedure:

1. Perform a one-key power up* to set instrument to default conditions, then set the following additional parameters.

   *Power to STBY. Press and hold one key. Power to ON. Release key when "Powerup Self Test Passed!" is displayed.

MENU SELECT	FUNCTION SELECT	SETTING
Chan 1,2,3,4	Display	Chan 1 On/Chan 2,3,4 Off
Timebase	TIME/DIV	2 us/div
Display	NUMBER OF AVERAGES Screen Graticule	64 Single Grid

2. Connect the 10:1 probe to CHAN 1 of the HP 54112D.

3. If you are using an HP 10431A or 10033A probe skip this step. Press ***more, Utility, Probe Menu***, and ***CHAN 1 PROBE ATTN***, then ENTER 10.

4. If you just did the Voltage Measurement Accuracy tests skip this step. Calibrate the HP 54112D to the 10:1 probe being used for the test. Press ***Utility, Cal Menu, Probe Tip Cal, Calibrate Probe Tip CHAN 1***, and ***Continue***. When calibration is done, press ***Exit, more, Chan 1***, and ***VOLTS/DIV***.

5. Use the following table for steps 6 through 13.

SUPPLY VOLTAGE	MEASUREMENT LIMITS TOLERANCE	MAX		MIN
0.00 V	±24 mV	-24 mV	_____	24 mV
300 mV	±28 mV	272 mV	_____	328 mV
-300 mV	±28 mV	-272 mV	_____	-328 mV
-9.50 V	±170 mV	-9.33 V	_____	-9.67 V
9.50 V	±170 mV	9.33 V	_____	9.67 V

6. Connect the probe ground clip to the probe tip.

7. Press ***VOLTS/DIV*** and ENTER 100 mV.

8. Press ***OFFSET*** and use the arrow keys to set the trace exactly to center screen when ***#Avgs*** = *64*. The ***Offset*** reading should be within the specification for 0.00 V in the table. Record the reading.

9. Set the supply to 0.00 V then connect the voltmeter and probe to the output of the supply (probe tip to + and ground clip to –).

10. Set the supply voltage and scope offset to the next value in the table. It is easiest to enter the offset value directly, using the key pad.

11. Adjust the offset using the knob and arrow keys until the trace is at center screen when ***#Avgs*** = *64*.

12. The ***Offset*** = value should be within the limits given in the table. Record the reading.

13. Repeat steps 10 through 12 with the other values in the above table. If using a supply with no polarity switch, for negative voltages reverse the probe tip and ground at the supply.

14. Remove the probe from the power supply and connect the probe ground to the probe tip.

15. Use the following table for steps 16 through 23. Follow steps 16 through 21 for a pass/fail test, or steps 16 and 17a through 20a for a precise test. The pass/fail test is faster. If a range is close to the specification for a pass/fail test, make a precise test of that range.

V/div	PASS/FAIL LIMITS(div)	PRECISE LIMITS		
50 mV	±0.4	-22 mV	_____	+22 mV
100 mV	tested previously			
200 mV	±0.2	-47 mV	_____	+47 mV
500 mV	±0.2	-120 mV	_____	+120 mV
1 V	±0.2	-240 mV	_____	+240 mV
2 V	±0.2	-470 mV	_____	+470 mV
5 V	±0.2	-1.2 V	_____	+1.2 V
10 V	±0.2	-2.4 V	_____	+2.4 V
20 V	±0.2	-4.7 V	_____	+4.7 V

NOTE

Note that the minor division marks on the display are at 0.25 division increments and the specifications in the PASS/FAIL column of the table are 1.0, 0.4, and 0.2 divisions.

16. Press ***VOLTS/DIV*** and ENTER 50 mV.

PASS/FAIL TEST

17. Press ***OFFSET*** and ENTER 0 V.

18. Check the distance of the trace from the center horizontal axis. It should be within the DIVISIONS limits shown in the table above when ***#Avgs = 64***.

19. If trace is within limits in step 18, record the range as passing. If it appears to be outside the limits, make a precise test of this range (steps 17a and 18a at right), then continue with step 20.

20. Repeat steps 18 and 19 for each V/div range in the table.

21. After checking all ranges go to step 22.

PRECISE TEST

17a. Press ***OFFSET*** and use the cursor keys to set the trace to exactly center screen when ***#Avgs = 64***.

18a. Check that the Offset reading is within the specification in the LIMITS - VOLTAGE column. Record the reading and set offset to 0.0 V.

19a. Repeat steps 17a and 18a for each V/div range in the table. If if you are doing a precise test of all ranges it is not necessary to set the offset to 0.00 V (step 18a) after each range check.

20a. After checking all ranges go to step 22.

22. Press ***Chan 1***, ***Display (Off)***, ***Chan 2***, and ***Display (On)***.

23. Repeat steps 2 through 22 for channels 2, 3, and 4 substituting channel references as appropriate.

24. If probe attenuation factors (step 3) were entered, set them back to 1.000 to avoid improper results in further tests. Press ***more***, ***Utility***, ***Probe Menu***; then for all channels ***CHAN X PROBE ATTN*** and in the ENTRY keys, 1 and ENTER.

3-14. BANDWIDTH

Description:

This test checks the -3 dB bandwidth of the HP 54112D. If the test fails, consult an HP Customer Service representative.

Specification: (-3dB bandwidth point)
dc coupled, 0 to 100 MHz; ac coupled*, 10 Hz to 100 MHz
* Not tested.

Equipment Required:

EQUIPMENT	CRITICAL SPECIFICATIONS	RECOMMENDED MODEL
Signal Generator	100 KHz to 100 MHz -22 to +12 dBm	HP 8656B
Power Meter/Sensor	100 KHz to 100 MHz <-28 dBm to >+8 dBm	HP 436A/8482A
Power splitter	Outputs differ by <0.15dB	HP 11667A
Cable Adapter	Type N(m) 24 inch N(m) to BNC(m)	HP 11500B HP 1250-0082

Procedure:

1. Zero and calibrate the power meter using the Power Reference on the meter and the REF Cal Factor on the power sensor.

2. Connect the equipment as shown in the following diagram.

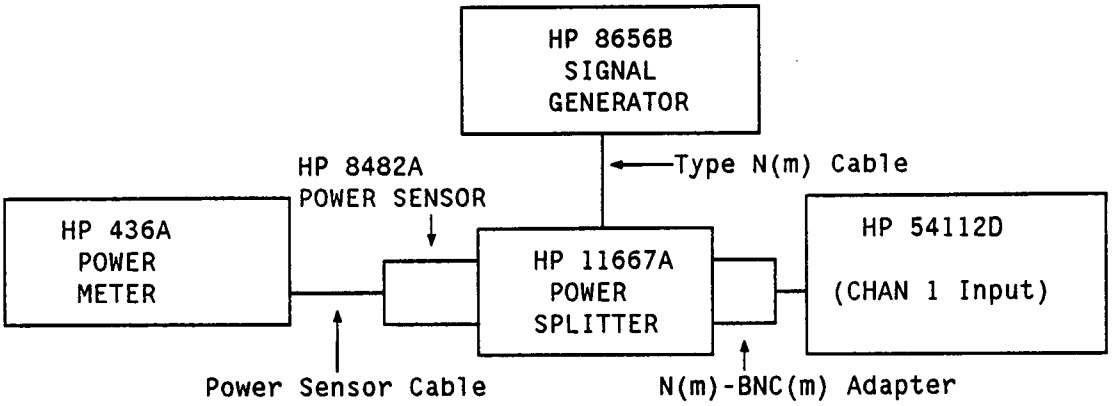


Figure 3-1. Bandwidth Test Connections.

3. Perform a one-key power up* to set instrument to default conditions, then set the following additional parameters in the order given.
*Power to STBY. Press and hold one key. Power to ON. Release key when "Powerup Self Test Passed!" is displayed.

MENU SELECT	FUNCTION SELECT	SETTING
Display	Disp Mode NUMBER OF AVERAGES Screen	Repetitive 8 Single
Chan 1,2,3,4	Display VOLTS/DIV Input Impedance	Chan 1 On/Chan 2,3,4 Off 200 mvolts/div 50Ω
Timebase	TIME/DIV	2 us/div
Trigger	Trig Src	Chan 1
Delta V	V Markers Preset Levels	On 0-100%

4. Set up the 8656B signal generator with a 100 kHz signal at +12 dBm. The HP 54112D should display two cycles of a sinewave signal.

5. Set power meter Cal Factor % to 100 kHz value from the cal chart on the probe and press dB[REF] to set a 0 dB reference.

6. Press ***more, Delta V*** and ***Auto Level Set***. The V Markers will mark the top and bottom of the signal. Note the ΔV= value at the bottom of the screen.

7. Change the frequency of the signal generator to 100 MHz and change the power meter Cal Factor to the 100 MHz % value from cal chart.

8. Press ***more, Timebase*** and ***TIME/DIV*** and ENTER 5 ns.

9. Press ***more*** and ***Delta V***. Increment the signal generator output amplitude while occasionally pressing ***Auto Level Set*** on the HP 54112D.

10. When the ΔV= value (bottom of screen) is the same as noted in step 6, read and record the level on the power meter. It should be less than +2.85 dB from the zero reference.

11. Connect the signal to the CHAN 2 BNC input. Press ***more*** and set the following on the HP 54112D.

MENU SELECT	FUNCTION SELECT	SETTING
Chan 1 Chan 2	Display Display	Off On
Timebase	TIME/DIV	2 us/div
Trigger	Trig Src	Chan 2

12. Repeat steps 4 through 11 for channels 2, 3, and 4, substituting channel references as appropriate. Omit step 11 after channel 4 has been tested.

3-15. TIME MEASUREMENT ACCURACY

Description:

Time measurement accuracy is checked by correlating time measurements with a frequency-stable signal.

Channel Skew Alignment is a front panel firmware calibration that can be done by the user and it will affect the channel-to-channel time accuracy of the instrument. The user may calibrate the time reference between channels to suit his measurements. If the Channel-to-Channel Accuracy part of the Time Measurement Accuracy tests is done without recalibrating Channel Skew, the test will be done with the users calibration and the instrument may fail.

To return the instrument to traceable calibration before the Time Measurement Accuracy tests, use the Channel Skew Alignment procedure in the adjustment procedures, section 4 of this service manual. Channel Skew can be done without affecting any other performance tests or adjustments.

If the tests fail after Channel Skew is calibrated, consult an HP Customer Service representative.

Specification:

Single Channel:

2 to 24.9 ns/div - ±500 ps ±0.002% of reading
25 ns/div and slower - ±0.2% of time range* ±0.002% of reading

Dual Channel:

2 to 24.9 ns/div - ±1.0 ns ±0.002% of reading
25 ns/div and slower - ±0.4% of time range* ±0.002% of reading

* Time range is TIME/DIV x 10.

Equipment Required:

EQUIPMENT	CRITICAL SPECIFICATIONS	RECOMMENDED MODEL
Signal Generator	1.0 MHz and 50 MHz time base accuracy - 5 ppm	HP 8656B-check time base to be within 5 ppm
Power splitter	----------	HP 11667A
Cable	Type N(m) 24 inch	HP 11500B
Adapter (2)	N(m) to BNC(f)	HP 1250-0780
Cables (2)	BNC(m) >24 inch (equal length)	HP 10503A
Termination	BNC 50Ω feedthrough	HP 10100C

Procedure:

1. Set the signal generator frequency to 50 MHz and amplitude to 120 mV.
2. Connect the signal generator to the input of the power splitter with the type N cable. With the N-to-BNC adapters and the BNC-to-BNC cables, connect the outputs of the power splitter to the CHAN 1 and CHAN 2 inputs.

3. Perform a one-key power up* to set instrument to default conditions.
   *Power to STBY. Press and hold one key. Power to ON. Release key when "Powerup Self Test Passed!" is displayed.

4. Press ***Chan 1, 2, 3, 4*** menu keys in turn and set the ***Input Impedance*** on all to 50Ω.

5. Press AUTOSCALE to establish the display, then set or confirm the following parameters in the order given.

MENU SELECT	FUNCTION SELECT	SETTING
Display	NUMBER OF AVERAGES Screen	8 Single
Chan 1,2,3,4	Display VOLTS/DIV OFFSET	Chan 1 On/Chan 2,3,4 Off 20 mvolts/div 0.00 V
Timebase	TIME/DIV	5 ns/div
Trigger Ch 1,2,3,4 Ext. Trig	Trig Src TRIGGER LEVEL Slope	Chan 1 0.00 V (all channels and ext) Pos (all channels and ext)

SHORT DELAY - TIMEBASE ACCURACY

6. Press ***Trigger*** and ***TRIGGER LEVEL***. Adjust Chan 1 Trigger Level so the positive edge crosses exactly at center screen.

7. Press ***Timebase*** and ***DELAY***. With the entry keys, set Delay to each setting in the following table. Check that the positive edge crosses the horizontal graticule line within the "Divisions" specification from center screen. Record a pass or fail for each delay setting.

   If you want to measure the error, for each Set Delay value adjust the delay to make the positive edge cross at center screen. Record the difference between the instrument reading and the Set Delay value. Each should be within the "Time" specification.

Set Delay	Specification Divisions	Time	Record
20 ns	±0.1	±501 ps	_____
40 ns	±0.1	±501 ps	_____
60 ns	±0.1	±502 ps	_____
80 ns	±0.1	±502 ps	_____
100 ns	±0.1	±502 ps	_____
1.0 µs	±0.1	±520 ps	_____
15.0 µs	±0.16	±800 ps	_____

NOTE. 0.2 div = one minor horizontal graticule division

CHANNEL TO CHANNEL ACCURACY

8. Further set up the HP 54112D with the following parameters.

MENU SELECT	FUNCTION SELECT	SETTING
Chan 2	Display	On
Timebase	Delay	0.00 s
Delta V	V Markers	On
	MARKER 1 POSITION	Chan 1 0.00 V
	MARKER 2 POSITION	Chan 2 0.00 V
	Preset Levels	50-50%
Delta t	T Markers	On
	START ON XXX	POS
	EDGE X	1
	STOP ON XXX	POS
	EDGE X	1

9. At ***Delta t*** press ***Edge Find***. The Δt= reading, in the lower-right corner of the display, should be 0.00 ±1.00 ns. Record the reading.

10. Remove the cable from the CHAN 2 input and connect it to the CHAN 3 input.

11. Change the following parameters on the HP 54112D.

MENU SELECT	FUNCTION SELECT	SETTING
Chan 2	Display	Off
Chan 3	Display	On
Delta V	MARKER 2 POSITION	Chan 3 0.00 V
	Preset Levels	50-50%

12. Press ***Delta t*** and ***Edge Find***. The Δt= reading should be 0.00 ±1.00 ns. Record the reading.

13. Remove the cable from the CHAN 3 input and connect it to the CHAN 4 input.

14. Change the following parameters on the HP 54112D.

MENU SELECT	FUNCTION SELECT	SETTING
Chan 3	Display	Off
Chan 4	Display	On
Delta V	MARKER 2 POSITION	Chan 4 0.00 V
	Preset Levels	50-50%

15. Press ***Delta t*** and ***Edge Find***. The Δt= reading should be 0.00 ±1.00 ns. Record the reading.

LONG DELAY - TIMEBASE ACCURACY

16. Change the frequency of the signal generator to 1 MHz.

17. Change the HP 54112D with the following parameters.

MENU SELECT	FUNCTION SELECT	SETTING
Chan 4	Display	Off
Delta V	V Markers	Off
Delta t	T Markers	Off
Timebase	TIME/DIV	200 ns/div

18. Press ***Trigger*** and ***Trigger Level***. Adjust the trigger so that the positive edge of the signal crosses exactly at center screen.

19. Press ***Timebase*** and ***Delay***. Enter 15 ms. The positive edge of the signal should cross within 1.5 divisions of center screen. Use the knob or cursors to set the positive edge at center screen. The delay should read between 14.9997 and 15.0003 ms (15 ms ± 304 ns). Record the reading.

3-16. TRIGGER SENSITIVITY

Description:

Channel and external trigger paths are checked for sensitivity vs. frequency. The displayed signal must remain triggered with a given input at the system bandwidth.

If these tests fail consult an HP Customer Service representative.

Specification:

Channels 1, 2, 3, 4: 0.1 of full scale, dc to 100 MHz
External: 100 mV p-p, dc to 50 MHz

Equipment Required:

EQUIPMENT	CRITICAL SPECIFICATIONS	RECOMMENDED MODEL
Signal Generator	50 MHz and 100 MHz sine wave 5 mV to 250 mV rms amplitude (-33 dBm to +9 dBm output)	HP 8656B
Power Meter/Sensor	50 MHz measure approximately 250 µW	HP 436A/8482A
Power splitter	Outputs differ by <0.15 dB	HP 11667A
Attenuator	10 ±0.6 dB 50 MHz	HP 8491B
Cable Adapter Adapters (2)	Type N(m) 24 inch N(f) to BNC(m) N(m) to BNC(f)	HP 11500B HP 1250-0077 HP 1250-0780
Cables (2) Termination	BNC(m) >24 inches BNC 50Ω feedthrough	HP 10503A HP 10100C

Procedure:

CHAN 1,2,3,4 TRIGGER TEST

1. Perform a one-key power up* to set instrument to default conditions.
   *Power to STBY. Press and hold one key. Power to ON. Release key when "Powerup Self Test Passed!" is displayed.
2. Set the signal generator frequency for 100 MHz and amplitude to 9 mV rms.
3. With the Type N cable and N(f)-to-BNC(m) adapter, connect the signal generator to the CHAN 1 input.

4. Press AUTOSCALE to establish the display, then set or ensure the following parameters. Press ***Chan 1***, 20 and mV, then ***Input Impedance*** to select 50Ω.

MENU SELECT	FUNCTION SELECT	SETTING
Display	NUMBER OF AVERAGES	8
Chan 1	VOLTS/DIV Input Impedance	20 mV 50Ω
Delta V	V Markers Preset Levels	On 0-100%

5. Press ***more, Trigger*** and ***Trigger Level***.

6. Reduce the output of the signal generator until ***Auto Triggering*** appears (top of display). Adjust ***Trigger Level*** as necessary to maintain triggering as long as possible. Slight movement of the waveform is due to sampling and averaging characteristics of the instrument. Increase output until stable triggering returns, indicated by no occurences of ***Auto Triggering*** in the display.

7. Press CLEAR DISPLAY. When ***#Avgs = 8***, press ***more, Delta V***, and ***Auto Level Set***. Read and record ***ΔV=***. It should be less than 16 mV (0.1 of full scale or 0.8 div.).

8. Repeat steps 3 through 7 for channels 2, 3, and 4, substituting channel references as appropriate.

EXTERNAL TRIGGER TEST

9. Connect the equipment as shown in the following diagram. Temporarily leave the BNC cable with 50Ω termination disconnected from the EXT. TRIGGER BNC connector on the rear panel.

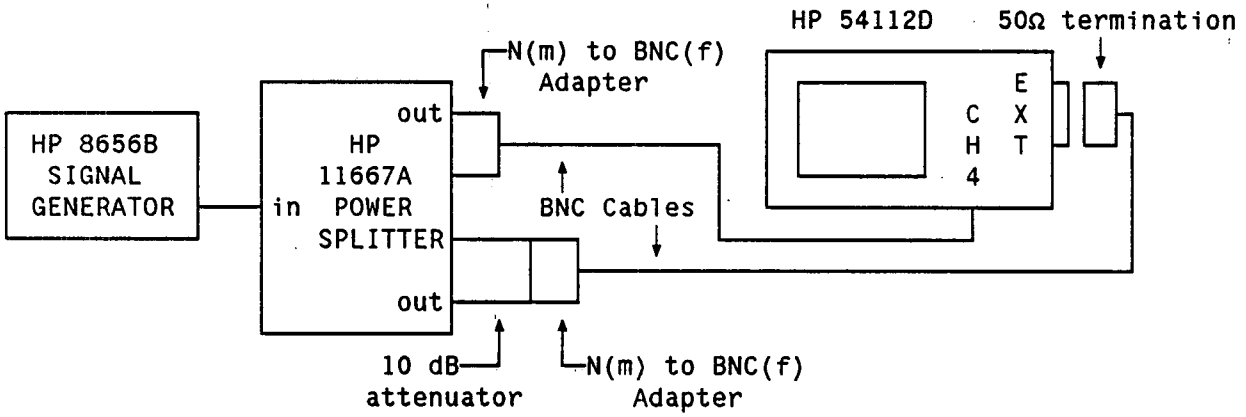


Figure 3-2. Trigger Sensitivity Test Connections.

10. Press ***Delta V*** and ***V Markers*** to shut them off and press ***more, Chan 4***, and ***VOLTS/DIV*** and ENTER 50 mV.

11. Zero and calibrate the power meter using the Power Reference on the meter and the REF Cal Factor on the power sensor.

12. Set the signal generator frequency to 50 MHz and output level to 250 mV rms.

13. Set the power meter Cal Factor % to the 50 MHz value from the chart on the probe.

14. Press ***Trigger*** and ***Trigger Src*** to select ***External***. Check that ***HF Reject*** is ***Off***.

15. Set ***TRIGGER LEVEL*** to 0.00 V. If any occurence of ***Running*** appears in the display (upper left corner) raise the trigger level until only occurences of ***Auto Triggering*** appear.

16. Connect the BNC cable with 50Ω termination to the EXT. TRIGGER INPUT on the rear panel. The waveform should be stably triggered.

17. Reduce the output of the signal generator until the waveform is no longer stably triggered. Slight movement of the waveform is due to the sampling and averaging characteristics of the instrument. Increase output until stable triggering returns.

18. Disconnect the 10 dB attenuator at the power splitter and connect the power meter to this port of the splitter.

19. Read the power reading. It should be less than 250.0 μW (100 mV p-p + 10 dB).

20. To convert the power reading to a peak-to-peak voltage value for recording, use the following formula:

$$V_{p\text{-}p} = 2.83\sqrt{\frac{P \times 50}{10}}$$

$$V_{p\text{-}p} = 6.32\sqrt{P}$$

$V_{p\text{-}p}$	EXT. TRIGGER input voltage
2.83	converts RMS to p-p
P	power reading on meter
50	ohms impedance
10	compensates for 10 dB atten.

NOTES

Table 3-2. Performance Test Record

HEWLETT-PACKARD
MODEL 54112D
DIGITAL OSCILLOSCOPE

SERIAL NO. _____

Recommended Cal Interval - 1 year/2000 hrs

Recommended Next Calibration _____

Tested by _____

Work Order No. _____

Date _____

Temperature _____

Humidity _____

TEST	LIMITS	RESULTS
3-9 Calibrator Amplitude	0.796 to 0.804 V	_____
3-10 Input Resistance	LIMITS 49.5Ω to 50.5Ω	CHAN 1 CHAN 2 CHAN 3 CHAN 4 _____ _____ _____ _____
3-11 Voltage Measurement Accuracy	RANGE LIMITS 50 mV 338 mV to 362 mV 100 mV 676 mV to 724 mV 200 mV 1.35 V to 1.45 V 500 mV 3.38 V to 3.62 V 1 V 6.76 V to 7.24 V 2 V 13.5 V to 14.5 V 5 V 33.8 V to 36.2 V 10 V 67.6 V to 72.4 V 20 V 135 V to 145 V	CHAN 1 CHAN 2 CHAN 3 CHAN 4 _____
3-12 Vertical Offset Accuracy	SUPPLY VOLTAGE LIMITS 0 mV -24 mV to 24 mV +300 mV 272 mV to 328 mV -300 mV -272 mV to -328 mV -9.50 V -9.33 V to -9.67 V +9.50 V 9.33 V to 9.67 V	CHAN 1 CHAN 2 CHAN 3 CHAN _____

Table 3-2. Performance Test Record (con't.)

TEST	LIMITS	RESULTS
3-12 Vertical Offset Accuracy (cont.)	RANGE 50 mV ±0.4 div or ±22 mV 200 mV ±0.2 div or ±47 mV 500 mV ±0.2 div or ±120 mV 1 V ±0.2 div or ±240 mV 2 V ±0.2 div or ±470 mV 5 V ±0.2 div or ±1.2 V 10 V ±0.2 div or ±2.4 V 20 V ±0.2 div or ±4.7 V	CHAN 1 CHAN 2 CHAN 3 CHAN 4 _____
3-13 Bandwidth	Down from reference Repetitive 100 MHz <2.85 dB	CHAN 1 CHAN 2 CHAN 3 CHAN 4 _____ _____ _____ _____
3-14 Time Measurement Accuracy	Short Delay - Timebase Acc. 20 ns ±0.1 div or ±501 ps 40 ns ±0.1 div or ±501 ps 60 ns ±0.1 div or ±502 ps 80 ns ±0.1 div or ±502 ps 100 ns ±0.1 div or ±502 ps 1.0 µs ±0.1 div or ±520 ps 15.0 µs ±0.16 div or ±800 ps Channel-to-Channel Accuracy Chan 1 to Chan 2 Δt = 0.00 ±1.0 ns Chan 1 to Chan 3 Δt = 0.00 ±1.0 ns Chan 1 to Chan 4 Δt = 0.00 ±1.0 ns Long Delay - Timebase Acc. 15.0 ms ±304 ns - 14.9997 to 15.0003 ms	_____ _____ _____ _____ _____ _____ _____ _____ _____ _____ _____
3-15 Trigger Sensitivity	Triggers on less than: 0.8 div/16 mV p-p, 100 MHz Triggers on less than: 100 mV p-p, 50 MHz	CHAN 1 CHAN 2 CHAN 3 CHAN 4 _____ _____ _____ _____ EXTERNAL _____

Adjustments

SECTION 4
ADJUSTMENTS

4-1. INTRODUCTION

This section describes the adjustments required to make the instrument meet published specifications. Included are adjustments to the power supplies, acquisition system and color display.

4-2. ADJUSTMENT REQUIREMENTS

Adjustments should be performed as warranted by the Calibration Procedure (see section 3), by requirements after repair or requirements due to failure of a performance test (see section 3). Except for the Calibrator Amplitude Adjustment, which should be checked before every calibration cycle, adjustments should not be performed only on the basis of an elapsed period of time.

WARNING

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

4-3. ADJUSTMENTS REQUIRED AFTER REPLACEMENTS

Some adjustments may be necessary after replacement of an assembly, though it may not be necessary to make all adjustments. Table 4-1 (next page) gives the adjustments necessary after replacement of a major assembly.

4-4. TEST EQUIPMENT REQUIRED

Required test equipment is listed in Table 1-4, Recommended Test Equipment.

4-5. ACCESS TO ADJUSTMENTS

Most adjustments can be accessed by removing the instrument covers (see section 6A, Instrument Disassembly).

Power supply adjustments (not done during routine calibration) require the additional removal of the power supply cover (under the top cover).

Adjustment of the attenuators requires partial removal of the front panel and attenuators. For this reason, and because misadjustment is unlikely, attenuator adjustment is not recommended during routine calibration.

Most adjustments of the Color CRT Module are under the clear plastic covers and are accessable from the sides or bottom of the instrument. However, several are at the rear of the module and require removal of the module from the instrument and operation of the module while outside the instrument. They also require a special tool as noted in the procedure. These adjustments are also not recommended during routine calibration.

4-6. ONE-KEY POWER UP

A one-key power up is a procedure where any one key is held depressed when the power is turned on. The key is held depressed until the power up cycle completes; "Powerup Self Test Passed!" (or Failed) is displayed. This is done to preset or reset the instrument to default conditions and prevent previous setups from interfering with the next test. It also simplifies the instrument setup procedure.

The one-key power up is a part of many procedures and should be performed like any other procedural step.

Table 4-1. Adjustments Required After Assembly Replacement.

ADJUSTMENT / ASSEMBLY	Power Supplies	V_{B1}	Calibrator Amplitude	Flatness	Complete* Software Calibration	Attenuator
Acquisition				RCO	X	
Timebase/Trig		X	X		X	
Attenuator				RCO	X	Adjusted at factory
Microprocessor					X	
Input/Output					X	
Power Supplies	Adjust supply replaced					

NOTE: The **Color Display** assembly and **Color CRT Module** do not require any adjustment after replacement.

KEY: RCO Replaced Channel Only. Perform this adjustment only on the channel in which the assembly was replaced.

X This adjustment must be performed.

* Software calibration includes: Vertical Cal, Probe Tip Cal, Offset Cal, Trigger Cal, and Timebase Cal (Channel Skew). See the appropriate procedures in this section.

4-7. POWER SUPPLY ADJUSTMENTS

Description:

This procedure is provided to adjust the power supply voltages in cases where a power supply has been inadvertently mis-adjusted or repairs have been made.

No performance tests are required after power supply adjustments.

Equipment Required:

EQUIPMENT	CRITICAL SPECIFICATIONS	RECOMMENDED MODEL
DC Voltmeter	Better than 0.05% accuracy	HP 3468A

Analog Power Supply Procedure:

NOTE

First, check for the presence of adjustment A12R61, located at the top front corner of the Analog Supply assembly. If there is no potentiometer there, the analog supply is a later version and no adjustment is required. Continue with the Digital Supply procedure.

This procedure adjusts the supply voltage to the fans. The locations of the test points are marked on the power supply cover as well as the PC board.

NOTE

*The instrument **MUST** be stabilized at ambient temperature with power off (front panel power switch to STBY) before this adjustment is made. This voltage will rise as internal temperature increases.*

1. Connect positive voltmeter lead to the FAN test point.
2. Connect negative voltmeter lead to the -18 V test point.
3. Turn on instrument power (from STBY to ON).
4. Before instrument warms up, adjust A12R61 (the only adjustment on Analog Supply) for a voltmeter reading of 9.5 Vdc ±0.1 V.

Digital Power Supply Procedure:

The locations of test points are marked on the power supply cover as well as the assemblies. First, the voltage is measured to be sure that it requires adjustment.

1. Allow the instrument to stabilize (power on) for one to two minutes.
2. Connect positive voltmeter lead to the +5 V test point (actual voltage = +5.1 V).
3. Connect negative voltmeter lead to the −5 V test point (actual voltage = −5.3 V).
4. The voltmeter should read 10.4 Vdc ±0.01 V. If the measurement is within specifications stop here. If not, then continue.
5. Disconnect power cord and remove voltmeter leads.

WARNING

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

6. When the +300 V LED is extinguished, remove the top power supply cover.
7. Reconnect voltmeter leads per steps 2 and 3 above.
8. Reconnect power cord and allow instrument to stabilize for 1 to 2 minutes.
9. Adjust A13R56 (only adjustment on Digital Supply) for a voltmeter reading of 10.4 Vdc ± 0.01 V.
10. Disconnect power cord and wait until the +300 V LED is extinguished before re-installing power supply shield.

4-8. TIMEBASE VB1 ADJUSTMENT

Description:

This procedure adjusts the V_{B1} voltage level on the sync mux hybrid U4. V_{B1} represents a current level and may cause apparent failures if badly misadjusted.

No performance test is necessary after this adjustment.

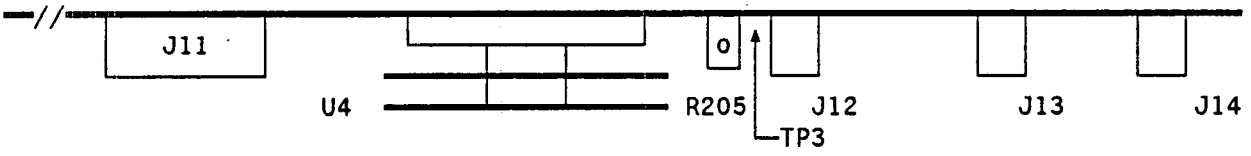
Equipment Required:

EQUIPMENT	CRITICAL SPECIFICATIONS	RECOMMENDED MODEL
Digital Voltmeter	Better than 0.3% accuracy	HP 3468A

Procedure:

Refer to the drawing for the location of components.

Top view of rear of Timebase/trigger assembly (A8).



1. Turn off instrument power.
2. Connect the positive lead of the DVM to TP3 on the Timebase/trigger assembly A8. TP3 is a pad on the PC board and is marked "TP3."
3. Connect the negative lead to ground on the Timebase/trigger assembly. The shield of J12 is a good place.
4. Turn on instrument power.
5. Adjust R205 for a reading of −4.50 ±0.045 V (-4.455 V to -4.545 V).

4-9. CALIBRATOR AMPLITUDE ADJUSTMENT

Description:

This procedure adjusts the amplitude of the front panel CAL signal. This signal is used to run calibration routines in the instrument.

The adjustment is done by forcing this signal high and adjusting it while measuring it with an accurate voltmeter. Forcing the signal high is done from the front panel through one of the Extended Tests.

The specification for this adjustment is tighter than that required to perform an accurate calibration using the signal. The specification for CAL signal use is ±4 mV (as displayed on screen when the test is started). The signal is adjusted as close as possible, and not greater than ±2 mV, which will assure an accurate signal throughout the next calibration cycle.

Since the adjustment specification is tighter than the performance test specification, no performance test is necessary after this adjustment.

Equipment Required:

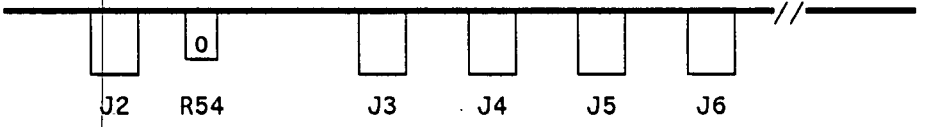
EQUIPMENT	CRITICAL SPECIFICATIONS	RECOMMENDED MODEL
DC Voltmeter	Better than 0.05% accuracy	HP 3468A

Procedure:

1. Connect the DC voltmeter + input to the front panel calibrator signal and – input to ground at the CHAN 1 input BNC.

2. In order, press ***more, Utility, Test Menu***, and ***Extended Tests***, press 21 and ENTER, then ***Start Test***.

Top view of front of Timebase/Trigger assembly (A8).



4. Adjust R54 so that the CAL voltage is as close as possible to +0.8000 V. It must be within ±0.002 Vdc.

5. Press ***Stop Test*** then ***Exit Test Menu***.

4-10. FLATNESS ADJUSTMENT

Description:

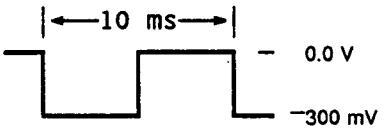
This adjustment equalizes low and high frequency gains. If adjustment is a result of assembly replacement (table 4-1), see table 3-1 for required performance tests. Otherwise, for any channel that has been adjusted, perform the Measurement Accuracy and Offset Accuracy tests in section 3.

Equipment Required:

EQUIPMENT	CRITICAL SPECIFICATIONS	RECOMMENDED MODEL
Pulse Generator	≤±1% perturbations after 10 ns 0.0 to -300 mV output	Tek PG 506
Cable	BNC (m)	HP 10503A

Procedure:

1. Set the following parameters on the signal generator:
   Fast Rise output
   Period: 10 ms -- vernier to minimum
   Pulse amplitude: midrange (≈300 mV)



2. Connect the FAST RISE OUTPUT center BNC of the pulse generator to the CHAN 1 input.

1. Perform a one-key power up* to set the instrument to default conditions.
   *Power to STBY. Press and hold one key. Power to ON. Release key when "Powerup Self Test Passed!" is displayed.

3. Press ***Chan 1*** and set ***Input Impedance*** to 50Ω.

4. Press AUTOSCALE to establish the signal on the display.

5. Set the pulse generator amplitude to 300 mV p-p and period to 100 ms, then set the following parameters on the HP 54112D.

MENU SELECT	FUNCTION SELECT	SETTING
Chan 1,2,3,4	Display	Chan 1 On/Chan 2,3,4 Off
	VOLTS/DIV	15.0 mV/div
	OFFSET	0.00 V
	Input Impedance	50Ω
Timebase	TIME/DIV	7.00 ms/div
	DELAY	28.0000 ms
	Auto/Trgd Sweep	Trgd
Trigger Ch 1,2,3,4	Trigger Mode	Edge
	TRIGGER LEVEL	-150 mV
Display	NUMBER OF AVERAGES	8
	Graticule	Grid

6. You should have a display somewhat like that in the following figure. The figure shows the signal when adjusted and mis-adjusted.

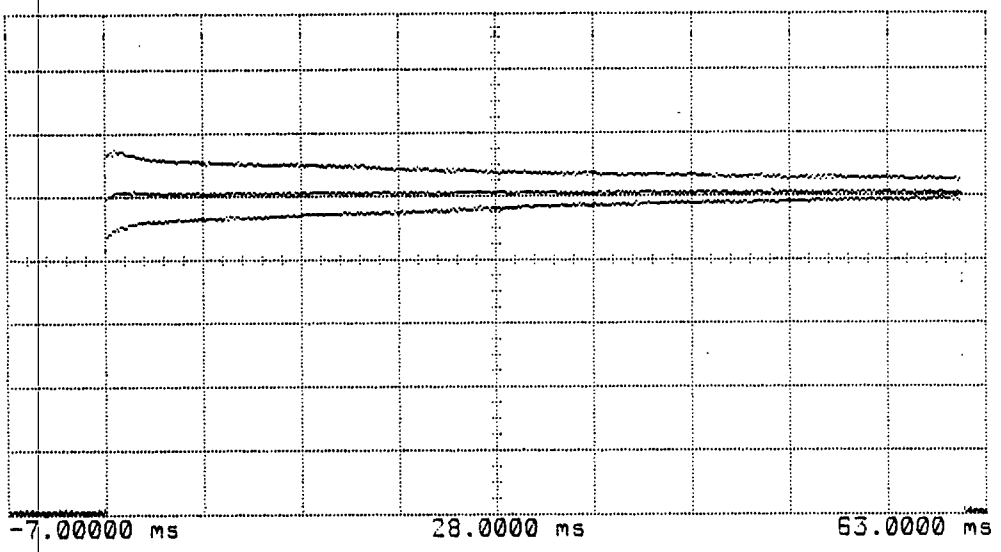


Figure 4-1. Flatness adjustment waveforms.

The following drawing shows a top view of the front of an ADC assembly. There are four of these assemblies, A4 - A7, one for each channel. Card cage assemblies are designated A1 to A9, from left to right starting near the Color CRT Module. A3 and A9 are not used.

Top view of front of ADC assemblies (A4 - A7).

7. Adjust R88 on the channel 1 ADC assembly for a level pulse top. Press ***Chan 1*** and ***Offset*** and use the offset to keep the waveform close to the grid line. This helps in judging the flatness of the pulse.

8. Press ***Display (Off)***, ***Trigger***, ***Trg Src***, ***Chan 2***, and ***Display (On)*** to set up channel 2.

9. Connect the cable from the pulse generator to the CHAN 2 input. Ensure that the ***Input Impedance*** is 50Ω.

10. Adjust R88 on the channel 2 ADC assembly for a level pulse top. Use the offset to keep the waveform close to the grid line.

11. Repeat steps 8, 9, and 10 for channels 3 and 4. Substitute appropriate channel references when necessary.

4-11. SOFTWARE CALIBRATION

Software calibration procedures calibrate circuitry with internal routines and adjustments. If doing a complete adjustment procedure, follow software calibration completely and in order.

No performance tests are necessary after software calibration.

4-12. Vertical Calibration

Description:

Vertical calibration calibrates vertical sensitivity.

Procedure:

1. Disconnect all inputs to channels.
2. Press the ***more, Utility, Cal Menu, Vertical Cal*** and ***Continue***. Follow the instructions on the display. When calibration is complete the instrument will return to the Cal Menu.

4-13. Probe Tip Calibration

Description:

Probe Tip Cal calibrates the vertical channel from the probe tip through the A/D converters.

NOTE

This procedure is usually done for any channel that has had the probe changed. A channel's vertical specifications are met only when it's used with the probe it was calibrated with.

Equipment Required:

EQUIPMENT	CRITICAL SPECIFICATIONS	RECOMMENDED MODEL
Divider Probe	10:1 1 MΩ	HP 10431A/033A/017A

Procedure:

NOTE

You may use the same probe for all channels unless you need to calibrate each input to a specific probe (see note above).

1. Press ***Probe Tip Cal*** and ***Calibrate Probe Tip CHAN 1***. Follow the instructions on the display.
2. When the calibration for CHAN 1 is done, calibrate CHAN 2, 3, and 4.
3. Press ***Exit*** then continue with the next procedure.

4-14. Offset Calibration

Description:

The Offset Cal adjusts the channel offset values for various vertical sensitivities.

Equipment Required:

EQUIPMENT	CRITICAL SPECIFICATIONS	RECOMMENDED MODEL
DC Power Supply	10 ±0.01 Vdc	HP 6115A
Oscilloscope Probe	10:1 1 MΩ	HP 10431A/033A/017A

Procedure:

1. Set the power supply to 10.0 ±0.01 V.
2. Connect the 10 V level through the 10:1 probe to the CHAN 1 input.
3. Press ***more, Utility, Cal Menu, Offset Cal*** and ***Calibrate Offset Channel 1***. Follow the instructions on the display.
4. When the calibration for CHAN 1 is done, calibrate CHAN 2, 3, and 4.
5. Press ***Exit*** then continue with the next procedure.

4-15. Trigger Calibration

Description:

Trigger Cal calibrates trigger levels and trigger sensitivity (hysteresis). This procedure does not require operator interaction but takes about 10 minutes.

Procedure:

1. Press ***Trigger Cal*** and follow the instructions on the display. The arrow will move across the display, showing the calibration is proceeding.
2. When calibration of the triggers is complete, the instrument will return to the Cal Menu.

4-16. Channel Skew Alignment

Description:

Channel Skew time-aligns the signal that is input to the channels and external trigger.

Alignment occurs at the intersection of the input signal's rising edge and the HP 54112D's center horizontal graticule. For each input, this point becomes time-aligned with the zero-delay point.

Alignment includes time delays both internal and external to the HP 54112D, including BNC cable length.

The reason for doing Channel Skew Alignment in the adjustment procedures is to set references for the Time Measurement Accuracy tests in the Performance Tests.

Equipment Required:

EQUIPMENT	CRITICAL SPECIFICATIONS	RECOMMENDED MODEL
Cables (2)	BNC to BNC (equal length and three feet long or longer)	HP 10503A
Adapter	BNC Tee (m)(f)(f)	HP 1250-0781
Termination	BNC 50Ω feedthrough	HP 10100C

Procedure:

1. Using the BNC tee, connect both cables to the rear panel TIMEBASE CAL output.
2. Press ***more, Utility, Cal Menu, Timebase Cal***, and ***Ch1 and Ch1-Ch2 Skew***.
3. Follow the instructions on the display.
4. When channnels 1 and 2 calibration is complete, perform the Ch1-Ch3, Ch1-Ch4, and Ch1-Ext skew calibrations. Press the appropriate softkey and follow the instructions on the display.

4-17. ATTENUATOR ADJUSTMENT

Description:

The channel attenuator assemblies have two compensation adjustments, X10 and X100. These are set at the factory and normally do not require further adjustment.

Perform Measurement Accuracy, Offset Accuracy, and Bandwidth tests (section 3) on any channel which has had the attenuator adjusted.

NOTE

DO NOT PERFORM THESE ADJUSTMENTS DURING ROUTINE CALIBRATIONS. *It is necessary to partially disassemble the instrument for these adjustments.* ***DO NOT*** *perform these adjustments unless the Flatness Adjustments have been made and it is desirable to optimize flatness from 50 mV/div to 5 V/div.*

Equipment Required:

EQUIPMENT	CRITICAL SPECIFICATIONS	RECOMMENDED MODEL
Pulse Generator	≤1% perturbation	Tektronix PG 506
Cable	BNC (m)	HP 10503A
Adjustment tool	----------	HP 8710-1515

Procedure:

1. Without disconnecting any cabling, perform the Front Panel Removal procedure in Section 6A of this service manual. Set the front panel about 10 cm in front of its normal position.

2. Some attenuators do not need further removal to reach adjustments. Skip this step if the adjustments can be reached on the attenuator needing adjustment.

   The adjustments are about 1 cm from the front edge. The X100 adjustment is toward the front and the X10 directly behind it.

   With instrument in its normal operating position, remove the screw that fastens the rear of the attenuator to be adjusted. It can be reached from the top. *This screw is not captive.* ***DO NOT*** *allow it to fall into the instrument because it will be difficult to retrieve.*

3. Set the instrument on its left side. Without disconnecting any cabling, slide foreward to expose adjustments any attenuator loosened in step 2.

4. Set up the pulse generator with the following parameters.
   ```
   Output select   - Fast rise
   Period          - 0.1 ms
   Pulse Amplitude - 500 mV
   ```

5. Connect the FAST RISE OUTPUT left-hand BNC of the pulse generator to the input of the attenuator to be adjusted.

6. Press ***Chan X*** (whichever is appropriate) and ensure the ***Input Impedance*** is ***50Ω***. Press AUTOSCALE to establish the signal. Continue setup of the HP 54112D by setting or verifying the following parameters.

MENU SELECT	FUNCTION SELECT	SETTING
Chan 1 - 4	VOLTS/DIV	50 mvolts/div
	OFFSET	100 mV
Timebase	TIME/DIV	5 us/div
	DELAY	20 us
	Delay Ref at	Center
Display	Disp Mode	Repetitive
	Averaging	ON
	NUMBER OF AVERAGES	8
	Screen	Single
	Graticule	Grid

7. Press ***Chan X*** (whichever is appropriate) and ***OFFSET*** and set the the offset to put the top of the pulse 3 divisions above center screen. If it is slightly above or below a grid line, flatness deviations will be more readily apparent.

8. Adjust X10 adjustment (rear capacitor) for best flatness.

9. Set VOLTS/DIV to 500 mV/div.

10. Set pulse generator amplitude to MAX or 5 V, whichever occurs first.

    NOTE: *If you are using a PG 506 the maximum output is about 1 V, so the pulse amplitude will be about 2 divisions. Do not set the HP 54112D for a lower range since 500 mV/div is the lowest that this adjustment covers.*

11. Press ***Chan X*** (whichever is appropriate) and ***OFFSET*** and set the the offset to put the top of the pulse 3 divisions above center screen. If it is slightly above or below a grid line, flatness deviations will be more readily apparent.

12. Adjust X100 adjustment (front capacitor) for best flatness.

13. If other channels are being adjusted, repeat steps 2 through 12 for them.

14. After adjustments are complete, reassemble instrument following procedures in section 6A.

CAUTION

Before installing front panel, be sure the three-wire cables at front of the attenuators do not become pinched and ensure that all probe sense rings around the input BNCs are inserted into their recesses properly.

4-18. COLOR CRT MODULE ADJUSTMENTS

NOTES

DO NOT PERFORM THESE ADJUSTMENTS DURING 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 has caused an unusable display due to mis-convergence that cannot be corrected by degaussing the entire CRT screen.*

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

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

Description:

The Color CRT Module is adjusted to compensate for magnetic influences causing mis-convergence.

NOTE

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.* ***During any of the following adjustments, the CRT module must face west.***

Equipment Required:

Non-metallic Adjustment Tool ..... HP Part Number 8710-1355

Procedure:

NOTE

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 on the next page. There will be cases where it will not be necessary to perform all adjustment group procedures. For example, if the Geometry Adjustment Group corrects the problem, this will be the only group that should be performed.

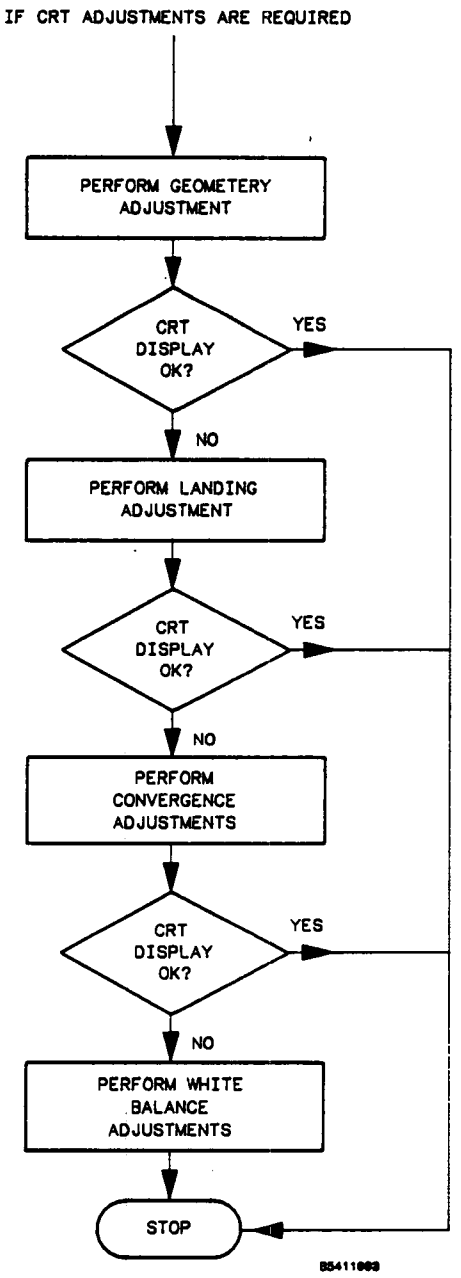


Figure 4-2. CRT Module Adjustment Flow Diagram.

Geometry Adjustments

1. Press ***Utility***, ***CRT Setup Menu***, then ***Pattern*** key as required until the white cross-hatch is displayed on CRT.

2. Preset front panel BACKGROUND control to mechanical center.

3. Preset front panel BRIGHTNESS control maximum clockwise.

4. Preset H.SUB SHIFT (RV006) and V.SUB SHIFT (RV008) located on the bottom PC board to mechanical center.

5. Using a flexible ruler, adjust H.SIZE (RV504) AND V.HEIGHT (RV502) located on the left hand side PC board so that the border of the cross-hatch pattern displayed on the CRT is 120.5 mm (4.74 in.) vertically and 161 mm (6.34 in.) horizontally.

6. Adjust V.CENT (RV510) AND H.CENT (RV503) located on the left hand side PC board to center pattern.

7. Adjust PIN AMP (RV506) located on the left hand side PC board to eliminate pincushion distortion in the vertical lines of the cross-hatch pattern as shown in the next figure.

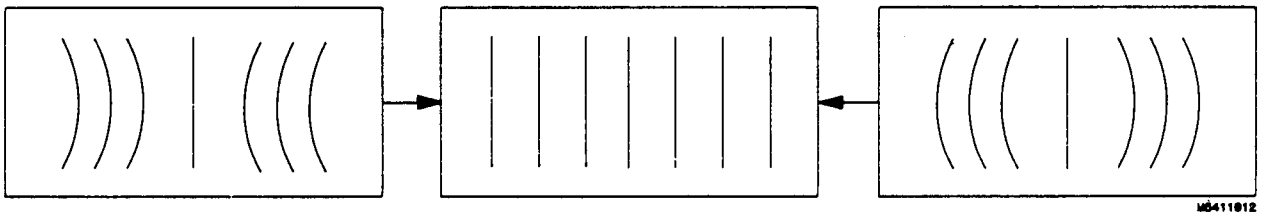


Figure 4-3. PIN AMP Adjustment.

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

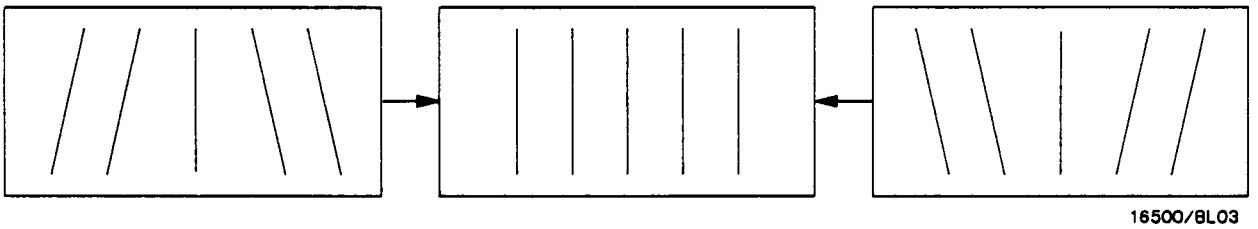


Figure 4-4. PIN PHASE Adjustment.

9. Adjust TOP PIN (RV511) located on the left hand side PC board so that top horizontal line is parallel with the center horizontal line.

10. Adjust BOTTOM PIN (RV512) located on the left hand side PC board so that bottom horizontal line is parallel with the center horizontal line.

Focus, Landing, and Convergence Adjustment Preparation Procedures

NOTE

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

1. Remove Color CRT Module from the instrument (see section 6A of this service manual).
2. Reconnect instrument front panel and re-install front panel and CRT bezel (use two screws to temporarily hold front panel in place).
3. Loosen deflection yoke clamp screw.
4. With Color CRT Module placed to the left of mainframe, reconnect module.
5. Remove deflection yoke spacers by moving deflection yoke backward and removing spacers.

NOTE

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

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

Focus Adjustment

NOTE

Geometry adjustments must be performed before making focus adjustment.

1. In ***Utility*** menu, press ***CRT Setup Menu***, then press ***Pattern*** key as required until the white cross-hatch is displayed on CRT.
2. Adjust FOCUS (RV701) located on the rear PC board for best overall focus.

Landing Adjustment

1. In ***Utility*** menu, press ***CRT Setup Menu***, then press ***Color Purity*** key (fourth key from top) as required until a white raster is displayed on CRT.

2. Turn front panel BRIGHTNESS control fully clockwise.

3. Degauss entire CRT screen by pressing momentary DEGAUSSING switch located on the instrument rear panel.

NOTE

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

4. Set purity magnet tabs to mechanical center (see next figure).

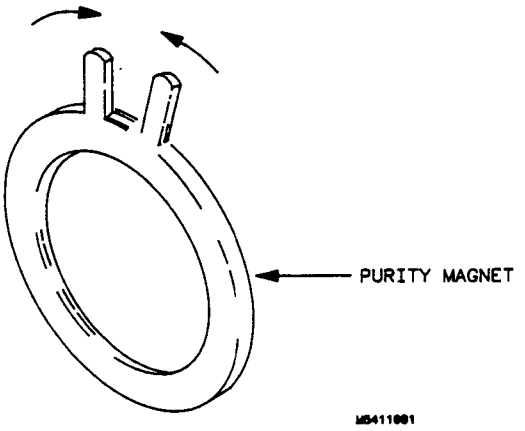


Figure 4-5. Purity Magnet Centering.

5. Press ***Color Purity*** key as required until a green raster is displayed on CRT.

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

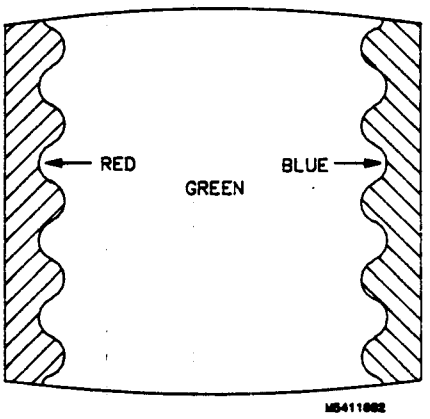


Figure 4-6. Purity Magnet Adjustment Raster.

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

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

NOTE

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

9. Using ***Color Purity*** key, replace green raster with red and then blue raster each time checking for proper landing adjustment (color purity of each).

10. If landing is not correct in step 9, repeat steps 6 through 9 for best compromise (see next figure).

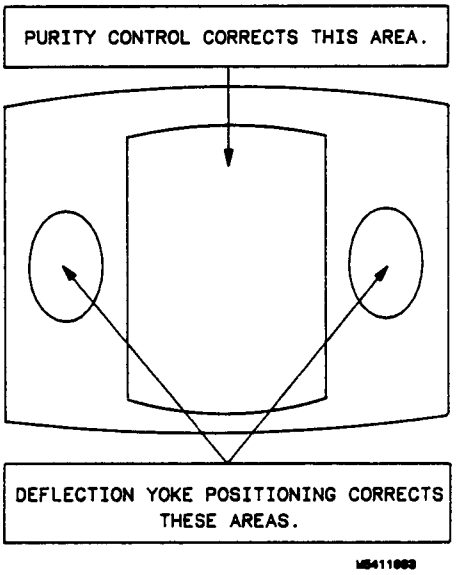


Figure 4-7. Landing and Purity Adjustment Guide.

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

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

NOTE

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

Static Convergence

1. Preset front panel BACKGROUND control to mechanical center.

2. Preset front panel BRIGHTNESS control maximum clockwise.

3. Temporarily disconnect power from instrument and remove PC board shield cover from rear of Color CRT Module by prying evenly on all four sides.

4. Re-apply power. Press ***more***, ***Utility***, and ***CRT Setup Menu*** keys. Press ***Pattern*** key as necessary to obtain the white cross-hatch pattern.

5. 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).

NOTE

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

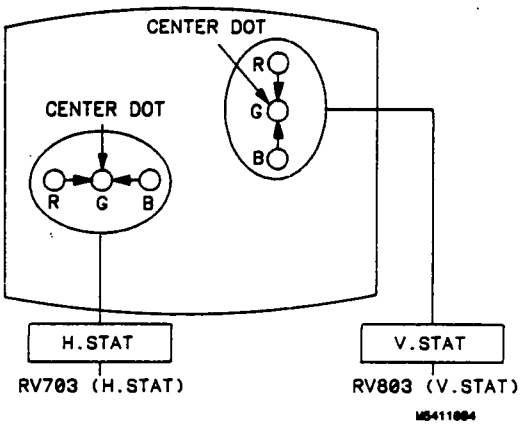


Figure 4-8. Static Convergence.

Dynamic Convergence

1. In ***Utility***, press ***CRT Setup Menu***, then press ***Pattern*** key (second key from top) as necessary to obtain 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).

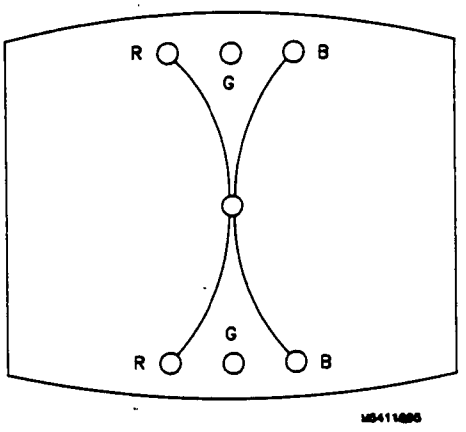


Figure 4-9. Y BOW Adjustment.

3. Adjust Y BOW 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).

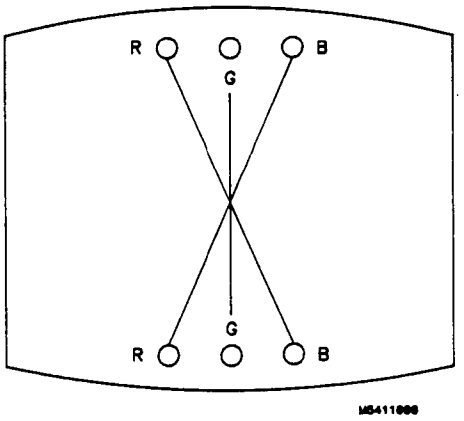


Figure 4-10. Y BOW CROSS Adjustment.

4. Adjust V.STAT TOP (RV801) and V.STAT 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 (see next two figures).

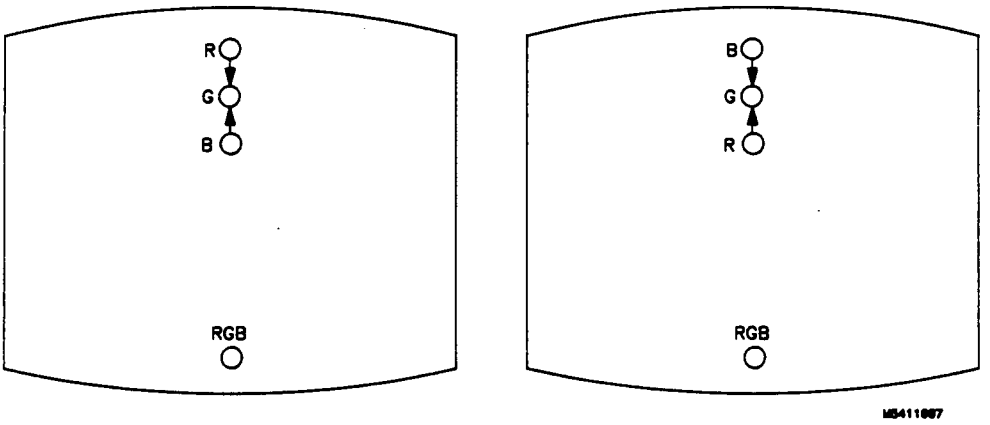


Figure 4-11. V.STAT TOP Adjustment.

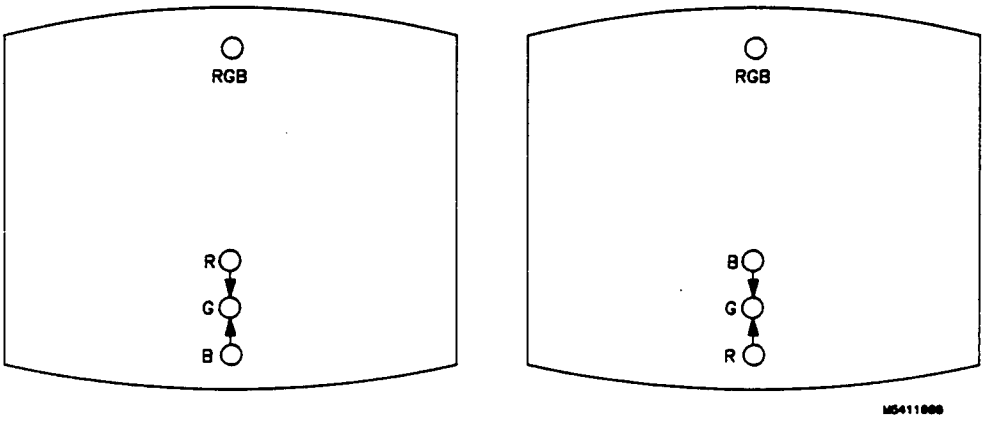


Figure 4-12. V.STAT BOTTOM Adjustment.

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

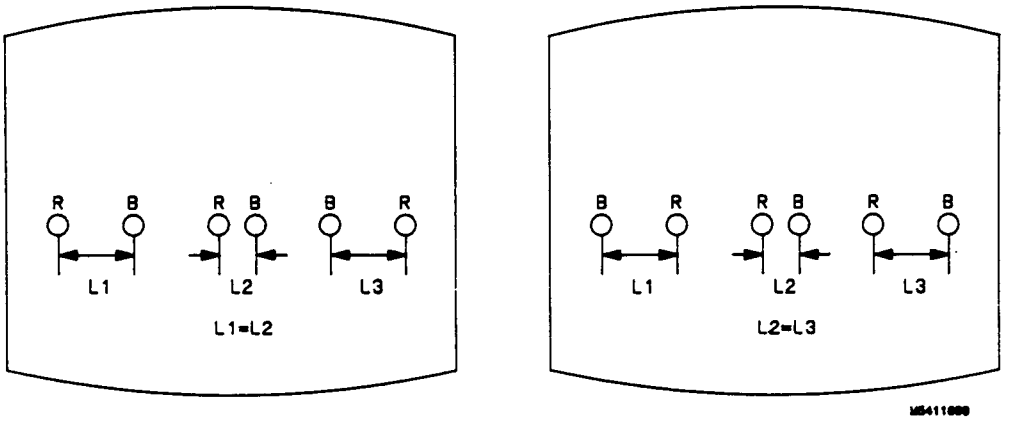


Figure 4-13. H.AMP Adjustment.

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

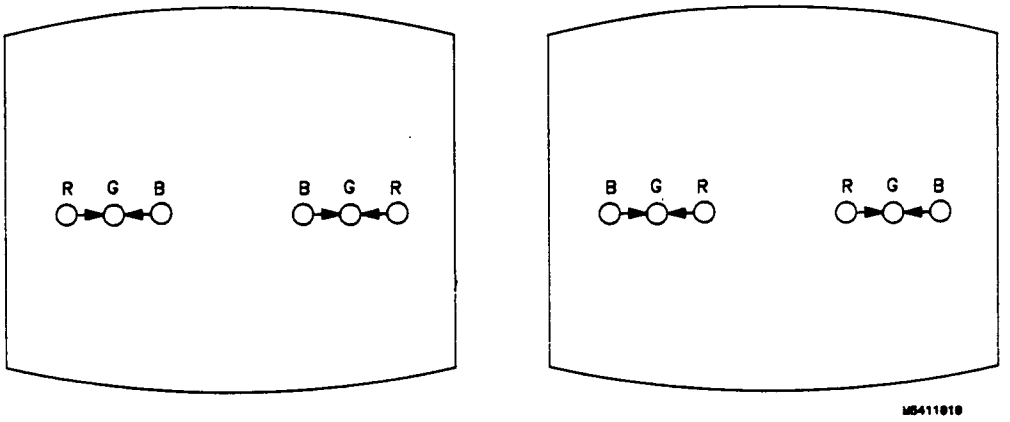


Figure 4-14. H.TILT Adjustment.

White Balance

1. In ***Utility***, press ***CRT Setup Menu***, then press ***Light Output*** key (third key from top) as necessary to obtain a blanked raster.

NOTE

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. Set front panel BACKGROUND and SUB BRT (RV901) located on the bottom PC board to mechanical center.
3. Set front panel BRIGHTNESS and SUB CONT (RV902) located on the bottom PC board to mechanical center.
4. Set G. DRIVE (RV921), B. DRIVE (RV931) and R. DRIVE (RV911) located on the bottom PC board to mechanical center.
5. Set G. BKG (RV721), B. BKG (RV731) and R. BKG (RV711) located on the rear PC board fully counterclockwise (CCW).
6. Adjust the SCREEN (RV702) located on the rear PC board until either 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 best white balance.
8. Press ***Color Purity*** key as necessary to obtain the white raster.
9. Set front panel BRIGHTNESS control at maximum.
10. Observe the screen and adjust the DRIVE controls (RV921, RV931 and RV911) located on the bottom PC board for best white balance.

NOTE

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

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

SECTION 5
REPLACEABLE PARTS

5-1. INTRODUCTION

This section contains information for ordering parts. Table 5-1 lists the abbreviations used in the parts list and throughout this manual. Figure 5-1, which covers several pages, shows the locations of mainframe parts. Table 5-2 lists replaceable mainframe parts for the HP 54112D. Table 5-3 contains the names and addresses that correspond to the manufacturers' code numbers. Replaceable parts for individual assemblies are included in the HP 54112D Service Data Supplement which provides parts lists and schematics for applicable assemblies.

5-2. ABBREVIATIONS

Table 5-1 lists abbreviations used in the parts list, the schematics, and elsewhere in this manual. In some cases two forms of the abbreviation are used, one all in capital letters, and one partial or no capitals. This occurs because the abbreviations in the parts list are always all capitals. However, in the schematics and other parts of the manual, other abbreviation forms may be used with both lowercase and uppercase letters.

5-3. PARTS LIST

Table 5-2, the list of replaceable mainframe parts, is organized as follows:

a. Exchange assemblies. These assemblies can be ordered at reduced cost when the inoperative assembly is returned to Hewlett-Packard.

b. External parts. These parts are associated with the outside of the instrument and might be replaced during routine maintenance due to loss or damage.

c. Internal parts. These parts would be encountered only if the instrument was disassembled for repair. It includes assemblies, cables, mechanical parts, hardware, and other parts.

The information given for each part consists of the following:

a. Hewlett-Packard part number and the check digit (for HP internal use).

b. Total quantity (Qty) in the instrument, given only once, at the first appearance of the part number in the list.

c. Description of the part.

d. A typical manufacturer of a given part in a five digit code. Refer to table 5-3 for a code to manufacturer cross reference.

e. The manufacturers' number for the part.

5-4. EXCHANGE ASSEMBLIES

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

Exchangeable parts are listed in a separate section in the replaceable parts table. They have a part number in the form XXXXX-695XX (where the new part would be XXXXX-665XX).

Before ordering a Blue-stripe assembly, check with you're local parts or repair organization for the procedures associated with the Blue-stripe program.

5-5. ORDERING INFORMATION

To order a part listed in the replaceable parts list, quote the Hewlett-Packard part number and check digit, indicate the quantity required, and address the order to the nearest Hewlett-Packard Sales/Service Office.

To order a part that is not listed in the replaceable parts table, include the instrument serial number, the description and function of the part, and the number of parts required. Address the order to the nearest Hewlett-Packard Sales/Service Office.

5-6. DIRECT MAIL ORDER SYSTEM

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

a. Direct ordering and shipment from the HP Parts Center.

b. No maximum or minimum on any mail order (there is a minimum order amount for parts ordered through a local HP office when the orders require billing and invoicing).

c. Prepaid transportation (there is a small handling charge for each order).

d. No invoices - to provide these advantages, a check or money order must accompany each order.

Mail-order forms and specific ordering information is available through your local HP office. Addresses and phone numbers are located at the back of this manual.

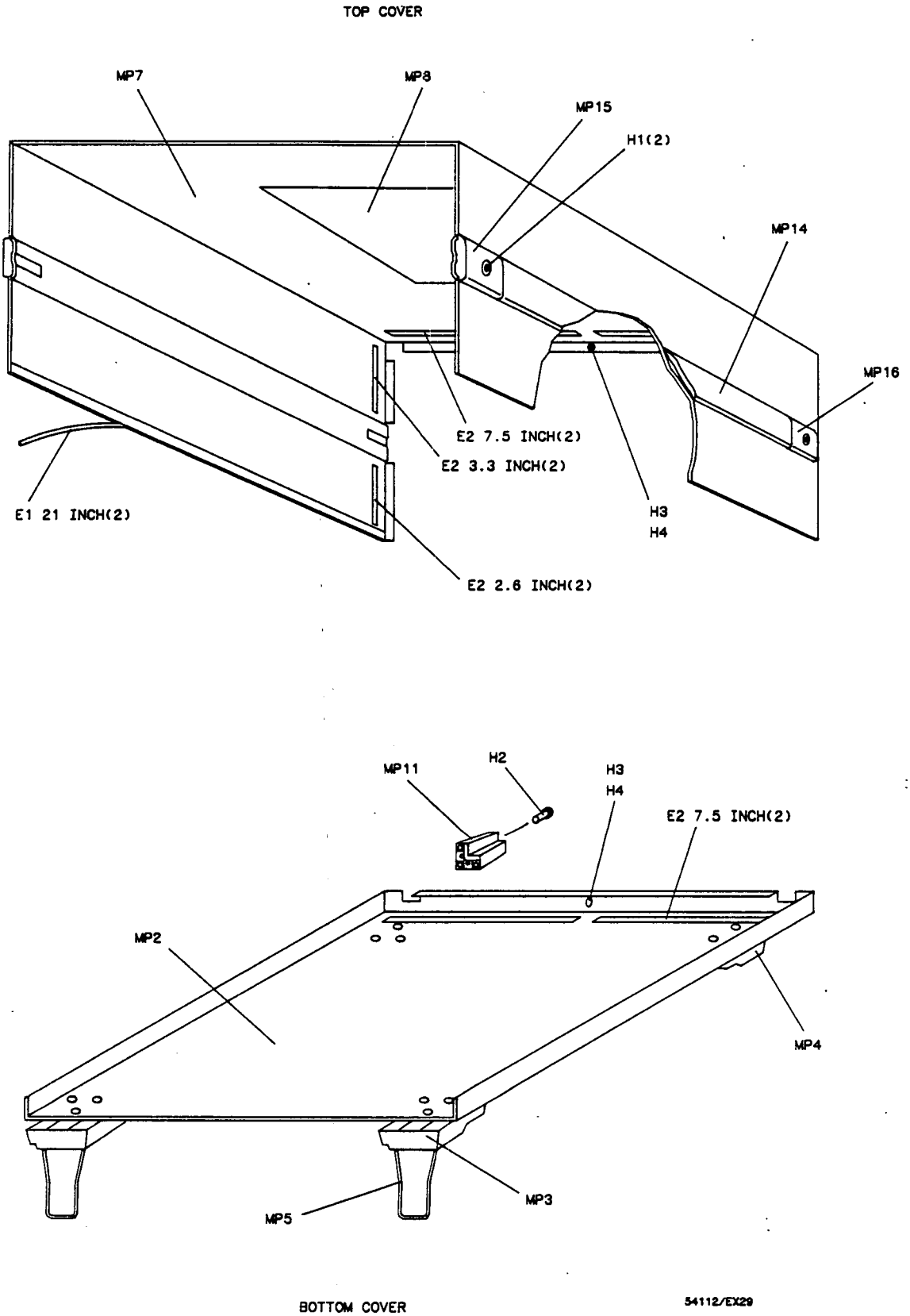
Table 5-1. Reference Designators and Abbreviations.

REFERENCE DESIGNATORS

A	=assembly
B	=fan;motor
BT	=battery
C	=capacitor
CR	=diode;diode thyristor; varactor
DL	=delay line
DS	=annunciator;lamp;LED
E	=misc. electrical part
F	=fuse
FL	=filter
H	=hardware
J	=electrical connector (stationary portion);jack
L	=coil;inductor
MP	=misc. mechanical part
P	=electrical connector (moveable portion);plug
Q	=transistor;SCR; triode thyristor
R	=resistor
RT	=thermistor
S	=switch;jumper
T	=transformer
TB	=terminal board
TP	=test point
U	=integrated circuit; microcircuit
V	=electron tube; glow lamp
VR	=voltage regulator; breakdown diode
W	=cable
X	=socket
Y	=crystal unit(piezo-electric or quartz)

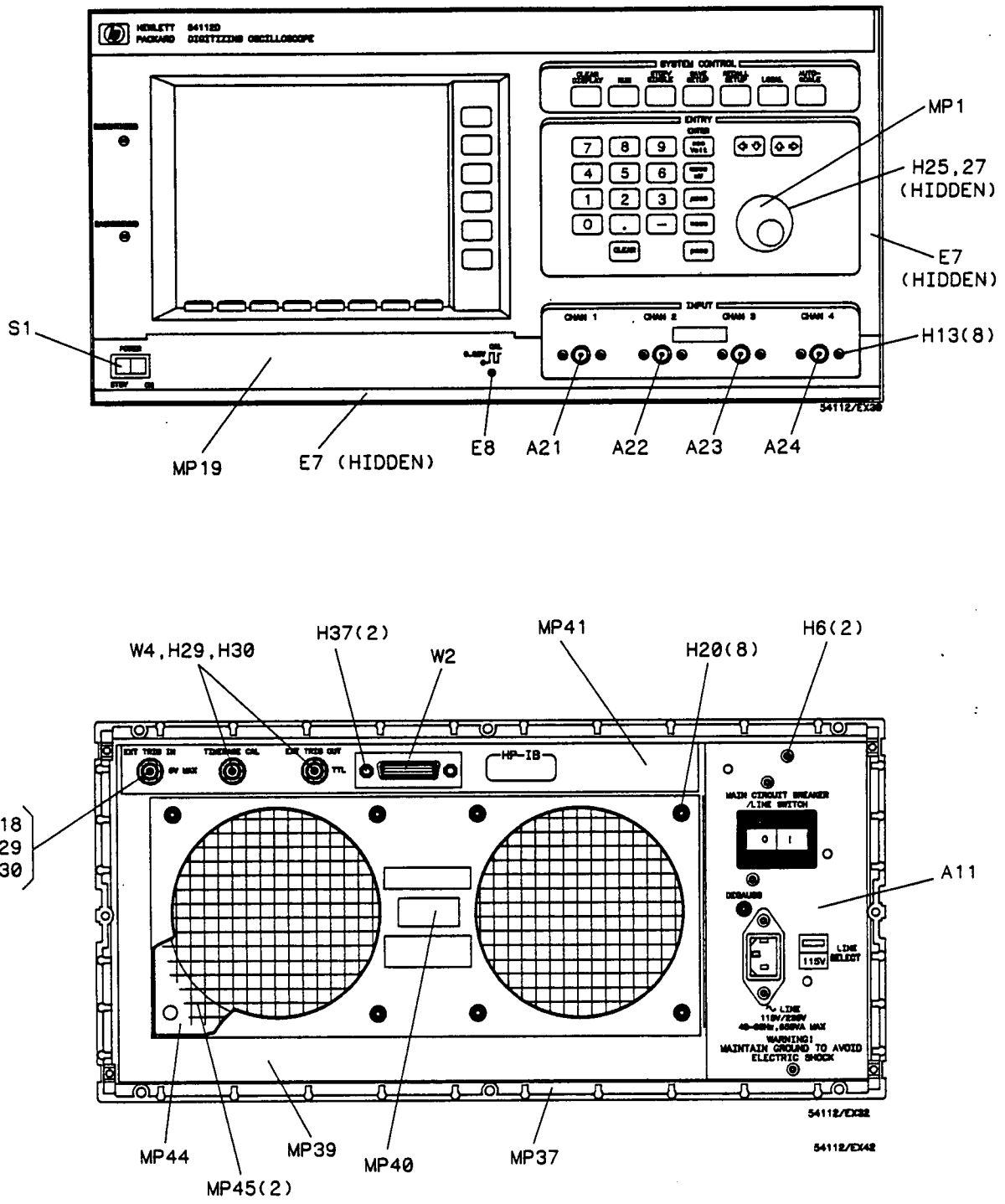
ABBREVIATIONS

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



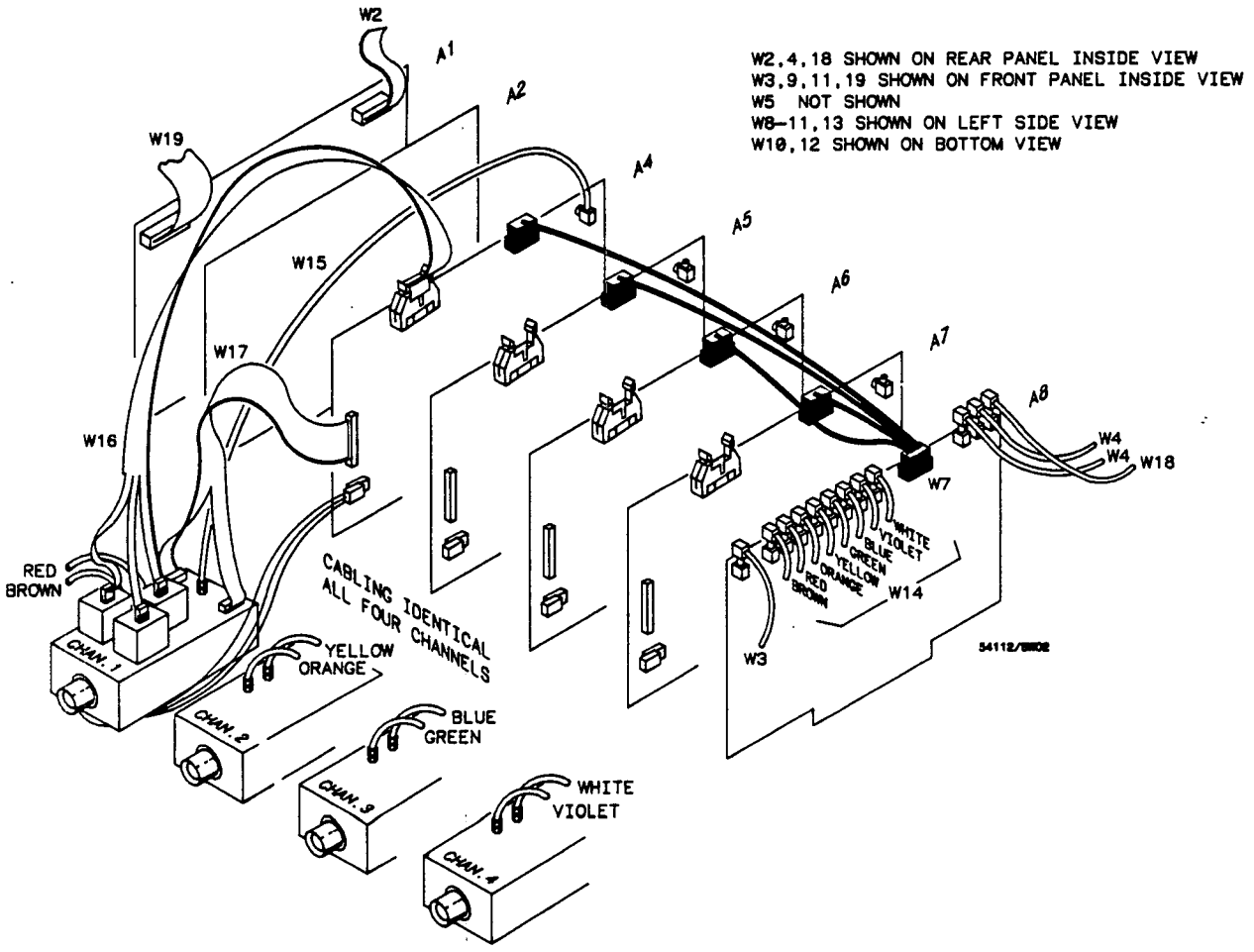
COVER PARTS

Figure 5-1. Mainframe Parts Locations (sheet 1 of 7)



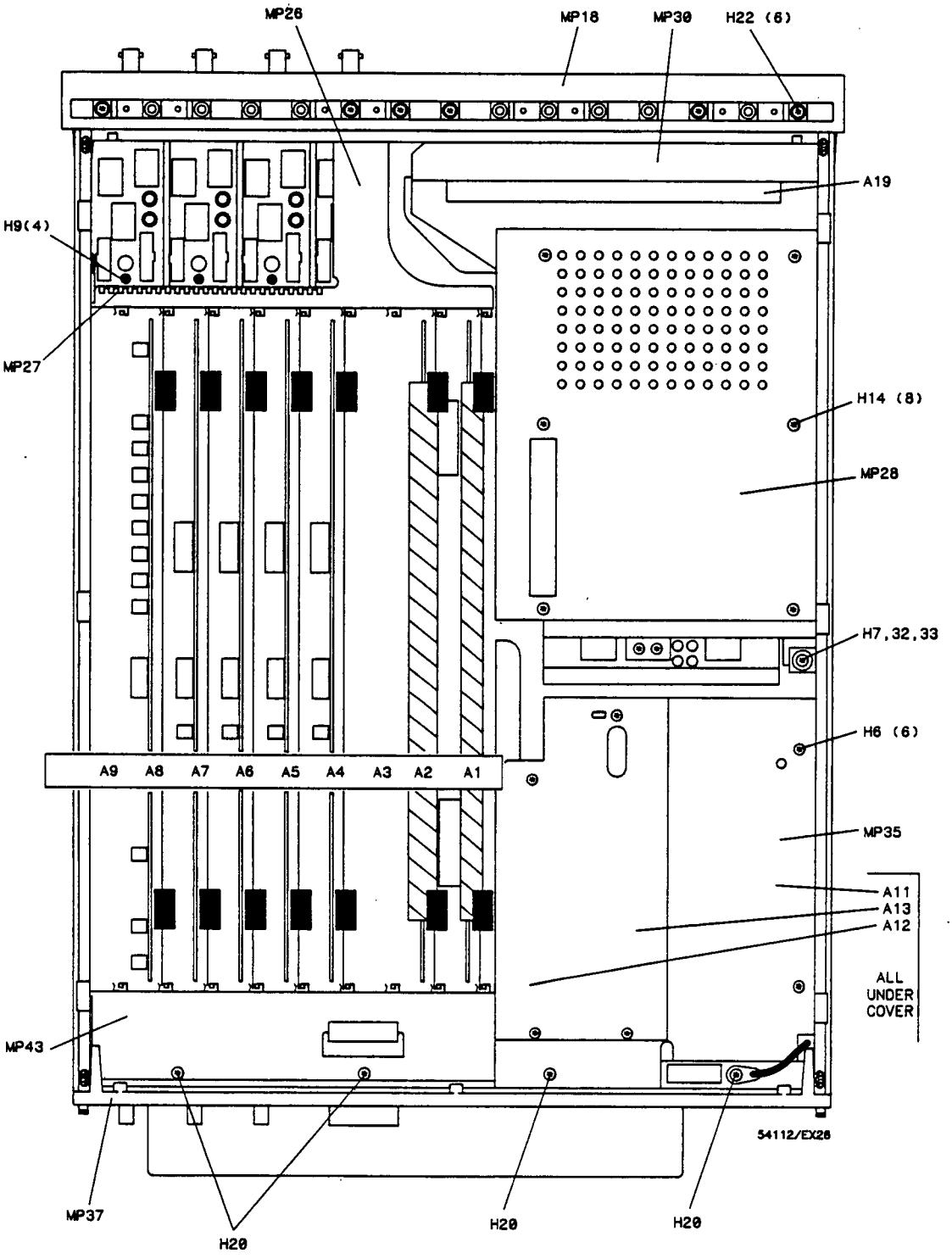
FRONT AND REAR PANEL VIEWS

Figure 5-1. Mainframe Parts Locations (sheet 2 of 7)



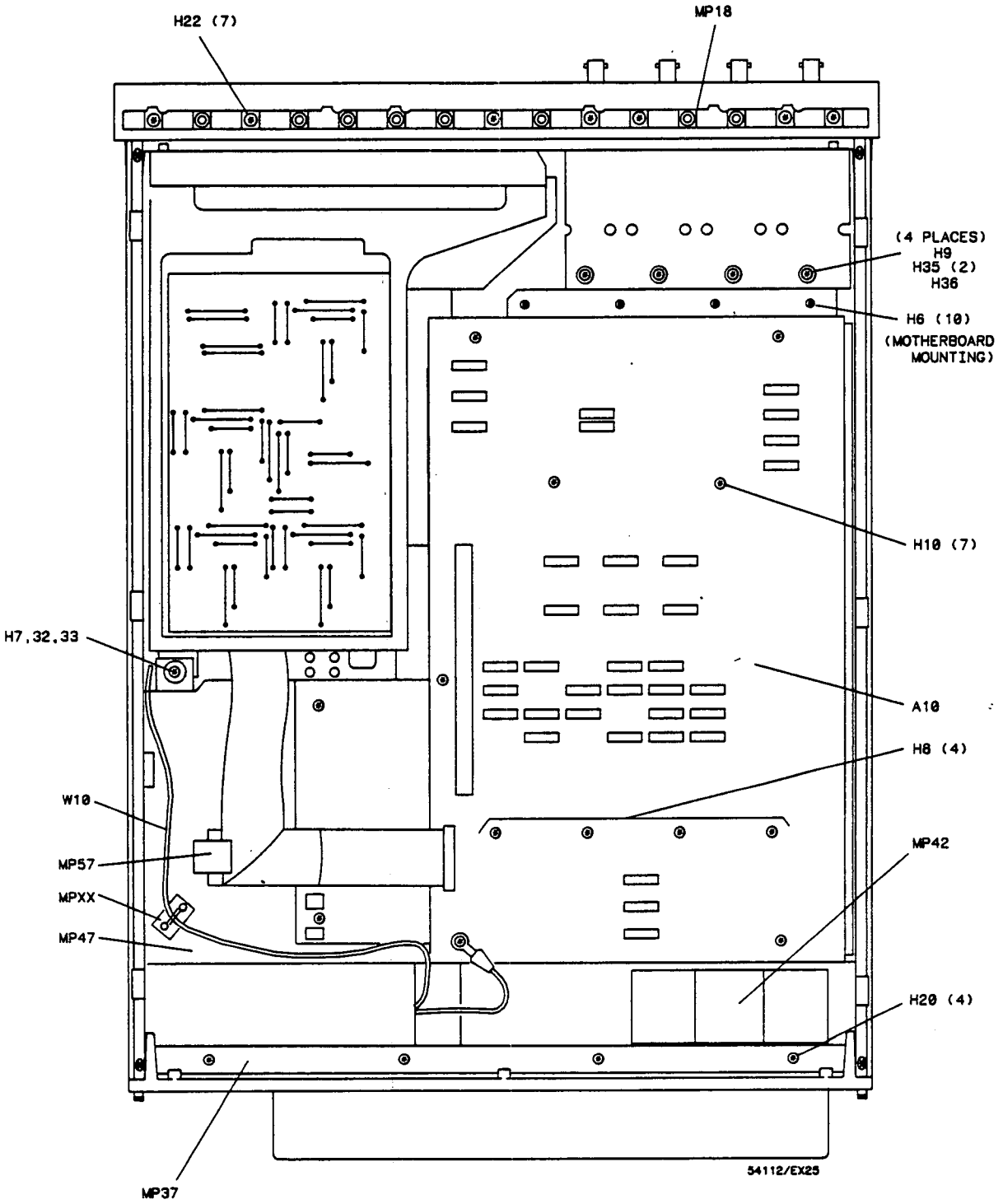
CABLING

Figure 5-1. Mainframe Parts Locations (sheet 3 of 7)



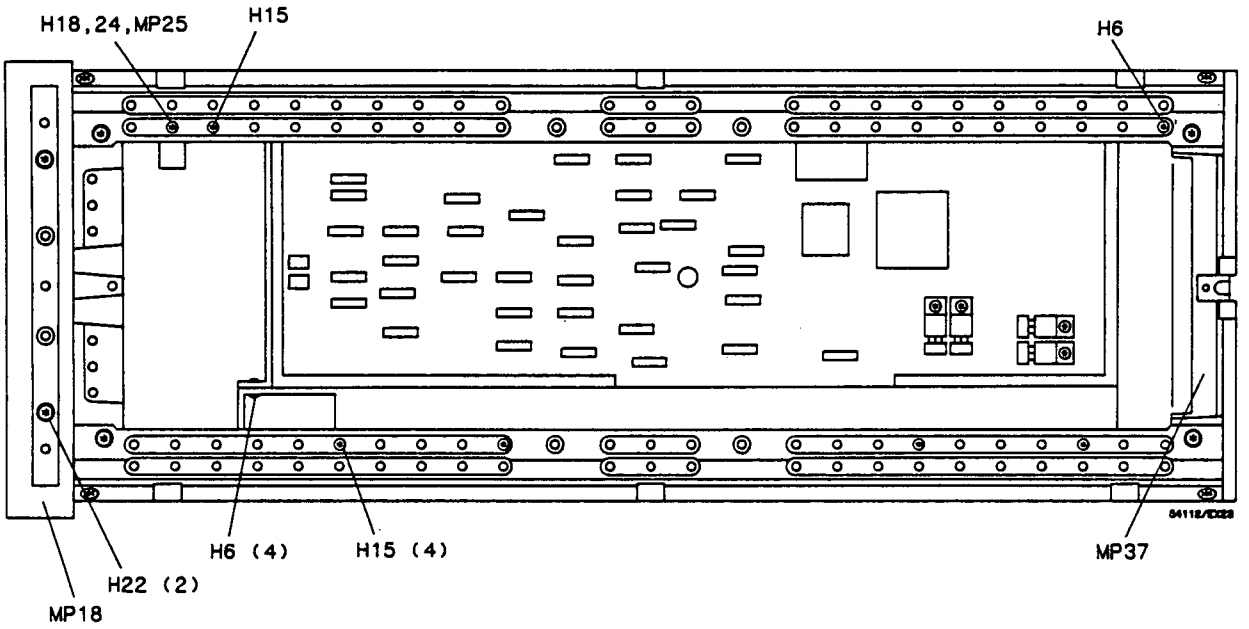
INSIDE, TOP VIEW

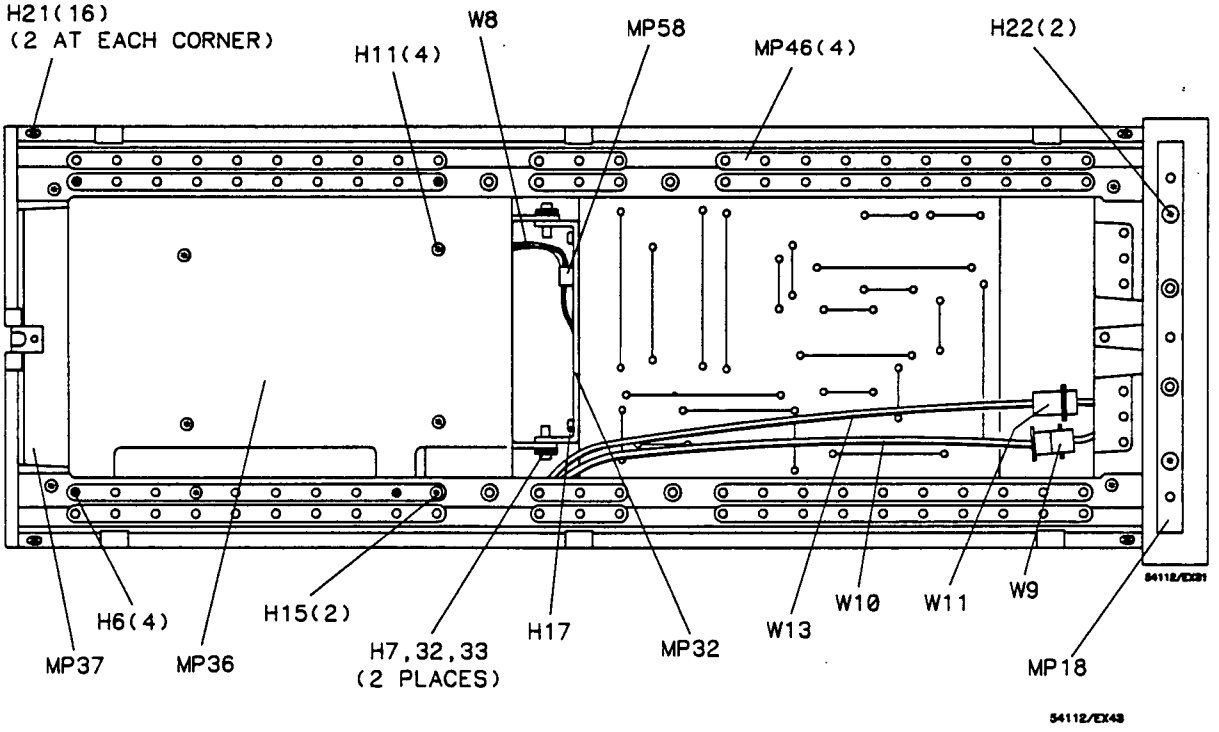
Figure 5-1. Mainframe Parts Locations (sheet 4 of 7)



INSIDE, BOTTOM VIEW

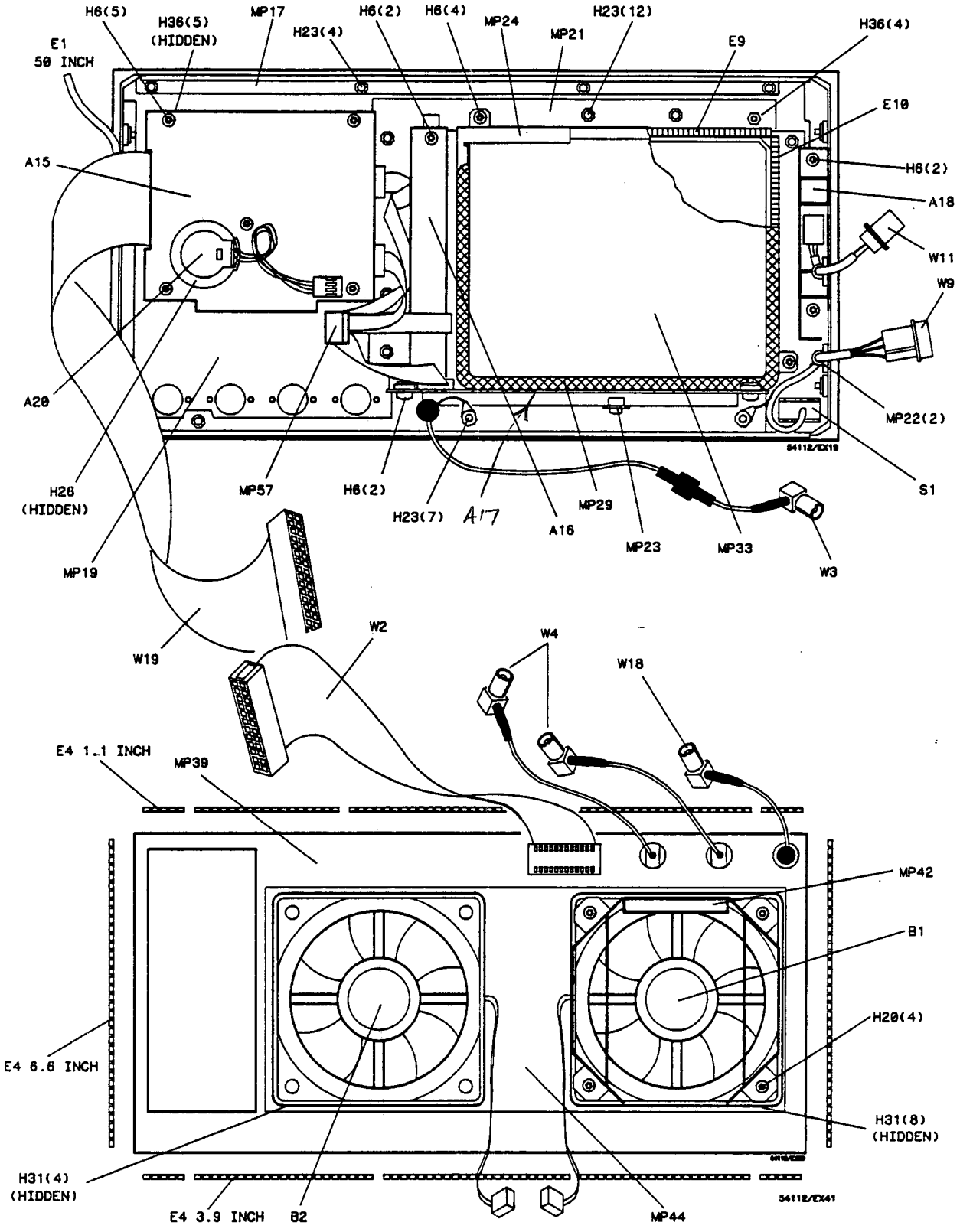
Figure 5-1. Mainframe Parts Locations (sheet 5 of 7)





INSIDE, SIDE VIEWS

Figure 5-1. Mainframe Parts Locations (sheet 6 of 7)



FRONT AND REAR PANELS, INSIDE VIEW

Figure 5-1. Mainframe Parts Locations (sheet 7 of 7)

Table 5-2. Replaceable Parts (Cont'd)

Reference Designator	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
				CURRENT PARTS LIST FOR HP 54112D		
				MAINFRAME ASSEMBLIES/PARTS FOR SERIAL PREFIX 2735A		
EXCHANGE ASSEMBLIES				(See paragraph 5-4 for exchange assembly ordering information)		
A1	54111-69506	8	1	INPUT/OUTPUT ASSEMBLY	28480	54111-69508
A2	54111-69511	5	1	MICROPROCESSOR ASSEMBLY	28480	54111-69511
A3				NOT ASSIGNED		
A4	54112-69503	8	4	ADC ASSEMBLY CHANNEL 1	28480	54112-69503
A5	54112-69503	6		ADC ASSEMBLY CHANNEL 2	28480	54112-69503
A6	54112-69503	6		ADC ASSEMBLY CHANNEL 3	28480	54112-69503
A7	54112-69503	6		ADC ASSEMBLY CHANNEL 4	28480	54112-69503
A8	54112-69502	5	1	TIMEBASE/TRIGGER ASSEMBLY	28480	54112-69502
A9				NOT ASSIGNED		
A10	54110-69512	5	1	BD ASSY COLOR DISPLAY	28480	54110-69512
A11	54110-69504	5	1	BD ASSY PRIMARY POWER SUPPLY	28480	54110-69504
A12	54110-69510	3	1	BD ASSY ANALOG POWER SUPPLY	28480	54110-69510
A13	54110-69508	1	1	BD ASSY DIGITAL POWER SUPPLY	28480	54110-69508
EXTERNAL PARTS						
E1	8160-0577	4	8ft	GASKET - RFI - BRAIDED WIRE - 0.1 IN	28480	8160-0577
E2	0363-0125	0	2	CONTACT STRIP - FINGERS - 24 IN LENGTH	28480	0363-0125
E3				NOT ASSIGNED		
H1	0515-1384	8	4	SCREW-MACH M5 10MM-LG FLAT-HEAD T25	00000	ORDER BY DESCRIPTION
H2	0515-1444	1	4	SCREW-MACH M3.5 25.4MM-LG PAN-HD T10	00000	ORDER BY DESCRIPTION
H3	0515-1245	0	2	SCREW-MACH M3.5 12MM-LG COVER MOUNTING	28480	0515-1245
H4	0510-1253	0	2	RETAINING RING FOR COVER MOUNTING SCREW	28480	0510-1253
H5				NOT ASSIGNED		
MP1	01650-47401	7	1	KNOB - RPG	28480	01650-47401
MP2	5061-9448	3	1	COVER - BOTTOM	28480	5061-9448
MP3	5040-7201	8	2	FOOT - BOTTOM - FRONT	28480	5040-7201
MP4	5040-7222	3	2	FOOT - BOTTOM REAR - NON SKID	28480	5040-7222
MP5	1460-1345	5	2	TILT STAND SST	28480	1460-1345
MP6				NOT ASSIGNED		
MP7	54112-04104	7	1	CVR - TOP	28480	54112-04104
MP8	54112-94302	6	1	CABLE ROUTING DIAGRAM	28480	54112-94302
MP9	5001-0441	2	2	TRIM STRIP - SIDE - SELF STICK	28480	5001-0441
MP10	5040-7202	9	1	TRIM STRIP - TOP - PLASTIC	28480	5040-7202
MP11	54110-40502	3	4	FOOT - REAR PANEL	28480	54110-40502
MP12				NOT ASSIGNED		
MP13				NOT ASSIGNED		
MP14	5060-9805	4	2	STRAP - HANDLE	28480	5060-9805
MP15	5041-6819	4	2	CAP - STRAP HANDLE (FRONT)	28480	5041-6819
MP16	5041-6820	7	2	CAP - STRAP HANDLE (REAR)	28480	5041-6820
W1	8120-1521	6	1	POWER CORD 125V USA/CANADA	28480	8120-1521
	8120-1703	6		POWER CORD OPTION 900 UNITED KINGDOM	28480	8120-1703
	8120-0696	4		POWER CORD OPTION 901 AUST/NEW ZEALAND	28480	8120-0696
	8120-1692	2		POWER CORD OPTION 902 EUROPEAN CONTINENT	28480	8120-1692
	8120-0698	6		POWER CORD OPTION 904 250V USA/CANADA	28480	8120-0698
	8120-2296	4		POWER CORD OPTION 906 SWITZERLAND	28480	8120-2296
	8120-2957	4		POWER CORD OPTION 912 DENMARK	28480	8120-2957
	8120-4211	7		POWER CORD OPTION 917 SOUTH AFRICA	28480	8120-4211
	8120-4754	3		POWER CORD OPTION 918 JAPAN	28480	8120-4754
PROBES	10033A	8	4	DIVIDER PROBE - 10:1	28480	10033A
RACK MOUNT KIT	5061-9679	2		RACK MOUNT KIT - OPTION 908	28480	5061-9679

Table 5-2. Replaceable Parts (Cont'd)

Reference Designator	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
INTERNAL PARTS						
A1	54111-66506	2	1	INPUT/OUTPUT ASSEMBLY	28480	54111-66506
A2	54111-66511	9	1	MICROPROCESSOR ASSEMBLY	28480	54111-66511
A3				NOT ASSIGNED		
A4	54112-66503	0	4	ADC ASSEMBLY CHANNEL 1	28480	54112-66503
A5	54112-66503	0		ADC ASSEMBLY CHANNEL 2	28480	54112-66503
A6	54112-66503	0		ADC ASSEMBLY CHANNEL 3	28480	54112-66503
A7	54112-66503	0		ADC ASSEMBLY CHANNEL 4	28480	54112-66503
A8	54112-66502	9	1	TIMEBASE/TRIGGER ASSEMBLY	28480	54112-66502
A9				NOT ASSIGNED		
A10	54110-66512	9	1	COLOR DISPLAY ASSEMBLY	28480	54110-66512
A11	54110-66513	0	1	BD ASSY PRIMARY POWER SUPPLY	28480	54110-66513
A12	54110-66510	7	1	BD ASSY ANALOG POWER SUPPLY	28480	54110-66510
A13	54110-66506	1	1	BD ASSY DIGITAL POWER SUPPLY	28480	54110-66506
A14	54110-66511	8	1	BD ASSY MOTHER	28480	54110-66511
A15	54100-66505	8	1	BD ASSY CONTROL KEYBOARD	28480	54100-66505
A16	54110-66502	7	1	BD ASSY FUNCTION KEYBOARD	28480	54110-66502
A17	54100-66520	7	1	BD ASSY MENU KEYBOARD	28480	54100-66520
A18	54111-66514	2	1	BD ASSY DISPLAY CONTROL	28480	54111-66514
A19	2090-0092	3	1	MODULE - COLOR CRT * *Also order 8 ea H14 3 mm tapping screws	28480	2090-0092
A20	01980-61062	5	1	ASSY - RPG	28480	01980-61062
A21	1NC1-0003	9	4	ATTENUATOR ASSEMBLY CHANNEL 1	28480	1NC1-0003
A22	1NC1-0003	9		ATTENUATOR ASSEMBLY CHANNEL 2	28480	1NC1-0003
A23	1NC1-0003	9		ATTENUATOR ASSEMBLY CHANNEL 3	28480	1NC1-0003
A24	1NC1-0003	9		ATTENUATOR ASSEMBLY CHANNEL 4	28480	1NC1-0003
B1	3160-0521	3	2	FAN - TUBEAXIAL	28480	3160-0521
B2	3160-0521	3		FAN - TUBEAXIAL	28480	3160-0521
E4	8160-0590	8	3	RFI STRIP - FINGERS - 18 INCH LENGTH	28480	8160-0590
E5				NOT ASSIGNED		
E6				NOT ASSIGNED		
E7	4320-0418	8	1	GASKET - RFI - BRAIDED WIRE - 0.2 IN	28480	4320-0418
E8	0360-1848	8	1	TEST POINT - FRONT PANEL CAL SIGNAL	28480	0360-1848
E9	54112-07101	0	2	RFI STRIP - FINGERS - CRT BEZEL - LONG	28480	54112-07101
E10	54112-07102	1	2	RFI STRIP - FINGERS - CRT BEZEL - SHORT	28480	54112-07102
H6	0515-0372	2	46	SCREW-MACH M3 8MM-LG PAN-HD T10	00000	ORDER BY DESCRIPTION
H7	0515-0664	5	2	SCREW-MACH M3 12MM-LG PAN-HD T10	00000	ORDER BY DESCRIPTION
H8	0515-0430	3	4	SCREW-MACH M3 6MM-LG PAN-HD T10	00000	ORDER BY DESCRIPTION
H9	0515-0665	6	8	SCREW-MACH M3 14MM-LG PAN-HD T10	00000	ORDER BY DESCRIPTION
H10	0515-1410	1	7	SCREW-MACH M3 20MM-LG PAN-HD T10	00000	ORDER BY DESCRIPTION
H11	0515-1025	6	4	SCREW-MACH M3 26MM-LG PAN-HD T10	00000	ORDER BY DESCRIPTION
H12				NOT ASSIGNED		
H13	0515-1035	4	8	SCREW-MACH M3 8MM-LG FLAT-HEAD T10	00000	ORDER BY DESCRIPTION
H14	0515-1271	2	8	SCREW-MACH M3 6MM-LG THREAD ROLLING	00000	ORDER BY DESCRIPTION
H15	0515-0433	6	6	SCREW-MACH M4 8MM-LG PAN-HD T15	00000	ORDER BY DESCRIPTION
H16				NOT ASSIGNED		
H17	0515-0841	8	2	SCREW-MACH M4 10MM-LG THREAD ROLLING	00000	ORDER BY DESCRIPTION
H18	0515-0435	8	13	SCREW-MACH M4 14MM-LG PAN-HD T15	00000	ORDER BY DESCRIPTION
H19				NOT ASSIGNED		
H20	0515-0380	3	12	SCREW-MACH M4 10MM-LG PAN-HD T15	00000	ORDER BY DESCRIPTION
H21	0515-1403	2	16	SCREW-MACH M4 6MM-LG FLAT-HEAD T15	00000	ORDER BY DESCRIPTION
H22	0515-1269	9	17	SCREW-MACH M4 10MM-LG FLAT-HEAD T15	00000	ORDER BY DESCRIPTION
H23	0535-0031	2	23	NUT-HEX M3 W/LOCK WASHER	00000	ORDER BY DESCRIPTION
H24	0535-0043	6	1	NUT-HEX M4 W/LOCK WASHER	00000	ORDER BY DESCRIPTION
H25	2950-0043	6	1	NUT-HEX 3/8-32	00000	ORDER BY DESCRIPTION
H26	3050-1176	3	1	WASHER-FLAT NYLON 3/8	28480	3050-1176
H27	2190-0018	3	1	WASHER-INTERNAL LOCK 3/8	00000	ORDER BY DESCRIPTION
H28				NOT ASSIGNED		
H29	2950-0035	4	3	NUT-HEX 15/32-32	00000	ORDER BY DESCRIPTION
H30	2190-0068	5	3	WASHER-INTERNAL LOCK 1/2	00000	ORDER BY DESCRIPTION
H31	5061-6138	2	12	NUT-INSERT M4	28480	5061-6138
H32	2190-0763	1	2	WASHER-FLAT METAL 0.14ID 0.50D	28480	2190-0763
H33	3050-1238	8	2	WASHER-FLAT NEOPRENE 0.149ID 0.478OD	28480	3050-1238
H34				NOT ASSIGNED		
H35	3050-0005	5	8	WASHER-SHOULDER 0.14ID 0.375OD	28480	3050-0005
H36	0380-1902	9	13	STANDOFF-HEX M3	28480	0380-1902
H37	0380-1886	6	2	STANDOFF-HEX HP-IB	28480	0380-1686
MP17	54112-01206	4	1	UPPER BRACKET - FRONT PANEL	28480	54112-01206
MP18	5021-5807	6	1	FRAME - FRONT	28480	5021-5807
MP19	54112-00201	7	1	PANEL - FRONT	28480	54112-00201
MP20	54112-01205	3	1	LOWER BRACKET - FRONT PANEL	28480	54112-01205

See introduction to this section for ordering information

Table 5-2. Replaceable Parts (Cont'd)

Reference Designator	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
MP21	54112-02201	1	1	BEZEL - CRT	28480	54112-02201
MP22	1400-1122	0	2	CLAMP - CABLE - STICK-ON	28480	1400-1122
MP23	0403-0092	6	1	RUBBER BUMPER (MENU KEYBOARD SUPPORT)	28480	0403-0092
MP24	54112-01204	2	1	RETAINER - GLASS FILTER * * Also order 1 ea MP29 CRT dust barrier	28480	54112-01204
MP25	1400-0025	0	1	CLAMP - CABLE - TRIG CABLE SUPPORT	28480	1400-0025
MP26	54111-01203	0	1	BKT - CARD CAGE FRONT	28480	54111-01203
MP27	0400-0018	0	.4ft	CHANNEL GROMMET - NYLON	28480	0400-0018
MP28	54112-00808	8	1	SHIELD - COLOR CRT MODULE	28480	54112-00808
MP29	54100-42701	8	1	CRT DUST BARRIER - FOAM	28480	54100-42701
MP30	54112-01203	1	1	BRACKET - COLOR CRT MOD - FRONT TOP	28480	54112-01203
MP31	54112-01202	0	1	BRACKET - COLOR CRT MOD - FRONT BOTTOM	28480	54112-01202
MP32	54110-04702	9	1	BRACKET - COLOR CRT MOD - REAR	28480	54110-04702
MP33	54112-22701	8	1	GLASS FILTER * * Also order 1 ea MP29 CRT dust barrier	28480	54112-22701
MP34				NOT ASSIGNED		
MP35	54112-04103	8	1	COVER - POWER SUPPLY (TOP)	28480	54112-04103
MP36	54112-04101	4	1	COVER - POWER SUPPLY (SIDE)	28480	54112-04101
MP37	5021-5808	7	1	FRAME - REAR	28480	5021-5808
MP38	54110-94303	5	1	LABEL - GROUND CONNECTION WARNING	28480	54110-94303
MP39	54112-60201	3	1	PANEL - REAR	28480	54112-60201
MP40	5958-5582	9	1	LABEL - X-RAY	28480	5958-5582
MP41	54112-94301	5	1	LABEL - REAR PANEL CONNECTORS	28480	54112-94301
MP42	54112-85201	3	1	AIR DIFFUSER ASSEMBLY	28480	54112-85201
MP43	54112-05201	7	1	BRACKET - CARD CAGE - REAR	28480	54112-05201
MP44	54112-04701	0	1	SPACER - FAN	28480	54112-04701
MP45	18500-00803	3	2	SCREEN - FAN	28480	18500-00803
MP46	5021-5838	3	4	STRUT - SIDE	28480	5021-5838
MP47	54111-00101	5	1	DECK - MAIN	28480	54111-00101
MP48				NOT ASSIGNED		
MP49	5041-1480	5	2	WIRE MARKER - BROWN	28480	5041-1480
MP50	5041-1481	6	2	WIRE MARKER - WHITE	28480	5041-1481
MP51	5041-1482	7	2	WIRE MARKER - VIOLET	28480	5041-1482
MP52	5041-1483	8	2	WIRE MARKER - BLUE	28480	5041-1483
MP53	5041-1484	9	2	WIRE MARKER - GREEN	28480	5041-1484
MP54	5041-1485	0	2	WIRE MARKER - YELLOW	28480	5041-1485
MP55	5041-1486	1	2	WIRE MARKER - ORANGE	28480	5041-1486
MP56	5041-1487	2	2	WIRE MARKER - RED	28480	5041-1487
MP57	1400-0611	0	2	CLAMP - RIBBON CABLE	28480	1400-0611
MP58	1400-0679	0	1	CLAMP - CABLE	28480	1400-0679
MP59	1400-1382	0	1	CLAMP - CABLE - TWIST TYPE	28480	1400-1382
S1	3101-2911	5	1	SWITCH - ROCKER (Standby)	28480	3101-2911
W2	54111-61612	1	1	CABLE - HPIB	28480	54111-61612
W3	54112-61610	0	1	CABLE - COAX - FRONT PANEL CAL SIGNAL	28480	54112-61610
W4	54100-61610	6	2	CABLE - COAX - TRIG OUT - TIMEBASE CAL	28480	54100-61610
W5	54100-61612	8	2	CABLE - 3-WIRE - 300VDC PRIMARY POWER	28480	54100-61612
W6				NOT ASSIGNED		
W7	54112-61604	2	1	CABLE - ACQUISITION CLOCK	28480	54112-61604
W8	54110-61601	5	1	CABLE - 3-WIRE - COLOR CRT MOD POWER	28480	54110-61601
W9	54112-61606	4	1	CABLE - SHIELDED - STBY SWITCH - FRONT	28480	54110-61610
W10	54111-61610	9	1	CABLE - SHIELDED - STBY SWITCH - REAR	28480	54111-61610
W11	54112-61611	9	1	CABLE - DISPLAY CONTROL - FRONT	28480	54112-61611
W12	54110-61607	3	1	CABLE - RIBBON - DISP ASSY TO COLOR MOD	28480	54110-61607
W13	54112-61612	1	1	CABLE - DISPLAY CONTROL - REAR	28480	54112-61612
W14	54111-61602	9	8	CABLE - COAX - TCLOCK/LTCLOCK	28480	54111-61602
W15	54112-61608	6	4	CABLE - VERTICAL SIGNAL	28480	54112-61608
W16	54111-61604	1	4	CABLE - ATTENUATOR SOLENOID CABLE	28480	54111-61604
W17	54111-61605	2	4	CABLE - RIBBON - ATTENUATOR POWER	28480	54111-61605
W18	54112-61602	0	1	CABLE - COAX - EXTERNAL TRIGGER INPUT	28480	54112-61602
W19	54100-61601	3	1	CABLE - RIBBON - I/O TO FRONT PANEL	28480	54100-61601

Table 5-3. List of Manufacturers' Codes

Mfr No.	Manufacturer Name	Address		Zip Code
C0633	RIFA	BROMMA	SE	
S0167	FUJITSU LTD	TOKYO	JP	
00000	ANY SATISFACTORY SUPPLIER			
01121	ALLEN-BRADLEY CO	MILWAUKEE	WI	53204
01281	TRW INC SEMICONDUCTOR DIV	LAWNDALE	CA	90260
01295	TEXAS INSTR INC SEMICOND CMPNT DIV	DALLAS	TX	75222
02111	SPECTROL ELECTRONICS CORP	CITY OF IND	CA	91745
04713	MOTOROLA SEMICONDUCTOR PRODUCTS	PHOENIX	AZ	85008
08665	PRECISION MONOLITHICS INC	SANTA CLARA	CA	95050
07263	FAIRCHILD SEMICONDUCTOR DIV	MOUNTAIN VIEW	CA	94042
18546	VARO SEMICONDUCTOR INC	GARLAND	TX	75040
15454	AMETEK/RODAN DIV	ANAHEIM	CA	92806
19701	MEPCO/ELECTRA CORP	MINERAL WELLS	TX	76067
24546	CORNING GLASS WORKS (BRADFORD)	BRADFORD	PA	16701
25403	N.V. PHILIPS-ELCOMA DEPARTMENT	EINDHOVEN	HL	02878
27167	CORNING GLASS WORKS (WILMINGTON)	WILMINGTON	NC	28401
28480	HEWLETT-PACKARD CO CORPORATE HQ	PALO ALTO	CA	94304
3L585	RCA CORP SOLID STATE DIV	SOMERVILLE	NJ	
34335	ADVANCED MICRO DEVICES INC	SUNNYVALE	CA	94086
34649	INTEL CORP	MOUNTAIN VIEW	CA	95051
52763	STETTNER ELECTRONICS INC	CHATTANOOGA	TN	13035
56289	SPRAGUE ELECTRIC CO	NORTH ADAMS	MA	01247
72138	ELECTRO MOTIVE CORP	FLORENCE	SC	06226
73138	BECKMAN INSTRUMENTS INC HELIPOT DIV	FULLERTON	CA	92634
75915	LITTELFUSE INC	DES PLAINES	IL	60018

SECTION 6A
MAINFRAME DISASSEMBLY

6A-1. INTRODUCTION

This section contains removal and replacement procedures for mainframe assemblies. It includes a diagram showing assembly locations and a diagram showing cabling.

6A-2. SAFETY CONSIDERATIONS

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

WARNING

The standby switch on the front panel of this instrument DOES NOT de-energize all power supplies. To avoid shock hazards capable of causing injury or death, de-energize the instrument with the main power switch on the rear panel or by disconnecting the power cable.

WARNING

These procedures are used while repairing an instrument without protective covers and which may have been recently powered. Only trained service personnel who are aware of the hazards involved (for example, fire and electrical shock) should perform this maintenance. Read the Safety Summary in the front of this manual.

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 instrument is powered.

6A-3. TOOLS REQUIRED

Most hardware requires TORX® type tools in size #10, #15, #20, or #25. Also needed might be wrenches size 4.5 mm, 5.5 mm (7/32 inch), 9/32 inch (also fits 7 mm), 8 mm, 7/16 inch, and 15/32 inch.

A 6 mm open end wrench is needed when replacing an Attenuator assembly. This wrench is provided in the HP 54100 Family Support Kit.

6A-4. COVERS

There are two outside covers on the HP 54112D – a top cover (which also covers the sides) and a bottom cover. For most procedures it is not necessary to remove the bottom cover. However, for easier removal of the top cover, remove the bottom cover first.

While removing covers, note where shielding braid is located. If it separates from the covers, reinstall it when replacing covers or the instrument may not meet EMI specifications.

COVER REMOVAL

1. Remove rear feet. Their screws are accessible through the holes in the end.

2. Remove side strap handles. Note that the handles have smoother curves on the side closest to instrument. Reinstall with the same side toward the instrument.

3. Remove bottom cover. The screw at the rear center of the cover is captive and it will pull the cover back as it is removed.

   If the shielding braid pulls out of the channel at the edges of the top cover, be sure to reinstall it before replacing the cover.

4. Remove top cover. The screw at the rear center of this cover is also captive and will pull the cover back as it is removed.

   Later covers have two threaded inserts, identifiable by two holes either side of the cover screw and near the sides. Install a 3 mm screw about 25 mm long into each insert. When screwed in they will contact the frame and help force the cover off.

   Use the effective force of these screws while removing the cover with the center screw. Notice that the removal effect is with counter-clockwise rotation of the center screw and clockwise rotation of the side screws.

COVER INSTALLATION

Cover replacement is the reverse of removal.

CAUTION

Be sure all shielding components are installed when reinstalling covers. Incomplete shielding may result in the instrument not meeting EMI specifications. Refer to the drawings in the parts list for locations of shielding parts.

6A-5. MAJOR ASSEMBLY REMOVAL PROCEDURES

The following procedures should be followed when disassembling the instrument. Particular care should be taken with the cabling connecting card cage assemblies and attenuators.

6A-6. Card Cage PC Assemblies

REMOVAL

1. Disconnect power cable.

2. Remove covers (see previous procedure).

3. Disconnect any cables from assembly to be removed. Be very careful to pull coaxial connectors straight off. Do not bend the connectors. Some assemblies have cables along the front edge. These must be removed before the assembly is pulled up.

4. Refer to the illustration on top the power supply. Release PC assembly by pulling the flexible plastic extractors away from the assembly shield, then up.

5. Pull the assembly from the connector by pulling up on the extractors. As the assembly is removed, check for cables connected to the center of the assembly and remove them.

CAUTION

Removing the Microprocessor or Input/Output assemblies (A1 or A2) results in loss of calibration.

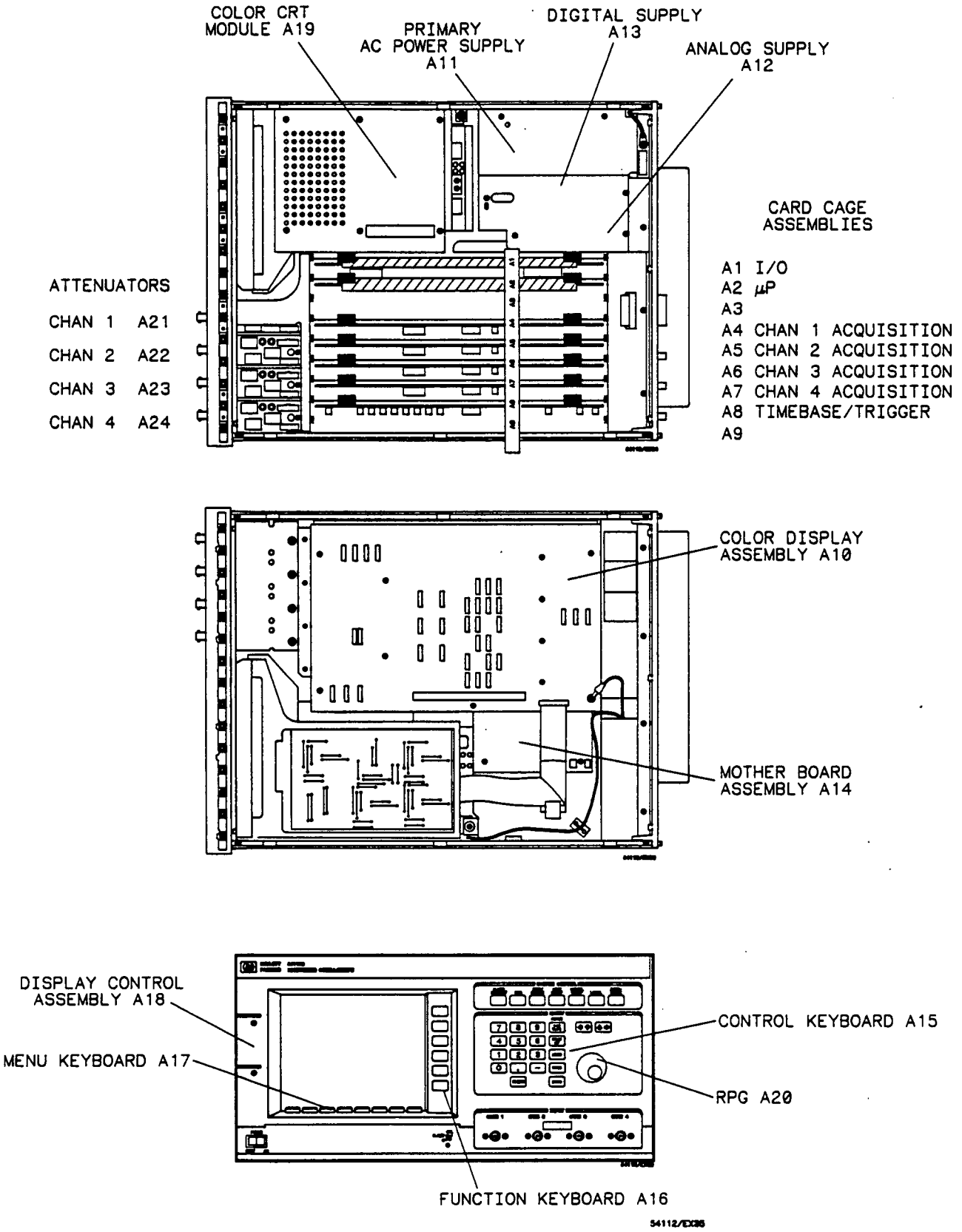


Figure 6A-1. Major Assembly Locations.

REPLACEMENT

1. Insert PC assembly shield edges in proper guides.

2. Keep the extractors up while sliding the assembly in.

3. If the assembly has cabling to its center area, it must be connected as the board is being inserted.

4. If the assembly has cabling to its front edge, it will be easier to connect the cables as soon as the connector is below the top edge of the card cage frame. Refer to the cabling diagram on the instrument top cover or the diagram at the end of this section.

5. While keeping assembly properly aligned in guides, push it in. When the top edge of the assembly is nearly level with the top of the card cage, the connector will start to engage. Keep assembly level and apply even pressure until connector is seated.

CAUTION

Do not use the extractors to lever the assembly into the connector. *Using the extractors makes it too easy to apply excessive force that might bend misaligned connector pins. If the connector will not seat with moderate pressure, remove the assembly and check for bent pins.*

Avoid pinching cabling between the assembly and the mainframe. Coaxial cables are particularly vulnerable to damage by pinching.

6. Reconnect all remaining cabling. Refer to the diagram on the instrument cover or the diagram at the end of this section.

6A-7. Power Supplies

This procedure should be used to remove all supplies: Primary, Digital, and Analog. Follow the procedure as far as necessary to remove the desired supply.

PRIMARY SUPPLY REMOVAL

1. Disconnect power cable.

2. Remove covers (see cover removal procedure).

WARNING

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

3. Through the hole in the top power supply shield, observe the red LED located on the Primary Power Supply. This LED indicates the presence of 300 volts. It will stay illuminated until the filter capacitors discharge. Wait until this LED is no longer illuminated before proceeding.
4. Remove top power supply shield (six small screws, and one large screw at rear frame).
5. Remove the screw that attaches the ground wire (green/yellow) to top corner of rear frame.
6. Remove the three cables at the top front of the Primary Power Supply PC board.
7. Remove four screws from power supply side cover (figure 6A-2).
8. Remove two screws which attach power supply assembly to rear panel (figure 6A-2).
9. Turn instrument onto its left side. Pull the power supply assembly rearward until the STBY switch cable at the rear bottom of power supply board can be disconnected. Disconnect the cable.
10. Pull supply rearward until it clears the instrument.
11. Continue with step 12 to remove the Digital and/or Analog supplies.

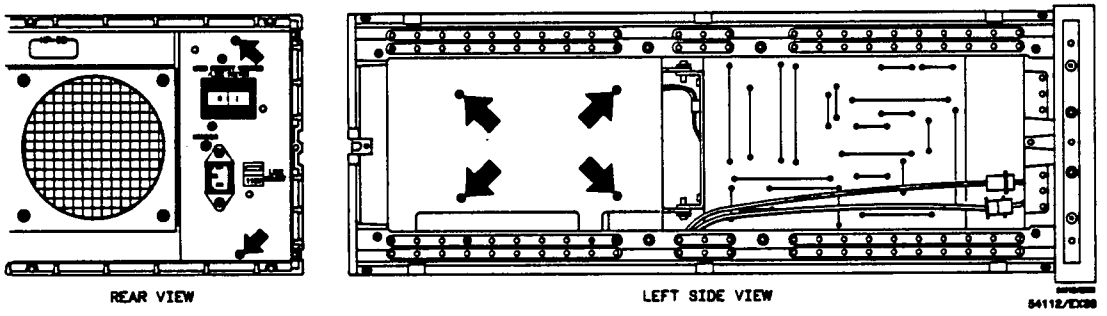


Figure 6A-2. Primary Power Supply Mounting Screws.

PRIMARY SUPPLY REPLACEMENT

Reverse removal procedure to install supply.

WARNING

Power supply safety grounding will be defeated if ground wire removed in step 5 above is not reconnected. To avoid a defeated ground, make sure this green/yellow wire is re-attached to top rear corner of the rear frame.

DIGITAL SUPPLY REMOVAL

12. After removing the Primary supply, steps 1 through 10, use a flat-blade screwdriver to loosen the captive screw at the bottom front of the Digital supply.

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

14. Slide the rear end of the supply toward the left side of the instrument so that it is diagonal in the power supply area. It can then be lifted out of the instrument.

15. Continue with step 16 to remove the Analog supply.

DIGITAL SUPPLY REPLACEMENT

Reverse the procedure to install the Digital and Primary supplies.

WARNING

Power supply safety grounding will be defeated if ground wire removed in step 5 above is not reconnected. To avoid a defeated ground, make sure this green/yellow wire is re-attached to top rear corner of the rear frame.

ANALOG SUPPLY REMOVAL

16. After removing the Primary and Digital supplies, steps 1 through 14, remove the six additional 4 mm screws that secure the rear panel in the rear frame. There are two on the top (two have already been removed) and four on the bottom.

17. Slide the left side of the rear panel (power supply end) out 1 to 2 inches. It shouldn't be necessary to disconnect any of the cabling to the rear panel but it may be necessary to guide cable slack through the rear card cage frame.

18. Use a flat-blade screwdriver to loosen the captive screw at the bottom front of the Analog supply, under the rear edge of the Color CRT Module.

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

20. Slide the rear end of the supply toward the left side of the instrument so that it is diagonal in the power supply area. Remove it from the instrument by lifting the front end first.

ANALOG SUPPLY REPLACEMENT

Reverse the entire power supply removal procedure to install all supplies.

WARNING

Power supply safety grounding will be defeated if ground wire removed in step 5 above is not reconnected. To avoid a defeated ground, make sure this green/yellow wire is re-attached to top rear corner of the rear frame.

6A-8. Front Panel Assemblies

This procedure covers removal of the front panel, keyboards, CRT Control board, and CRT bezel. Front panel removal is also a step preliminary to removal of Attenuator assemblies and Color CRT Module.

These procedures are necessarily different than those for similar models such as the HP 54110D and 54111D and should be followed without regard to those two instruments. The front frame must be removed along with the front panel and associated assemblies.

FRONT PANEL ASSEMBLY REMOVAL

1. Disconnect main power cable.
2. Remove covers. (See cover removal procedure.)
3. Remove top trim strip. There are two slots (visible from the rear) to aid in removal.
4. Remove the two screws on either side of each of the input BNC connectors.
5. Remove the front panel screws marked in the following figure.

CAUTION

The instrument will be hard to handle once the connection between the front frame and struts is removed. When the front frame is removed the only support for the Color CRT Module is at the rear bracket. Handle the instrument carefully and with consideration for the structural instability.

6. At each corner of the front frame, remove two screws that attach the struts (long pieces from front to back) to the front frame.

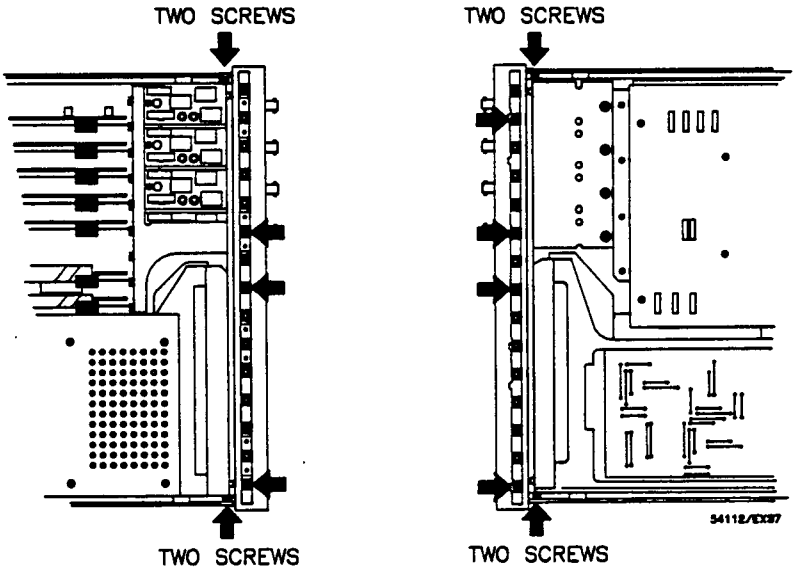


Figure 6A-3. Front Panel Assembly Mounting Screws.

7. Set instrument in its normal operating position.

8. Note the routing of the calibrator signal coax at the front connector on the Timebase/trigger assembly (A8, right-most card cage assembly) and disconnect it at the Timebase/trigger and slide it out through the slot in the card cage frame.

9. Disconnect the STBY switch and Display Control cables by separating the connectors at the front of the left side of the instrument. If you have an older instrument there may be only one connection, see step 10.

10. If you have an older instrument with only one cable connection in step 9, disconnect the one, then pull the front panel just far enough to gain access to the cable connector on the CRT Control board (left side of front panel) and disconnect the cable. Open the cable clamp that holds this cable and remove the cable.

11. Disconnect the large ribbon cable from the Control Keyboard and separate the front panel from the instrument.

NOTE

At the front of the attenuators is a plastic bushing containing the Probe ID sensing ring. Note the orientation of this bushing and ring. The tabs of the bushing should be horizontal and fit into the recess on the front of the attenuator. Be sure the bushings for all attenuators are properly aligned before replacing the front panel.

GLASS FILTER REMOVAL

The glass filter is designed to limit EMI as well as reflected light. It is secured by a metal retainer which has a screw at each corner. In early instruments the glass filter is fastened to the bezel with conductive glue. In later instruments, four sections of metal fingers contact the perimeter of the glass for electrical conduction.

When replacing a glass filter that has been glued to the bezel, contact an HP Service Center

The foam dust barrier is not part of the metal retainer and may be destroyed when the retainer is removed.

DISPLAY CONTROL REMOVAL

Remove two screws attaching the Display Control assembly.

CONTROL KEYBOARD REMOVAL

1. Disconnect the RPG cable at the Control Keyboard and if necessary the cables from the Function and Menu Keyboards.

   The Function Keyboard (side of display) cable goes to the top connector and the Menu Keyboard (bottom of display) cable goes to the bottom connector on the Control Keyboard.

2. Remove five screws and remove keyboard.

3. Pass RPG cable through hole in Control Keyboard.

MENU KEYBOARD REMOVAL

To remove the Menu Keyboard (along the side of the display) remove two screws attaching the Keyboard and disconnect the cable at the Control Keyboard.

FUNCTION KEYBOARD REMOVAL

1. The screws for the Function Keyboard (across the bottom of the display) cannot be reached with the front panel in the frame. To remove the front panel, remove the remaining screws around the outside of the front frame casting. There are two at each side, three across the top, and three across the bottom.

2. Remove the front panel from the front frame. There is a section of RFI braid along the left side and bottom (as viewed from the back) between the panel and the frame. Be sure to reinstall it during reassembly or EMI specifications may be compromised.

3. The screws to the Function Keyboard can now be reached and removed.

4. Remove the rubber bumper below the keyboard.

5. Remove the keyboard and disconnect the cable at the Control Keyboard.

ASSEMBLY REPLACEMENT

1. Replace minor assemblies, keyboards, CRT Control board, etc. in reverse of their removal procedures.

2. Check that all front panel cabling is dressed properly. Dress the small ribbon cables so they will clear the channel 1 Attenuator assembly and insert them into the clamp.

3. Set the instrument vertical, so that it rests on the fan housing with the front up.

4. Check that each sense ring around an Attenuator assembly BNC is aligned with the recess in the front of the assembly.

5. Set the front panel lightly in place over the Color CRT Module and Attenuator assemblies.

   Check the CAL cable and wide ribbon cable so they are not caught in the hardware and can be dressed later.

   Check that corner struts are outside the front frame.

   Allow the BNC connectors and sense rings to center in the holes in the front panel.

   The front panel assembly should fit into place without forcing. If not check for pinched cables and other obstructions. It may however, be held up slightly by the foam dust shield between the CRT and bezel.

6. Fasten the struts to all four corners of the front frame using two screws on each corner. Be sure to use the same screws removed.

7. Set instrument down in its normal operating position.

8. Fasten the Color CRT Module top bracket and the card cage brace using three screws through the top of the frame (see figure 6A-3).

   If the Color CRT Module does not align well, temporarily loosen the screws securing the module at the rear bracket, install the screws at the top front bracket, and retighted the screws at the rear bracket.

9. Turn instrument onto its left side and fasten the Color CRT Module bottom bracket and the main deck using four screws through the bottom of the frame (see figure 6A-3).

10. Set the instrument in the normal operating position.

11. Loosen the screw at the back of each Attenuator assembly.

12. Use eight screws to fasten the front of the Attenuator assemblies to the front panel.

13. Tighten the screw at the rear of each Attenuator assembly.

14. Pass the wide ribbon cable through an opening in the front of the card cage and connect to the front connector of the Input/output assembly.

15. Pass the front panel CAL cable through an opening in the front of the card cage and connect to the front connector of the Timebase/trigger assembly.

6A-9. Attenuator Assemblies

CAUTION

Protect against static discharge while working with attenuators. Input FET of preamplifier is sensitive to static discharge.

REMOVAL

1. Remove covers and front panel (refer to front panel removal procedure). Set instrument in its normal operating position.

2. Remove the screw at the rear of the attenuator assembly to be removed. This screw is not captive. Don't let it fall into the interior of the instrument because it will be hard to retrieve.

3. Remove the connector for the three-wire cable that connects to the front of the attenuator assembly. The connection is made at the front edge of one of the card cage boards.

3. Remove the three connectors from the attenuator solenoids.

4. Remove the cable connectors at the back of the Attenuator assembly. Note the orientation of these connectors.

5. Remove the three coaxial cables. Of the two trigger cables, remove the rear one first. The HP 54100 Family Support Kit provides a 6 mm open-end wrench for removing these cables. The Attenuator assembly should now be free of the instrument.

REPLACEMENT

1. Use the following table while connecting the coaxial cables to an attenuator.

NOTE

The two cables on the side are the trigger connections. The cable at the rear is the vertical signal connection. The trigger cables have a colored marker at each end. Connect the cables to the attenuator using the following chart.

ATTENUATOR	FRONT CONNECTOR	REAR CONNECTOR
CHAN 1	Brown	Red
CHAN 2	Orange	Yellow
CHAN 3	Green	Blue
CHAN 4	Violet	White

In the event that the cables were inadvertently removed at the Trigger/timebase assembly, they should be re-installed in order of color, front to back, following the standard color code. You can also use the diagram on the cover of the instrument or at the back of this section.

CAUTION

To avoid damage to the ceramic substrate of the preamplifier, push connectors onto the Attenuator Assembly gently.

2. Connect the rear ribbon cables to the Attenuator assembly. The connectors are keyed.

3. Carefully connect the cables to the solenoids. The connectors are keyed but the keying can be defeated by excessive force. Use the cabling diagram on the inside of the instrument top cover or the figure at the end of this section.

4. Connect the three-wire cable to the front of the appropriate card cage assembly. Use the cabling diagram for reference. Route the cable along the right side of the Attenuator assembly.

5. Insert the rear mounting screw into the hole at the rear of the Attenuator assembly. Slide the Attenuator assembly into place and rest the mounting screw on the standoff. Temporarily tighten the screw.

6. Recheck the routing of all cables, especially the three-wire cable. It can become pinched when the front panel is installed.

7. Check the alignment of the probe sensing ring on the BNC connector of all attenuator assemblies. It should fit into the recess at the front of the attenuator.

8. Install the front panel per the front panel procedures and reassemble the rest of the instrument. Use the appropriate procedures in this section.

6A-10. Color CRT Module

The Color CRT Module is replaceable only as a complete unit.

REMOVAL

1. Remove covers and front panel (refer to the appropriate procedures).
2. Disconnect the wide ribbon cable from the Color Display Assembly and remove cable from clip.
3. At rear of module, remove two screws attaching module mounting bracket to the mounting bracket on the mainframe. Each screw uses a metal washer and a rubber washer.
4. Slowly pull module forward until the power cable (small three-wire) can be disconnected at the Primary Power Supply board.
5. Continue pulling module forward until it clears the instrument.

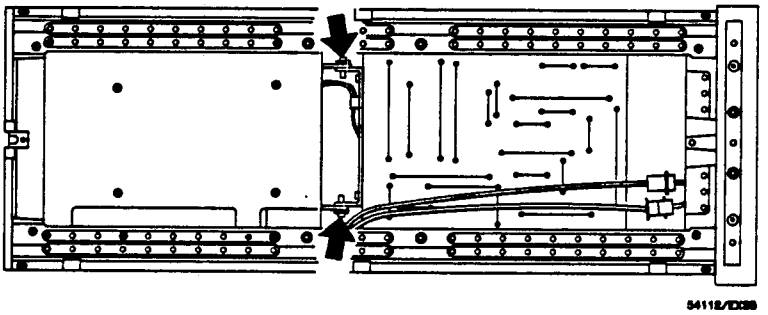


Figure 6A-4. Color CRT Module, Rear Mounting Screws.

REPLACEMENT

It is necessary to remove several items from the inoperative Color CRT Module and install them on the new one. Use the following procedures to do that and install the new module.

TRANSFER PARTS TO NEW MODULE

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

CAUTION

These screws are special self-tapping screws, different from others the same size. Do not use them anywhere else in the instrument.

It is best if you throw the old screws away and use new ones when installing a new module. Used ones may not be good enough to tap the holes in the new module.

2. Use an 8 mm wrench to remove the four nuts on the front of the inoperative module and remove the shield.

3. Remove the front mounting brackets and put the 8 mm nuts back on the module.

4. Remove the large nuts from the new module, do not remove any other hardware, and install the front mounting brackets.

5. Install the shield on the new module. Place it over the two front mounting screws and front mounting brackets.

6. Install the four large nuts but leave them loose so the shield can move.

7. Use the special self-tapping screws (step 1) to fasten the top and side of the shield. They will be hard to start while they are tapping the holes.

CAUTION

Be careful that excessive tightening does not strip the self-tapped holes. It is best to use new screws. If you use screws from the old module they may be ruined while trying to tap the holes on the new module.

8. Tighten the large nuts at the front of the module.

9. Remove the two screws that hold the rear bracket to the inoperative module.

   THESE SCREWS ARE SPECIAL self-tapping screws that must be used for mounting the bracket assembly on the new module. Do not use them for any other purpose.

10. Mount the rear bracket to the new module. The screws will be hard to start because they must self-tap the mounting holes. Be careful that excessive tightening does not strip the self-tapped holes.

11. Note the routing of the power cable and CRT Control cable and <u>one at a time</u>, remove them and install them on the new module.

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

INSTALL NEW MODULE

13. Install the new module most of the way into the instrument. Avoid pinching cables as module is being installed.

14. Connect the power cable to the appropriate connector at the top front corner of the Primary Power Supply and slide module the rest of the way in.

15. Install the two rear mounting screws (see figure 6A-4). These may be loosened later to align the module while installing the front panel.

16. Install the front panel using the installation procedure in the front panel procedures.

6A-11. Fans

REMOVAL

1. Remove the Primary Power Supply following the procedure in this section.
2. Remove remaining six 4 mm screws that fasten the rear panel to the rear frame. (Two were removed when the Primary Power Supply was removed.)
3. Disconnect fan power cables from rear corner of Mother board.
4. Disconnect HP-IB cable at the Input/Output assembly.
5. Disconnect three coaxial cables at the rear of the Timebase/trigger assembly.
6. While noting cable routing, carefully remove rear panel from instrument.

CAUTION

The fan on the instrument's right side (card cage side) has an air deflector mounted to it. Note the orientation of the deflector in the instrument and the orientation to the fan. The opening in the side of the deflector should be toward the bottom of the instrument when the rear panel is installed.

7. If replacing the right-side fan, remove the air deflector.

NOTE

Before removing fan, note the orientation of the fan in the housing. The side of each fan where the cable exits is toward the center of the housing.

8. Remove the four screws holding the defective fan in the rear panel.

REPLACEMENT

TRANSFER PARTS TO NEW FAN

The screws securing the fans in the housing and the air deflector to the right-side fan are held by nuts pressed into the mounting holes from the back side of the flanges. Remove these press-in nuts and use a plier to press them into the mounting holes of the new fan. The right-side fan uses eight nuts and the other fan four.

INSTALL FAN AND DEFLECTOR

Reverse removal procedure to install fan. If only one fan is removed, the fan spacer and screens should stay in place. If both fans were removed and parts have shifted, the screens go into the housing first, then the fan spacer, then the fans. Check the orientation of fans and air deflector during installation.

6A-12. Color Display Assembly

REMOVAL

1. Disconnect power cable.
2. Remove bottom rear feet and bottom cover.
3. Disconnect wide ribbon cable from Color Display assembly.
4. Remove assembly mounting screws as shown in the figure below.
5. Carefully lift board straight up to disengage Mother board connector.

NOTE

The connector between the Display assembly and Mother board exhibits resistance while the board is being removed. The major lifting force should be exerted along the edge of the Color Display assembly at the connector.

REPLACEMENT

Reverse removal procedure to install assembly. Use additional care when inserting the connector pins into connector on Mother board.

NOTE

Color Display assembly power comes from the Mother board via the four short mounting screws marked +5 or GD on the board. Install and tighten these screws before expecting proper operation of the instrument.

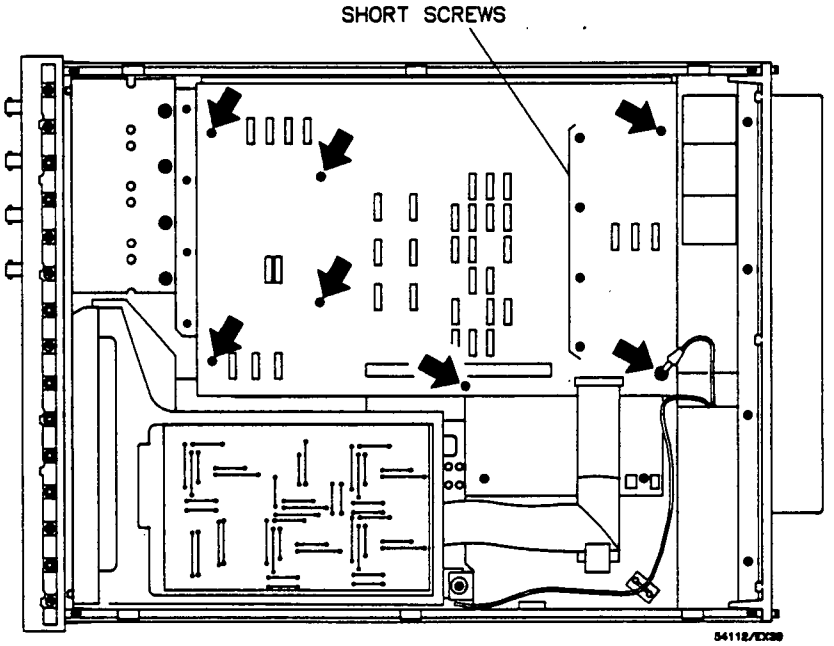


Figure 6A-5. Color Display Assembly Mounting Screws.

6A-13. Mother Board

REMOVAL

1. Disconnect power cable.
2. Remove covers (refer to appropriate paragraph).
3. Remove all card cage PC boards (refer to appropriate paragraph).
4. Remove Power Supplies (refer to appropriate paragraph).
5. Remove Color Display Assembly (refer to appropriate paragraph).
6. Disconnect fan power cables at corner of Mother board.
7. Remove the remaining mounting screws and remove board (see figure below).

REPLACEMENT

Reverse removal procedure to install board.

NOTE

The Mother board and Color Display assembly share some of the same mounting screws. When installing the Mother board install only the screws removed in step 7 above (see figure below).

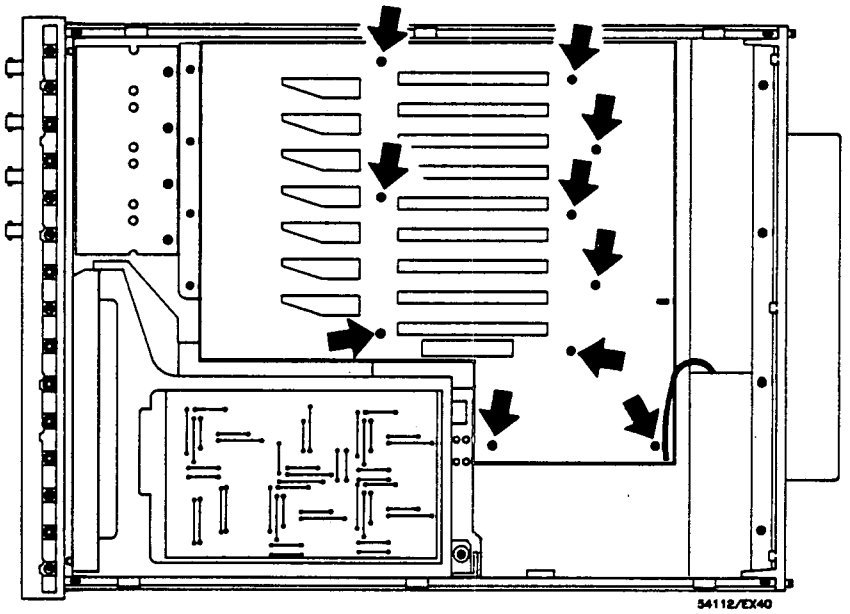


Figure 6A-6. Mother Board Mounting Screws.

6A-14. CABLING DIAGRAM

The following cabling diagram should be used when removing and replacing boards and assemblies.

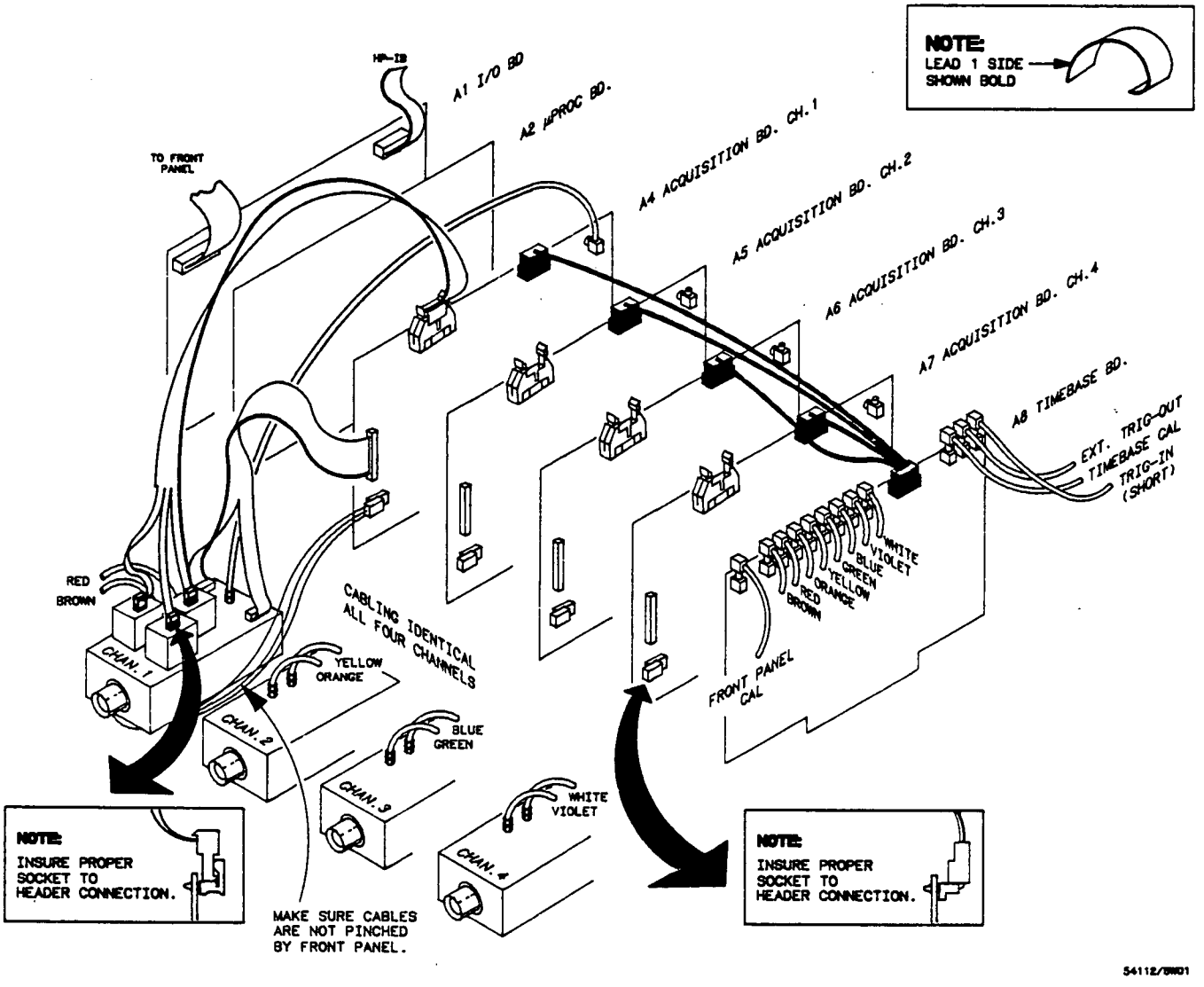


Figure 6A-7. Cabling Diagram.

SECTION 6B
THEORY OF OPERATION

6B-1. INTRODUCTION

The HP 54112D is a digitizing oscilloscope with up to 400 MS/s sampling rate and 100 MHz bandwidth. It has four input channels, which are simultaneously digitized and provide internal trigger. There is an additional external trigger input.

There are two sections of theory. The instrument theory, consisting of Acquisition System and Mainframe, covers a general view of the instrument from a major assembly perspective. The functional theory, Acquisition Theory and Timebase/trigger Theory, covers general operation of Attenuator Functions, Acquisition Functions, Trigger Functions, and Timebase Functions.

Following the theory is a brief description of the operating cycle during a real-time acquisition.

6B-2. INSTRUMENT THEORY

The mainframe consists of Power Supplies, Color CRT Module, and Display assembly. The Microprocessor and Input/Output assemblies, which for instrument theory are part of the mainframe, are located in the card cage. The card cage also holds the acquisition system (except Attenuator assemblies).

The acquisition system consists of four Attenuator assemblies, four Acquisition assemblies, and the Timebase/trigger assembly. The Attenuator assemblies are located between the card cage and the front panel.

Refer to the adjacent block diagrams for the following discussion.

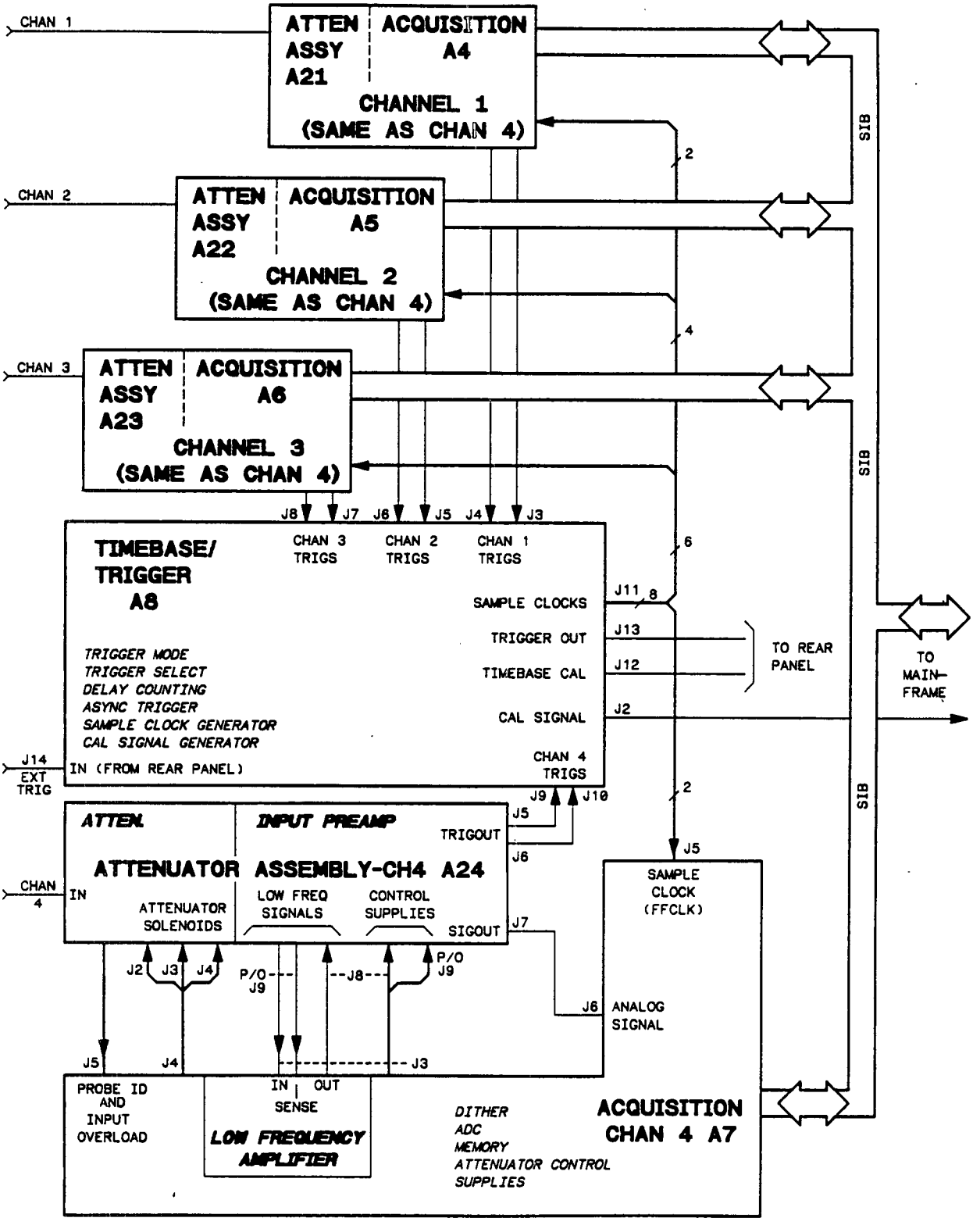


Figure 6B-1. Instrument Block Diagram, Acquisition System

6B-3. Acquisition System

All four acquisition channels are identical.

ATTENUATORS. Attenuator assemblies provide signal conditioning between the front panel channel input and the Acquisition assembly. At full scale, the outputs are a ±0.64 V single-ended signal, representative of the input signal, and two complementary trigger signals whose edges represent the desired trigger point for the channel. The Acquisition assembly provides power supplies, control signals, and the low frequency amplifier, and it receives the probe ID and input overload signals in addition to the channel signal. The trigger signals go to the Timebase/trigger assembly.

ACQUISITION. The Acquisition assembly digitizes and stores the channel input signals. It receives sample clocks from the Timebase/trigger assembly. The output from memory is read onto the system interface bus (SIB). The Acquisition assembly also provides the low frequency amplifier, supplies, and control for the Attenuator assembly.

TIMEBASE/TRIGGER. The Timebase/trigger sets up the trigger modes and generates the sample clocks for the Acquisition assembly.

The channel and external trigger signals are processed and provide the acquisition trigger to the timebase. A 400 MHz oscillator,part of the timebase, provides the base sample rate. Frequency dividers provide sample rates down to 50 Hz.

The acquisition trigger is provided at the rear-panel Trigger Out BNC.

The Timebase/trigger provides a vertical calibration signal to the CAL connector on the front panel.

The Timebase/trigger provides either of two signals to the rear panel Timebase Cal BNC. When the instrument is running in the acquisition modes, the signal is approximately 32 KHz and asynchronous with other signals. In a test mode (Extended Test 21) it is 10 MHz and derived from acquisition clock.

6B-4. Mainframe

MICROPROCESSOR. The Microprocessor uses a 68000 16-bit processor to handle all processing on the system interface bus (SIB). The assembly includes 512K bytes of ROM and 32K bytes of non-volitile CMOS RAM. Bus buffers, interrupt logic, and a time-out counter are part of the Microprocessor assembly.

INPUT/OUTPUT. The Input/Output (I/O) assembly combines several functions on one PC board. The dynamic RAM on this assembly is used for basic operation of the instrument and to store waveforms.

The keyboard control provides scanning and reading of the three keyboards and RPG (rotary pulse generator).

The HP-IB interface couples the SIB to the HP-IB port on the rear panel.

An oscillator and divider circuit provides 16, 8, 4, and 2 MHz clocks for the system. The battery back-up provides power to non-volitile RAM on the microprocessor assembly.

The Power Test circuitry monitors the supplies on the SIB. The output of the circuit is a status bit that the microprocessor can read. If all supplies are greater than 50% it will register as passing.

The Power-On Reset provides a glitch-free reset pulse to the SIB for use by any circuitry on the bus.

FRONT PANEL ASSEMBLIES. Front panel assemblies include three keyboards, an RPG (rotary pulse generator), and the Display Control. The Control Keyboard allows direct entry of values into the field selected on the CRT. The Function and Menu keyboards, to the right of and below the CRT respectively, give control of functions noted on the display. The RPG provides the digital equivalent of a potentiometer for functions such as OFFSET or TRIGGER LEVEL as well as sequential stepping through functions such as V/div and Sweep Speed. The Display Control provides analog brightness and background control of the display.

COLOR DISPLAY ASSEMBLY. The Color Display Assembly provides interface between the SIB and the Color CRT Module. It includes graphics RAM, character generation, and RGB generation. Horizontal and vertical sync also drive the Color CRT Module.

COLOR CRT MODULE. The Color CRT Module includes the color CRT and its associated driving circuitry. It uses H and V sync and red, green, and blue video from the Color Display assembly. It gets 120V dc power from a switching supply on the Primary Power Supply.

6B-5. Power Supplies

PRIMARY SUPPLY. The Primary supply provides an unregulated 300Vdc primary voltage to the switching supplies. It can be set for 115 or 230 V line input (-25%, +15%). A circuit breaker provides rear panel switching of the line input. The STBY (standby) switch on the front panel controls a 120 Vdc switching regulator which supplies the Color CRT Module as well as an on/off control voltage to the Analog and Digital supplies.

DIGITAL SUPPLY. The Digital Supply switching regulator provides +5 V and -5.2 V to most of the digital circuitry. It uses 300 Vdc from the Primary Supply and is controlled (on/off) by an output from the 120 V Supply. These supplies are designated +5 and -5 on the SIB and are referenced to DGND of the SIB.

ANALOG SUPPLY. The Analog Supply switching regulator provides ±8.5 Vdc and ±18.5 Vdc to much of the analog circuitry. It uses 300 Vdc from the Primary Supply and is controlled (on/off) by an output from the 120 V Supply. Many assemblies in the instrument use local regulation of these supplies to provide decoupling from system noise. These supplies are designated ±8 and ±18 on the SIB and are referenced to AGND of the SIB.

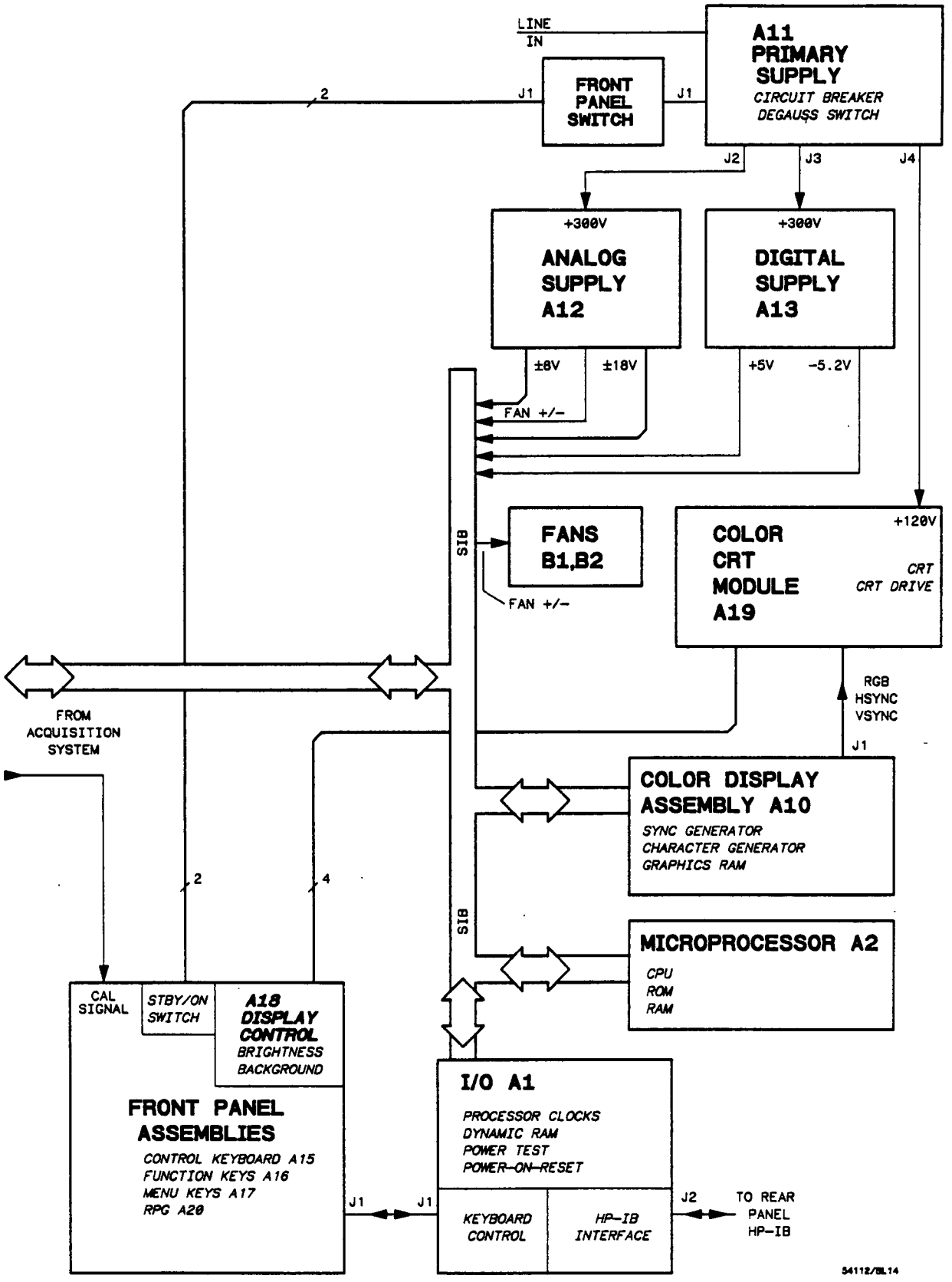


Figure 6B-2. Instrument Block Diagram, Mainframe

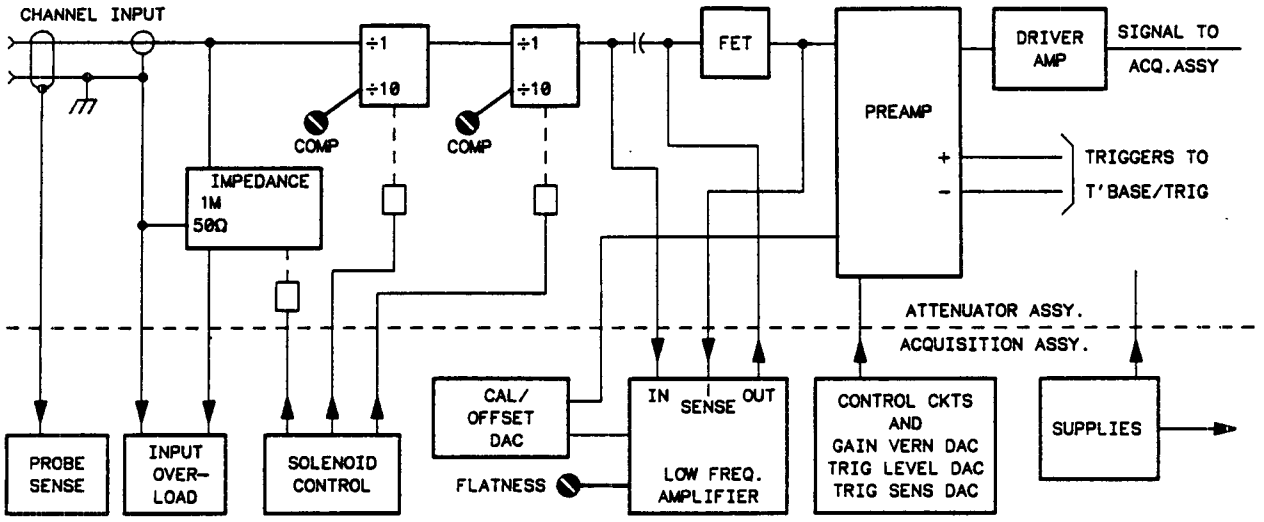


Figure 6B-3. Attenuator and Preamp Functions Block Diagram

6B-6. ACQUISITION THEORY

6B-7. Attenuator Functions

The Attenuator assembly consists of two main sections, the attenuator and the preamplifier. It gets power and control from the Acquisition assembly for its respective channel.

INPUT ATTENUATOR. The input attenuator section provides 50Ω or 1MΩ impedance switching and two ÷10 sections which can be cascaded for ÷100. Magnetically latching solenoids control the switching. A ring on the input BNC connector provides means for identifying properly equipped high impedance 10:1 voltage divider probes. A sample of the input signal from a tap on the 50Ω input termination is used to control an overload protection circuit. The microprocessor will remove the 50Ω termination under certain overload conditions.

PREAMPLIFIER. The preamplifier hybrid consists of several sections, a high-pass filter and FET and associated circuitry, the main preamplifier with trigger circuitry, and the driver amplifier.

At the input to the preamp, the low frequency component of the input signal is sent to the low frequency amplifier on the Acquisition assembly. AC/DC coupling and offset are incorporated in the low frequency amplifier.

Upon return to the attenuator assembly, the low frequency and high frequency signals are summed at the input FET of the preamplifier. The preamplifier incorporates the gain changing and the trigger conditioning. Three incremental gain ranges, ÷1, ÷2, and ÷4 affect the signal before trigger pick-off. Vernier gain affects the signal after trigger pick-off.

The output of the preamplifier is fed to the driver and the output of the driver is fed by a coaxial cable to the Acquisition assembly and analog-to-digital converter hybrid.

The trigger signals are complementary, with edges representing the selected trigger point on the input signal. Two coaxial cables conduct them to the Timebase/trigger assembly.

6B-8. Acquisition Functions

The Acquisition assembly samples one channel input signal and stores it in memory. It also provides interface to the system interface bus (SIB) and attenuator supplies and control.

LOW-PASS FILTER. The input signal is the output of the Attenuator assembly. A low-pass passive filter, with a 3 dB rolloff of about 115 MHz, attenuates signals above 200 MHz to eliminate aliasing by the analog-to-digital convertor (ADC).

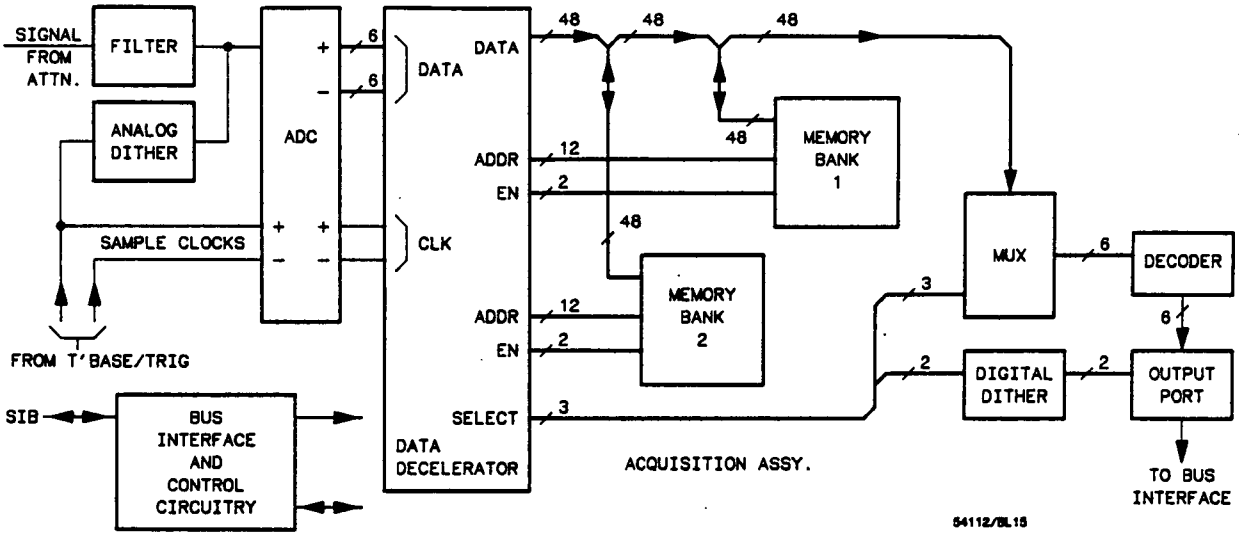


Figure 6B-4. Waveform Sampling and Storage Block Diagram

ANALOG DITHER. Analog dither, part of the dithering circuitry, acts directly on the analog signal. Two flip-flops form a divide-by-four counter clocked by the sample clock. They repeatedly subtract the equivalent of 1/4, 1/2, 3/4, or 0 LSB (least significant bit) from the signal for four successive samples. Together with digital dithering, when several dithered acquisitions are averaged the result is improved resolution over a single undithered acquisition.

SAMPLE CLOCKS. The complementary sample clocks (FFCLK+/-) come from the Timebase/trigger assembly.

ADC. The ADC hybrid is a six bit silicon flash converter. The rising edge of the sample clock samples the input signal and the falling edge clocks a counter that provides the clock signal for the data decelerator. The six-bit data is in grey-code.

DATA DECELERATOR. The data decelerator slows data from six-bit samples at a 400 MHz (max) sample rate, to a pair of 48-bit words at one sixteenth the sample rate. Eight six-bit data samples are accumulated in the decelerator. While the eight samples, one 48-bit word, are being stored in one memory bank eight more samples are being accumulated to store in the other memory bank.

The decelerator provides separate addresses and enables for the memory banks. Data lines are common. The decelerator also addresses memory for reading data onto the SIB (system interface bus) for processing. When instructed by the microprocessor through the data bus, it also provides data patterns for testing the memory banks.

MEMORY BANKS. The memory consists of of twenty-four 4K x 4 static RAMs organized in two banks of 4K x 48. It can store a total of 64K six-bit samples. The decelerator writes to alternate memory banks because the 48 bit word is updated faster than it can be stored.

MULTIPLEXER. Waveform data is read from memory into the multiplexer which, now at a rate compatible with the microprocessor, feeds data through a grey-to-binary converter and port onto the SIB. The 48-bit data word is demultiplexed by the select lines, actually the three LSBs of the address counters.

DIGITAL DITHER. Digital dither works in synchronism with analog dither. It appends two lesser bits to the six bits representing the signal sample. These two bits, an addition, are proportional to the subtraction of the analog dither. As was stated before, several dithered and averaged acquisitions result in improved resolution.

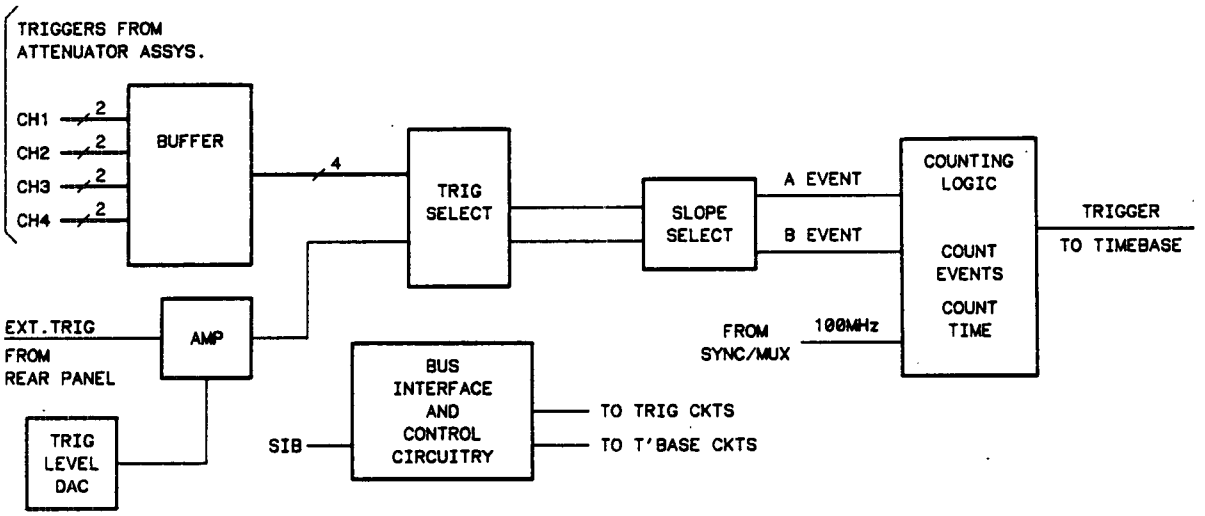


Figure 6B-5. Triggering Block Diagram

6B-9. TIMEBASE/TRIGGER THEORY

The Timebase/trigger assembly provides trigger logic, sample clocks, external trigger amplifier, front panel CAL, and rear panel timebase cal and trigger output.

6B-10. Triggering Functions

CHANNEL TRIGGERS. Channel triggers are converted from complementary to single-ended signals in buffer circuitry.

EXTERNAL TRIGGER. The external trigger amplifier conditions the signal from the rear panel. The 200 KΩ input impedance at the rear panel BNC is fixed. A front panel menu selection can limit the frequency response to approximately 4 KHz. Trigger level and slope are selected in this circuitry.

TRIGGER SELECT. Trigger select circuitry provides two trigger events, either of which can be a combination of the channel or external triggers. Trigger combinations are set up by the requirements of the front panel trigger mode selections: edges, patterns, or a combination thereof.

SLOPE SELECT. The polarity of the two trigger events can be changed to accomodate the further requirements of front panel trigger modes.

COUNTING LOGIC. The two trigger events are fed into the counting logic. The counting logic can count one of the events to qualify the other or use the 100 MHz input as a time reference to qualify one event after the other.

BUS INTERFACE AND CONTROL. The bus interface provides level shifting, gating, and other functions necessary to couple trigger and timebase circuitry to the system interface bus (SIB).

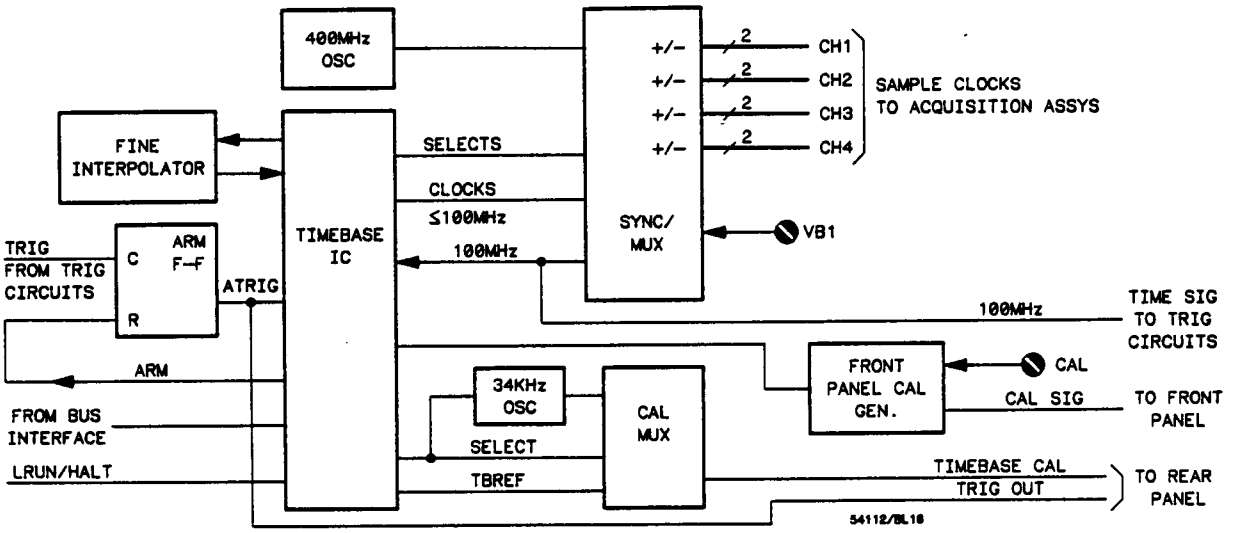


Figure 6B-6. Timebase Block Diagram

6B-11. Timebase Functions

Timebase circuitry develops the acquisition sample clock in reference to the trigger. It also does the trigger interpolation and several other functions.

400 MHZ OSCILLATOR. The 400 MHZ oscillator is a packaged circuit that generates the basic acquisition sample clock.

MUX/SYNCHRO. The multiplexer/synchronizer IC provides the high frequency division ratios for the acquisition sample clock. It develops the 400, 200, and 100 MHz sample rates. A 100 MHz output goes to the timebase IC for further division. It provides fan-out of the sample clocks to the four Acquisition assemblies.

TIMEBASE IC. The timebase IC is a multifunction IC. It provides the majority of the sample clock rates, from 100 MHz down to 50 Hz. It divides the 100 MHz output of the multiplexer/synchronizer IC in a 1, 2, 4, 10 sequence. It feeds the divided rate back into the mux/synchro for output to the Acquisition assemblies. It also provides counters and gating for coarse and fine interpolators and the pre- and post-trigger counting.

ARM FLIP-FLOP. The arm flip-flop receives qualified triggers from the triggering circuitry. Once the flip-flop has been reset by the ARM signal from the timebase IC, the next valid trigger will clock the flip-flop and assert the ATRIG line. ATRIG is also an output to the rear panel as the trigger out signal.

FINE INTERPOLATOR. During sampling, acquired data must be correlated to the trigger point. Each acquisition cycle has a different relationship to the trigger. Correlation is done by the trigger interpolator. It makes a high precision time interval measurement which is used to position the acquired data. The coarse interpolator is part of the timebase IC. The fine interpolator uses a dual slope technique to increase the accuracy of the time interval measurement. It is gated by the timebase IC and its output controls a counter in the timebase IC.

FRONT PANEL CAL GENERATOR. This 2 KHz oscillator provides a square-wave signal to the front panel CAL output. It can be latched by using a cal menu so that it can be measured and/or adjusted.

6B-12. OPERATING CYCLE

The following discussion gives a general description of a real time acquisition cycle. Numbers given are only general and vary in actual operation. The memory size is a 64K sample loop for all acquisitions; the record length can be less, and is 8K samples for this discussion. The size of the display is 501 points. Use the drawings on the right for the following description. The "T" represents the trigger point.

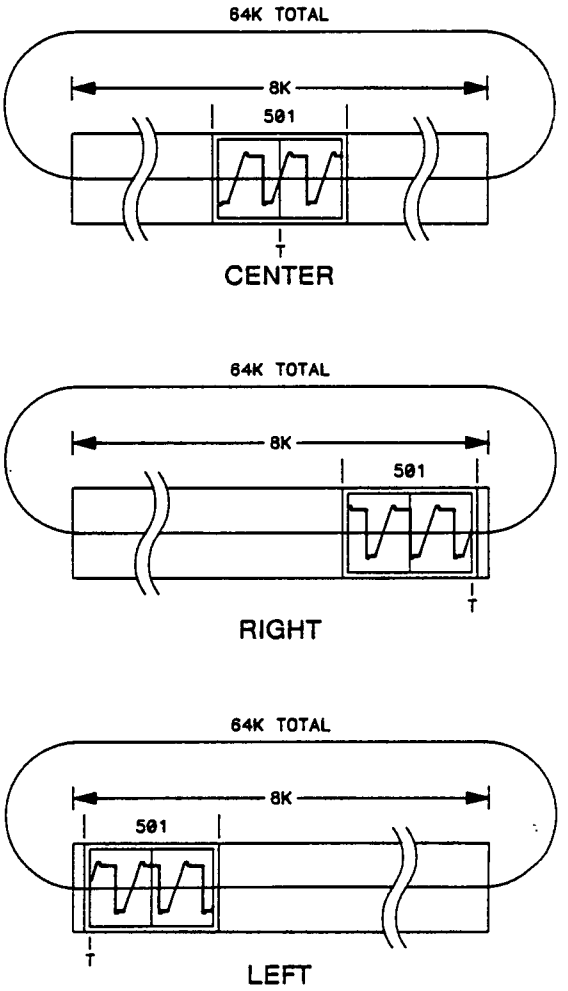


Figure 6B-7. Acquisition Cycle Diagrams

6B-13. General Description

The instrument fills the entire record length during each acquisition. Where the Delay Reference is set — Center, Right, or Left — determines several things. It sets the trigger point reference for the display, at the center or the right or left edges of the graticule respectively. It also positions the trigger point within the acquisition record. It therefore influences the minimum number of samples that must be taken before the trigger. For example, with the Delay Reference at center at least half the record, 4K samples, must be taken before trigger. The pre-trigger counter is set to 4K and the post-trigger counter is set to the remainder, 4K.

With the Delay Reference on the right, nearly the entire 8K record is pre-trigger. The pre-trigger counter counts almost 8K samples. Enough post-trigger samples are taken to view the trigger time and a short period thereafter.

With the Delay Reference at left, very few samples must be taken before the trigger; enough to allow seeing a short time before the trigger. The balance, for the post-trigger counter, is nearly the full record, 8K samples.

Though the pre-trigger count is set so that enough of the record fills with signal data before the trigger is armed, the post trigger count is what really determines what part of the acquired signal comprises the record. The period between trigger arming and the trigger is not known, so the acquisition will continue and could fill the entire 64K memory more than once before a trigger.

Once trigger occurs the post-trigger counter will start. When the post-trigger counter stops, the microprocessor will calculate how far back in the memory loop an 8K record would start and that is the beginning of the actual record. The rest of the memory is skipped by counting through it at high speed to the beginning of the record.

The reason for a choice between 64K or 8K record length is processing time and therefore update time. Display update is much faster with the 8K record because the system needs to process one eighth the amount of data.

6B-14. In Brief

Use the figure at right in conjunction with those on the previous page for the following description, in brief, of the real-time operating cycle.

1. Microprocessor loads pre-and post-trigger counters.

2. Microprocessor asserts low LRUN/HALT to timebase IC and pre-trigger acquisition begins.

3. Pre-trigger count ends and timebase IC enables triggering by resetting Arm F-F with ARM signal.

4. Next qualified trigger clocks Arm F-F and the result, ATRIG (asynchronous trigger), initiates trigger interpolators and post- trigger counter.

5. At the third sample clock after ATRIG, STRIG (synchronous trigger) marks the sample the trigger interpolators measure to.

6. Post-trigger count ends.

7. The microprocessor, through the timebase IC, provides the correct number of clocks at 100 MHz to move the memory address to the beginning of the record. Meanwhile, it also reads the trigger interpolators.

8. Clock rate is lowered and memory is read onto the SIB.

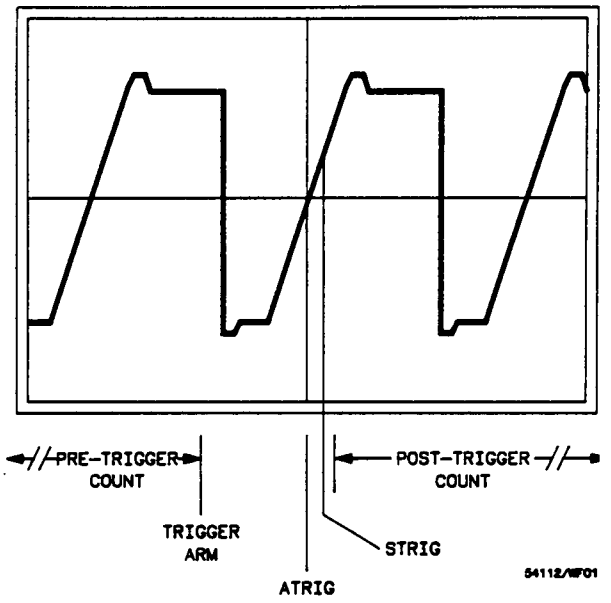


Figure 6B-8. Operating Cycle Trigger Diagram

Service Menus/Keys

SECTION 6C
SERVICE MENUS/KEYS

6C-1. INTRODUCTION

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

6C-2. SERVICE MENUS

The service menus are part of the Utility menu, in the second level of the menu softkeys. Once Utility is pressed, six function keys will be displayed: Probe Menu, HP-IB Menu, Cal Menu, Test Menu, Color Menu, and CRT Setup Menu.

PROBE MENU. The Probe Menu is used to set the attenuation factor before the input of the instrument. This sets the instrument scaling factors for a special probe or other device. This is not a service menu though the functions may be used during service procedures. Further use of this menu is covered in the Operating and Programming and other user manuals.

HPIB MENU. The HPIB Menu provides keys that are used to set the HPIB attributes. These attributes are address number, Talk/Listen, and EOI. This menu is discussed in detail in the Operating and Programming and other user manuals.

CAL MENU. The Cal Menu is used to calibrate the instrument. The calibration factors are stored in non-volitle memory. Use of this menu is covered in the *HP 54112D Operating and Programming Manual*. Basic functions of the Cal menus are covered in this section.

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

COLOR MENU. The Color Menu provides functions used to set the characteristics of the colors displayed. These characteristics include hue, saturation, and luminosity. This menu is covered in detail in the Operating and Programming and other user manuals.

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

6C-3. ONE-KEY POWER UP

A one-key power up is often performed to return the instrument setup to default conditions. This is done as follows:

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

6C-4. TWO-KEY POWER UP

CAUTION

Using the two-key power up will leave the instrument uncalibrated. Effort needed for recalibration should be considered before using this mode to reset the instrument. Calibration traceability will be lost if a two-key powerup is used.

A two-key power up is a basic reset of the entire operating system of the HP 54112D. All volatile and non-volatile RAM is cleared. As a

result, all calibration factors are purged and the instrument must be recalibrated.

All calibration except Offset Cal can be done with just the front panel CAL signal or the rear panel Timebase Cal signal and the software cal menus. Offset Cal requires a 10 Vdc power supply. The two-key power up is performed in much the same way as the one-key power up.

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

6C-5. CAL MENU

When the Cal Menu key is pressed the following calibration keys are displayed.

6C-6. Vertical Cal

Vertical Cal sets software gain coefficients for vernier control of various gain settings. Cal is run by pressing the appropriate menu and function keys. No front panel inputs are needed. All front panel inputs and rear panel trigger input should be removed to avoid extraneous noise. An internal signal is supplied to the attenuator preamplifier from the Acquisition assembly. This cal sets gain from the attenuator assembly preamp through the ADC hybrid.

6C-7. Probe Tip Cal

The Probe Tip Cal uses a triggering technique to measure where the CAL signal from the front panel triggers the system. The front panel CAL signal is calibrated independently from the operating system. The software stores the cal factors and uses them to manipulate acquired data.

The vertical specifications of the HP 54112D are based on calibration of the vertical system through the probe. Changing the probe at an input nullifies the calibration of that channel or trigger. Restoring calibration at that input requires a Probe Tip Cal of that input.

Use of Probe Tip Cal in service procedures is accompanied by instructions appropriate to the procedure. Other information about Probe Tip Cal can be found in the Utility Menu chapter of the *HP 54112D Operating and Programming Manual*.

6C-8. Offset Cal

The Offset Cal sets the offset coefficients at various vertical sensitivities. An external +10 Vdc source is required for this cal. The accuracy of the source must be ±0.1% or the accuracy of the instrument will be compromised and the instrument may not pass the performance tests. See the Adjustments section of this service manual or the appropriate chapter of the operators manuals for the Offset Cal procedure.

6C-9. Trigger Cal

Trigger Cal is a trigger level and sensitivity calibration. There are no input signals used for this calibration and the user needs only to follow the prompts on the screen to remove any signals before the routine is run.

The software sets the trigger level and hysteresis (sensitivity).

6C-10. Timebase Cal

Channel Skew, in the Timebase Cal menu, compensates for time differences between the channel displays and triggers. A signal from the rear panel is applied to the CHAN 1 input and another input, CHAN 2, CHAN 3, CHAN 4, and the external trigger in turn. A measure routine finds the edges of the signals, and the time difference between them is stored and used to time-align displayed signals and triggers.

For the channels, the reference points are the offset voltage (vertical center screen) for the displayed signals and the trigger levels for the triggers.

For the external trigger, the reference is the trigger level.

The procedure for this calibration is covered in the Adjustment procedures, the *HP 54112D Operating and Programming manual*, or you can follow the prompts on the display in the Channel Skew menu.

6C-11. TEST MENU

Five sub-menus are available when the Test Menu is selected. The menus allow the user to access and run internal diagnostics and view the results. In addition, the position of printed circuit assemblies located in the card cage can be displayed.

Use of the test menus is covered in depth in section 6D, Troubleshooting.

6C-12. Repeat Loop/Run From Loop

The top key toggles between REPEAT LOOP and RUN FROM LOOP. These keys in conjunction with Loop # = [0-68], # Repetitions = [1-1000 or Infinite], and Start/Stop Test key will execute internal self-test diagnostic routines. All input signals must be disconnected from the instrument for these tests.

REPEAT LOOP. Selecting this mode will continuously execute the Loop # entered at RUN FROM LOOP. Pressing ***Start Test*** will start execution and the loop will continuously run until the ***Stop Test*** key is pressed. Pressing ***Display Errors*** will show the number of executions and number of failures of the loop.

Entering a value in # Repetitions will cause the software to run the designated loop that many times and stop. Start the test at REPEAT LOOP.

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

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

Starting tests at RUN FROM LOOP ignores the number of repetitions (entered at REPEAT LOOP) and defaults to infinite.

If any test should fail, the instrument will change from RUN FROM LOOP to REPEAT LOOP and will repeatedly execute the loop that failed and appear to be stuck.

By starting the self-test at Loop 1 and letting it run for a bit, then stopping the test, it's easy to determine which loop the self-test stopped at. This loop should have more than one execution. To check the rest of the self test loops, ENTER the next highest loop number at RUN FROM LOOP and restart the test. The test will continue until the next loop fails. By continuing this, all loops will be forced to be tested.

When the instrument is powered up all loops will be tested except those purposely skipped due to specific failed tests. Four loops, 47, 51, 55, and 59 (one test on each of the four channels), will not cause a "Powerup Self Test Failed" message if they fail. This is because of possible noise during power up, if a signal is at the input of the instrument for example. The loops will be reported as failed in the Display Errors menu however. For more information see the Data Acquisition Subsystem Diagnostic Routines table in section 6D.

6C-13. Extended Tests

When this key is chosen there are 22 internal instrument tests that may be selected by entering the test number with the entry devices. The tests are numbered 0 through 21. All input signals must be disconnected from the instrument for these tests.

Many of the extended tests are useful only at the factory. Those that are of use to field service personnel are covered in the troubleshooting in section 6D.

6C-14. Start/Stop Test

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

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

6C-15. Display Errors

Pressing this key will display the number of any loops which failed while one of the following tests was run:

- Powerup self test
- INTERFACE tests
- REPEAT and RUN FROM LOOP tests
- HP-IB commanded self test

The display shows the current loop or last loop executed, the number of times the loop was executed, and the number of times that it failed. The bottom of the display shows all loops that failed starting with the first failure.

Error indications are accumulated since the last occurence of any of the following: Power up, I/O Assembly reset pushed, or Extended Test 12 run. An occurence of one of these conditions resets the error list.

The four STATUS x = xxxxx lines in the Display Errors field are primarily for factory use. Any field usable information in this part of the display is covered in section 6D.

To return to the Test Menu, press ***Exit Display***.

6C-16. Display Configuration

Most of the assemblies used in the HP 54112D have circuitry that allows interrogation directly by the microprocessor, the exception being the Microprocessor assembly itself. The HP 54112D card cage has 9 slots. When ***Display Configuration*** is pressed, the resulting display shows the firmware date and location of the card cage assemblies, except the microprocessor.

To return to the Test Menu, press ***Exit Display***.

6C-17. CRT SETUP MENU

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

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

6C-18. Confidence Test

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

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

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

NOTE

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

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

6C-19. Pattern

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

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

Pressing ***Pattern White*** key changes the pattern color to red and the key lable changes to "Pattern Red". Successive pressings of this key will change the color of the pattern to green then blue, the name of the Pattern key is the color displayed.

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

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

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

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

6C-20. Light Output

These displays are used by the factory.

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

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

6C-21. Color Purity

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

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

SECTION 6D
SELF-TESTS/TROUBLESHOOTING

6D-1. INTRODUCTION

This section describes the self-tests and troubleshooting routines that service personnel can use to locate failures to the assembly level. A basic understanding of the service menus and keys will be helpful in troubleshooting failures and is covered specifically in Section 6C.

The material presented in this section is in only a general order of importance, or use. Depending on the problem encountered, troubleshooting may progress back and fourth within the section but should start with the Main Troubleshooting Procedure.

Following are the troubleshooting sections in order of appearance:

- Main Troubleshooting
- "No Display" Troubleshooting
- Power Supply Troubleshooting
- Color CRT Module Failure Isolation
- Software Troubleshooting
- Core Subsystem Troubleshooting
- Data Acquisition Troubleshooting
- Front End Troubleshooting
- Hints, Tricks, and Arcana

6D-2. FAILURE INDICATIONS

The majority of failures in the HP 54112D are initially indicated in one of several ways: improper display (blank, distorted, or random) on the CRT after power-up, the keyboard is locked after power up, or "Powerup Self Test Failed!" is displayed on the CRT.

Other failures may be apparent during normal operation, but most problems are caught by the internal self-test routines and will result in one of the indications mentioned.

Loop failures may occur occasionally due to system or environmental noise. This may result in intermittent power-up failure messages. Loops must fail a certain percentage of the time to be considered a true failure and must be specially tested if random failures are occuring. See Main Troubleshooting for further information and procedures.

NOTE

In addition to the front panel power switch (STBY), there is a main breaker power switch located on the rear panel. Before troubleshooting a "no display" failure, make sure the rear panel switch has not been inadvertently turned off.

6D-3. TEST EQUIPMENT REQUIRED

The HP 54100 Family Product Support Kit consists of assembly and cable extenders and other tools. Some of the parts in this kit are necessary for certain assembly level diagnostic procedures. These procedures aid in troubleshooting, but are not necessary for troubleshooting most failures.

In addition, other than the equipment required for performance tests and adjustments, all that is needed is a general purpose 300 MHz oscilloscope such as the HP 54201A.

6D-4. ONE-KEY POWER UP

A one-key power up is often performed to return the instrument setup to default conditions. This is done as follows:

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

6C-5. TWO-KEY POWER UP

CAUTION

Using the two-key power up will leave the instrument uncalibrated. Effort needed for recalibration should be considered before using this method to reset the instrument. Calibration traceability will be lost if a two-key powerup is used.

A two-key power up is a basic reset of the entire operating system of the HP 54112D. All volatile and non-volatile RAM is cleared. As a result, all calibration factors are purged and the instrument must be recalibrated.

All calibration except Offset Cal can be done with just the front panel CAL signal or the rear panel Timebase Cal signal and the software cal menus. Offset Cal requires a 10 Vdc power supply. The two-key power up is performed in much the same way as the one-key power up.

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

6D-6. MAIN TROUBLESHOOTING

Figure 1, Main Troubleshooting Flow Diagram, should be used as the initial and primary troubleshooting procedure.

6D-7. Connectors

Most instruments are sensitive to connectors and assemblies that are not completely seated. So, one of the initial steps needs to be to make a mechanical check of all the connectors and assemblies to make sure that everything is properly seated before you start the trouble shooting procedure.

Check the coaxial connectors, ensure that the ribbon connectors are completely snapped in place, and press down gently on each of the card cage assemblies to ensure that they are properly seated.

6D-8. System Lock-up

After running the power-up self tests the instrument may be locked up by a system error, it will not respond to the keyboard. This can be a random failure or a hard failure. An error message such as one of the following,

```
SYSTEM  ERROR! Zero Divide XXXXXXH
SYSTEM  ERROR! Bus Error XXXXXXH
SYSTEM  ERROR! Address Error XXXXXXH
```

will be displayed on screen, followed by

```
To clear, cycle power with one front-panel key
pressed. If the error condition remains please
consult the service manual.
```

Note the hex number (XXXXXXH) after the error message. This may be useful if help from an HP Service Center is needed later.

Follow the instructions to see if the one key power-up is sufficient to reset the instrument. If the instrument is failing after a one key power-up and calibration traceability need not be maintained, try to reset the instrument with a two key power-up.

CAUTION

Using the two-key power up will, at least temporarily, leave the instrument in an uncalibrated state. Effort needed for recalibration should be considered before using this mode to reset the instrument. Calibration traceability will be lost if a two-key powerup is used.

If the instrument is still failing, to obtain information about the failure mode it will be necessary to "break in" to the power-up routine before the system becomes locked. Go to the Software Troubleshooting procedure for further information.

6D-9. Input Overload

If an Input Overload message is displayed on screen immediately after power-up the cause is usually an input sense cable that has become disconnected or mis-connected. This failure also results in lock-up of the instrument; there will be no response to the keyboard.

CAUTION

Do not perform a two-key powerup. The instrument will be harder to return to proper operation.

Use the following procedure to check for this problem.

1. Turn the POWER to STBY.

2. Remove the covers (see section 6A).

3. Ensure that all of the input sense cables are properly connected. (See the diagram on the cover of the instrument or at the end of section 6A.)

4. If the instrument still fails to power up properly, continue with troubleshooting based on known symptoms.

If a two-key powerup was performed, it may be necessary to clear the non-volitile RAM manually.

1. Turn POWER to STBY.

2. Pull the Microprocessor assembly clear of the mother board. This separates the RAM from its battery supply on the I/O assembly. Leave separated for several seconds.

3. Re-insert Microprocessor assembly and apply power. Instrument should power up and display a message that calibration is needed.

6D-10. Intermittent Failures

Loop failures that are intermittent may not be true failures. A loop must fail more than one percent of the time to be considered a true failure. If a loop seems to be intermittent it should be run in the REPEAT LOOP mode to determine the failure percentage.

Use the following procedure to check the failure percentage of a given loop.

1. Press ***more, Utility***, and ***Test menu***.

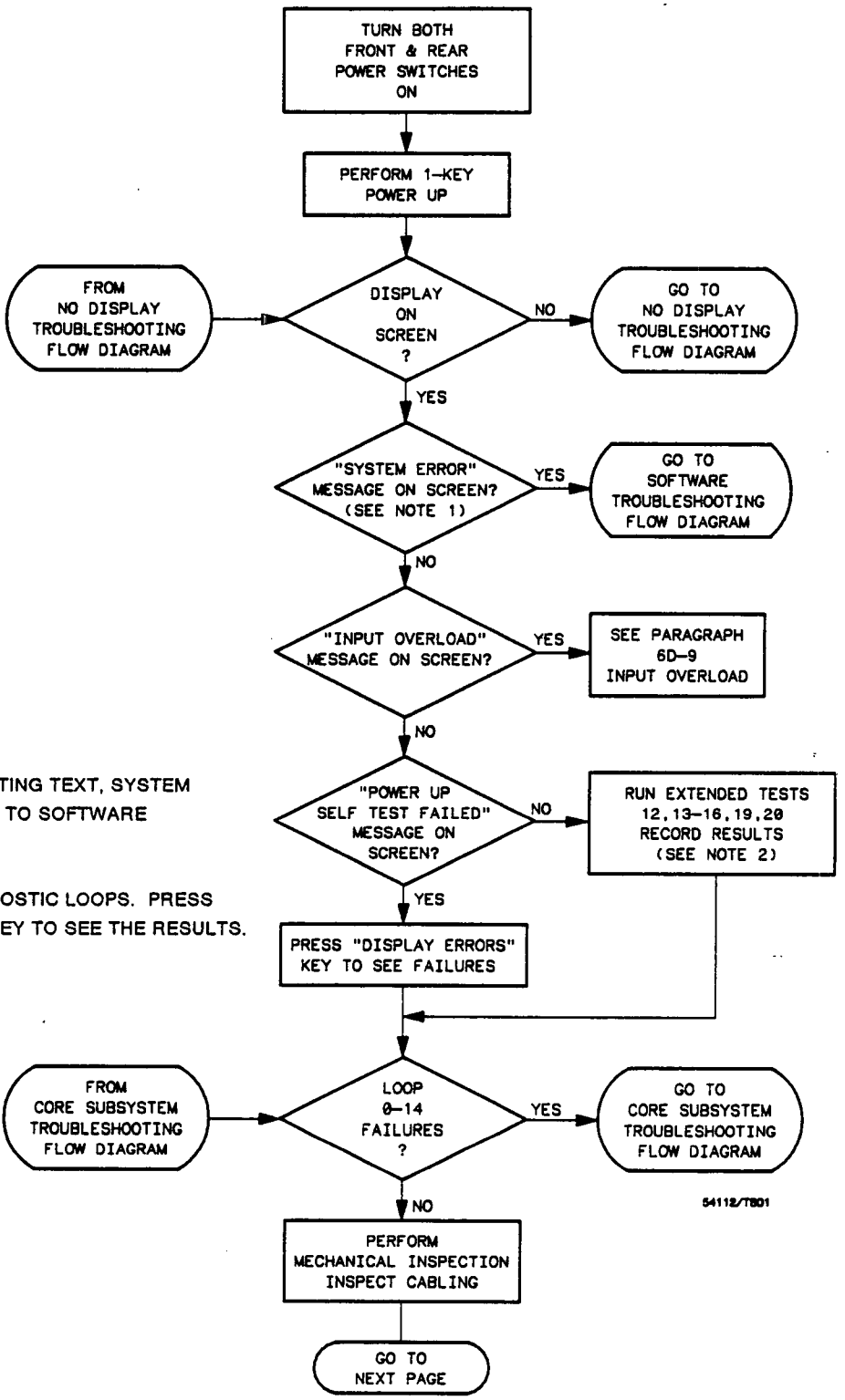
2. Press the top softkey to get ***RUN FROM LOOP*** and ENTER the Loop # with the ENTRY keys.

3. Press ***RUN FROM LOOP*** to get ***REPEAT LOOP*** and ENTER the # Repetitions with the ENTRY keys. The number of repetitions must be high enough to get a proper sampling. Checking for one percent of errors will need several hundred repetitions for a good sample.

4. Press ***Start Test***.

   Several hundred samples may take a few minutes to complete. You can press ***Stop Test*** then ***Display Errors*** to check on the progress of the test but starting the test again will start it at the beginning.

5. When the display returns to the test menu press ***Display Errors*** to check the error rate. If ***Failures*** = is greater than one percent of ***Executions*** = the loop has a true failure.



NOTES

1. SEE MAIN TROUBLESHOOTING TEXT, SYSTEM LOCK-UP, BEFORE GOING TO SOFTWARE TROUBLESHOOTING.

2. TEST 12 RUNS THE DIAGNOSTIC LOOPS. PRESS THE "DISPLAY ERRORS" KEY TO SEE THE RESULTS.

Figure 6D-1. Main Troubleshooting Flow Diagram

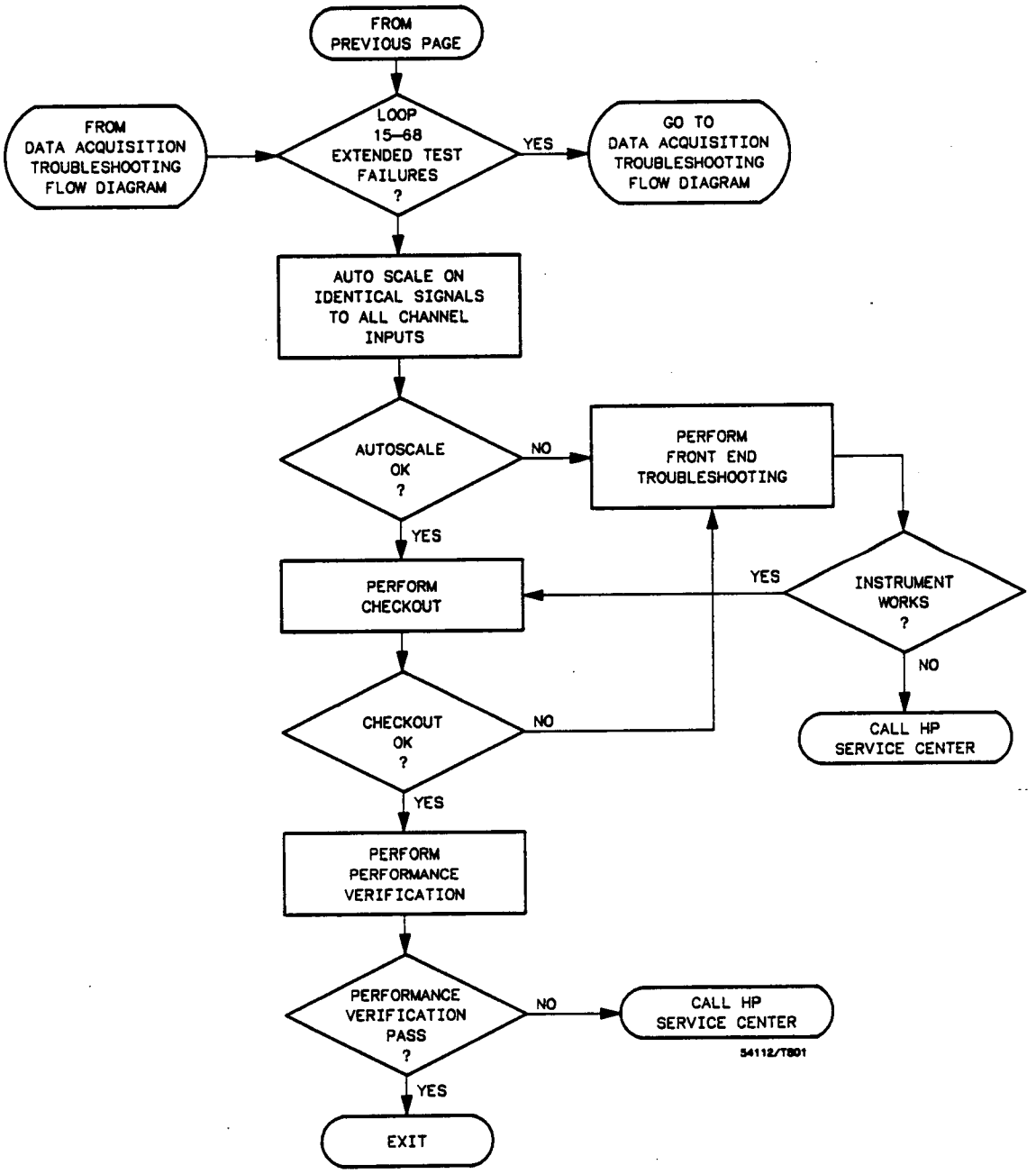


Figure 6D-1. Main Troubleshooting Flow Diagram (con't.)

6D-11. NO-DISPLAY TROUBLE-SHOOTING

Check to see whether the power supply is functioning correctly by checking the four LEDs that indicate supply function. One is located on the I/O assembly (A3), and the others are located on the primary, digital, and analog power supply boards. If any of these LEDs is not lit, proceed directly with the Power Supply Troubleshooting procedures.

Use a voltmeter to check the voltages at the test points on the power supply. If voltages are not correct (see Power Supply Troubleshooting) proceed with the Power Supply Troubleshooting procedure.

If the supplies are correct and there is still no display, cycle the power with the front panel switch. If the display produces a normal flash at powerup and powerdown, the Color CRT Monitor is probably working. If it does not light at all, check if the 120 V LED at the front of the Primary Supply is lit. If it is, outrig a working Color CRT Module (see Color CRT Module Outrigging). Replace Color CRT Module if outrigged module works. If outrigged module does not work, see Power Supply Troubleshooting procedure.

If the display lights, determine whether the problem is in the Color Display assembly or in the Color CRT Module, as follows:

1. Check the voltage on the 120 Volt pin on the Color CRT Module; also check the Red, Blue, and Green Video signals. If these signals are correct (see Color CRT Module Failure Isolation) then outrig a new Color CRT Module and test it. If it works, replace the module.

2. If they are not correct, the display assembly is suspect. Check the +/- 5 Volts on the display assembly and the Vertical and Horizontal Sync signals coming from the display assembly. If these are not present, the Color Display assembly is suspect. Remove boards not in the core system and proceed with verifying its operation (see Core Subsystem Troubleshooting).

If you have not been able to find the problem using these techniques, call your HP Service Center.

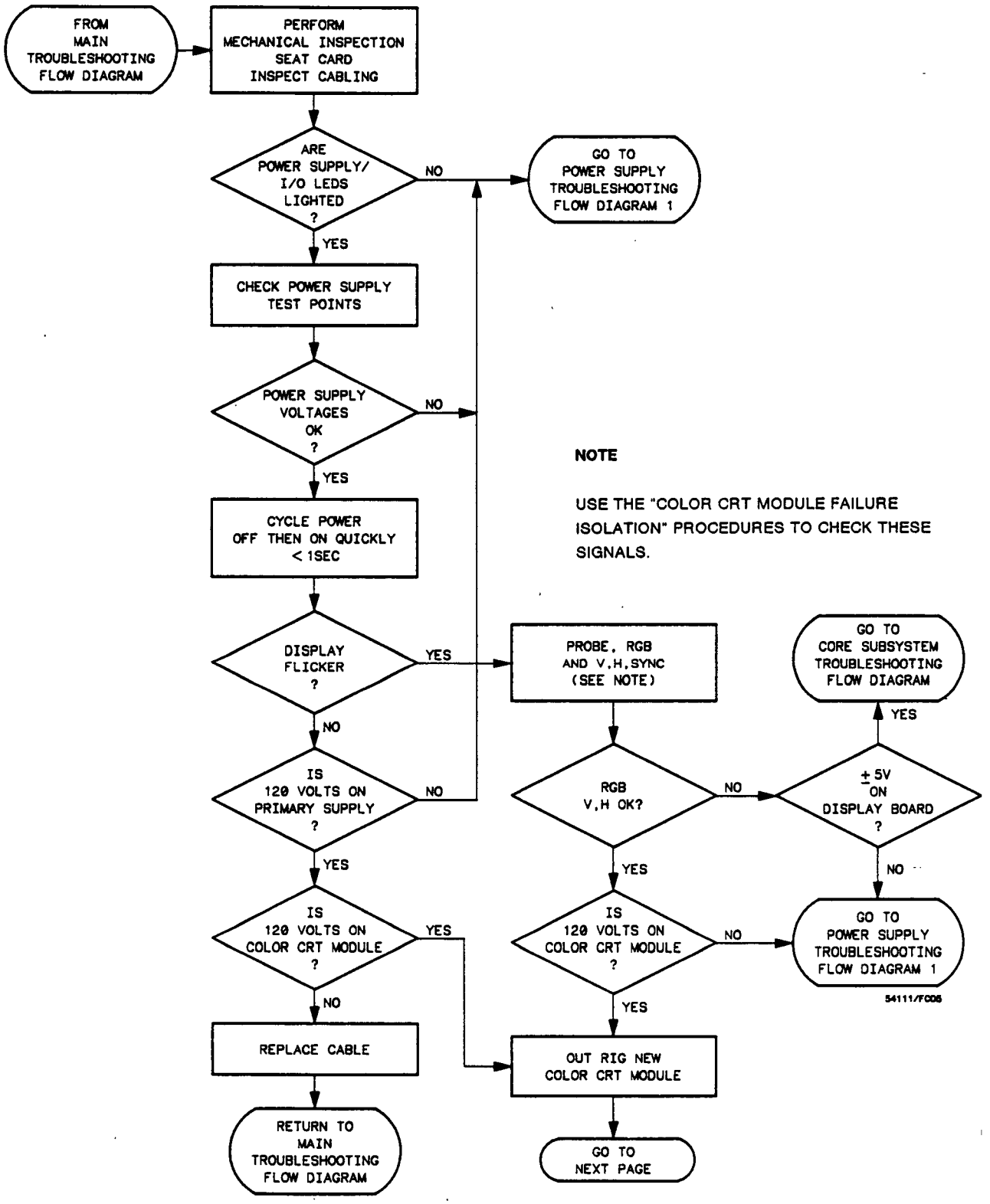


Figure 6D-2. No Display Troubleshooting Flow Diagram

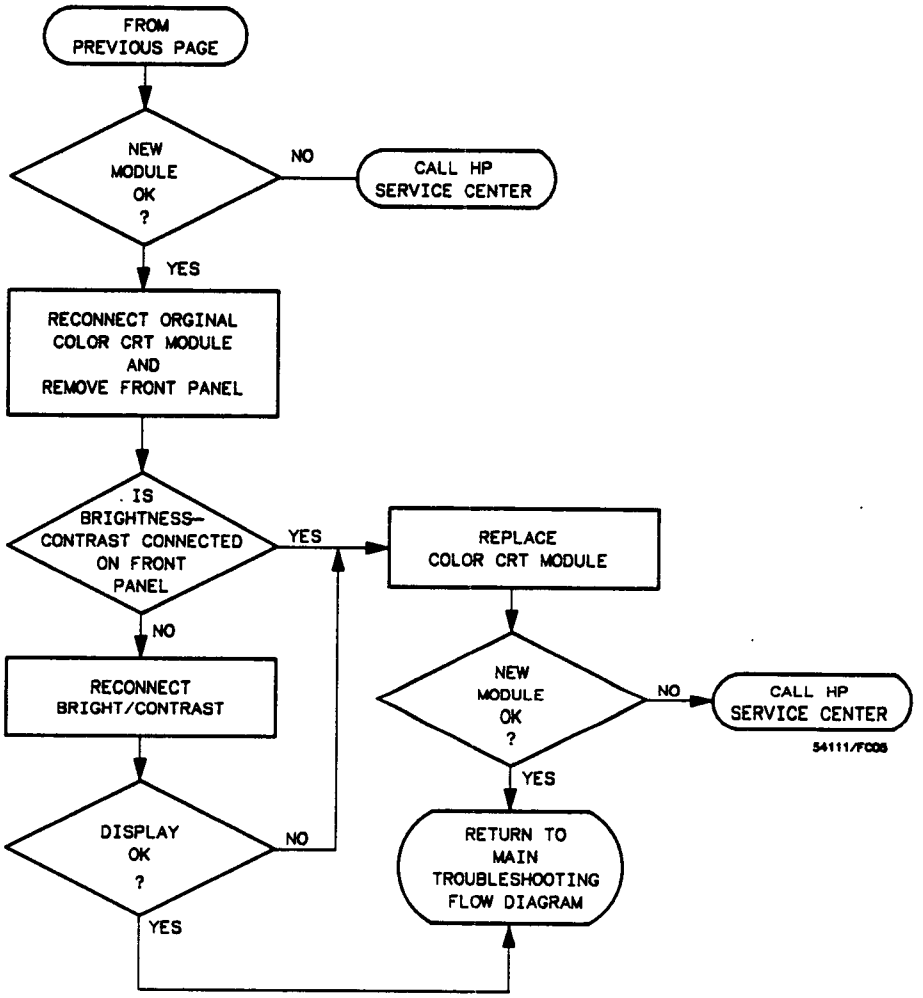


Figure 6D-2. No Display Troubleshooting Flow Diagram (con't.)

6D-12. POWER SUPPLY TROUBLE-SHOOTING

When a power supply problem is suspected, it is first important to make sure that no unusual load is keeping the supply in a current limited condition. The table below shows which supplies are used on each assembly.

1. If the 300V LED on the Primary Supply is not lit go directly to the Power Supply Troubleshooting Flow Diagram, next page.

2. If the 300V LED is lit, find the LEDs on the Analog and Digital supplies and I/O assembly. They are near the top-front of each assembly, so if you cannot see them they are probably not lit.

3. If the LEDs are lit and you still suspect a supply problem, go to the Power Supply Troubleshooting Flow Diagram, next page.

4. If the LEDs are not lit continue with this procedure before going to the Power Supply Troubleshooting Flow Diagram, next page.

5. Pull up the Timebase/trigger assembly (right side of card cage) until it clears the motherboard connector, about one half inch.

6. Check to see if the LEDs are lit. If the LEDs are lit troubleshoot the Trigger Qualifier for excessive loading. If they are not lit, leave the assembly up and go to the next step.

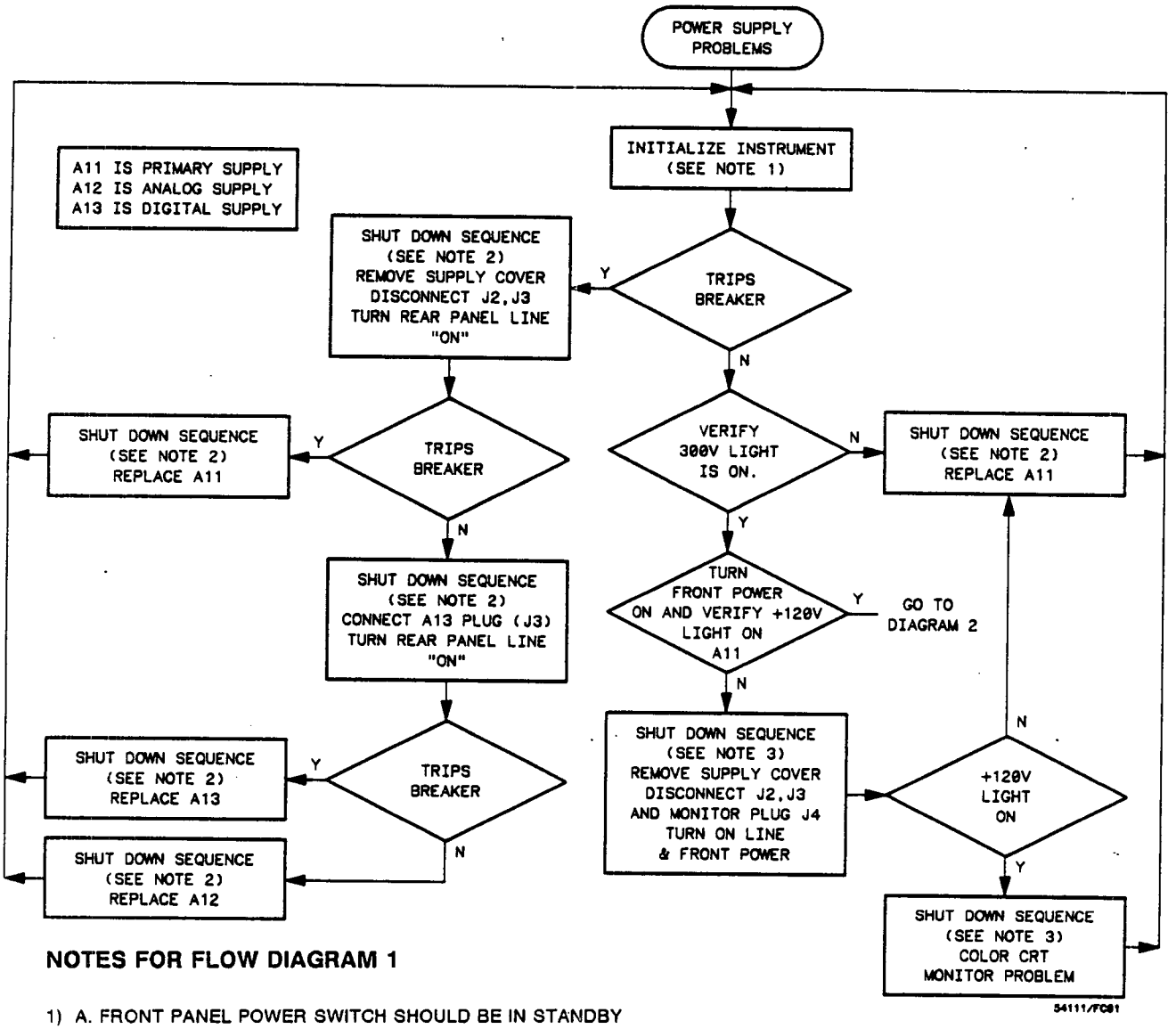
7. Working from right to left, pull up each card cage assembly while watching for the LEDs to light. If they light, troubleshoot for excessive loading, the last assembly pulled up.

8. After the I/O assembly is pulled up, watch only for the supply LEDs. If all nine card cage assemblies are up, and the supply LEDs are not lit, go to the following Power Supply Troubleshooting Flow Diagram.

Table 6D-1. Power Supply Distribution

	+5V	-5V	+18V	+8V	-8V	-18V	+120V
MICROPROCESSOR	*						
INPUT/OUTPUT †	*	*	*	*	*	*	
ACQUISITION	*	*	*	*	*	*	
TIMEBASE/TRIG			*	*	*	*	
COLOR DISPLAY	*						
COLOR CRT MOD.							*

†ONLY THE +5V IS USED FOR POWER. THE OTHER SUPPLIES CONNECT FOR POWER TEST ONLY AND ARE HIGH IMPEDANCE POINTS. LIKELYHOOD OF LOADING THESE SUPPLIES IS LOW.



NOTES FOR FLOW DIAGRAM 1

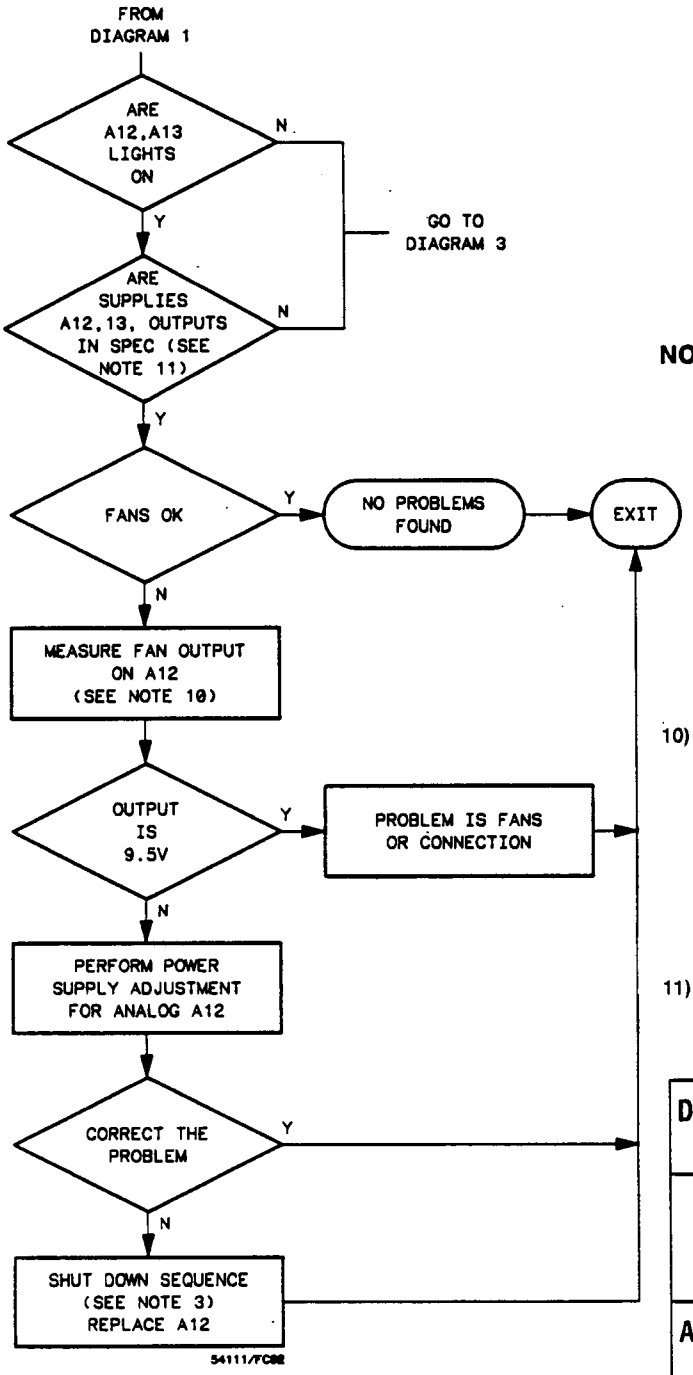
1) A. FRONT PANEL POWER SWITCH SHOULD BE IN STANDBY
   B. REAR PANEL LINE SWITCH SHOULD BE OFF "0"
   C. CONNECT AC POWER SOURCE
   D. TURN REAR PANEL LINE SWITCH TO ON "1"

2) A. TURN REAR PANEL LINE SWITCH TO OFF "0"
   B. ALWAYS UNPLUG AC POWER SOURCE
   C. **CAUTION!!!** ***WAIT UNTIL +300V LIGHT IS COMPLETELY OFF (ABOUT 3 MINUTES) BEFORE PROCEEDING; SHOCK HAZARD EXISTS AND YOU CAN CAUSE DAMAGE TO THE INSTRUMENT!!***

WARNING
EXTREME CAUTION MUST BE TAKEN WHEN REMOVING POWER SUPPLY COVER.

3) A. TURN FRONT PANEL SWITCH TO STANDBY
   B. TURN REAR PANEL LINE SWITCH TO OFF "0"
   C. ALWAYS UNPLUG AC POWER SOURCE
   D. **CAUTION!!!** ***WAIT UNTIL +300V LIGHT IS COMPLETELY OFF (ABOUT 3 MINUTES) BEFORE PROCEEDING; SHOCK HAZARD EXISTS AND YOU CAN CAUSE DAMAGE TO THE INSTRUMENT!!***

Figure 6D-3. Power Supply Troubleshooting Flow Diagram (part 1)



A11 IS PRIMARY SUPPLY
A12 IS ANALOG SUPPLY
A13 IS DIGITAL SUPPLY

NOTES FOR FLOW DIAGRAM 2

3) A. TURN FRONT PANEL SWITCH TO STANDBY
   B. TURN REAR PANEL LINE SWITCH TO OFF "0"
   C. ALWAYS UNPLUG AC POWER SOURCE
   D. **CAUTION!!!** ***WAIT UNTIL +300V LIGHT IS COMPLETELY OFF (ABOUT 3 MINUTES) BEFORE PROCEEDING; SHOCK HAZARD EXISTS AND YOU CAN CAUSE DAMAGE TO THE INSTRUMENT!!***

10) CONNECT THE VOLTMETER (+) LEAD TO THE "FAN" TEST POINT AND THE (-) LEAD TO THE -18V TEST POINT. THE READING SHOULD BE 9.5V. THIS VOLTAGE WILL INCREASE WITH INCREASING AMBIENT TEMPERATURE. SEE THE POWER SUPPLY ADJUSTMENT PROCEDURE FOR THE ANALOG SUPPLY.

11) FOR POWER SUPPLY TEST POINTS AND SPECIFICATIONS SEE TABLE BELOW.

DIGITAL SUPPLY TST PTS (+) LEAD	(-) LEAD	VOLTAGE
+5V	GND	+5.10 ±0.1V
-5V	GND	-5.30 ±0.1V
+14B	GND	>+5V
ANALOG SUPPLY TST PTS (+) LEAD	**(-) LEAD**	**VOLTAGE**
+18V	GND	+18.5 ±0.3V
+8V	GND	+8.9 ±1V
-8V	GND	-8.5 ±1V
-18V	GND	-18.5 ±0.3V
FAN	-18V	+9.5 ±0.3V
+26B	GND	>+5V

Figure 6D-3. Power Supply Troubleshooting Flow Diagram (part 2)

NOTES FOR FLOW DIAGRAM 3

3) A. TURN FRONT PANEL SWITCH TO STANDBY
   B. TURN REAR PANEL LINE SWITCH TO OFF "0"
   C. ALWAYS UNPLUG AC POWER SOURCE
   D. **CAUTION!!!** ***WAIT UNTIL +300V LIGHT IS COMPLETELY OFF (ABOUT 3 MINUTES) BEFORE PROCEEDING; SHOCK HAZARD EXISTS AND YOU CAN CAUSE DAMAGE TO THE INSTRUMENT!!***

4) THE NOMINAL OUTPUT FOR +14B IS 21V. HOWEVER, WHEN THE SUPPLY IS OPERATING IN THE CURRENT LIMIT MODE, IT CAN BE AS LOW AS +5V. THE NOMINAL OUTPUT FOR +26B IS 26V. IT TOO CAN BE AS LOW AS +5V WHEN IN CURRENT LIMIT.

5) MEASURE OUTPUTS +5V AND -5V ON THE DIGITAL POWER SUPPLY. IF BOTH OUTPUTS ARE LOW, I.E. HALF OF NORMAL OUTPUT OR LESS, THEN DIRECTION TO TAKE IS YES. IF OUTPUTS ARE GREATER THAN HALF THE ANSWER IS NO.

6) WHEN THE SUPPLIE(S) ARE RUNNING IN THE CURRENT MODE THIS MEANS THAT AN EXTERNAL LOAD IS PULLING DOWN THE SUPPLY OUTPUT(S). AN EXTERNAL LOAD COULD BE A BOARD IN THE CARD CAGE OR THE COLOR DISPLAY ASSEMBLY (NOT THE COLOR CRT MODULE). THE ONLY WAY TO ISOLATE THE COLOR DISPLAY ASSEMBLY IS TO COMPLETELY REMOVE IT FROM THE MAINFRAME. THE FANS CAN ALSO PUT THE ANALOG BOARD INTO THE CURRENT MODE. YOU CAN DISCONNECT THE FANS BY REMOVING THE BOTTOM COVER AND DISCONNECTING THE FAN CABLE.

   TO ISOLATE A CURRENT PROBLEM, REMOVE ONE LOAD AT A TIME UNTIL THE PROBLEM IS FOUND. PROBLEMS COULD INCLUDE BENT PINS ON THE MOTHER BOARD OR A BAD COMPONENT ON A PC ASSEMBLY. SEE THE TABLE BELOW FOR POWER DISTRIBUTION TO THE VARIOUS ASSEMBLIES.

7) MEASURE OUTPUTS ±18V AND ±8V ON THE ANALOG SUPPLY. IF BOTH OUTPUTS ARE LOW, I.E. HALF OF NORMAL OUTPUT OR LESS, THEN DIRECTION TO TAKE IS YES. IF OUTPUTS ARE GREATER THAN HALF THE ANSWER IS NO.

8) THE TEST POINTS TO MEASURE +14.6V ARE AT THE BACK OF THE BOARD CLOSE TO THE TOP. CONNECT THE VOLTMETER COMMON LEAD TO THE COM TEST POINT ON THE BOARD. **CAUTION!!!** ***USE CAUTION WHEN MEASURING THIS VOLTAGE. IT IS NOT ISOLATED FROM THE LINE (MAINS) INPUT AND THE PRIMARY SUPPLY IS EXPOSED WITH THE POWER SUPPLY COVER REMOVED.***

9) BY REMOVING THE CONNECTORS AT J2 AND J3 YOU ARE CHECKING IF EITHER THE ANALOG OR DIGITAL SUPPLY IS LOADING VCNTL.

   EXTREME CAUTION MUST BE TAKEN WHEN MEASURING VCNTL ON THE PRIMARY SUPPLY. THE TOP PIN ON CONNECTORS J2 AND J3 IS VBULK WHICH IS +300V. THE PINS BELOW ARE VCNTL, THEN GROUND.

   TO MEASURE VCNTL, TURN THE POWER OFF AND MAKE SURE THE +300V LAMP (NEAR TOP OF BOARD) IS OFF. CONNECT THE VOLTMETER (+) LEAD TO VCNTL (SECOND PIN FROM TOP) AND THE (-) LEAD TO GROUND (BOTTOM PIN). APPLY POWER AND OBSERVE THE METER READING. WITH ONE SUPPLY CONNECTED THE READING SHOULD BE ABOUT +25V AND WITH NEITHER CONNECTED ABOUT +42V. TURN OFF POWER (+300V LAMP IS OFF) BEFORE REMOVING THE VOLTMETER LEADS.

	+5V	-5V	+18V	+8V	-8V	-18V	+120V
MICROPROCESSOR	*						
INPUT/OUTPUT †	*	*	*	*	*	*	
ACQUISITION	*	*	*	*	*	*	
TIMEBASE/TRIG			*	*	*	*	
COLOR DISPLAY	*						
COLOR CRT MOD.							*

NOTE:

†ONLY THE +5V IS USED FOR POWER. THE OTHER SUPPLIES CONNECT FOR POWER TEST ONLY AND ARE HIGH IMPEDANCE POINTS. LIKELYHOOD OF LOADING THESE SUPPLIES IS LOW.

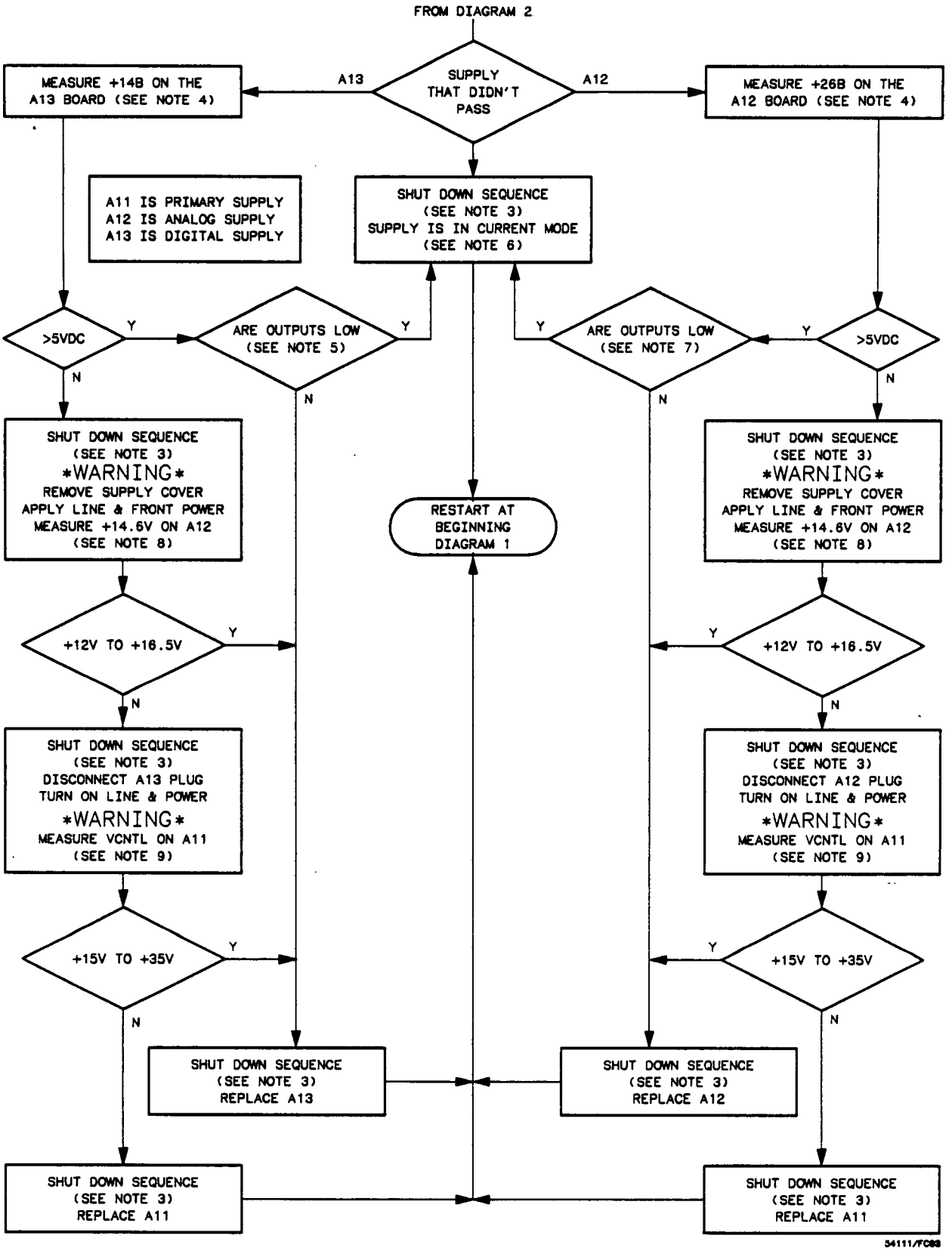


Figure 6D-3. Power Supply Troubleshooting Flow Diagram (part 3)

6D-13. COLOR CRT MODULE FAILURE ISOLATION

The following procedure causes the processor to write a known pattern of video to the module. The video waveforms, the vertical and horizontal sync signals, and the +120V primary module power are checked at the module inputs. If the inputs are present and correct, use the Color CRT Module Outrigging procedure to ensure that replacement of the module will correct the problem.

6D-14. Troubleshooting Procedure

1. Turn instrument to STBY using the front panel power switch.

2. Remove covers (see Instrument Disassembly, section 6A).

3. Turn power on and check the +120 V module power at the module power input connector (see next figure). The correct voltage will be between +118 and +122 volts. If the +120 V supply voltage is incorrect, see the power supply troubleshooting procedures.

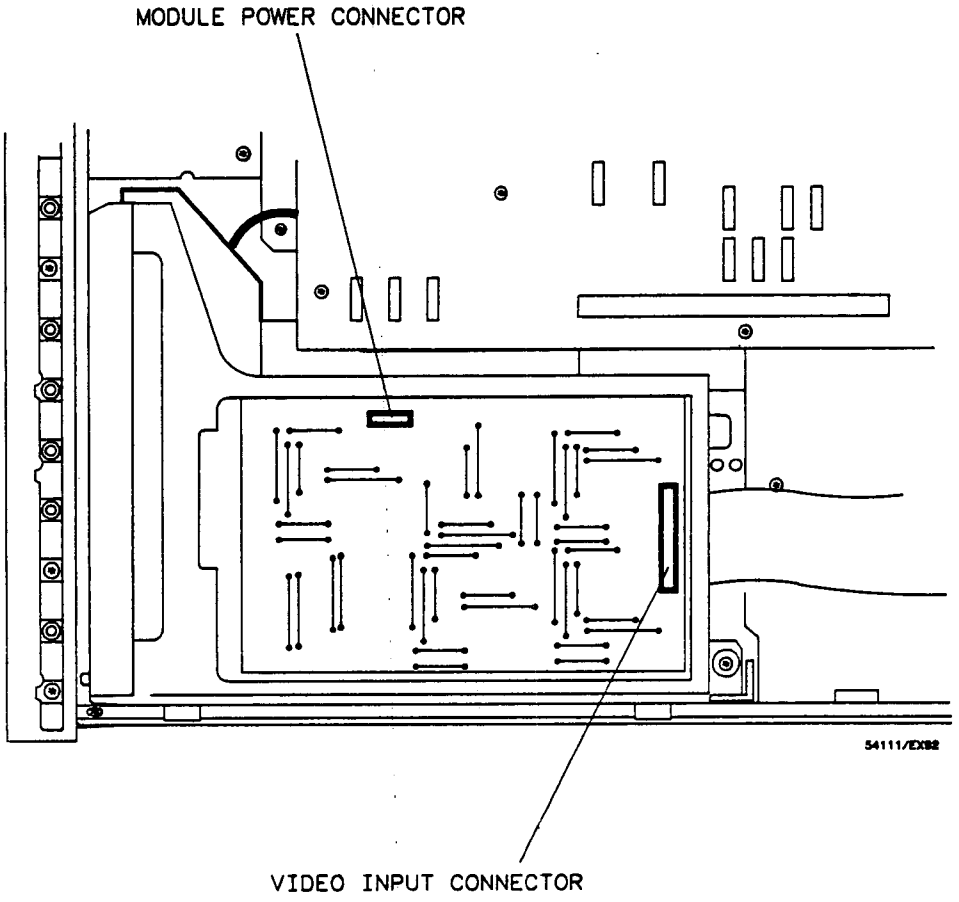


Figure 6D-4. Color CRT Module Input Connections

4. Move clear plastic board shield on bottom of Color CRT Module by pushing rearward until it clears front frame and hinge it away from the board.

5. With 10:1 divider probes, connect channel 1 of the monitor oscilloscope to vertical sync test point VD (located on module video input connector, pin 3) and channel 2 of the monitor oscilloscope to horizontal sync test point HD (located on module video input connector, pin 7). These test points are located on the Color CRT Module (A19). The vertical and horizontal sync signals are TTL levels and should resemble the waveforms in the following figure. The vertical sync is on the top and the horizontal sync on the bottom.

6. To see if the Color CRT Module is loading the signals, disconnect the wide ribbon cable at the Color Display assembly and check the signals at the two labled test points (VSYNC, HSYNC near U119) on the Color Display assembly.

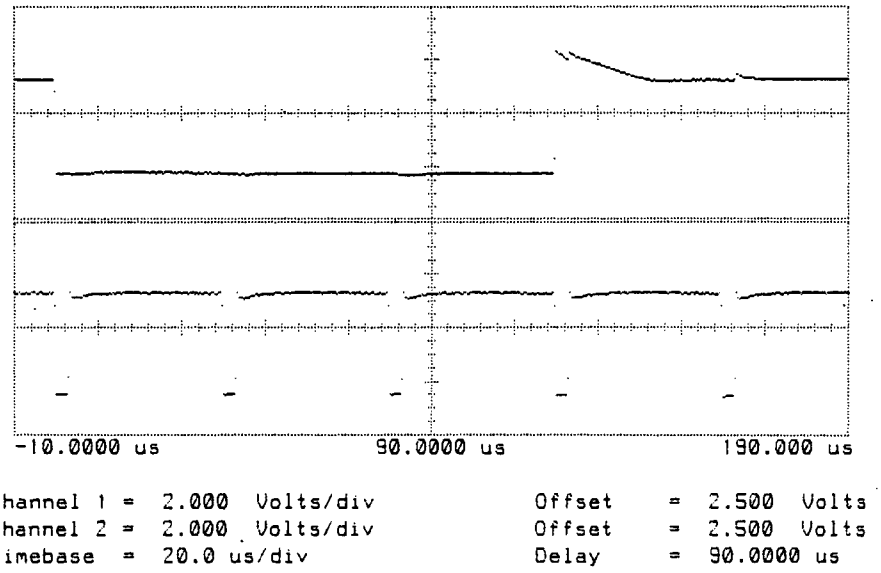


Figure 6D-5. Vertical and Horizontal Sync Waveforms

7. It is helpful to try to get a known display before checking the video waveforms. If the display is operating, press ***more, Utility, CRT Setup Menu***, and ***Color Purity***. This will give a white raster so all video signals will be at maximum.

   If there is no display, try to get the same signals using the following procedure.

   a. Turn instrument off, then on, then press the following softkeys, in order given.

   b. In bottom row press:
      Key at extreme right
      Key second from right
   c. In vertical column press:
      Key at bottom
      Key third from bottom

8. Check the red, green, and blue video signals at the module video input connector at pins 21, 29, and 37 respectively (see Color CRT Module Input Connections drawing).

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

9. Video signals can be adversely loaded by input circuit failures within the Color CRT Display Module. Therefore, before assuming Color Dispaly assembly failures, repeat this test with the video cable disconnected from the Color CRT Module and the measurements taken at the pins of U145 on the Color Display assembly. The red, green, and blue signals are on U145 pins 14, 18, and 22 respectively.

6D-15. Incorrect Display Color

Using the CRT Setup Menu, then pressing the ***Color Purity*** key it is easy to locate a potentially defective CRT write gun or associated electronics. By pressing the ***Color Purity*** key several times the primary colors will be displayed. The colors displayed on the measurement screens are user definable, while the color purity check displays fixed primary colors.

6D-16. Module Outrigging Procedure

Due to the amount of work and time involved in changing the Color CRT Module it is prudent to verify the defective module diagnosis by outrigging a good module. Required parts which are part of the 54100 Family Support Kit are: Color CRT Module power cable, Display Control assembly, and Display Control Cable. Also necessary is a working Color CRT Module which is not part of the service kit.

1. Turn power off and remove instrument power cable.

2. Remove covers (see Instrument Disassembly, section 6A).

3. Disconnect Color CRT Module power cable at the primary power supply.

4. Connect the Color CRT Module power cable from the support kit to the primary power supply.

5. On the bottom of the instrument, disconnect the wide ribbon cable from the the suspect Color CRT Module and extend it as far as possible from the instrument when it is in a normal operating position.

6. Set the working Color CRT Module next to the instrument.

7. Connect the wide ribbon cable to working module.

8. Connect the module power cable to the mating connector towards the front of the CRT Module. This connection can be verified by noting that the connector is labled B-4 on the bottom of the PC board at the connector.

9. Connect the Display Control Cable from the support kit to the mating connector which is toward the rear of the module. This connector is labled B-2 on the bottom of the PC board.

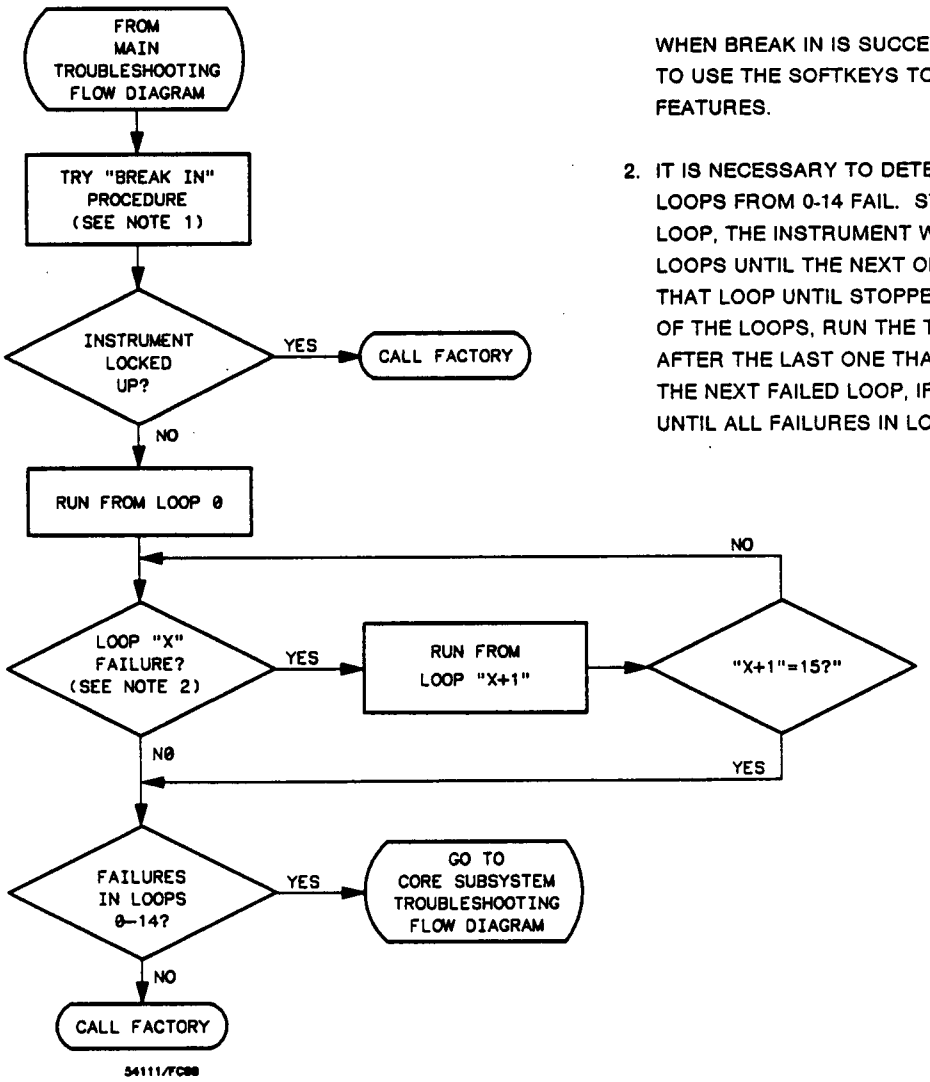
10. Connect the CRT Brightness Control from the support kit to the other end of the Display Control Cable.

11. Re-connect the power cord and turn instrument on.

12. Verify display operation.

6D-17. SOFTWARE TROUBLE-SHOOTING

Software troubleshooting is used to evaluate a software problem that prevents the instrument from displaying self-test information by locking up the keyboard. This routine is entered from the Main Troubleshooting Flow Diagram.



NOTES

1. THIS PROCEDURE ALLOWS YOU TO "BREAK IN" TO AN INSTRUMENT THAT IS LOCKING UP DURING THE POWERUP CYCLE. IT IS NECESSARY TO INTERRUPT THE POWERUP CYCLE BEFORE IT LOCKS UP THE INSTRUMENT.

   IF THE INSTRUMENT IS LOCKING UP, CYCLE THE POWER WITH THE STBY SWITCH. JUST AS THE GRATICULE IS BEING DISPLAYED DURING THE POWERUP ROUTINE, PRESS THE STOP/SINGLE KEY. TIMING IS IMPORTANT HERE AND IT MAY TAKE SEVERAL TRIES TO "BREAK IN".

   WHEN BREAK IN IS SUCCESSFUL, YOU WILL BE ABLE TO USE THE SOFTKEYS TO ACCESS THE SELF TEST FEATURES.

2. IT IS NECESSARY TO DETERMINE WHICH OF THE LOOPS FROM 0-14 FAIL. STARTING AT A SELECTED LOOP, THE INSTRUMENT WILL RUN THROUGH THE LOOPS UNTIL THE NEXT ONE FAILS, THEN REPEAT THAT LOOP UNTIL STOPPED. TO CHECK THE REST OF THE LOOPS, RUN THE TEST FROM THE LOOP AFTER THE LAST ONE THAT FAILED AND CHECK FOR THE NEXT FAILED LOOP, IF ANY. REPEAT THIS UNTIL ALL FAILURES IN LOOPS 0-14 ARE FOUND.

Figure 6D-6. Software Troubleshooting Flow Diagram

6D-18. CORE SUBSYSTEM TROUBLESHOOTING

GENERAL

It is best to attempt to get the HP 54112D to pass all the Core Tests before going on to fix more complex loops. Occasionally, bent motherboard pins or defects in other system elements will cause these loops to fail. By making a system of the Microprocessor assembly, I/O assembly and one other assembly, it is possible to determine which socket or assembly may be causing an interaction that causes one of the core loops to fail. Using this technique, seat each assembly into the motherboard one at a time. Be sure to turn the power off before raising or seating an assembly into the motherboard.

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

LOOP 11

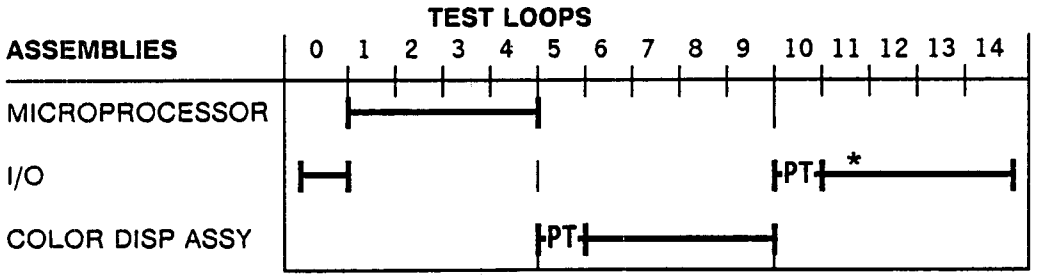
Loop 11, which can test every addressable location in the DRAM on the I/O assembly, is a special case. Using RUN FROM LOOP does not completely execute this test because that would take about 18 minutes to complete. Instead, RUN FROM LOOP tests a random block of this memory.

The REPEAT LOOP mode will run the complete Loop 11 test, but only once due to its length. A complete test of DRAM should be done only if the I/O assembly is suspected of failing and there is not enough proof, or if loop 11 has an intermittent failure. This test takes about 18 minutes to run.

Table 6D-2. Core Subsystem Diagnostic Routines.

NOTE

For the Core Subsystem tests to be available and meaningful, the power supplies, Color CRT Module, and Color Display assembly must be working, and the Microprocessor, I/O, and one other assembly must be present.

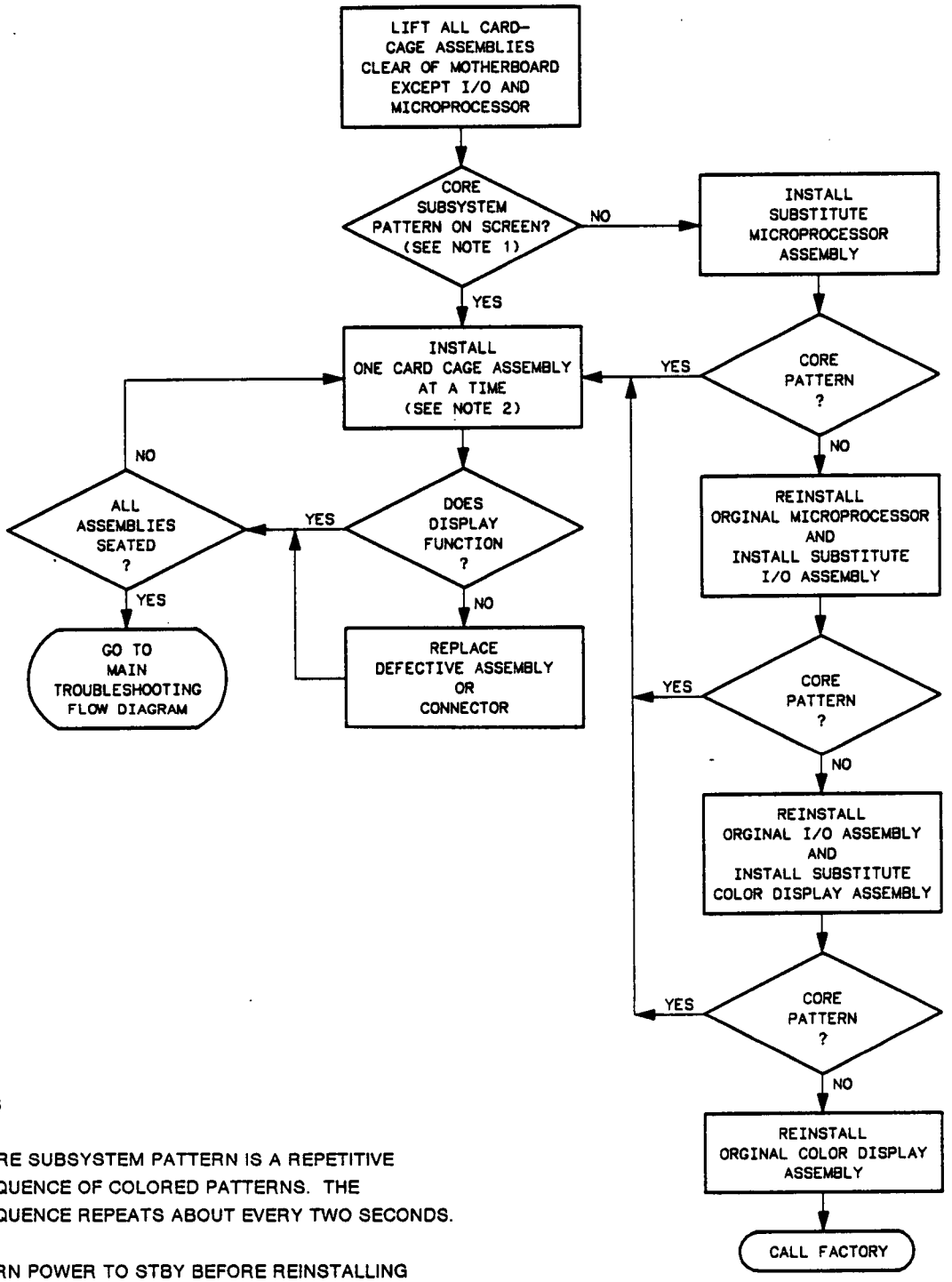


KEY:

PT — Presence test. If the diagnostic software fails to find the assembly, this loop fails and all other self tests that include this assembly are skipped.

This assembly must work for the test to be successful. The test will be skipped and will not show a failure if the assembly is not present.

* See Loop 11 text above.



NOTES

1. CORE SUBSYSTEM PATTERN IS A REPETITIVE SEQUENCE OF COLORED PATTERNS. THE SEQUENCE REPEATS ABOUT EVERY TWO SECONDS.

2. TURN POWER TO STBY BEFORE REINSTALLING EACH ASSEMBLY, THEN TURN POWER TO ON TO CHECK DISPLAY.

Figure 6D-7. Core Subsystem Troubleshooting Flow Diagram

6D-19. DATA ACQUISITION SUBSYSTEM TROUBLESHOOTING PROCEDURE

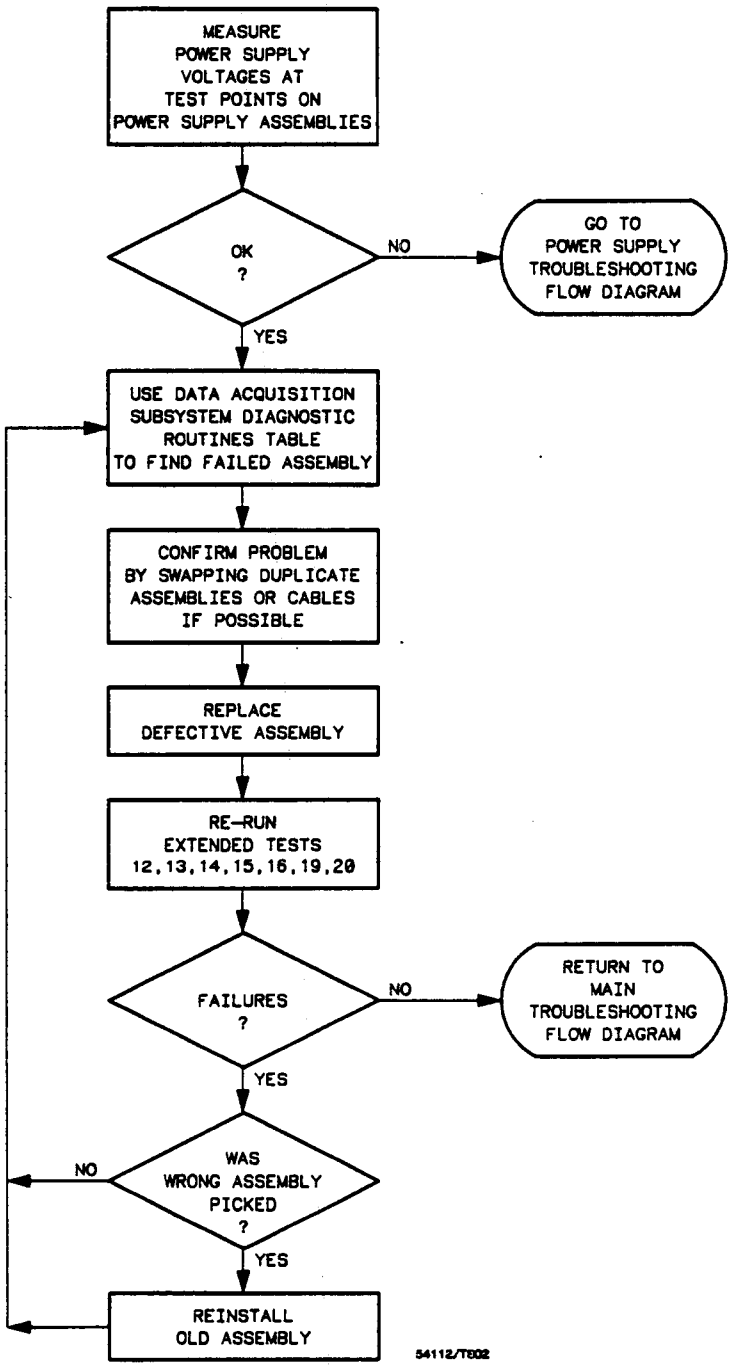


Figure 6D-8. Data Acquisition Subsystem Troubleshooting Flow Diagram

6D-20. Data Acquisition Subsystem Diagnostic Routines

The Data Acqusition Diagnostics consists of several tests:

- Timebase Tests
- Acquisition Control Tests
- Acquisition Memory Tests
- Acquisition System Tests
- Trigger Tests
- State Trigger Tests
- Extended Tests

The tests are arranged in a meaningful order. The more complex and complete tests are located at the end of the group. The software executes the tests in numerical order.

Troubleshooting the Data Acquisition Subsystem is based on the Data Acquisition Subsystem Diagnostic Routines table, table 6D-3. The areas tested are shown across the top of the table. Various letters indicate a function of the card in a particular test. If a particular card is not present, its presence test fails, and the tests for that assembly are skipped. Test loop numbers are shown at the top and bottom of the table.

Information about instrument loop errors is accessed by pressing ***Utility, Test Menu,*** and ***Display Errors.*** The display shows only the numbers of failed loop tests. Once an error appears on the Display Errors screen the error will stay until the power is cycled or until extended test 12 is run, even if the fault has been corrected.

NOTE

It is best to disconnect all front panel inputs from the instrument while using the self-test loops for troubleshooting. Some of the loops can be affected by a signal at a front panel BNC.

6D-21. How To Use The Diagnostic Routines Table

The table on the next pages correlates diagnostic loop test and extended test results to replaceable assemblies. It provides a technique for rapidly and correctly identifying an assembly to replace when loop failures occur. Most true hardware failures result from the failure of a single circuit element on a single assembly, though they can cause several loops to fail. The correct use of this table allows the technician to confidently determine the most probable cause of the observed loop failures.

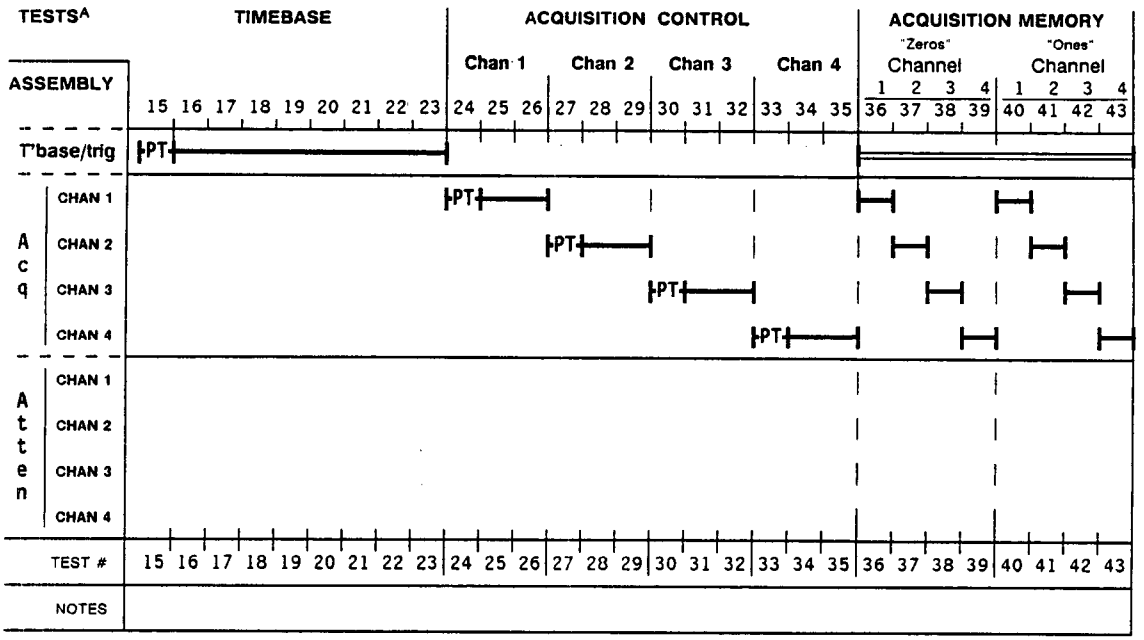
After running the powerup self-tests (or extended test 12) and extended tests 13, 14, 15, 16, 19, and 20, you will have a set of test results, consisting of a "pass" or "fail" for each loop. It is important to emphasize that passing a loop test is valuable information, even though only failures are displayed. If a loop is not listed in the "Loop failures" list on the DISPLAY ERRORS screen, it has passed its most recent test.

Comparing these test results to the information in the table often yields an immediate, clear indication of the most probable cause of failure. For example, when loops 25, 26, 36, 40, and 44-47 have failed, and all other loops and extended tests have passed, the most probable cause is a failure of the channel 1 acquisition assembly. This can be verified by swapping the channel 1 and channel 2 acquisition assemblies and running the tests again. Now loops 28, 29, 37, 41, and 48-51 should fail.

In some cases, several assemblies appear to be suspect from looking at the list of loop failures. In such cases, noting which loops have successfully completed before the first failure often allows you to conclude that at least part of one of the suspect assemblies is working. For example, when only loops 44 and 46 fail, the Timebase/trigger, channel 1 Acquisition, and channel 1 Attenuator assemblies are suspect. However, loops 15-23, 36-43, 45, and 47-68 which test the timebase/trigger have passed. This means initial attention should be directed away from the Timebase/trigger and toward the Attenuator and Acquisition assemblies.

Extended test 20 can help verify the cabling connecting the Attenuator assembly to the channel 1 Acquisition assembly.

Table 6D-3. Data Acquisition Subsystem Diagnostic Routines



KEY:

|PT| Presence test. If the diagnostic software fails to find the assembly, this loop fails and all other self tests that include this assembly are skipped.

This assembly must work for the test to be successful. The test will be skipped and will not show a failure if the assembly is not present.

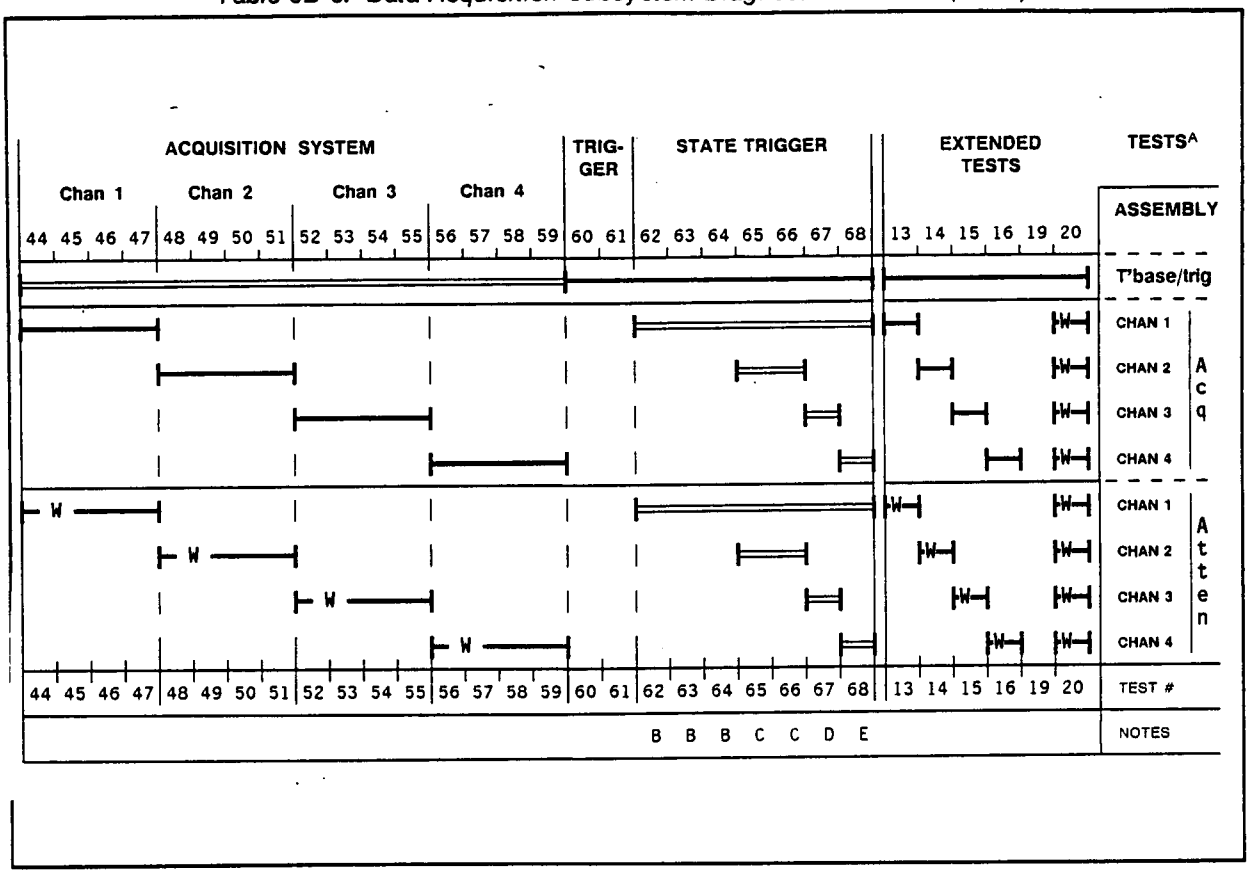
This assembly is involved in the test and must be working; but it is not likely the source of a problem if it has passed earlier tests.

|W| This assembly must work for the test to be successful. However, in this test there is no presence test for this assembly; the software assumes that it is there. If the assembly is not present, then the loop will fail just as if the assembly functions failed.

NOTES:

A. The Microprocessor, I/O, and Color Display assemblies must work for these tests to be valid.
B. This test will not run if loops 45 or 61 fail.
C. This test will not run if loops 45 or 49 fail.
D. This test will not run if loops 45 or 53 fail.
E. This test will not run if loops 45 or 57 fail.

Table 6D-3. Data Acquisition Subsystem Diagnostic Routines (con't.)



Extended tests 13 and 19 may help isolate between a channel or Timebase/trigger failure.

It may then help to swap the channel 1 and channel 2 Acquisition or Attenuator assemblies. If loops 48 and 50 fail (channel 2 loops), the failure has been further isolated.

If unexpected failures, or no changes result from swapping two assemblies, the cause is probably elsewhere. Factory experience has shown that careful rechecking of the interconnections of the swapped assemblies, or restoring the orginal setup and swapping related assemblies (the ones not swapped in the example immediately preceeding), are the most effective courses in this situation.

Sometimes the loop failures will not make any sense at all. Try The Core System Plus One (following) to isolate individual assemblies into a "suspect bad" or "known good" status.

If the failure still cannot be isolated, more information is available from the status fields for each loop, and can be analyzed by the factory. If you can not resolve your loop test results, we encourage you to call your nearest HP Service Center. They will help you or obtain information from the factory to resolve the problem.

6D-22. The Core System Plus One

Occasionally, the indications from the loop errors, the extended tests and the display can be so confusing that it is difficult to determine where to start the trouble shooting process. When this happens, it's sometimes best to start with the Core System plus one other assembly. This means that all assemblies are pulled up except the I/O assembly, microprocessor assembly and one other assembly, usually the Timebase/trigger.

Always turn power OFF when pulling or seating assemblies, and be sure to use proper ESD precautions.

Once you get this system working with no loop errors associated with the Timebase/trigger assembly, then one Acquisition assembly can be reinserted. Again, check for associated loop errors with these particular assemblies.

Once a small system is successful the other Acquisition assemblies can be put down one at a time. Always rerun extended test 12 to write the current loop failures into display memory.

Another useful technique is to put the core system in place, plus one assembly, and check it. If it functions correctly, then remove that assembly and reinsert another assembly and check it. Using the diagnostic table you should be able to quickly draw some good conclusions about the status of all the assemblies in the system.

Note that if an assembly is not present, after it fails its presence test none of the remaining tests that include that assembly are run.

6D-23. Timebase Tests

Self Test Loops 15 - 23

These loops test the timebase functions of the Timebase/trigger assembly. They are very independent loops, so if any are failing this assembly is most certainly the cause.

If the Timebase/trigger assembly presence test fails none of these tests will be run. Additionally, no other test loops that require use of the Timebase/trigger assembly will be run.

LOOP	TEST
15	Timebase/trigger Presence
16	Pre-Trigger Delay Clock on the Timebase IC
17	Pre-Trigger Delay Time in the Timebase IC
18	Clear Coarse and Fine Interpolators
19	Fine Interpolator at 100 MHZ
20	Fine Interpolator at 200 MHZ
21	Coarse Interpolator on the Timebase IC
22	Post Trigger Delay Time
23	Event Delay

6D-24. Acquisition Control Tests — Self Test Loops 24 - 35

In this group there are four sets of three tests each, one set for each channel.

TEST / CHANNEL	Assembly Presence	Preamp Control Register	Solenoid Register
Chan 1	24	25	26
Chan 2	27	28	29
Chan 3	30	31	32
Chan 4	33	34	35

ASSEMBLY PRESENCE TEST

Tests for the presence of the Acquisition assembly. If an assembly is not present or does not respond to a poll, the test fails. If the presence test fails, the rest of the loops that require that assembly to be present are not run.

PREAMP CONTROL REGISTER TEST

These loops check the ability of the preamp control registers to accept the values the CPU programs into them. This is done by toggling each bit in the control string and reading the status register on the Acquisition assembly to see if it changed. The test checks only that the register latched the data, not that it is actually being received by the Attenuator assembly.

SOLENOID REGISTER TEST

These loops are identical to the preamp control register tests except that the solenoid control registers are checked.

6D-25. Acquisition Memory Tests — Self Test Loops 36 - 43

There are two sets of tests in this group of loops. The first set tests that "0"s (zeros or low state) can be stored in all acquisition memories. The second set tests for "1"s (ones or high state). Acquisition memory is located on each of the Acquisition assemblies.

Four loops, 36 through 39, test for the ability of the memories of channels 1 through 4 respectively to store all "0"s. Data is written directly into memory through special circuitry.

Loops 40 through 43 test channels 1 through 4 respectively for ability to store "1"s. The tests are performed in the same way as the test for "0"s.

"0"s (low state) Test

LOOP	CHANNEL
36	1
37	2
38	3
39	4

"1"s (high state) Test

LOOP	CHANNEL
40	1
41	2
42	3
43	4

6D-26. Acquisition System Tests — Self Test Loops 44 - 59

Four sets of four test loops check several functions of the acquisition system. There is one set for each channel. The sets are identical except for the channel tested. The table shows a cross-reference between tests, channels, and loop numbers.

TEST / CHANNEL	Cal/Offset DAC	Trig Lvl/Sens DAC	Gain Vern DAC	Analog Dither Flip-Flop
Chan 1	44	45	46	47
Chan 2	48	49	50	51
Chan 3	52	53	54	55
Chan 4	56	57	58	59

GENERAL

Use of these loops requires that an acquisition be taken. This means that the Timebase/trigger assembly must have working timebase functions. Loops 16 through 23 test those timebase functions so if they pass, the timebase functions of the timebase/trigger should be working well enough for loops 44 through 59 to run.

CAL/OFFSET DAC TEST

The Cal/offset DAC is a dual purpose DAC used to perform firmware calibration or provide dc offset, depending on the instrument mode.

These test loops test the data acquisition path from the Attenuator assembly preamp through to the acquisition memory.

First the test disables the dither circuitry. It starts an acquisition cycle and during the acquisition ramps the Cal/offset DAC from 0 (zero) up to its maximum output voltage. When the DAC reaches maximum, the acquisition memory is read. The test looks for the minimum and maximum voltages and checks for a linear ramp.

Troubleshooting these loops would involve first swapping the Acquisition assembly with that of a working channel, then the attenuator if necessary.

TRIGGER LEVEL DAC AND TRIGGER SENSITIVITY DAC TESTS

The trigger level DAC sets the nominal trigger level. The trigger sensitivity DAC sets gain in the trigger circuitry on the Attenuator assembly preamp hybrid.

These loops tests the trigger sensitivity of the channels. The test checks a signal path from the Attenuator assembly preamp through the trigger circuitry on the Timebase/trigger assembly.

The test compares trigger sensitivities for two different trigger gains. The sensitivity for high gain should be greater than that for a lower gain.

To determine the sensitivity for high gain, the loop sets the trigger level DAC to a median value and the trigger sensitivity DAC to the maximum value. The Cal/offset DAC is then ramped up from 0 V

until a trigger occurs and the offset level is recorded. The offset DAC is then set to maximum and ramped down until another trigger occurs and the offset level is again recorded. The difference between the two levels is the sensitivity for high gain.

To determine the sensitivity for low gain, the trigger sensitivity DAC is set to a median value (gain) and the process is repeated. The sensitivity at high gain should be a smaller value than that at low gain.

The DAC's are separate for each channel and trigger paths are separate until they reach the Timebase/trigger assembly. Trigger paths are combined on the Timebase/trigger so a failure of one trigger path may be a failure in an attenuator preamp or a failure of trigger functions on the Timebase/trigger assembly. A failure on the Timebase/trigger is less likely so the channel path should be checked first when only one channel is failing this test.

GAIN VERNIER DAC TEST

The gain vernier DAC sets the channel gain on the Attenuator assembly preamp hybrid.

These loops test function of the gain vernier DAC. With a given instrument setup, an acquisition taken with the vernier DAC at maximum should give a higher output from the ADC than an acquisition taken with the DAC at a middle value.

The trigger level is at zero, the trigger sensitivity is maximum, and the cal/offset DAC is at a high value. Since no triggers are present, acquisitions are initiated by auto-triggering.

ANALOG DITHER FLIP-FLOP TEST

There are two dither functions in the HP 54112D, analog dither and digital dither. Analog dither influences the analog signal before digitizing.

This test checks the analog dither function.

The dither circuitry is turned off and the cal/offset DAC is adjusted until a level is found that produces a 50-50 distribution between two q-levels in the digital output of the ADC. The dither is turned on. The ADC output is read and should show a change in the q-level distribution caused by the dither.

This test is susceptible to noise and can fail if a connection is on any of the front panel inputs or if the instrument is in a noisy environment. Failures during power-up do not result in a "Powerup Self Test Failed" message because of the noise susceptibility. If there was a failure during powerup however, the failed loop will be listed in the Loop Failures section of the Display Errors menu. It may be necessary to run a manual test of the loop to confirm the failure.

6D-27. Trigger Tests — Self Test Loops 60, 61

These two loops test trigger functions of the Timebase/trigger assembly.

LOOP 60 TIME DELAY TEST

Loop 60 disables the all trigger inputs and sets delay to a long value. False trigger events are created and a software clock times the delay between trigger events.

This test is nearly identical to loop 23.

LOOP 61 EXTERNAL TRIGGER TEST

Loop 61 checks the function of the rear panel external trigger input. It slews the external trigger level DAC and checks for the simulated trigger transitions.

6D-28. State Trigger Tests — Self-Test Loops 62 - 68

These loops test the Timebase/trigger assemblies' ability to recognize various state trigger patterns. These loops are highly dependent on the trigger outputs of the Attenuator assemblies; therefore, if loops 45, 49, 53, or 57 (trigger level/sensitivity DAC) fail or loop 61 (external trigger level DAC) fails, some of these tests may not be executed.

LOOP	TEST
62	Trigger on Pos edge of CHAN 1 when -XXXH pattern is present.
63	Trigger on Pos edge of CHAN 1 when -XXXL pattern is present.
64	Trigger on Pos edge of CHAN 1 when -XXXL pattern is not present.
65	Trigger on Pos edge of CHAN 1 when -HXXX pattern is present.
66	Trigger on Pos edge of CHAN 2 when H-XXX pattern is present.
67	Trigger on Pos edge of CHAN 1 when -XHXX pattern is present.
68	Trigger on Pos edge of CHAN 1 when -XXHX pattern is present.

6D-29. Extended Tests

Not all Extended Tests are of use to field service personnel. Tests 11 and 12 can be used for service. Tests 13-16, 19, and 20 are part of the table and they have the most use for field service.

The extended tests must be individually executed by the service person. The Extended Tests are part of the Test Menu. To select a test, press ***Extended Test***, ENTER the test number, and press ***Start Test***. The results of the test appear in a few seconds. To exit the test, press ***Stop Test***. Errors or problems appear in red on the screen after the test.

TESTS 0 - 9. These tests have factory use only.

TEST 10. Test 10 repeats loops 6-9 continually. It is similar to the test that runs when all of the acquisition boards are removed. This is an alternative to removing the boards; however it is usually better to remove the boards while troubleshooting the core system because the CPU interface to the data acquisition system is eliminated.

TEST 11. Extended Test 11 is not covered in the table. It is used to verify that all front panel keys and RPG are working. When the test is entered and initiated a keyboard mockup is displayed on the CRT. The mockup consists of boxes corresponding to each key on the front panel. A box lights when it's key is pressed. The RPG mockup consists of a set of radial lines representing a circle. When the RPG is rotated, an O cursor rotates around the circle.

To exit this test at any time the third key from the top, along the right edge of the display, must be pressed twice.

TEST 12. Test 12 is not part of the diagnostic table. Test 12 resets the system and initiates the powerup self test. If the advisory message "Powerup Self Test Failed" should appear on the display, the failing loops may be found by pressing ***Utility***, ***Test Menu***, then ***Display Errors*** keys.

TESTS 13 - 16. These are missing codes tests for the channel acquisition memory. They check for stuck bits in the acquisition circuitry. The offset DAC is incremented slowly and the output of the ADC is checked for proper progression of codes, from 000000 to 111111. Tests 13, 14, 15, and 16 test channels 1, 2, 3, and 4 respectively.

TEST 17. Has factory use only.

TEST 18. This test is for factory use. It slews all of the DAC outputs so that they can be checked for smooth outputs. Checking DAC outputs is only usefull for component level troubleshooting which is not supported on this instrument.

TEST 19. Test 19 evaluates the internal clock rates of the Timebase IC.

TEST 20. Test 20 uses the state trigger path to determine if the pre-amps are cabled properly. This test also checks the FET input. If a problem exists in the signal path in front of the FET, test 20 will not show a defective input.

TEST 21. This test serves two functions. First, it latches the front panel CAL signal in its high state, +800 mV dc. The cal signal can then be be measured for a performance test or measured and adjusted as in the adjustment procedures.

Test 21 also outputs a derivative of the acquisition sample rate to the Timebase Cal output on the rear panel. The menu describes steps to take to measure this signal but this part of test 21 has no use at this time.

6D-30. FRONT END TROUBLE-SHOOTING

Once all loop errors and extended test failures have been eliminated, some symptoms may persist. Most of the remaining problems will be found in the front-end subsystem, the attenuators. Below are identified some common symptoms and their causes, and procedures to ensure that the front end subsystem is functioning properly.

6D-31. Remaining Symptoms

PROBE OR OVERLOAD SENSE FAILURE

Probe and overload sense is conducted to the Acquisition assembly through a three-wire cable. The cable can get pinched between the frame and attenuator assembly and become grounded. If the overload wire is grounded the 50Ω input resistance will be out of specification and overload sense will not work.

If the probe sense wire is grounded the instrument will operate as if that channel has a 10:1 probe attached to it. The vertical scaling may be wrong or the menus will not allow access to the 50 ohm termination (the softkey selecting 50 ohms will not be displayed).

The cable is part of the attenuator. If a wire is pinched, repairing it with tape will be less expensive than replacing the attenuator.

INSTRUMENT WON'T TRIGGER AFTER TRIGGER CAL, OR TRIGGER CAL WON'T COMPLETE (Trigger Cal takes about 10 minutes).

Most probable cause: trigger output failure from an attenuator assembly. The trigger signal may be good enough to pass self tests but not good enough for operation.

To verify, apply a signal to the suspect attenuator and view the TCLOCK+ output on another oscilloscope. With a square wave input, such as the front panel CAL signal, the trigger signal out of the attenuator should be a square wave with approximately 50% duty cycle. You can use cables and adapters from the HP 54100 Family Support Kit to connect the trigger to the oscilloscope. If problems persist, replace the failed attenuator assembly.

6D-32. Checkout Procedure

If an attenuator assembly has been replaced, or if other front-end problems are suspected, use this check-out procedure to verify operation of the front end subsystem. Normally, it is not needed unless the front-end is suspected of failure and loop failures do not isolate the problem.

SIGNAL TESTS

1. Do a one-key power up.

2. Do the software calibrations. Perform Vertical Cal, Probe Tip Cal, Offset Cal, and Trigger Cal. Troubleshoot any cal failures before proceeding.

3. Connect a known signal to the channel inputs to be tested. If only one channel is suspected of failure, connect the signal to a functioning channel also, to provide a basis for comparison.

4. Press AUTOSCALE. All channels having signal inputs should be displayed. The result should be similar traces of the signal. Compare sensitivities, offset values and other parameters for clues about failures. Check for proper probe attenuation factor.

5. If the instrument does not autoscale properly, the most probable cause is an unrecognized failure of trigger calibration. Check for improper cabling as a potential cause of this failure, particularly the solenoid control cables. Try the "Click Tests" that follow this procedure.

6. If there is still a problem, the most probable cause of failure is an unrecognized probe-tip calibration failure, unless other loops have begun to fail. Check for other loop failures and if any are found, refer to the Data Acquisition System Troubleshooting Procedures. If none are found, perform a Probe Tip Cal. If this fails to solve the problem, contact HP Customer Support.

CLICK TESTS

1. Check to see that the 50 ohm/1Mohm switches work. Remove probes from front panel, and switch between 50 and 1M ohm at each channel menu. A click should come from the attenuator assembly as impedance is switched.

2. If there is no click, check the attenuator cabling for loose, miscabled, or detached connectors, and for debris such as loose screws or other conductive material on top of the attenuators.

3. Check the operation of the vertical sensitivity solenoids on the channel attenuators by varying the vertical sensitivity on each channel, as follows:

   Be sure the probes are disconnected and attenuation factors are 1:1. With a single display, and when using the increment/decrement (arrow) keys, clicks will occur on the channel attenuator assemblies when switching between vertical sensitivities of 20 and 50 mV/div and between 200 and 500 mV/div.

   Normally a click is heard when switching both ways through these transitions. Different circuitry is used when switching up than when switching down. However, if one switching direction is faulty the solenoid will stay in the first direction it switches to and no clicks will be heard at that range transition. If any clicks are not present, check cabling and look for debris in the solenoids.

   It is usually not be necessary to remove attenuators while determining if the attenuator, cable, or control is causing a failed click test. Use swapping techniques to isolate the fault. Swap one end of the solenoid cables (connected at the top of the Acquisition assembly) and try to control the suspect attenuator with a different channel menu; or swap the entire cable.

6D-33. Attenuator Outrigging

It is possible to quickly check the effect of replacing an attenuator by using the following procedure to outrig a substitute. The additional required cables are in the 54100 Family Support Kit.

NOTE

Use the cabling diagram on the top cover of the instrument or the end of section 6A to recable the instrument during or after this procedure.

1. Turn off power and remove covers.

2. Connect three Coaxial Cables to the good attenuator assembly.

3. Remove the Attenuator Power Cable from suspect assembly at the attenuator and Acquisition assemblies.

4. Extend the Power Cable using the extender cable from the support kit.

5. Connect the extended power cable between the good attenuator and the Acquisition assembly.

6. Disconnect the Solenoid Cable at the suspect attenuator and connect to the good attenuator.

7. The probe sense and input overload cable is difficult to remove and connect at the Acquisition assembly. It may not be necessary to connect the cable from the substitute attenuator, depending on the symptoms and methods being used to determine the failure. If necessary, disconnect the cable from the suspect attenuator and connect the one from the substitute.

8. Connect the signal and trigger coaxial cables to the proper locations on the Acquisition and Timebase/trigger assemblies.

9. Verify proper operation.

6D-34. HINTS, TRICKS, AND ARCANA

6D-35. Multiplicity of Function

Many parts of the HP 54112D are duplicated. This allows part swapping to troubleshoot for a defective assembly. There are four Attenuator assemblies and four Acquisition assemblies. Multiple inputs and outputs on these assemblies allow part swapping or recabling to be effective troubleshooting tools.

CLOCK SIGNALS

Four pairs of acquisition clock signals (FFCLKs) originate at the Timebase/trigger assembly. If the Timebase/trigger assembly is suspected as a probable cause for a defect and only one channel is affected, try to switch the clock outputs to the Acquisition assemblies, and see whether the symptoms change. If the symptoms change to a different channel the problem would be in the cable or on the Timebase/trigger assembly. The 54100 Family Support Kit includes a long clock cable that can be used as a substitute for troubleshooting.

The converse is also true, if the problem stays with the same channel, then the Acquisition assembly is the most suspect.

CONNECTORS AND CABLES

The many identical cables on the HP 54112D can be interchanged to test suspected defective cables.

6D-36. System Interface Bus

All the slots in the mother board are identical and have identical voltages or signals associated with each pin. This means that defective motherboard slots can be found by rearranging the assemblies in the card cage. The assemblies have been arranged in the order that gives the lowest system noise, but any of the assemblies can work in any of the slots.

Rearranging the assemblies is of course limited by the cabling, which may not accomodate some arrangements.

SERVICE NOTE

Supersedes:
54112D-1

HP MODEL 54112D DIGITIZING OSCILLOSCOPE

Serial Number 2735A00173 and below

LOSS OF RESOLUTION OR EXCESSIVE NOISE ON TRACE

This modification applies only to instruments having HP part number 54112-66503 acquisition assemblies (A4 through A7).

An oscillation on the +10 volt power supply in any of the acquisition assemblies (A4 through A7) may cause subtle loss of resolution or noise on the respective channel. To prevent or cure the problem, remove U58 and C91 and add two resistors on each of the affected assemblies.

PARTS NEEDED FOR MODIFICATION

Part No.	Qty	Description
0698-4428	4 per Instr	Resistor 1690 ohms 1%
0698-3442	4 per Instr	Resistor 237 ohms 1%
5001-3548	4 per Instr	PC Label -69504

MODIFICATION PROCEDURE

1. Remove instrument from power source.
2. Using cover disassembly procedure in section 6A of the service manual, remove feet, handle strap, bottom and top covers.
3. Check part numbers of A4 through A7 acquisition assemblies. The part number is located along top center of the board. (This modification is needed on p/n 54112-66503 assemblies only.)
4. Note the assemblies needing modification and mark which slot the respective assemblies are located. (If these assy's are returned to their original slot after modification, recalibration is not needed.)
5. While removing the affected assemblies, carefully remove the three cables at the top of the board and the two cables connected to the front of the board.
6. Remove U58 and C91 from the affected boards (See Figure 1).
7. Install R62 (1690 ohm) and R63 (237 ohm) in the U58 holes. Insure that the resistor leads are twisted and soldered between pins 5 and 6 on the back of the PC board (see Figure 2).

E/PM-OF/WO

2/88-08/RK

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8. Change Acquisition Assembly p/n to 54112-69504 by installing PC Label -69504 (HP p/n 5001-3548) over existing -66503 assembly p/n. (Changing the part number shows that these assemblies are updated.)
9. Reinstall the modified acquisition assemblies in their original slots.
10. Reconnect the five cables on each acquisition board.
11. Apply power and check instrument for proper operation. (If instrument does not operate correctly, check cabling using cabling diagram inside instrument top cover.)
12. Disconnect power and reinstall top and bottom covers.
13. Update the service manual. Change the part numbers on A4 through A7 Exchange Assemblies to 54112-69504.

This completes the modification.
The modification requiress about 1 hour labor to complete.

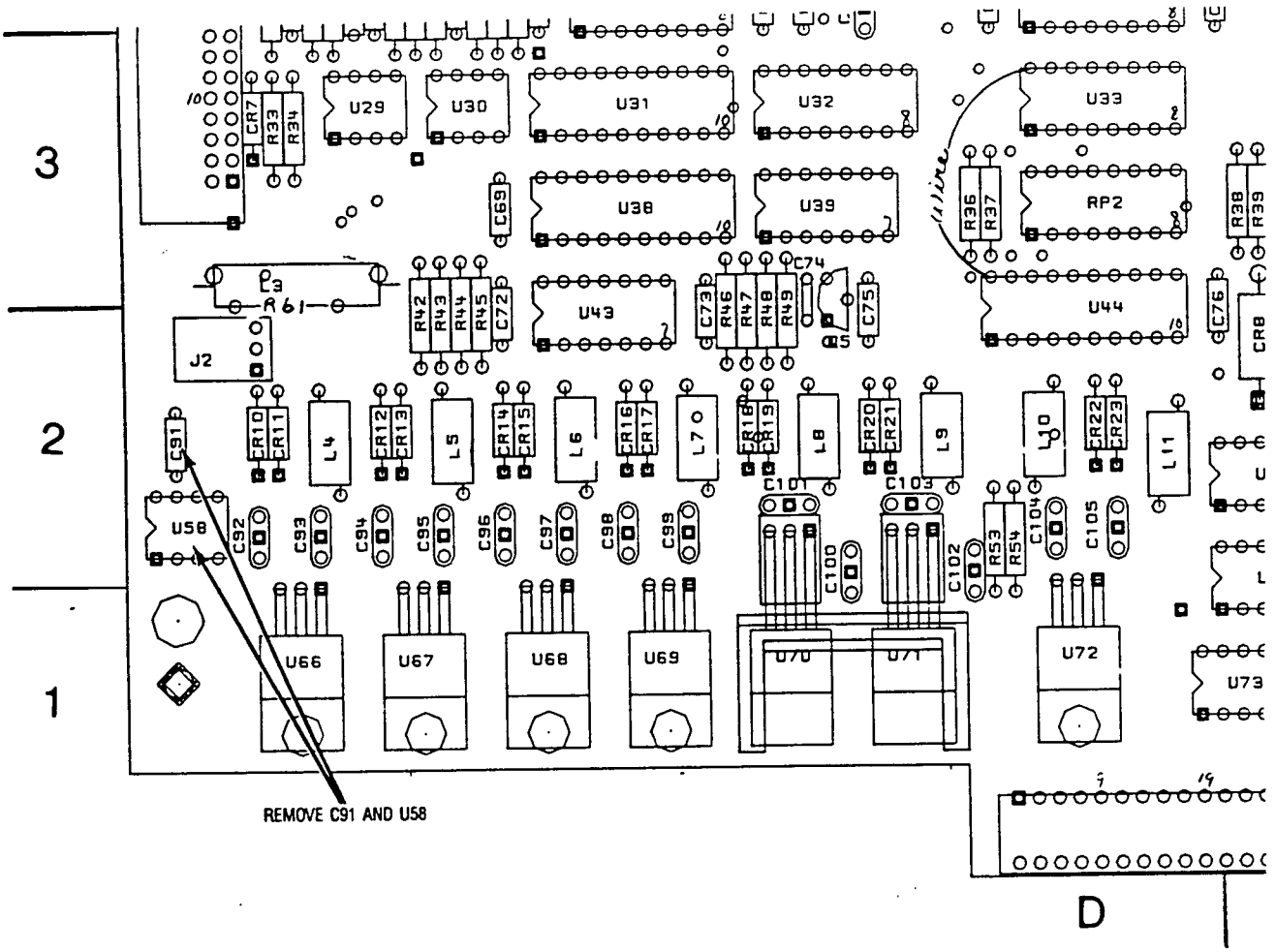

Figure 1. Acquisition Assembly A4 through A7 (Lower Left View of Assembly)

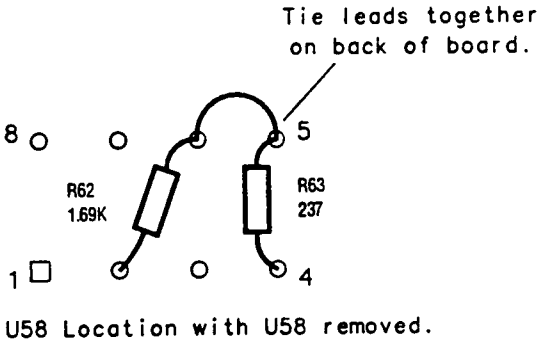

Figure 2. Location to add R62 and R63

S E R V I C E N O T E

Supersedes:
none

HP MODEL 54112D DIGITIZING OSCILLOSCOPE

ROM Revision Allows PaintJet Support and Improves Selftest Reliability

The HP 54112D firmware has been revised to support PaintJet Printers and improve self test reliability.

The self test changes include loops 45, 49, 53, 57 (Trigger Sensitivity) and loops 47, 51, 55, 59 (Analog Dither). These eight loops provided erroneous failure messages and have been ignored in the new firmware. These loops still run but can not be used for troubleshooting.

Given a failure of one the loops described above, the course of action should be to replace ROMs. Should a true hardware failure be present the new code will accurately diagnose the problem.

The new firmware is available via a kit Part Number 54112-68701.

D/OF/WA

8/88-08/JB

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S E R V I C E N O T E

HP 54112D Digitizing Oscilloscope

Serial Numbers: 2912A00059/2912A00666
(see text for specific serial numbers)

PLOT ERROR CAUSED BY FIRMWARE BUG

To Be Performed By: HP-qualified personnel

Parts Required:

HP P/N	Description
54112-68701	ROM upgrade kit

Situation:
A firmware bug has been discovered on the 54112D oscilloscope's PLOT function.

The error occurs when, in real time display mode, the STOP/SINGLE button is pressed prior to executing the PLOT function. The resultant plot is shifted left and compressed by one-half on the time axis. The TIMEBASE must be within the range: 500 usec/div to 2 msec/div to see this error.

Only oscilloscopes with 8 March 1989 firmware contain this bug. To determine the firmware present on an instrument, press UTILITY, TEST MENU, and DISPLAY CONFIGURATION.

Date: 12 July 1989

ADMINISTRATIVE INFORMATION

SERVICE NOTE CLASSIFICATION:

MODIFICATION RECOMMENDED

ACTION CATEGORY:	☐ IMMEDIATELY ☐ ON SPECIFIED FAILURE ■ AGREEABLE TIME	STANDARDS: LABOR 1 Hour	
LOCATION CATEGORY:	☐ CUSTOMER INSTALLABLE ☐ ON-SITE ■ HP LOCATION	SERVICE INVENTORY: ■ RETURN ☐ SCRAP ☐ SEE TEXT	USED PARTS: ■ RETURN ☐ SCRAP ☐ SEE TEXT
AVAILABILITY:	PRODUCT'S SUPPORT LIFE	RESPONSIBLE ENTITY: 0800	UNTIL: 25 May 1990
AUTHOR: RL	ENTITY: 0800	ADDITIONAL INFORMATION:	

HEWLETT PACKARD

54112D-04

The firmware date will appear on the bottom of the screen. Also, these ROM's have HP part numbers 54112-80029 through 54112-80042.

Our records show that only thirteen units were shipped with the bad ROM's, plus another 8 ROM kits (HP P/N 54112-68701) were sold through the Support Materials Organization, or provided by COL. The serial numbers of the thirteen units shipped from COL follow:

1) 2912A 00059
2) 2912A 00181
3) 2912A 00182
4) 2912A 00192
5) 2912A 00193
6) 2912A 00199
7) 2912A 00207
8) 2912A 00218
9) 2912A 00224
10) 2912A 00615
11) 2912A 00664
12) 2912A 00665
13) 2912A 00666

Solution:

This bug has been eliminated in a firmware revision. Repair strategy is to replace the ROM's on the microprocessor board.

1) Remove 54112D top cover and remove the microprocessor board A2.

2) Replace ROM's with those provided in the ROM upgrade kit 54112-68701. Follow the installation instructions provided with the kit. Note that odd numbered ROM's go on the top row, while even numbered ROM's are installed on the bottom row.

3) Recalibrate the instrument. Refer to sections 4-11 through 4-16 in the 54112D service manual. Press UTILITY and CAL MENU (do all).

S E R V I C E N O T E

SUPERSEDES None

54112D Digitizing Oscilloscopes

Vertical Gain Calibration Procedure Into 50 ohms

Situation:

In many applications, customers may want to optimize the vertical gain of the 54112D without using a 10:1 1 MegoOhm probe. In other words, it is often necessary to improve the vertical accuracy of measurements done with a straight- through BNC cable terminated into 50 ohms.

Solution:

The following is an optional calibration procedure that allows the user to calibrate the gain of the 54112D to be used as a 50 ohm system.

NOTE

This procedure allows the user to calibrate the gain of the 54112D to be used as a 50 ohm system. Thus, the vertical specifications of the scope will still be met without using a 10:1 1 Mohm probe. Also, the vertical specifications can be performance verified using the same tests as used with the probe in the service manual. However, the user must be aware that all voltage settings and voltage values must be divided by ten when doing a performance test without a 10:1 probe. Furthermore, the user must consider the inaccuracy of the test equipment and the 50 ohm termination when doing PV.

DATE 12 March 1990

ADMINISTRATIVE INFORMATION

SERVICE NOTE CLASSIFICATION:

INFORMATION ONLY

AUTHOR:	ENTITY:	ADDITIONAL INFORMATION:
HTG	0800	

HEWLETT PACKARD

Equipment and Procedure

Equipment Required:

1. Pulse/Function Generator HP 8116A (or any generator capable of driving 50 ohms and swinging 80 mV with 2kHz, 50% duty cycle square wave)

2. Digital Multimeter HP 3468A

3. 2 ea HP 10503A cables

4. 1 ea HP 1250-0781 BNC Tee (m)(f)(f)

5. 1 ea HP 1251-2277 BNC(f) to Dual Banana Plug(m)

6. 1 ea HP 10100C 50 ohm termination

Procedure:

1. Perform a one-key powerup to set the instrument to default conditions.

2. Set the 8116A to output a square wave at 2 kHz, 50% duty cycle, High level of 80 mV, low level of 0 mV, offset of 40 mV.

3. Connect the 50 ohm termination directly to the input BNC of channel 1. Connect the male end of the BNC tee to the 50 ohm termination. (Note: the 50 ohm termination must be within 1% of the scopes 50 ohm termination for best accuracy of this cal procedure)

4. Connect a cable from one of the tee's female ends to the 8116A output. Connect a cable from the other female end to the female end of the banana plug, and then to the voltmeter.

5. Press Channel 1 and set the input impedance to 1 Mohms. Adjust the high level of the generator until the voltmeter reads 40 mV DC.

6. Press autoscale to establish the display. Verify the following: 20 mV/div sensitivity, 100 usec/div sweep speed.

7. Press "more", "utility", "cal menu", "probe tip cal", then calibrate the 50 ohm termination by pressing "calibrate probe tip channel 1".

8. Repeat this procedure for channels 2, 3, and 4.

S E R V I C E N O T E

SUPERSEDES: NONE

HP 54112D Digitizing Oscilloscopes

Serials 0000A00000 / 2833A00000

Loop 42 failure message may be caused by a loop 50 failure

To Be Performed By: Not Applicable

Parts Required: None

Situation:

The first two sets of firmware for the 54112D will display a loop 42 error on power up when the true error is loop 50. These sets of firmware can be identified by date. The effected firmware will have firmware dates of July 18, 1988 and earlier. The date can be found by going through the following steps. Turn on the scope, press More, Utility, Test Menu and Display Configuration. The date will appear at the bottom of the screen.

Solution/Action

Given a loop 42 failure on power up selftest, go to the test menu and run loop 42 and then loop 50 to determine the true failure.

Date: 17 February 1989

ADMINISTRATIVE INFORMATION

SERVICE NOTE CLASSIFICATION:	**INFORMATION ONLY**	
AUTHOR	ENTITY	ADDITIONAL INFORMATION.
JFB	0800	

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