

ARTISAN®
TECHNOLOGY GROUP

Your **definitive** source for quality pre-owned equipment.

Artisan Technology Group
(217) 352-9330 | sales@artisantg.com | artisantg.com

Full-service, independent repair center
with experienced engineers and technicians on staff.

We buy your excess, underutilized, and idle equipment
along with credit for buybacks and trade-ins.

Custom engineering
so your equipment works exactly as you specify.

- Critical and expedited services
- In stock / Ready-to-ship
- Leasing / Rentals / Demos
- ITAR-certified secure asset solutions

Expert team | Trust guarantee | 100% satisfaction

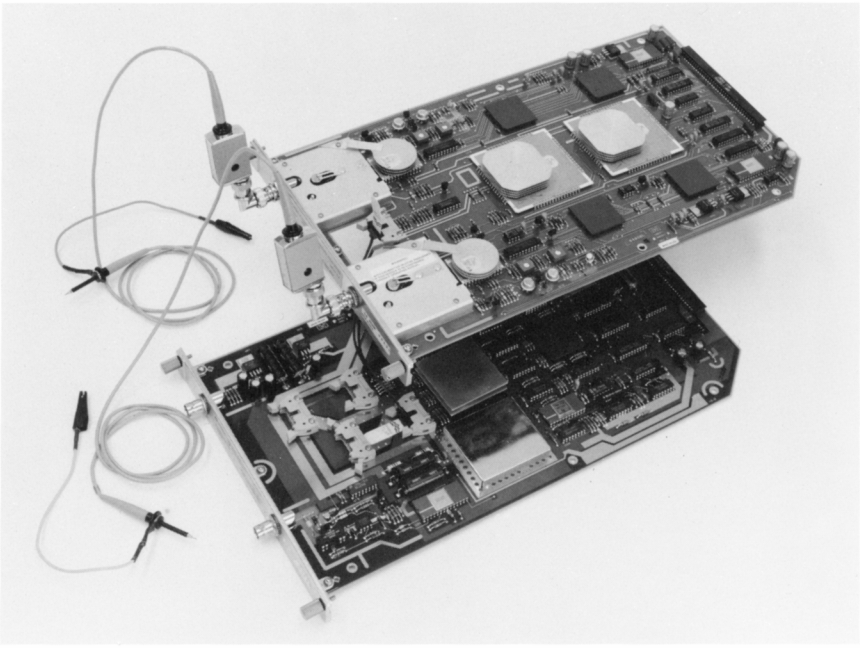
All trademarks, brand names, and brands appearing herein are the property of their respective owners.

Visit our website - *Click HERE*

HP 16530A/16531A

DIGITIZING OSCILLOSCOPE MODULE

Service Manual



HEWLETT PACKARD

HEWLETT PACKARD

SERVICE MANUAL

HP 16531A 400 Msample/s Digitizing Oscilloscope Acquisition Card

AND

HP 16530A 400 Msample/s Digitizing Oscilloscope Timebase Card

© COPYRIGHT HEWLETT-PACKARD COMPANY/COLORADO DIVISION 1987
1900 GARDEN OF THE GODS ROAD, COLORADO SPRINGS, COLORADO U.S.A.

ALL RIGHTS RESERVED

Manual Part No. 16530-90901
Microfiche Part No. 16530-90801

PRINTED: SEPTEMBER 1987

CERTIFICATION

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

WARRANTY

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

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

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

LIMITATION OF WARRANTY

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

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

EXCLUSIVE REMEDIES

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

ASSISTANCE

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

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

CWA584

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.

TABLE OF CONTENTS

SECTION **PAGE**

I. GENERAL INFORMATION 1-1

1-1. Introduction 1-1
1-2. Modules Covered By Manual 1-1
1-3. Safety Requirements 1-1
1-4. Product Description 1-2
1-5. Accessories Supplied 1-2
1-6. Accessories Available 1-2
1-7. Specifications 1-2
1-8. Operating Characteristics 1-2
1-9. Recommended Test Equipment 1-2

II. INSTALLATION 2-1

2-1. Introduction 2-1
2-2. Initial Inspection 2-1
2-3. Preparation For Use 2-1
2-4. Power Requirements 2-1
2-5. Installation 2-1
2-6. Module Installation 2-2
2-7. Adding Acquisition Cards 2-5
2-8. Operating Environment 2-8
2-9. Storage 2-8
2-10. Packaging 2-8
2-11. Tagging For Service 2-8

III. PERFORMANCE TESTS 3-1

3-1. Introduction 3-1
3-2. Recommended Test Equipment 3-1
3-3. Test Record 3-1
3-4. Performance Test Interval 3-1
3-5. Performance Test Procedures 3-1
3-6. Bandwidth Test 3-2
3-7. Voltage Measurement Accuracy Test 3-6
3-8. Time Interval Measurement Accuracy Test 3-9
3-9. Trigger Sensitivity Test 3-12

SECTION **PAGE**

IV. ADJUSTMENTS 4-1

4-1. Introduction 4-1
4-2. Calibration Interval 4-1
4-3. Maintaining Calibration Integrity 4-1
4-4. Safety Requirements 4-1
4-5. Recommended Test Equipment 4-2
4-6. Instrument Warmup 4-2
4-7. Calibration 4-2
4-8. Vertical Calibration 4-3
4-9. Trigger Level Calibration 4-4
4-10. Delay Calibration 4-5
4-11. Channel-To-Channel Skew 4-6
4-12. Extender Board Installation 4-13
4-13. Adjustments 4-16
4-14. Set to Default Values 4-16
4-15. DC Balance Adjustment 4-17
4-16. DC Matching Adjustment 4-19
4-17. Attenuator Compensation Adjustment 4-21
4-18. HF Compensation Adjustment 4-23

V. REPLACEABLE PARTS 5-1

5-1. Introduction 5-1
5-2. Abbreviations 5-1
5-3. Replaceable Parts List 5-1
5-4. Ordering Information 5-1
5-5. Exchange Assemblies 5-1
5-6. Direct Mail Order System 5-2

VI. SERVICE 6-1

6-1. Introduction 6-1
6-2. Safety Requirements 6-1
6-3. Recommended Test Equipment 6-1
6-4. Module Block Diagram and Theory Of Operation 6-1
6-5. Acquisition Card Theory of Operation 6-3
6-6. Timebase Card Theory Of Operation 6-4
6-7. Self Tests 6-5
6-8. Troubleshooting 6-9
6-9. Card Replacement 6-25

LIST OF TABLES

TABLE	TITLE	PAGE
1-1.	HP 16530/31A Specifications	1-3
1-2.	HP 16530/31A Operating Characteristics	1-5
1-3.	Recommended Test Equipment	1-10
3-1.	Performance Test Record	3-16
4-1.	Calibration Sequence	4-2
4-2.	Sequence of Adjustments	4-16
5-1.	Reference Designators and Abbreviations	5-3
5-2.	Replaceable Parts	5-4

LIST OF ILLUSTRATIONS

FIGURE	TITLE	PAGE
2-1.	Endplate Overhang	2-2
2-2.	Configuration Guide	2-2
2-3.	Cable End	2-3
2-4.	Cable Position	2-3
2-5.	Installation Summary	2-4
2-6.	Endplate Overhang	2-4
2-7.	Endplate Overhang	2-5
2-8.	Configuration Guide	2-5
2-9.	Cable End	2-6
2-10.	Cable Position	2-6
2-11.	Endplate Overhang	2-7
3-1.	Bandwidth Test Equipment Hookup	3-2
3-2.	Startup Screen	3-3
3-3.	Channel Screen Configuration	3-3
3-4.	Trigger Screen Configuration	3-4
3-5.	Display Screen Configuration	3-4
3-6.	Auto-Meas the V p-p	3-5
3-7.	Channel Configuration	3-6
3-8.	Trigger Configuration	3-6
3-9.	Display Configuration	3-7
3-10.	Voltage Measurement Accuracy Test Equipment Hookup	3-7
3-11.	Set V/Div to +2 Volts	3-8
3-12.	Channel Configuration	3-9

LIST OF ILLUSTRATIONS

FIGURE TITLE **PAGE**

3-13. Trigger Configuration 3-9
3-14. Display Configuration 3-10
3-15. Test Equipment Hookup 3-10
3-16. Auto Markers Configuration 3-11
3-17. Channel Configuration 3-12
3-18. Trigger Configuration 3-12
3-19. Display Configuration 3-13
3-20. Trigger Sensitivity Test Equipment Hookup 3-13
3-21. Auto-Meas the V p-p 3-14
3-22. Trigger Screen and External Source 3-14
3-23. Test Equipment Hookup 3-15

4-1. Startup Screen 4-3
4-2. Vertical Cal Choice Screen 4-4
4-3. Trigger Level Cal Choice Screen 4-4
4-4. Delay Cal Equipment Hookup 4-5
4-5. Channel Screen / Impedance Select 4-6
4-6. Channel Selection 4-6
4-7. Channel to be Calibrated 4-7
4-8. Input Label Field 4-7
4-9. Overlay Screen 4-8
4-10. Insert Field 4-8
4-11. Insert Channel Labels 4-9
4-12. Channel Screen 4-9
4-13. Channel to Channel Skew Equipment Hookup 4-10
4-14. Run Option Select 4-10
4-15. Overlayed Waveforms 4-11
4-16. Channel to Channel Skew Equipment Hookup 4-11
4-17. Channel for Skew Calibration 4-12
4-18. Card Endplate Overhang 4-13
4-19. Connector End 4-14
4-20. Cable Position 4-14
4-21. Installation Summary 4-15
4-22. Startup Screen 4-17
4-23. Set to Default Screen 4-17
4-24. Component Location 4-18
4-25. Offset Voltage Tick Marks 4-18
4-26. Dc Matching Adjustment Equipment Hookup 4-19
4-27. Square Wave Response 4-20
4-28. Attenuator Compensation Adjustment Equipment Hookup 4-21
4-29. Square Wave Response 4-22
4-30. HF Compensation Adjustment Equipment Hookup 4-23
4-31. Impedance Select 4-23
4-32. Channel Select Field 4-24
4-33. Square Wave Response 4-25
4-34. Square Wave Response 4-25

LIST OF ILLUSTRATIONS

FIGURE	TITLE	PAGE
6-1.	HP 16530/31A Oscilloscope Module Block Diagram	6-1
6-2.	Acquisition Card Block Diagram	6-2
6-3.	Timebase Card Block Diagram	6-2
6-4.	Startup Screen	6-5
6-5.	Load Test System	6-6
6-6.	Test System Screen	6-6
6-7.	Main Test Menu	6-7
6-8.	Acquisition Memory Test Run Screen	6-7
6-9.	Stop Field	6-8
6-10.	Exit Test System	6-8
6-11.	Troubleshooting Flow Chart	6-10
6-12.	Endplate Overhang	6-25
6-13.	Configuration Guide	6-26
6-14.	Cable End	6-26
6-15.	Cable Position	6-26
6-16.	Installation Summary	6-27
6-17.	Endplate Overhang	6-28

TABLE OF CONTENTS

GENERAL INFORMATION

1-1. Introduction 1-1
1-2. Modules Covered By Manual 1-1
1-3. Safety Requirements 1-1
1-4. Product Description 1-2
1-5. Accessories Supplied 1-2
1-6. Accessories Available 1-2
1-7. Specifications 1-2
1-8. Operating Characteristics 1-2
1-9. Recommended Test Equipment 1-2

SECTION I
GENERAL INFORMATION

1-1. INTRODUCTION

This service manual contains information for testing, adjusting, and servicing the HP 16531A 400 Msample/s Digitizing Oscilloscope Acquisition Card and HP 16530A 400 Msample/s Digitizing Oscilloscope Timebase Card. This manual is divided into six sections as follows:

I - General Information

II - Installation

III - Performance Tests

IV - Adjustments

V - Replaceable Parts

VI - Service

Information for operating, programming, and interfacing the HP 16530/31A Oscilloscope Cards is contained in the HP 16530/31A Operating and Programming Manual supplied with each module.

The General Information Section includes safety requirements, a product description, and a list of accessories supplied and of accessories available. Also included are tables listing specifications and operating characteristics, and a list of recommended test equipment.

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.

To complete the service documentation for the system, place this service manual in the 3-ring binder with your Logic Analysis System Service Manual.

1-2. MODULES COVERED BY MANUAL

The information covered in this manual is for the HP 16530/31A Oscilloscope Module. If either of the two cards in the module has been changed, it will have a new board number and the manual will be accompanied by a Manual Changes Supplement.

This supplement contains the changes and explains how to adapt the manual to the newer board. In addition, 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.

1-3. SAFETY REQUIREMENTS

Specific warnings, cautions, and safety instructions are placed wherever applicable throughout the manual. These must be observed during all phases of operation, service, and repair of the module. Failure to comply with them violates safety standards of design, manufacture, and intended use of this module.

Hewlett-Packard assumes no liability for the failure of a customer to comply with these safety requirements.

1-4. PRODUCT DESCRIPTION

The HP 16530/31A Oscilloscope is a 100 MHz, 400 Msample/s digitizing oscilloscope. There are two different cards in the oscilloscope module: the two channel acquisition card and the timebase card, which can be used by up to four acquisition cards. Some of the main features are:

- 400 Msamples/s digitizing for 100 MHz bandwidth single-shot and repetitive analysis.
- 4k samples per channel.
- Automatic pulse parameters, displays time between markers, acquires until capturing specified time between markers, performs statistical analysis on time between markers.
- Lightweight miniprobes.

1-5. ACCESSORIES SUPPLIED

The following accessories are supplied with the HP 16530/31A Oscilloscope Module. Quantity one unless shown otherwise.

- Operating manual set
- Service manual
- HP 10018A div by 10 probes Qty 2
- Right angle BNC adapters Qty 2 (HP 1250-0076)

1-6. ACCESSORIES AVAILABLE

- 10:1, 100:1, 10 MΩ, 10 pf resistive divider probe set, 1.5 m (HP 10020A)
- BNC to BNC cable, 1.2 m (HP 10503A)
- 24 pin IC test clip (HP 10211A)
- BNC-to-BNC ac coupling capacitor (HP 10240B)

10:1 Probes:

- 1 MΩ, 8 pf miniprobe, 1 m (HP 10017A)
- 1 MΩ, 10 pf miniprobe, 2 m (HP 10018A)

1:1 Probes:

- 36 pf miniprobe, 1 m (HP 10021A)
- 62 pf miniprobe, 2 m (HP 10022A)
- 50 Ω miniprobe, 1 m (HP 10026A)
- 50 Ω miniprobe, 2 m (HP 10027A)

100:1 Probes:

- 3 MΩ, 3 pf miniprobe, 1 m (HP 10032A)

1-7. SPECIFICATIONS

Module specifications are listed in table 1-1. They are the performance standards against which the module is tested.

1-8. OPERATING CHARACTERISTICS

Table 1-2 lists the module operating characteristics. They are not specifications, but are typical operating characteristics included as additional information for the user.

1-9. RECOMMENDED TEST EQUIPMENT

Equipment required for testing and maintaining the HP 16530/31A Oscilloscope Module is listed in table 1-3. Other equipment may be substituted if it meets or exceeds the critical specifications listed in the table.

Table 1-1. HP 16530/31A Specifications

HP 16530/31A SPECIFICATIONS

VERTICAL (at BNC)

Bandwidth (-3 dB): dc to 100 MHz (dc-coupled)

Range: 40 mV to 16 V full scale (adjustable with 2-digit resolution)

DC Gain Accuracy:

± 3% of full scale (valid within ± 10 degrees Celsius of auto-calibration temperature)

Analog-to-Digital Conversion (ADC) Resolution: ± 1.6% of full scale (6 bits)

DC Offset Accuracy:

± 1% of offset ± 3.2% of full scale (valid within ± 10 degrees Celsius of auto-calibration temperature)

DC Offset Range/Resolution:

Vertical Range	Offset Range	Offset Resolution
<800 mV	± 800 mV	1 mV
≥800 mV	± 16 mV	20 mV

Voltage Measurement Accuracy (DC):

Single Cursor (X or O) = Gain accuracy + ADC resolution + Offset accuracy

Dual Cursor (X to O measurement on the same waveform)

= Gain accuracy + 2 (ADC resolution)

Table 1-1. HP 16530/31A Specifications (cont.)

HORIZONTAL

Range: 50 ns to 100 s full scale, adjustable with 3-digit resolution

Time Interval Measurement Accuracy:

(Single channel or deskewed channels with equal rise time and fall times)

± 0.75 ns ± 0.2 % of timebase range ± 0.02 % of reading (2.5 ns sample period)

± sample period ± 0.2% of timebase range ± 0.02% of reading (≥ 5 ns sample period)

Delay (Time Offset):

Pre-trigger Range	4096 x sample period
Post-trigger Range	500 screen diameters
Resolution	Fine adjustment to 0.2% of screen diameter

TRIGGER

Sources: Any internal channel, or external trigger input.

Internal Trigger:

Sensitivity	≤ 12 % of full scale (dc to 100 MHz)
Range	Within display window (full scale and offset)
Resolution	1 % of full scale

External Trigger: Input (rear panel input BNC)

Sensitivity	≤ 20 mV (dc to 100 MHz)
Range	± 2 V
Resolution	2 mV
Input coupling	dc

Table 1-2. HP 16530/31A Operating Characteristics

HP 16530/31A OPERATING CHARACTERISTICS

VERTICAL

Input Coupling: dc

Transition Time (10% to 90%): ≤ 3.5 ns

Input RC: 1 MΩ ± 2% or 50 Ω ± 3%, shunted by approximately 13 pF

Maximum Safe Input Voltage:

1 MΩ input, ± 40 V (dc + peak ac)
50 Ω input, ± 5 V (dc + peak ac)

Probe Factors:

Any integer ratio from 1:1 to 1:1000, to scale the oscilloscope to represent voltages seen at the probe tip.

TIMEBASE

Deskewing:

Skew between channels can be nulled out to compensate for probe/cable lengths.

TRIGGER

External Trigger Input (Rear panel input BNC)

Input RC:

1 MΩ ± 2 % or 50 Ω ± 3 %, shunted by approximately 12 pf

Maximum Safe Input Voltage:

1 MΩ input ± 40 V (dc + peak ac)
50 Ω input ± 5 V (dc + peak ac)

Table 1-2. HP 16530/31A Operating Characteristics (cont.)

Trigger Modes

Immediate:

Allows oscilloscope to be triggered by port-in, or another HP 16500-series measurement module.

Edge:

Triggers on rising or falling edge of any internal channel or external trigger, count adjustable from 1 to 32,000.

Pattern:

Triggers on entering or exiting a specified pattern of all internal channels and external trigger, count adjustable from 1 to 32,000.

Auto-Trigger:

If enabled, the timebase will self-trigger if the trigger rate is below 40 Hz.

Events Delay:

The trigger can be set to occur on the nth edge or pattern, as specified by the user. The number of events (n) can be set from 1 to 32,000 events.

Outputs/Rear-panel BNC:

HP 16530A output BNC provides a probe compensation source ~ 1 kHz square wave, switching between - 0.4 V and - 0.8 V, with 50 Ω output resistance.

DIGITIZER

Resolution: 6 bits (1 part in 64)

Digitizing Rate: Up to 400 megasamples/second

Digitizing Technique:

Real-time digitizing; each 4k record is acquired on a single acquisition

Acquisition Memory Size: 4096 samples per channel

Table 1-2. HP 16530/31A Operating Characteristics (cont.)

WAVEFORM DISPLAY

Display Formats:

Waveforms can be displayed in an overlapping and/or non-overlapping format.

Display Resolution: 500 points horizontally

Display Modes

Single:

New acquisitions replace old acquisitions on screen.

Accumulate:

New acquisitions are added to the screen and displayed with older acquisitions until screen is erased.

Average:

New acquisitions are averaged with older acquisitions with updated waveform displayed until erased.

Overlay:

Up to 8 acquired waveforms can be overlayed in the same display area.

Connect-the-dots:

Provides a display of the sample points connected by straight lines.

Waveform Reconstruction:

When there is insufficient data to fill every horizontal location, a post acquisition reconstruction filter fills in the missing locations.

Waveform Math: Display capability of A-B and A+B functions is provided.

Table 1-2. HP 16530/31A Operating Characteristics (cont.)

MEASUREMENT AIDS

Markers:

Two vertical markers are provided for measurements of time and voltage. Capabilities are: measure voltage of X and O on each analog waveform; measure time from X to trigger, O to trigger, and X to O; automatic marker placement by specifying percentage of edge, edge number, and rising or falling edge type; run until X to O > than, < than, in range, and not in range provides selective event search; X to O statistics (mean, max, and min) provide analysis of time interval deviation.

Automatic Measurements:

The following pulse parameter measurements can be performed automatically:

Frequency	Rise time	+ pulse width
Period	Fall time	- pulse width
V p-p	Preshoot	V top-base *
	Overshoot	

(*only over bus)

Setup Aids:

Autoscale

Auto sets the vertical and horizontal ranges, offset, and trigger level to display the input signals. Requires an amplitude above 10 mV peak, and a frequency between 50 Hz and 100 MHz.

Presets

Scales the vertical range, offset, and trigger level to predetermined values for displaying ECL or TTL waveforms.

Table 1-2. HP 16530/31A Operating Characteristics (cont.)

OPERATING ENVIRONMENT

Temperature:

Instrument, 0 degrees to 55 degrees C (+32 degrees to 131 degrees F). Probes and cables, 0 degrees to 65 degrees C (+32 degrees to 149 degrees F).

Humidity:

Instrument, up to 95% relative humidity at +40 degrees C (+104 degrees F). Recommended disc media, 8% to 80% relative humidity at +40 degrees C (+104 degrees F).

Altitude: To 4600 m (15,000 ft).

Vibration

Operation: Random vibration 5-500 Hz, 10 minutes per axis, ~0.3 g (rms).

Non-operating:

Random vibration 5-500 Hz, 10 minutes per axis, ~ 2.41 g (rms); and swept sine resonant search, 5-500 Hz, 0.75 g (0-peak), 5 minute resonant dwell @ 4 resonances per axis.

Table 1-3. Recommended Test Equipment.

INSTRUMENT	CRITICAL SPECIFICATIONS	RECOMMENDED MODEL	USE*
Signal Generator	Frequency: 100 kHz to 300 MHz Output Accuracy: +/- 1 dB	HP 8656B	P
Oscilloscope	100 MHz Bandwidth	HP 54201A	T
Dc Power Supply	Range: +/- 100 mV to +/- 5 V Accuracy: +/- 0.1%	HP 6114A	P
Adapter	Type N(m)-to-BNC(m)	HP 1250-0082	P,A
BNC Cable	(m-to-m) 48-inch	HP 10503A	P,A
Type N(m) Cable	24-inch	HP 11500B	P,A
Adapter	BNC(f)-to-Dual Banana	HP 1251-2277	P
Pulse Generator	100 KHz Repetition Rate Overshoot: 5% of Amp.	HP 8161A	A
Pulse Generator	Risetime <= 70 ps	Tektronix Type 284	A
Extender Board	No Substitute	HP 16500-69004	A,T
BNC Cable	(m-to-m) 9 inch (Qty2)	HP 10502A	A,T
BNC Tee	1M,2F	HP 1250-0781	A

* P=Performance Tests A=Adjustments T=Troubleshooting

TABLE OF CONTENTS

INSTALLATION

2-1. Introduction 2-1
2-2. Initial Inspection 2-1
2-3. Preparation For Use 2-1
2-4. Power Requirements 2-1
2-5. Safety Requirements 2-1
2-6. Installation 2-1
2-7. Module Installation 2-2
2-8. Adding Acquisition Cards 2-5
2-9. Operating Environment 2-8
2-10. Storage 2-8
2-11. Packaging 2-8
2-12. Tagging For Service 2-8

SECTION II
INSTALLATION

2-1. INTRODUCTION

This section explains how to initially inspect the HP 16530/31A Oscilloscope Module, and how to prepare it for use, storage, and shipment. Also included are procedures for module installation.

2-2. INITIAL INSPECTION

Inspect the shipping container for damage. If the shipping container or cushioning material is damaged, it should be kept until the contents of the shipment have been checked for completeness and the module has been checked mechanically and electrically. The contents of the shipment should be as listed in the "ACCESSORIES SUPPLIED" paragraph in Section I.

Procedures for checking electrical performance are given in Section III. If the contents are incomplete, if there is mechanical damage or a defect, or if the instrument does not pass the performance tests, notify the nearest Hewlett-Packard office.

If the shipping container is damaged, or the cushioning material shows signs of stress, notify the carrier as well as the Hewlett-Packard office. Keep the shipping material for carrier's inspection. The Hewlett-Packard office will arrange for repair or replacement at Hewlett-Packard's option without waiting for claim settlement.

2-3. PREPARATION FOR USE

WARNING

Read the Safety Considerations in the front of this manual and in Section I before installing or operating this module.

2-4. POWER REQUIREMENTS

All power supplies needed to operate the HP 16530/31A Oscilloscope Module are supplied to the cards through the backplane connector of the Logic Analysis Mainframe.

2-5. SAFETY REQUIREMENTS

Specific warnings, cautions, and instructions are placed wherever applicable throughout the manual. These must be observed during all phases of operation, service, and repair of the module. Failure to comply with them violates safety standards of design, manufacture, and intended use of this module.

Hewlett-Packard assumes no liability for the failure of the customer to comply with these safety requirements.

2-6. INSTALLATION

CAUTION

Do not install, remove or replace the module in the instrument unless the instrument power is removed.

The HP 16530/31A Oscilloscope Module consists of two or more cards. The HP 16530A Timebase Card may have as many as four HP 16531A Acquisition Cards connected to it. For every additional acquisition card connected, an extra slot will be used in the card cage.

Procedures for installing the oscilloscope module and adding acquisition cards are shown in the step-by-step procedure in paragraphs 2-7 and 2-8.

2-7. MODULE INSTALLATION

The following procedure is for the installation of the HP 16530/31A Oscilloscope Module. If the system already has an HP 16530/31A Oscilloscope Module installed, and you are adding additional acquisition cards, follow the "ADDING ACQUISITION CARDS" procedure in paragraph 2-8.

INSTALLATION CONSIDERATIONS:

- Acquisition cards must be positioned above the timebase card.
- Use one cable per acquisition card. See figure 2-2.
- If there are not enough empty slots to install the module correctly, existing modules must be repositioned in card cage.
- Cards below the slots to be filled by oscilloscope module, do not have to be removed.

CAUTION

The effects of ELECTROSTATIC DISCHARGE can damage electronic components. Grounded wriststraps and mats should be used when you perform any kind of service to this instrument or the cards in it.

PROCEDURE:

a. Turn instrument power switch off, unplug power cord and disconnect any input BNCs.

b. Starting **from the top**, loosen thumb screws on filler panel(s) and card(s).

c. Starting **from the top**, begin pulling card(s) and filler panel(s) out **half way**. See figure 2-1.

CAUTION

Some modules are hooked together by intercard connecting cables.

d. Note the above "INSTALLATION CONSIDERATIONS" and use figure 2-2 to plan the card configuration and cable connection.

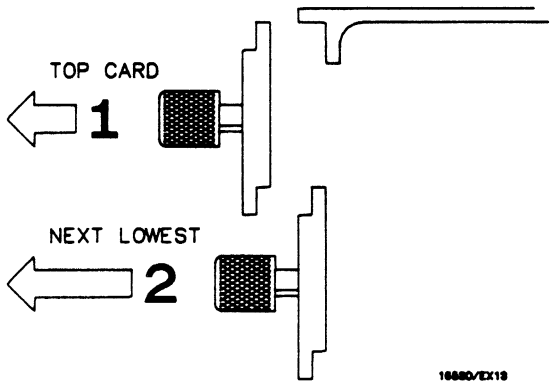


Figure 2-1. Endplate Overhang

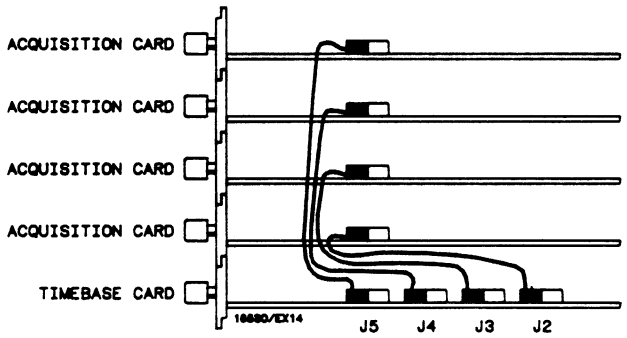


Figure 2-2. Configuration Guide

e. Remove the filler panels covering the slots to be filled by the oscilloscope module.

f. Push all other card(s) into the card cage, **but not completely in**, so they won't be in the way when you install the scope module.

g. Install one cable per acquisition card into the correct timebase card connector (see figure 2-2), making sure to install the correct cable end. Use figure 2-3 to identify the correct cable end.

h. Lay cable(s) flat and pointing out to rear of card. See figure 2-4.

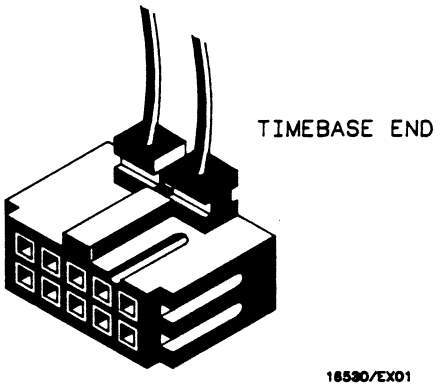


Figure 2-3. Cable End

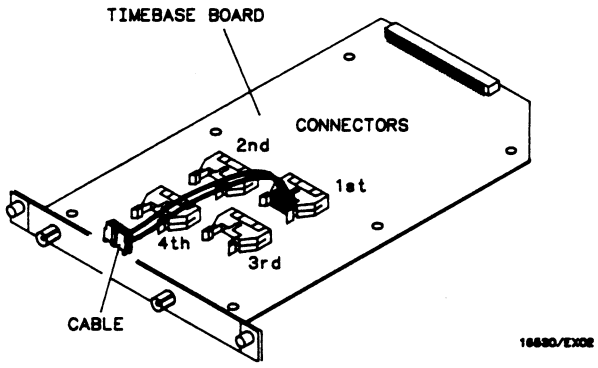


Figure 2-4. Cable Position

i. Slide timebase card approximately **half way** into lowest slot being used for the oscilloscope module.

j. Slide acquisition card in **half way**, feeding cable up through square hole in acquisition card.

k. Plug in other end of cable to connector on acquisition card. See figure 2-5.

l. If you have additional acquisition cards, repeat steps j through l until all cards are in **half way** and all cables are connected.

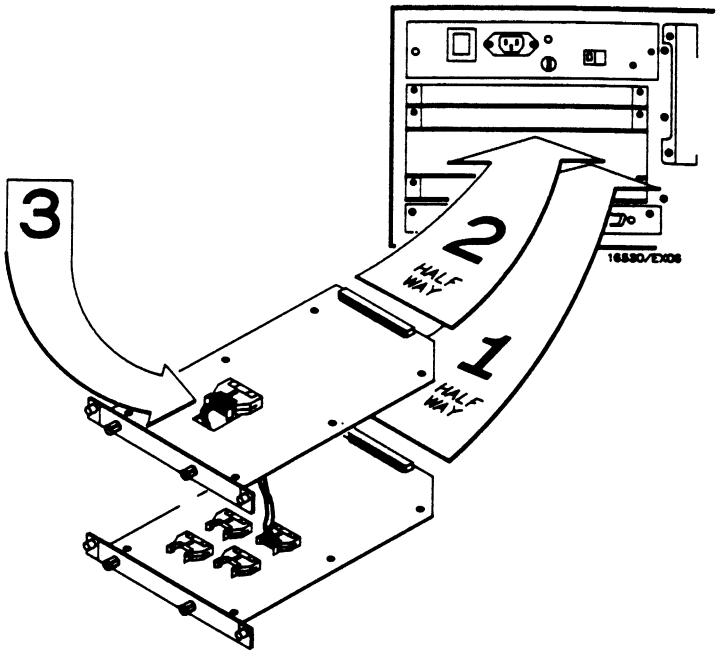


Figure 2-5. Installation Summary

m. Firmly seat bottom card into backplane connector. **Keep applying pressure to the center of card endplate while tightening thumb screws finger tight.**

n. Repeat for all cards and filler panels in a **bottom to top** order. See figure 2-6.

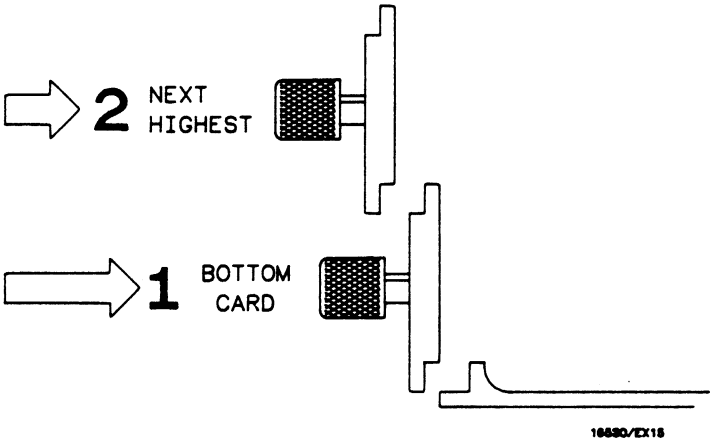


Figure 2-6. Endplate Overhang

o. Any filler panels that are not used should be kept for future use. Filler panels **must** be installed in all unused card slots for correct air circulation.

2-8. ADDING ACQUISITION CARDS

Use this procedure if you are adding acquisition cards to a system that already has an HP 16530/31A Oscilloscope Module installed. Make note of the "INSTALLATION CONSIDERATIONS" in paragraph 2-7 before starting.

a. Turn instrument power switch off, unplug power cord and disconnect all input BNCs.

b. Starting **from the top**, loosen thumb screws on filler panel(s) and card(s).

c. Starting **from the top**, begin pulling all cards out **half way**. See figure 2-7.

CAUTION

Some modules are hooked together by intercard connecting cables.

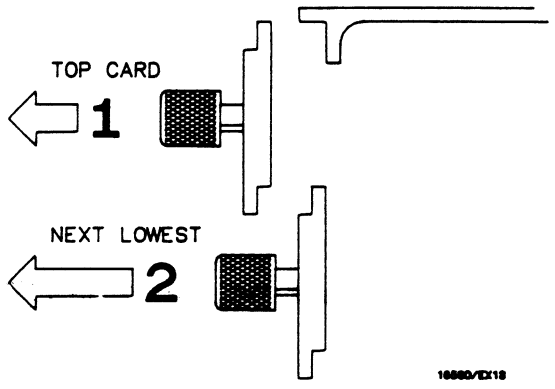


Figure 2-7. Endplate Overhang

d. Pull all cards in oscilloscope module completely out and disconnect all cable(s) from acquisition card(s).

e. Push all other cards into card cage, **but not completely in.** This will get them out of the way for oscilloscope module installation.

f. Use figure 2-8 to plan the card configuration and cable connection.

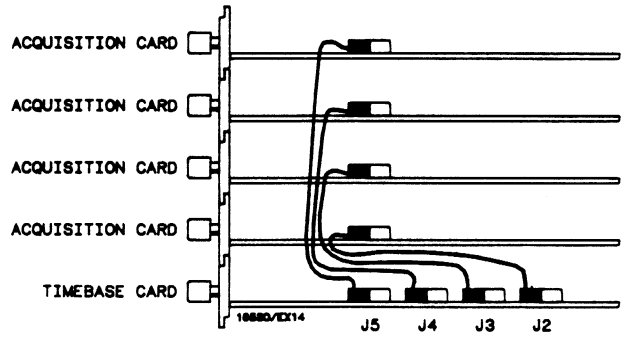


Figure 2-8. Configuration Guide

g. Install one cable per acquisition card in the correct timebase card connector, making sure that you install the correct end. See figure 2-9.

h. Lay cable(s) flat and pointing out to rear of card. See figure 2-10.

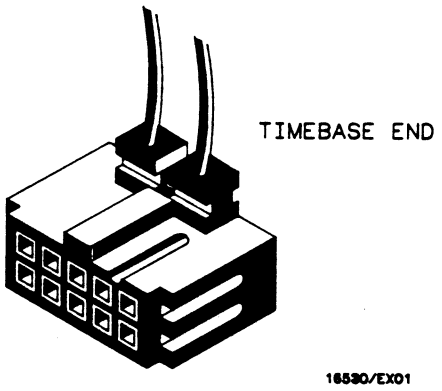


Figure 2-9. Cable End

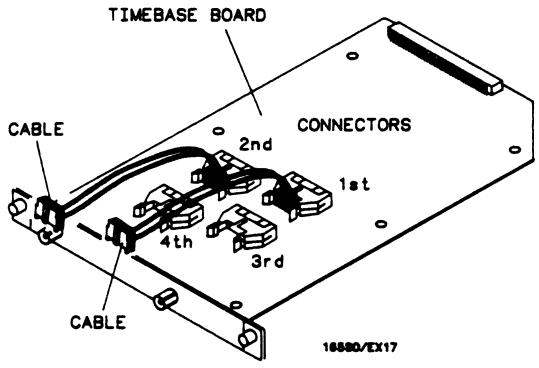


Figure 2-10. Cable Position

i. Slide timebase card approximately **half way** into lowest slot being used for the scope module.

j. Slide acquisition card in **half way**, feeding cable(s) up through square hole in acquisition card.

k. Plug in other end of cable to connector on acquisition card.

l. Slide next acquisition card in **half way**, feeding cable(s) up through square hole in acquisition card.

m. Plug in other end of next cable to connector on acquisition card.

n. If you have additional acquisition cards, repeat steps I through n until all cards are in **half way** and all cables are connected.

o. Firmly seat bottom card in backplane connector. **Keep applying pressure to the center of card endplate while tightening thumb screws finger tight.**

p. Repeat for all cards and filler panels in a **bottom to top** order. See figure 2-11.

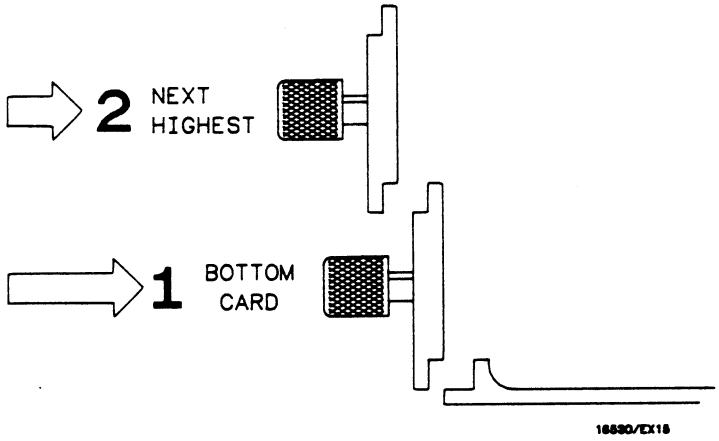


Figure 2-11. Endplate Overhang

q. Any filler panels that are not used should be kept for future use. Filler panels **must** be installed in all unused card slots for correct air circulation.

2-9. OPERATING ENVIRONMENT

The operating environment is listed in table 1-2. 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.

The HP 16530/31A will operate at all specifications within the temperature and humidity range given in table 1-2. However, reliability is enhanced by operating the instrument within the following ranges.

Temperature: +20 to +35° C (+68 to +95° F)
Humidity: 20% to 80% non-condensing

2-10. STORAGE

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

Temperature: -40° C to +75° C
Humidity: Up to 90% at 65° C
Altitude: Up to 15,300 meters (50,000 Feet)

The module should also be protected from temperature extremes which cause condensation on the module.

2-11. PACKAGING

The following general instructions should be used for repacking the module with commercially available materials.

- Wrap module in anti-static plastic.
- Use a strong shipping container. A double-wall carton made of 350 lb. test material is adequate.
- Use a layer of shock-absorbing material 70 to 100 mm (3 to 4 inch) thick around all sides of the module to provide firm cushioning and prevent movement inside the container.
- Seal shipping container securely.
- Mark shipping container FRAGILE to ensure careful handling.
- In any correspondence, refer to module by model number and board number.

2-12. TAGGING FOR SERVICE

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

TABLE OF CONTENTS

PERFORMANCE TESTS

3-1. Introduction 3-1
3-2. Recommended Test Equipment 3-1
3-3. Test Record 3-1
3-4. Performance Test Interval 3-1
3-5. Performance Test Procedures 3-1
3-6. Bandwidth Test 3-2
3-7. Voltage Measurement Accuracy Test 3-6
3-8. Time Interval Measurement Accuracy Test 3-9
3-9. Trigger Sensitivity Test 3-12

SECTION III
PERFORMANCE TESTS

3-1. INTRODUCTION

The procedures in this section test the oscilloscope module's electrical performance using the specifications listed in Section I as the performance standards. All tests can be performed without access to the interior of the instrument. At the end of this section is a form that can be used as a record of performance test results.

3-2. RECOMMENDED TEST EQUIPMENT

Equipment recommended for performance tests is listed in table 1-3. Any equipment that satisfies the critical specifications given in the table may be substituted for the recommended models.

3-3. TEST RECORD

Results of performance tests may be tabulated in the Performance Test Record (table 3-1) at the end of the procedures. The test record lists all of the tested specifications and their acceptable limits. The results recorded in the test record may be used for comparison in periodic maintenance and troubleshooting or after repairs and adjustments have been made.

3-4. PERFORMANCE TEST INTERVAL

Periodic performance verification of the HP 16530/31A Oscilloscope Module is required at two year intervals. The instrument's performance should be verified after it has been serviced, or if improper operation is suspected. Calibration should be performed before any performance verification tests. Further checks requiring access to the interior of the instrument are included in the adjustment section, but are not required for the performance verification.

3-5. PERFORMANCE TEST PROCEDURES

All performance tests should be performed at the instrument's environmental operating temperature and after a 15-minute warm up.

3-6. Bandwidth (-3dB) Test

SPECIFICATION: Dc to 100 MHz

EQUIPMENT:

Signal generator	HP 8656B
Cable type N(m)	HP 11500B
Adapter type N(m)-to-BNC(m)	HP 1250-0082

DESCRIPTION:

This test verifies that the signal amplitude will not decrease more than 3 dB through the specified operating frequencies.

PROCEDURE:

a. Turn instrument power off.

b. Connect signal generator to acquisition card as shown in figure 3-1, and set the output for a 200 kHz sine wave with an amplitude of 300 mV.

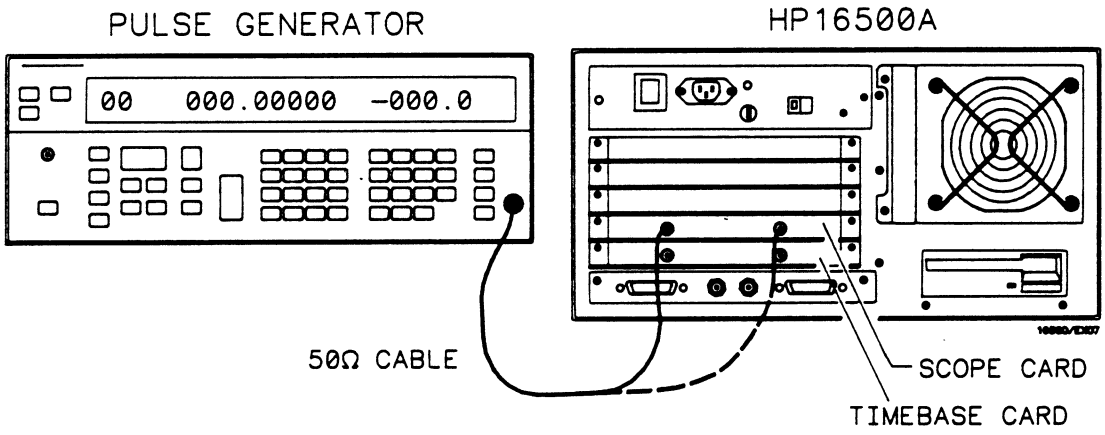


Figure 3-1. Bandwidth Test Equipment Hookup

c. Turn instrument power on.

d. From the startup screen shown in figure 3-2, touch **system**, then touch **Oscilloscope**.

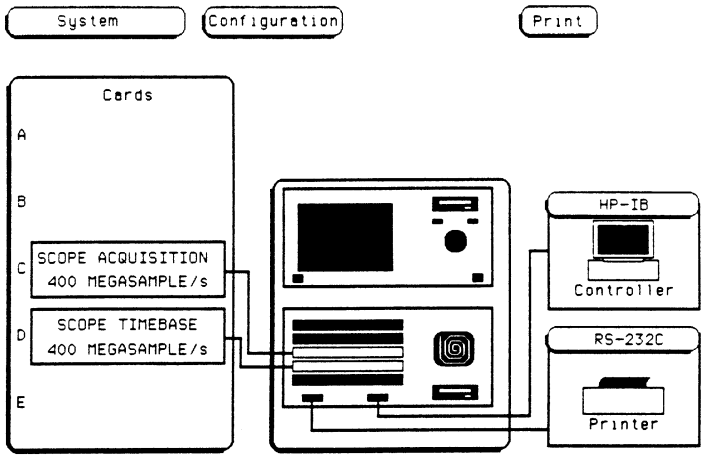


Figure 3-2. Startup Screen

e. Configure **Channel** screen as shown in figure 3-3, setting probe factor first.

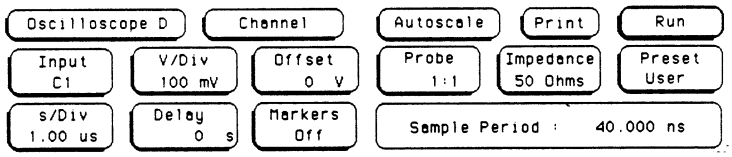


Figure 3-3. Channel Screen Configuration

Probe: 1:1 (set this first)
V/Div: 100 mV/Div
Offset: 0 V
Impedance: 50 Ohms
s/Div: 1 μs
Delay: 0 s

f. Configure **Trigger** screen as shown in figure 3-4.

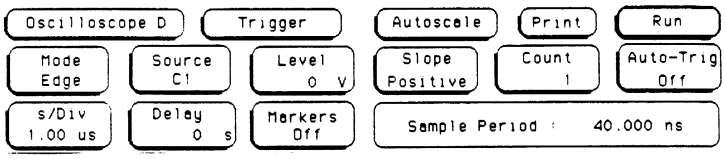


Figure 3-4. Trigger Screen Configuration

Mode: Edge
Source: Channel 1
Level: 0 V
Count: 1
Auto-Trig: Off

g. Configure **Display** screen as shown in figure 3-5.

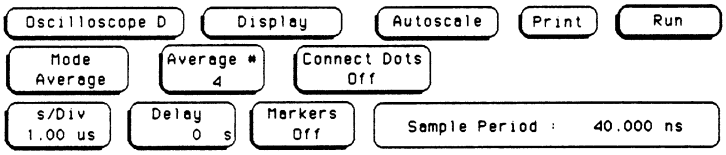


Figure 3-5. Display Screen Configuration

Mode: Average
Avg-no: 4
Connect the dots: Off

h. Touch **Display**, then touch **Auto-Meas**.

i. Touch **Autoscale** , then touch **Continue**, as shown in figure 3-6 and record the value of **Vp-p**.

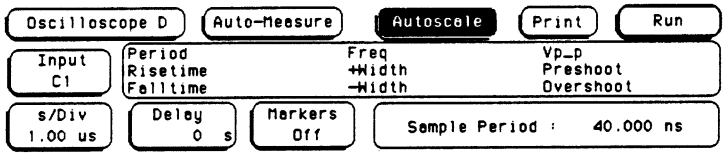


Figure 3-6. Auto-Meas the Vp-p

j. Change frequency of signal generator to 100 MHz.

k. Touch **Autoscale** , then touch **Continue** and read the value of **Vp-p**. This value should be ≥ 70% of the value recorded in step i.

l. Change amplitude on signal generator to 600 mV and change the frequency to 200 kHz.

m. Repeat steps i through k.

n. Set signal generator to 200 kHz with an amplitude of 300 mV.

o. Repeat steps i through n, testing all other channels, and specifying each channel as the trigger and measurement source.

3-7. Voltage Measurement Accuracy Test

SPECIFICATION:

Gain Accuracy	+	ADC Resolution	+	Offset Accuracy
(± 3% full screen)		(± 1.6% full screen)		(± 3 .2% full screen)

EQUIPMENT:

Dc Supply ..... HP 6114A
BNC(f)-to-Dual Banana Adapter ..... HP 1251-2277
BNC Cable ..... HP 10503A

DESCRIPTION:

This test verifies that the summation of the gain accuracy + ADC accuracy + offset accuracy is within specification.

PROCEDURE:

a. Configure **Channel** screen as shown in figure 3-7, setting probe factor first.

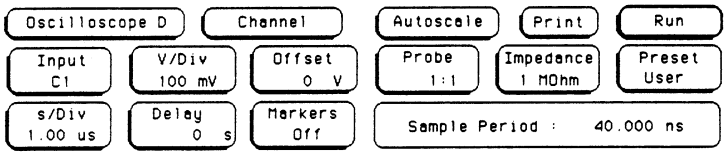


Figure 3-7. Channel Configuration

Probe: 1:1 (set this first)
V/Div: 100 mV/Div
Offset: 0 V
Probe: 1:1
Impedance: 1 MOhm

b. Configure **Trigger** screen as shown in figure 3-8.

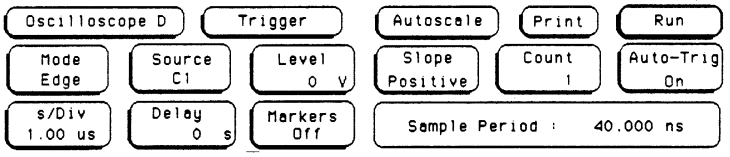


Figure 3-8. Trigger Configuration

Mode: Edge
Source: Channel 1
Level: 0 V
Slope: Positive
Count: 1
Auto-Trig: On

c. Configure **Display** screen as shown in figure 3-9.

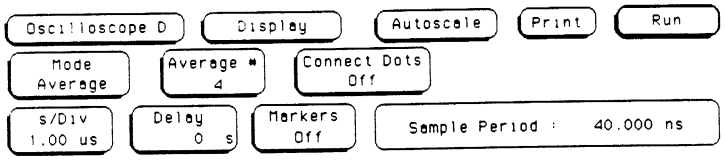


Figure 3-9. Display Configuration

Mode: Average
Avg. No: 4
Connect the dots: Off

d. Disconnect all inputs to all channels.

e. Touch **Markers**, then touch **On**. Touch **Autoscale**.

f. Note the X marker voltage and record this value as Vx. The limit for Vx is -12 mV to +12 mV.

g. Set dc supply to 100 mV and connect to channel 1. See figure 3-10. Voltage limits are now from (+81 mV + Vx measured in step f) to (+119 mV + Vx measured in step f).

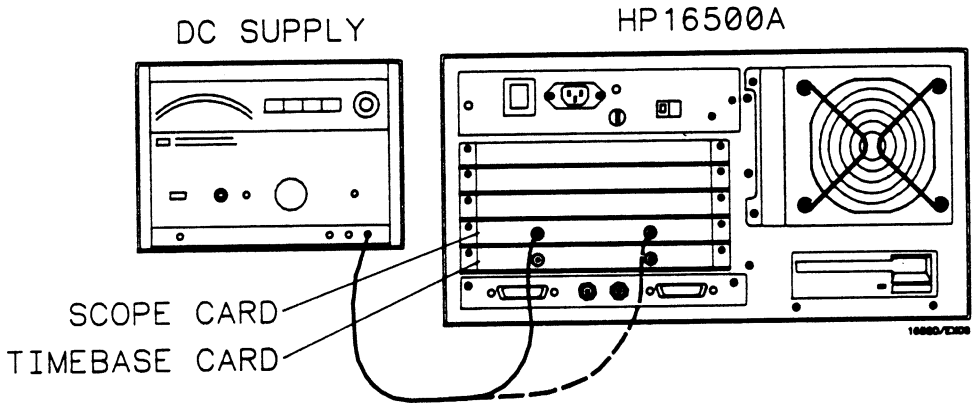


Figure 3-10. Voltage Measurement Accuracy Test Equipment Hookup

h. Switch to negative polarity of supply by reversing banana adapter. Voltage limits are now from (-119 mV + Vx measured in step f) to (-81 mV + Vx measured in step f).

i. Disconnect input.

j. Touch **Display**, then touch **Channel**.

k. Touch **V/Div** and set to +2 Volts. See figure 3-11.

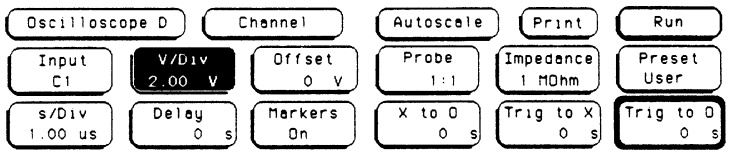


Figure 3-11. Set V/Div to +2 Volts.

V/Div: +2 V

l. Note the X marker voltage and record this value as Vx. The limit for Vx is -240 mV to +240 mV.

m. Switch back to positive polarity by reversing polarity of banana adapter and set dc power supply to +2 Volts.

n. Apply +2 Volts to channel 1 input. Voltage limits are now from (+1.66 V + Vx measured in step l) to (+2.34 V + Vx measured in step l).

o. Switch to negative polarity by reversing polarity of banana adapter.

p. Voltage limits now are -2.34 V + Vx measured in step l to -1.66 V + Vx measured in step l.

q. Repeat steps a through q for next channel to be tested, specifying that channel as trigger and measurement source.

3-8. Time Interval Measurement Accuracy Test

SPECIFICATION:

2.5 ns sample period: ± 0.75 ns ± 0.2% of timebase range ± 0.02% of reading
≥ 5 ns sample period: ± sample period ± 0.2% of timebase range ± 0.02% of reading

EQUIPMENT:

Signal Generator ..... HP 8656B
Type N(m)-to-BNC(f) Adapter ..... HP 1250-1476
Cable type N(m) ..... HP 11500B

DESCRIPTION:

This test verifies the accuracy of the master oscillator, timebase circuitry and the digital reconstruction filter.

PROCEDURE:

a. Configure **Channel** screen as shown in figure 3-12, setting probe factor first.

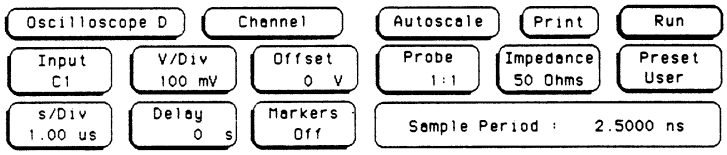


Figure 3-12. Channel Configuration

Probe: 1:1 (set this first)
V/Div: 100 mV/Div
Offset: 0 V
Impedance: 50 Ohms
s/Div: 100 ns/Div

b. Configure **Trigger** screen as shown in figure 3-13.

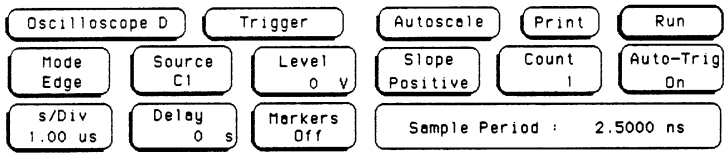


Figure 3-13. Trigger Configuration

Mode: Edge
Source: Channel 1
Level: 0 V
Count: 1
Auto-Trig: On

c. Configure **Display** screen as shown in figure 3-14.

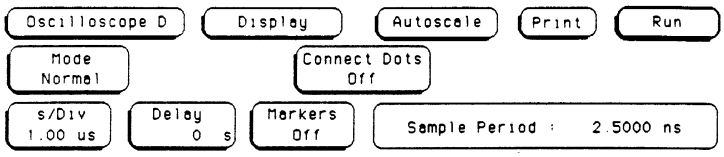


Figure 3-14. Display Configuration

Mode: Normal
Delay: 0 s
Connect the dots: Off

d. Connect signal generator as shown in figure 3-15.

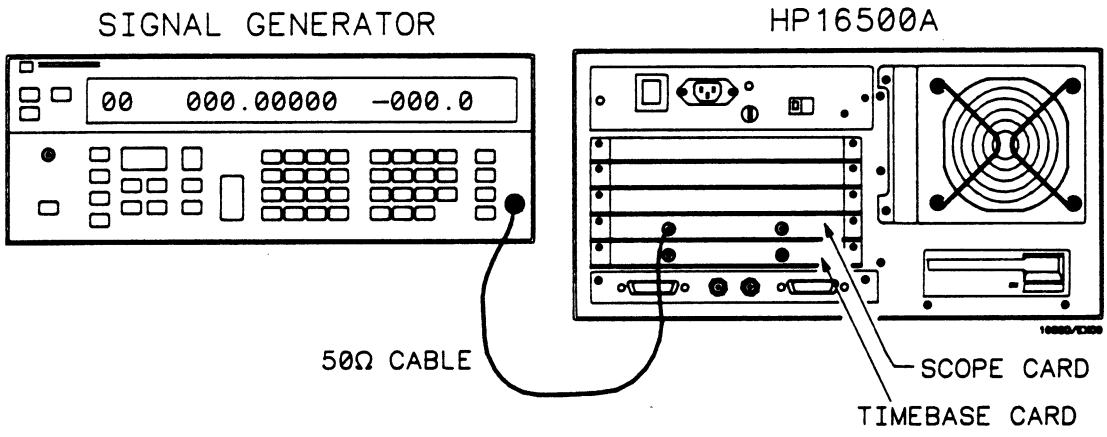


Figure 3-15. Test Equipment Hookup

e. Set output of signal generator to 2.5 MHz sine wave with 150 mV amplitude.

f. Touch **Markers**, then touch **Auto**.

g. Set **Auto markers** screen up as shown in figure 3-16.

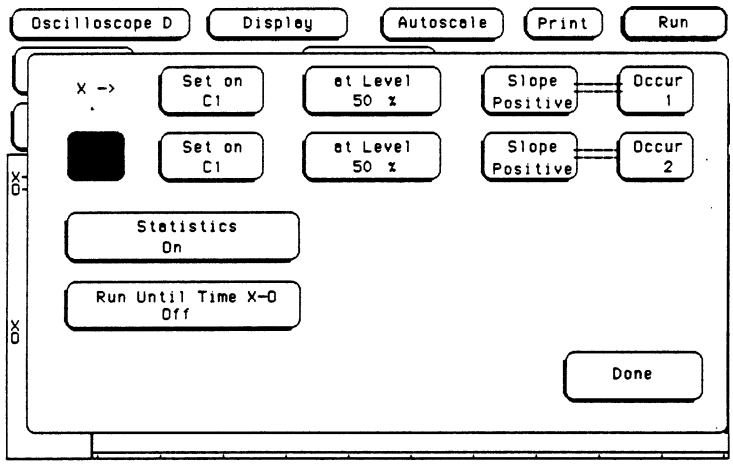


Figure 3-16. Auto Markers Configuration

Marker X: Set on channel 1 at 50% level - Positive edge - on 1
Marker O: Set on channel 1 at 50% level - Positive edge - on 2
Statistics: On

h. Touch **Done**. Touch **Run**, then drag finger to **Repetitive**.

i. Read the X to O value. The limits are 397.2 ns to 403.8 ns.

j. Change frequency on signal generator to 100 MHz.

k. Change timebase to 5 ns/Div.

l. Read the X to O value. The limits are 9.15 ns to 10.85 ns.

3-9. Trigger Sensitivity Test

SPECIFICATION: Internal trigger: ≤ 12% of full screen (dc to 100 MHz)
External trigger: ≤ 20 mV (dc to 100 MHz)

EQUIPMENT:

Signal Generator ..... HP 8656B
Cable type N(m) ..... HP 11500B
Adapter type N(m)-to-BNC(m) ..... HP 1250-0082

DESCRIPTION:

This test verifies the internal and external trigger sensitivity.

PROCEDURE:

a. Configure **Channel** screen as shown in figure 3-17, setting probe factor first. After setting **EXT TRIG** to 50 Ohms, switch **Input** back to channel 1.

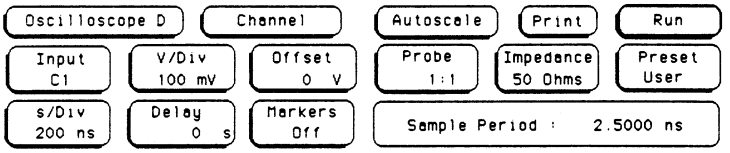


Figure 3-17. Channel Configuration

Probe: 1:1 (set this first)
V/Div: 40 mV/Div
Offset: 0 V
Impedance: 50 Ohms
EXT TRIG Impedance: 50 Ohms (set **Input** back to channel 1)
s/Div: 200 ns/Div
Delay: 0 s

b. Configure **Trigger** screen as shown in figure 3-18.

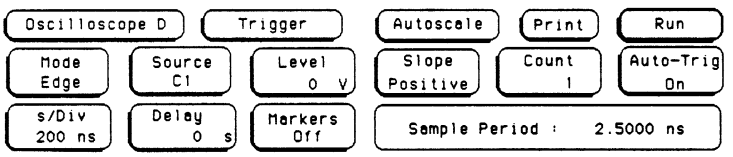


Figure 3-18. Trigger Configuration

Source: Channel 1
Mode: Edge
Level: 0 V
Count: 1
Auto-Trig: Off
Slope: Positive

c. Configure **Display** screen as shown in figure 3-19.

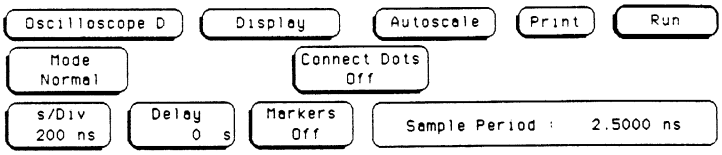


Figure 3-19. Display Configuration

Mode: Normal
Connect the dots: Off

d. Set signal generator for a 2.5 MHz sine wave and 6.31 mV RMS amplitude. (17.6 mVp-p)

e. Connect signal generator as shown in figure 3-20.

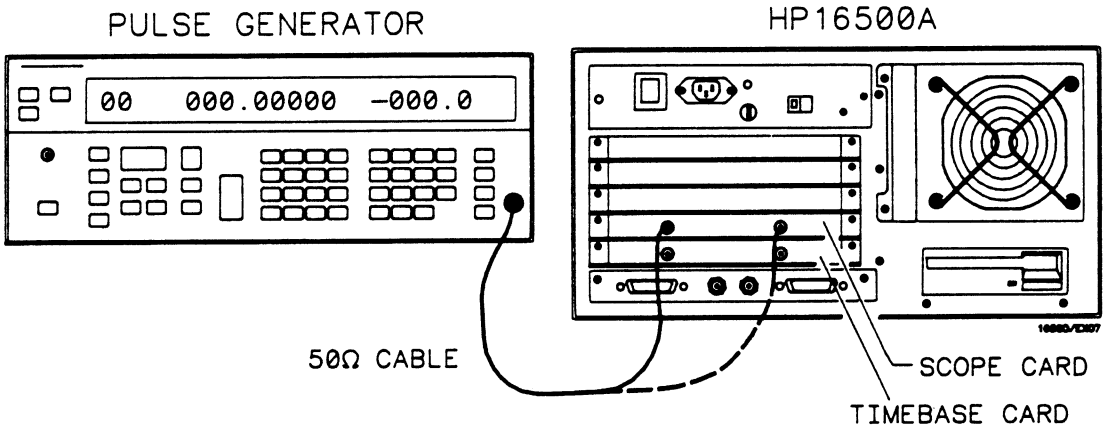


Figure 3-20. Trigger Sensitivity Test Equipment Hookup

f. Touch **Run**, then drag finger to **Repetitive**.

g. Waveform display should be updating and stable. If necessary, adjust trigger level between -20 mV and +20 mV to obtain an updating and stable display. If this can't be done, the test has failed.

h. Repeat steps a through g for other channels, specifying those channels as the trigger and measurement source.

EXTERNAL TRIGGER PROCEDURE:

a. Touch **Display**, then touch **Trigger**.

b. Touch **Source** and change trigger source to **External** as shown in figure 3-21.

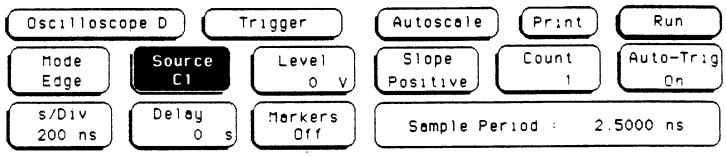


Figure 3-21. Trigger Screen And External Source

Source: External
Level: 0 V

c. Set trigger level to 0 Volts.

d. Set signal generator for a 100 MHz sine wave and 6.31 mV RMS amplitude. (17.6 mVp-p)

e. Connect signal generator as shown in figure 3-22.

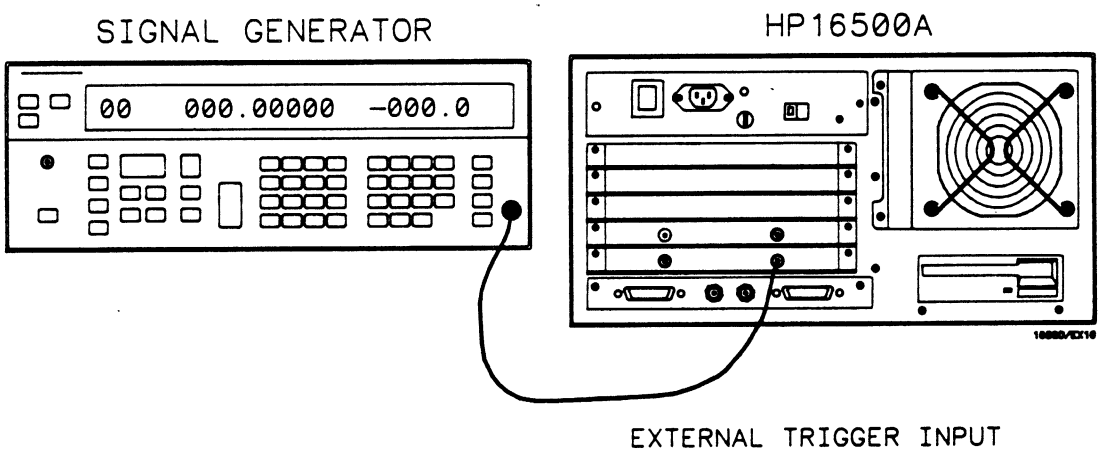


Figure 3-22. Test Equipment Hookup

f. Display should be updating and the "Awaiting Trigger" advisory should not appear.

Table 3-1. Performance Test Record

Hewlett-Packard
Model 16530/31A
Oscilloscope Module

Tested by _____

Work Order No. _____

Date Tested _____

Board No. _____

Recommended Calibration

Interval 24 Months

Paragraph No	Test	Results
3-6	Bandwidth (-3 dB)	Vp-p at 200 KHz _____ Vp-p at 100 MHz _____ Is Vp-p at 100 MHz >/= 70 % ? _____
3-7	Voltage Measurement Accuracy	Minimum / Actual (Vx) / Maximum -12 mV _____ +12 mV 81 mV+Vx _____ 119 mV+Vx -119 mV+Vx _____ -81 mV+Vx Minimum / Actual (Vx) / Maximum -240 mV _____ +240 mV 1.66 mV+Vx _____ 2.34 mV+Vx -2.34 mV+Vx _____ -1.66 mV+Vx

Table 3-1. Performance Test Record

Hewlett-Packard
Model 16530/31A
Oscilloscope Module

Tested by _____

Work Order No. _____

Date Tested _____

Board No. _____

Recommended Calibration

Interval 24 Months

Paragraph No	Test	Results
3-8	Time Interval Measurement Accuracy	Minimum Actual Maximum 397.2 ns _____ 403.8 ns 9.15 ns _____ 10.85 ns
3-9	Trigger Sensitivity Internal External	Is display updating ? Yes _____ No _____ Is display updating ? Yes _____ No _____

TABLE OF CONTENTS

ADJUSTMENTS

4-1. Introduction 4-1
4-2. Calibration Interval 4-1
4-3. Maintaining Calibration Integrity 4-1
4-4. Safety Requirements 4-1
4-5. Recommended Test Equipment 4-2
4-6. Instrument Warmup 4-2
4-7. Calibration 4-2
4-8. Vertical Calibration 4-3
4-9. Trigger Level Calibration 4-4
4-10. Delay Calibration 4-5
4-11. Channel-To-Channel Skew 4-6
4-12. Extender Board Installation 4-13
4-13. Adjustments 4-16
4-14. Set to Default Values 4-16
4-15. DC Balance Adjustment 4-17
4-16. DC Matching Adjustment 4-19
4-17. Attenuator Compensation Adjustment 4-21
4-18. HF Compensation Adjustment 4-23

SECTION IV
ADJUSTMENTS

4-1. INTRODUCTION

This section provides information on when to calibrate the module and how to calibrate, adjust and warm it up. Also included in this section are equipment setups and a procedure for installing the extender board.

4-2. CALIBRATION INTERVAL

The HP 16530/31A Oscilloscope Module can be calibrated from the front panel without access to the interior of the instrument. This procedure sets the oscilloscope calibration factors and stores them on the operating disc.

To maintain proper calibration, this calibration should be performed at approximately two year intervals when the instrument is being used under normal operating conditions. If the instrument is used more than one shift per day the calibration interval may need to be shorter. Immediate calibration is required if one of the following occurs:

- Oscilloscope module is installed or replaced
- Operating disc is changed
- Card configuration is changed
- Oscilloscope module is repaired
- Ambient temperature changes more than 10 degrees Celsius

Before the module is adjusted, it should be calibrated and the performance tests in Section III should be done. If the performance tests are within specifications, then adjustments are not necessary.

If either card is repaired, the oscilloscope module should be adjusted. New modules are pre-adjusted at the factory to meet the specifications in Section I. If adjustments are required, please read the safety summary at the front of this manual.

4-3. MAINTAINING CALIBRATION INTEGRITY

Calibration factors depend on the system disc, mainframe, acquisition cards and module configuration all staying together. If the system disc or acquisition cards are interchanged between mainframes or the scope module configuration is changed, calibration must be repeated. Recalibration is very easy to do. See paragraph 4-7, "Calibration". In an environment in which the possibility of sharing oscilloscope modules and system discs exist, we recommend taking the following precautions in order to maintain calibration integrity:

1. Install oscilloscope module in bottom slots.
2. Boot system using rear disc drive.
3. Perform calibration.
4. Seal oscilloscope module to mainframe.
5. Remove disc and write protect it.
6. Reinstall disc and seal it in the rear disc drive.

4-4. SAFETY REQUIREMENTS

Specific warnings, cautions, and instructions are placed wherever applicable throughout the manual. These must be observed during all phases of operation, service, and repair of the module. Failure to comply with them violates safety standards of design, manufacture, and intended use of this module. Hewlett-Packard assumes no liability for the failure of the customer to comply with these safety requirements.

4-5. RECOMMENDED TEST EQUIPMENT

Recommended test equipment for calibration and adjustment is listed in table 1-3. Any equipment that satisfies the critical specifications given in the table may be substituted for the recommended models.

WARNING

Read the safety summary at the front of this manual before any adjustment, replacement, maintenance, or repair is performed.

4-6. INSTRUMENT WARMUP

Adjust and calibrate the instrument at it's environmental ambient temperature and after a 15 minute warm-up.

4-7. CALIBRATION

The calibration procedures in this section should be followed in their entirety and in the sequence listed in table 4-1. When calibrating the HP 16530/31A Oscilloscope Module, the cards must be installed in the instrument and the instrument covers and filler panels must be in place. Refer to paragraph 4-6, "INSTRUMENT WARMUP" in this section.

Calibration factors for all calibrations except the Channel-to-Channel Skew are stored on the system disc for module set-up the next time the instrument is powered up. The Channel-to-Channel Skew is stored only when the oscilloscope's measurement paramenters for a particular state are stored.

Table 4-1. Calibration Sequence

SEQUENCE	CALIBRATION	PARAGRAPH NO
1	VERTICAL	4-8
2	TRIGGER LEVEL	4-9
3	DELAY	4-10
4	CHANNEL TO CHANNEL SKEW	4-11

4-8. Vertical Calibration

DESCRIPTION:

The offset DAC (AD667 ± 1% accuracy) applies a known voltage to the input. This voltage is digitized. The preamp gain and offset is then corrected to obtain digitized data equivalent to the known input voltage.

PROCEDURE:

a. Turn instrument on and from the startup screen shown in figure 4-1, touch these fields in the numbered sequence below:

1. **System**
2. **Oscilloscope**
3. **Channel**
4. **Calibration**
5. **Cal Choice**
6. **Vertical**

b. Disconnect all inputs.

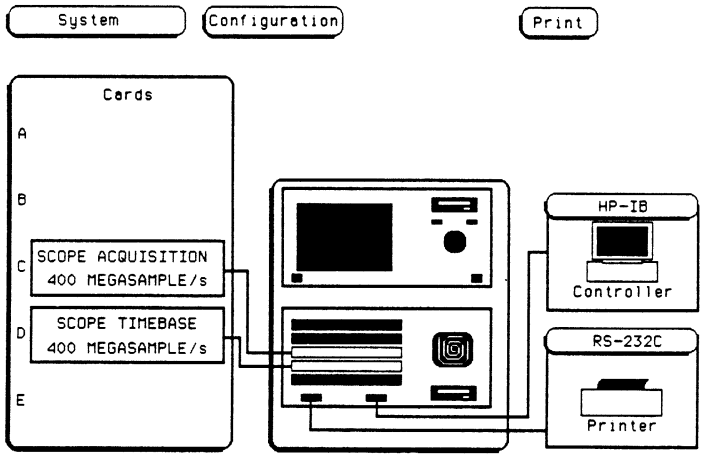


Figure 4-1. Startup Screen

c. From **VERTICAL** cal choice screen shown in figure 4-2, touch **Start**. Look for prompt on screen indicating calibration is completed.

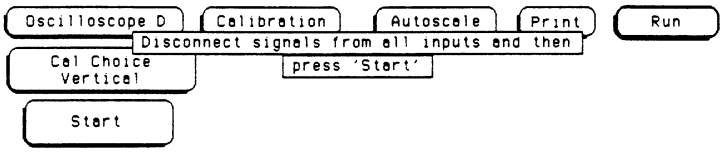


Figure 4-2. Vertical Cal Choice Screen

4-9. Trigger Level Calibration

DESCRIPTION:

The offset DAC (AD667 ± 1% accuracy) applies a known voltage to the input. The trigger level is then corrected to trigger at the input voltage.

PROCEDURE:

a. Touch **Cal Choice**, then touch **Trigger Level**.

b. From **Trigger Level** cal choice screen shown in figure 4-3, touch **Start**. Look for prompt on screen to show calibration is completed.

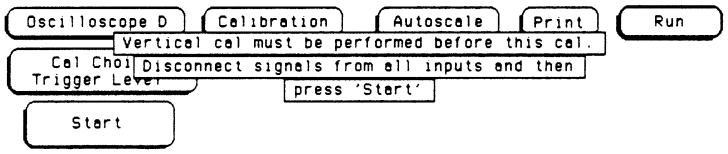


Figure 4-3. Trigger Level Cal Choice Screen

4-10. Delay Calibration

DESCRIPTION:

The rising edge of the compensation signal is set to Time = 0 (midscreen).

PROCEDURE:

a. Touch **Cal Choice**, then touch **Delay**.

b. Connect compensation signal to INPUT 1 of top acquisition card as shown in figure 4-4.

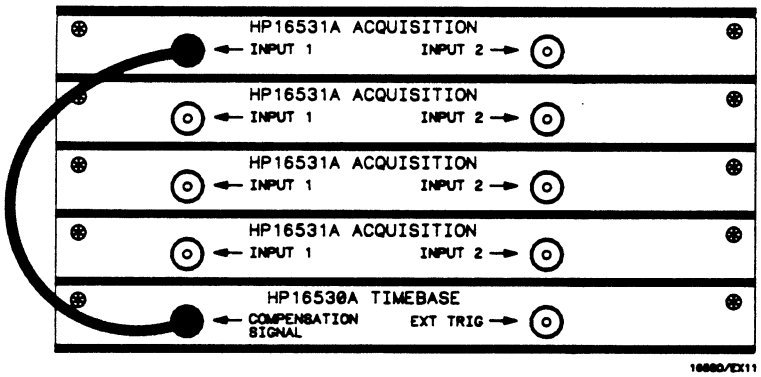


Figure 4-4. Delay Cal Equipment Hookup

c. Touch **Start**.

d. Connect compensation signal to INPUT 2 of same acquisition card.

e. Touch **Start**.

f. If there are additional acquisition cards installed, connect compensation signal to INPUT 1 of the next lowest acquisition card and repeat steps c through f.

4-11. Channel-To-Channel Skew

DESCRIPTION:

The channel-to-channel skew adjustment nulls any time delays caused by the lead lengths of the probes used for a measurement. Channel one is used as the reference against which all other channels are nulled.

Note

This procedure uses the compensation signal and BNC cables to simulate a signal and probes. Consider this procedure as an example only.

PROCEDURE:

a. Touch **Cal Choice**, then touch **Ch_ch_skew**.

b. Touch **Calibration**, then touch **Channel**.

c. Touch the **Impedance** field as shown in figure 4-5. This will switch impedance to 50 Ohms.

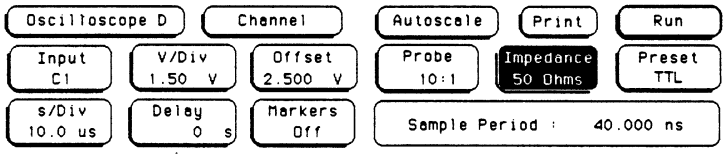


Figure 4-5. Channel Screen / Impedance Select

d. Touch channel label. See figure 4-6.

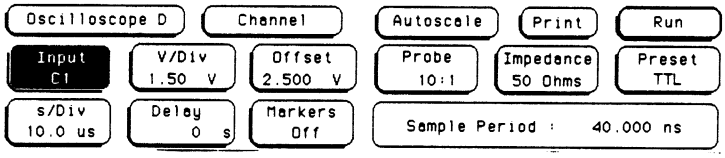


Figure 4-6. Channel Selection

e. Touch channel input label of next channel to be calibrated and change impedence to 50 Ohms. See figure 4-7.

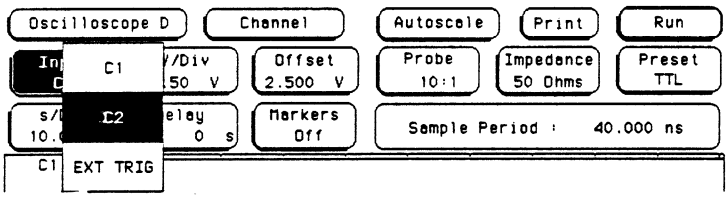


Figure 4-7. Channel to be Calibrated

f. If there are additional acquisition cards, repeat steps d and e until all channels are set to 50 Ohms.

g. Touch input label field as shown in figure 4-8.

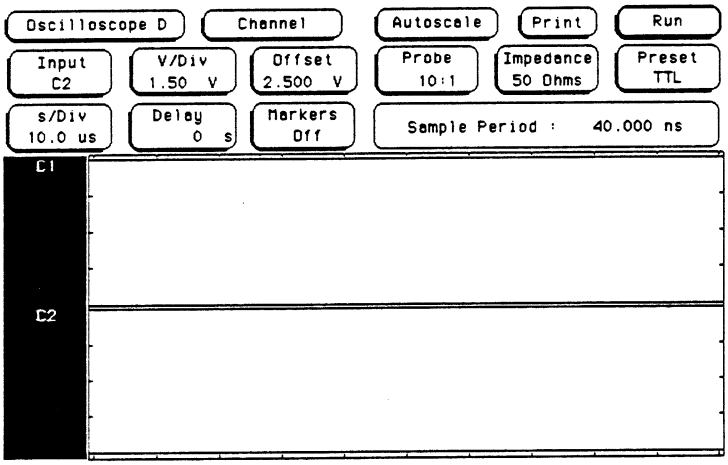


Figure 4-8. Input Label Field

h. Touch **Channel Mode**, then touch **Overlay**.

i. From **Overlay** screen shown in figure 4-9, delete channel labels displayed by touching **Delete** until all labels in the input label field are gone.

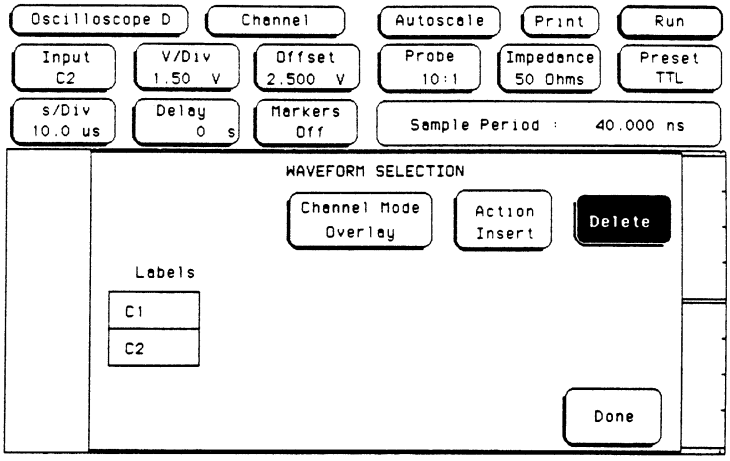


Figure 4-9. Overlay Screen

j. Touch **Action** field and set for insert. See figure 4-10.

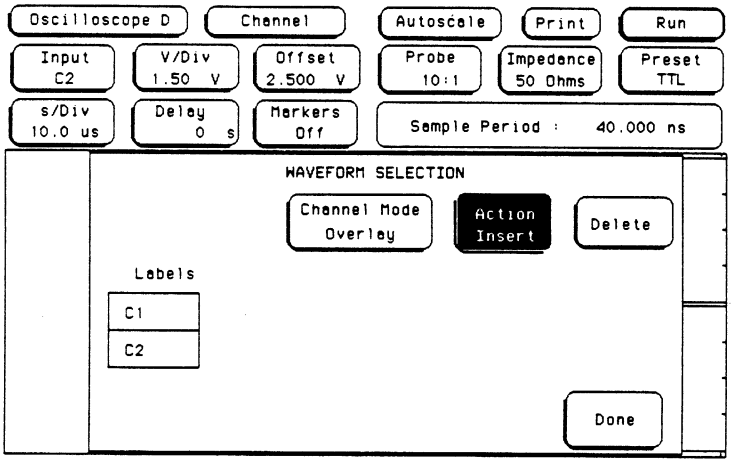


Figure 4-10. Insert Field

k. Touch all **Labels**, inserting them in the input label field. See figure 4-11.

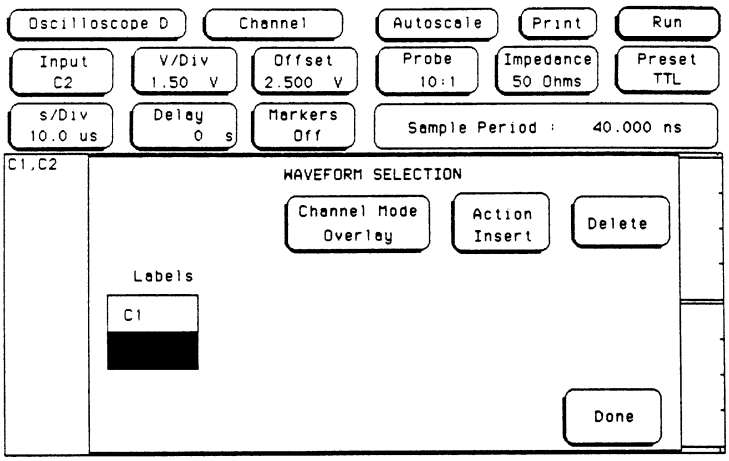


Figure 4-11. Insert Channel Labels

l. Touch **Done**.

m. From **Channel** screen shown in figure 4-12, touch the following fields in the numbered sequence below:

1. **Channel**
2. **Display**
3. **Mode**
4. **Average**
5. **Avg #**

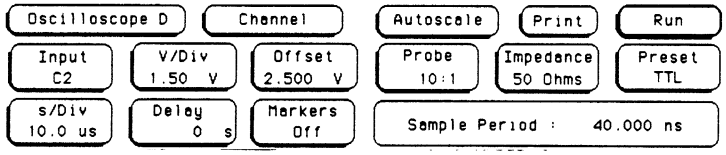


Figure 4-12. Channel Screen

n. Rotate knob to set averages to four. (Keypad may also be used)

o. Touch **Display**, then touch **Calibration**.

p. Using two cables of equal length and a BNC tee, connect Compensation Signal as shown in figure 4-13 to INPUT 1 and INPUT 2 of the **top** acquisition card. INPUT 1 of the top acquisition card will be the reference for all other channels. INPUT 2 will be the first channel to be calibrated.

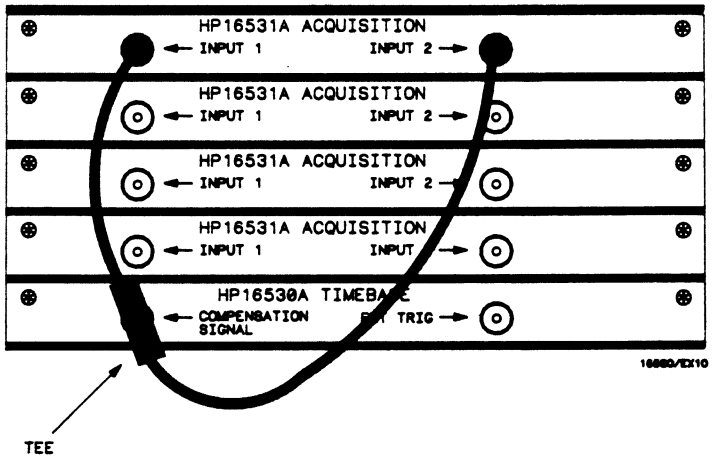


Figure 4-13. Channel-To-Channel Skew Equipment Hookup

q. Touch **Autoscale**, then touch **Continue**.

r. Touch **Run**, then drag finger to **Repetitive**. See figure 4-14.

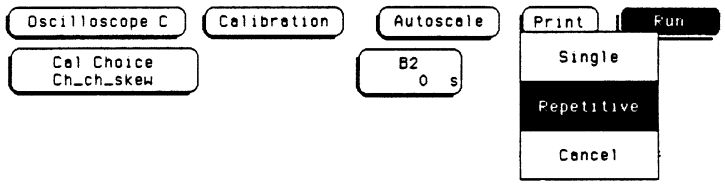


Figure 4-14. Run Option Select

s. Touch **Calibration**, then touch **Channel**. Set **s/Div** to 5 ns.

t. Touch **Channel**, then touch **Calibration**.

u. Rotate knob until both waveforms are overlayed at approximately the 50% point. See figure 4-15.

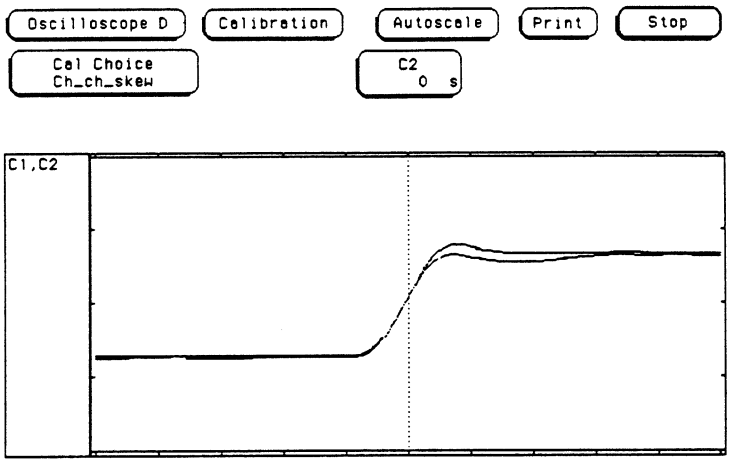


Figure 4-15. Overlayed Waveforms

v. If there are multiple acquisition cards, leave compensation signal connected to reference and move other BNC to next channel to calibrate. See figure 4-16. Touch **Autoscale**, then touch **Continue**.

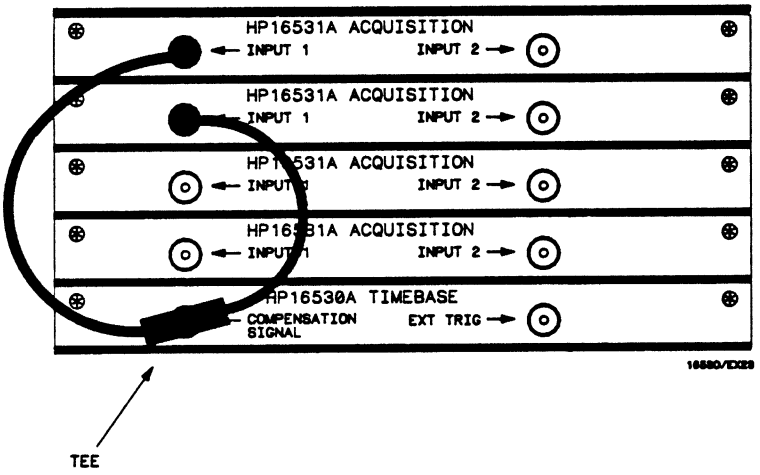


Figure 4-16. Channel-to-Channel Skew Equipment Hookup

w. Touch **Calibration**, then touch **Channel**. Set **s/Div** to 5 ns.

x. Touch **Channel**, then touch **Calibration**.

y. Touch label of next channel to calibrate. See figure 4-17.

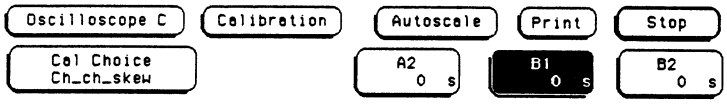


Figure 4-17. Channel for Skew Calibration

z. Repeat steps u through y until all channels are calibrated to the reference channel.

4-12. EXTENDER BOARD INSTALLATION

Before any adjustments are made, the acquisition card must be placed on the extender board.

CAUTION

The effects of ELECTROSTATIC DISCHARGE can damage electronic components. Use grounded wriststraps and mats when performing any kind of service to this instrument or the cards in it.

INSTALLATION CONSIDERATIONS:

- Any pair of unoccupied adjacent slots may be used.
- The extender board must be installed above the timebase card.
- Cards below the slots used by the extender board and timebase card do not have to be removed.

PROCEDURE:

a. Turn instrument power switch off, unplug power cord and disconnect any input BNCs.

b. Starting **from the top**, loosen thumb screws on filler panel(s) and card(s).

c. Starting **from the top**, begin pulling card(s) and filler panel(s) out **half way**. See figure 4-18.

CAUTION

Some modules are hooked together by intercard connecting cables.

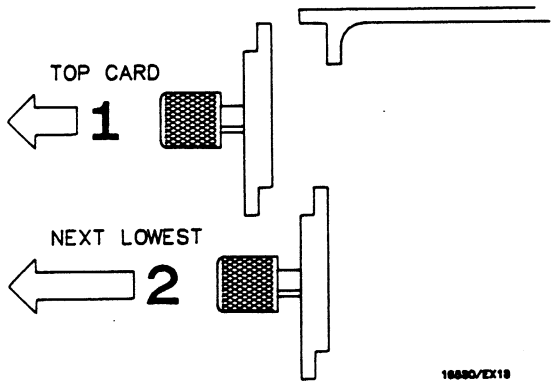


Figure 4-18. Endplate Overhang

d. Pull cards in module to be serviced completely out.

e. Push all other card(s) back into card cage, but **not completely in**. This will get them out of the way for extender board installation.

f. Disconnect all intercard connecting cables from the removed cards.

g. Plug the extra long ribbon cable into the timebase card. Make sure the correct end is installed. See figure 4-19.

h. Lay cable flat and pointing out to rear of card. See figure 4-20.

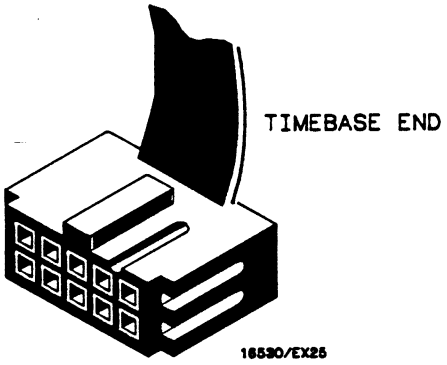


Figure 4-19. Connector End

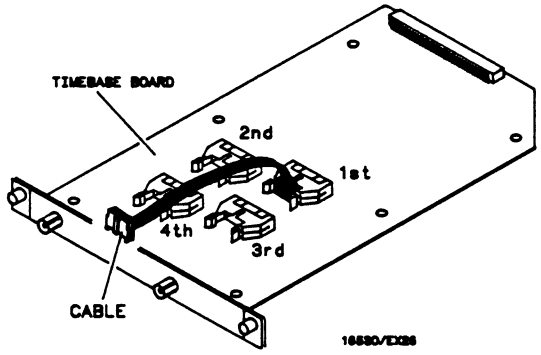


Figure 4-20. Cable Position

i. Slide timebase card **half way** into lowest of the two slots.

j. Slide extender board in next highest slot **half way**, feeding ribbon cable under extender board and out toward rear.

k. Push both timebase card and extender board in card cage until they are firmly seated into backplane connector.

l. Plug acquisition card into extender board. See figure 4-21.

m. Plug other end of cable into connector on acquisition card.

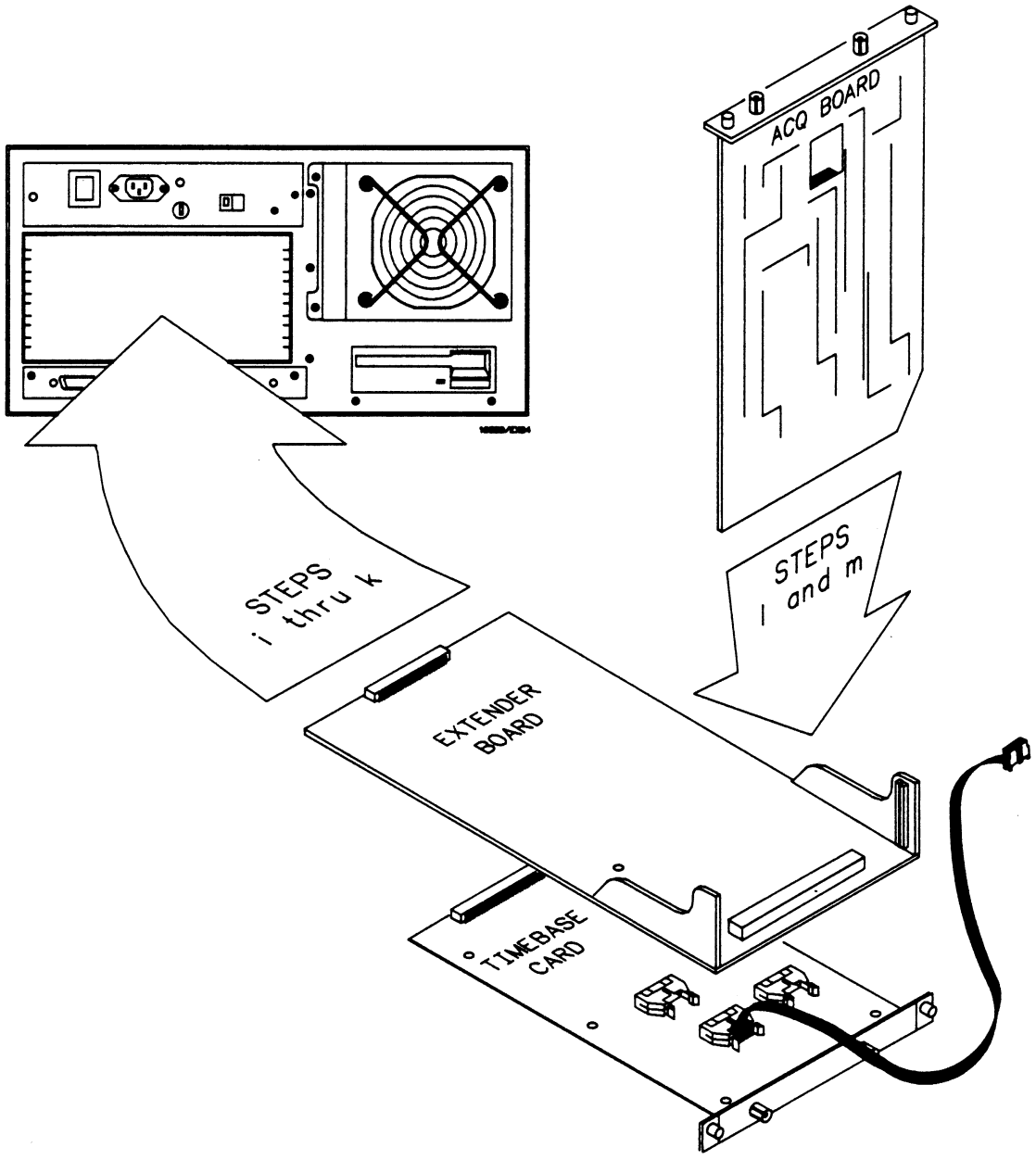


Figure 4-21. Installation Summary

4-13. ADJUSTMENTS

Adjustments in this section must be done in their entirety and in the sequence listed in table 4-2.

Table 4-2. Sequence of Adjustments

SEQUENCE	ADJUSTMENT	PARAGRAPH NO
1	Set to Default Values	4-14
2	DC Balance	4-15
3	DC Matching	4-16
4	Attenuator Compensation	4-17
5	HF Compensation	4-18

4-14. Set to Default Values

This will set the calibration factors to known nominal values.

PROCEDURE:

a. Turn power on.

b. From the startup screen in figure 4-22, touch these fields in the sequence below:

1. **System**
2. **Oscilloscope**
3. **Channel**
4. **Calibration**
5. **Cal Choice**
6. **Set to Default**

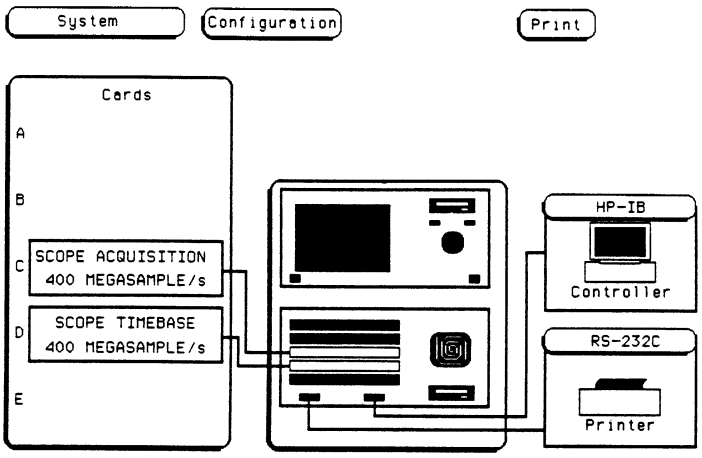


Figure 4-22. Startup Screen

c. From the Set to Default screen, touch **Set to Default values**. See figure 4-23.

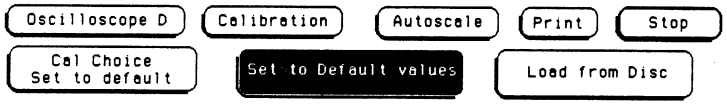


Figure 4-23. Set to Default Screen

4-15. DC Balance Adjustment

DESCRIPTION:

This adjustment will null channel 1 and channel 2 baseline to midscreen.

PROCEDURE:

a. Disconnect all inputs.

b. Touch **Run**, then touch **Repetitive**.

c. From the Set to Default screen in figure 4-23, touch these fields in the sequence below:

1. **Cal Choice**
2. **Balance Adjust**
3. **Start.**

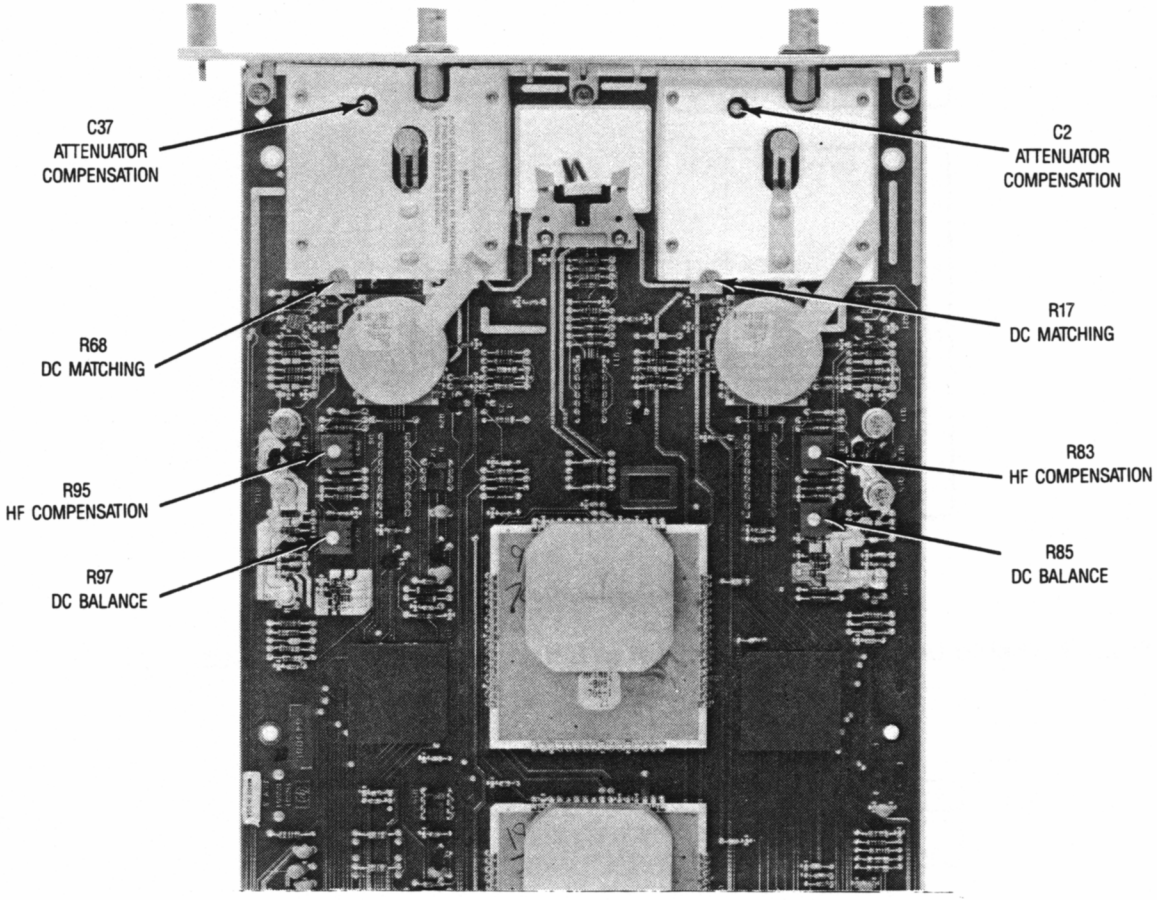


Figure 4-24. Component Location

d. Using figure 4-24 as a guide for component location, adjust R85 to center channel 1 trace on the offset voltage tick mark. See figure 4-25.

e. Adjust R97 to center channel 2 trace on the offset voltage tick mark. See figure 4-25.

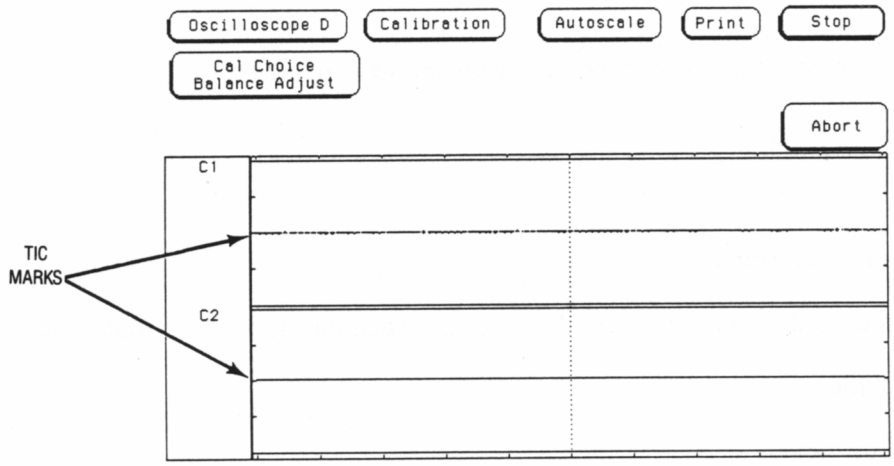


Figure 4-25. Offset Voltage Tick Marks

4-16. DC Matching Adjustment

DESCRIPTION:

This adjustment will match DC gain to AC gain.

EQUIPMENT:

Pulse Generator ..... HP 8161A
BNC Cable ..... HP 10503A

PROCEDURE:

a. Connect equipment as shown in figure 4-26.

b. Set pulse generator for 2 kHz, 0.1 ∀p-p square wave and apply signal to INPUT 1.

c. Touch **Autoscale**, then touch **Continue**.

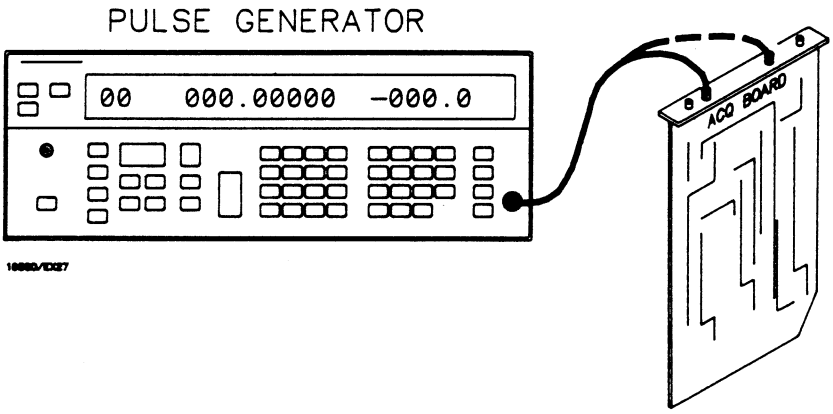


Figure 4-26. DC Matching Adjustment Equipment Hookup

d. Touch the following fields in the numbered sequence below:

1. **Calibration**
2. **Display**
3. **Mode Single**
4. **Average**
5. **Avg-No**

e. With knob, set averages to 4.

f. Touch **s/Div** and rotate knob setting s/Div to 100 μs/Div.

g. Adjust R17 for flattest square wave response. See figure 4-27. Allow a few seconds after each adjustment for averaged display to stabilize.

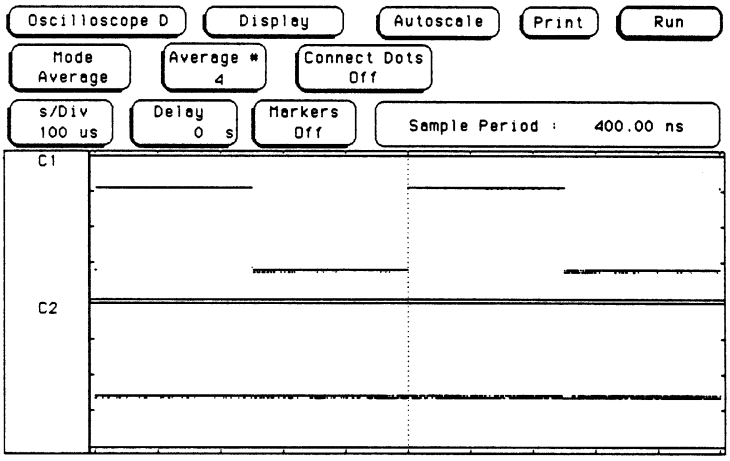


Figure 4-27. Square Wave Response

h. Connect signal to INPUT 2.

i. Touch **Autoscale**, then touch **Continue**.

j. Touch **s/Div**, and set to 100 μs/Div.

k. Adjust R68 for flattest square wave response. Allow a few seconds after each adjustment for averaged display to stabilize.

4-17. Attenuator Compensation Adjustment

DESCRIPTION:

This adjustment will match dc attenuation to ac attenuation.

EQUIPMENT:

Pulse Generator ..... HP 8161A
BNC Cable ..... HP 10503A

PROCEDURE:

a. Connect pulse generator to INPUT 1 as shown in figure 4-28.

b. Set pulse generator for a 100 kHz, 1 Vpp square wave.

c. Touch **Autoscale**, then touch **Continue**.

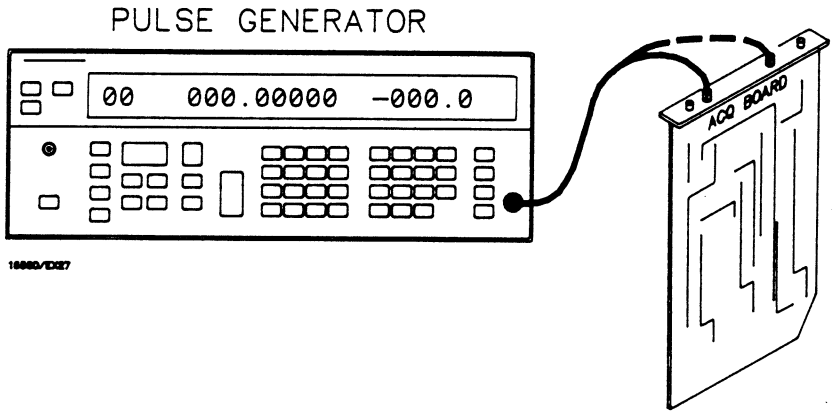


Figure 4-28. Attenuator Compensation Adjustment Equipment Hookup

d. Touch **s/Div**, and use knob to set to 2 μs/Div.

e. With a **non-metallic** adjustment tool, adjust C2 for flattest square wave response. See figure 4-29. Allow a few seconds for averaged display to stabilize.

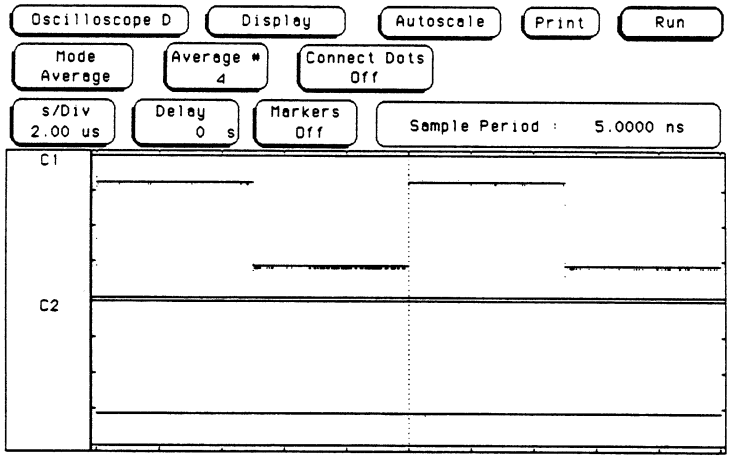


Figure 4-29. Square Wave Response

f. Connect signal to INPUT 2.

g. Touch **Autoscale**, then touch **Continue**.

h. Adjust C37 for flattest square wave response. Allow a few seconds for averaged display to stabilize.

4-18. HF Compensation Adjustment

DESCRIPTION:

This adjustment will maximize the high bandwidth gain with the best overshoot.

EQUIPMENT:

Pulse Generator ..... Tektronix Type 284
Cable type N ..... HP 11500B
Adapter N(m)-to-BNC(m) 1250-0028

PROCEDURE:

a. Connect fast rise time pulse generator to INPUT 1 as shown in figure 4-30.

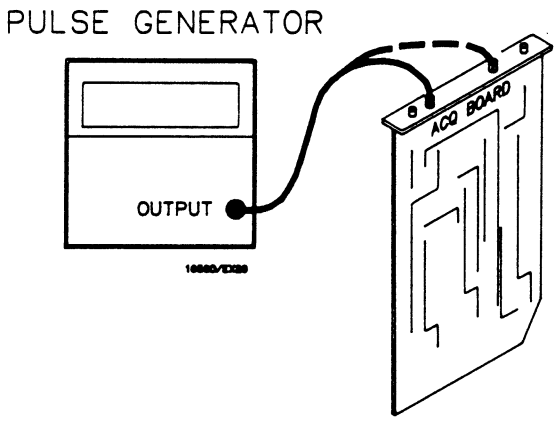


Figure 4-30. HF Compensation Adjustment Equipment Hookup

b. Set pulse generator for a fast rise time (<1ns) 0.2 Vp-p pulse.

c. Touch **Display**, then touch **Channel**.

d. Touch **Impedance** and set channel 1 to 50 Ohms. See figure 4-31.

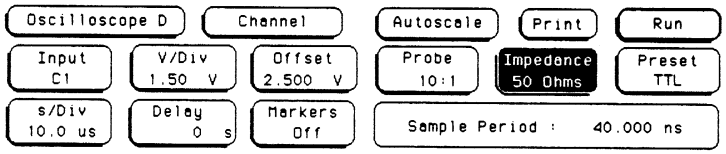


Figure 4-31. Impedance Select

e. Touch channel select field and switch to channel 2. See figure 4-32. Set impedance to 50 Ohms.

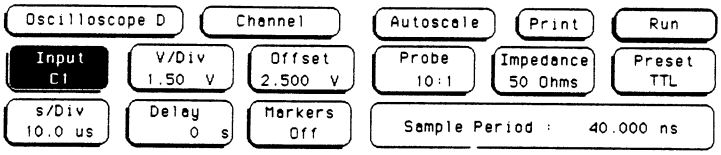


Figure 4-32. Channel Select Field

f. Touch channel select field and switch back to channel 1.

g. Touch these fields in the numbered sequence below:

1. **Channel**
2. **Auto-meas**
3. **Autoscale**, then touch **Continue**.
4. **s/Div**

h. With knob set to 5 ns/Div.

i. Touch **Delay**, and with knob adjust delay of signal until rising edge is centered at mid-screen.

i. Adjust R83 for flattest square wave response. Allow a few seconds for averaged display to stabilize. See figure 4-33.

j. Read **Risetime**. If risetime is not less than 3.5 ns, repeat steps i and j, adjusting for more overshoot.

k. Connect signal to INPUT 2.

l. Touch input field and switch measurement source to INPUT 2.

m. Touch **Autoscale**, then touch **Continue**.

n. Adjust R95 for flattest square wave response. Allow a few seconds for averaged display to stabilize. See figure 4-34.

o. Read **Risetime**. If risetime is not less than 3.5 ns, repeat steps n and o, adjusting for more overshoot.

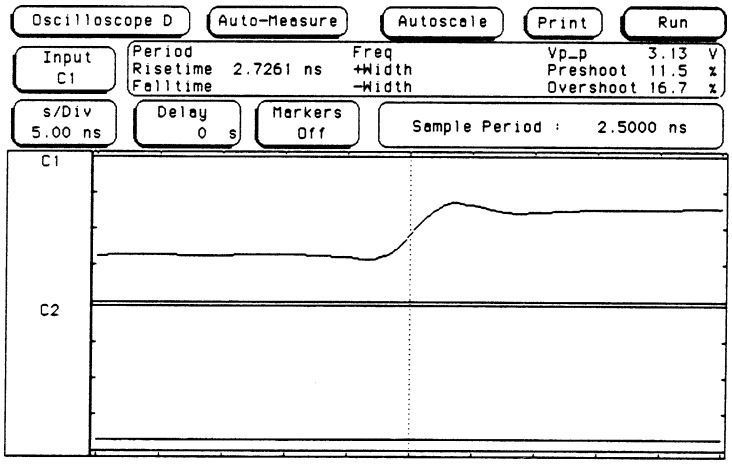


Figure 4-33. Square Wave Response

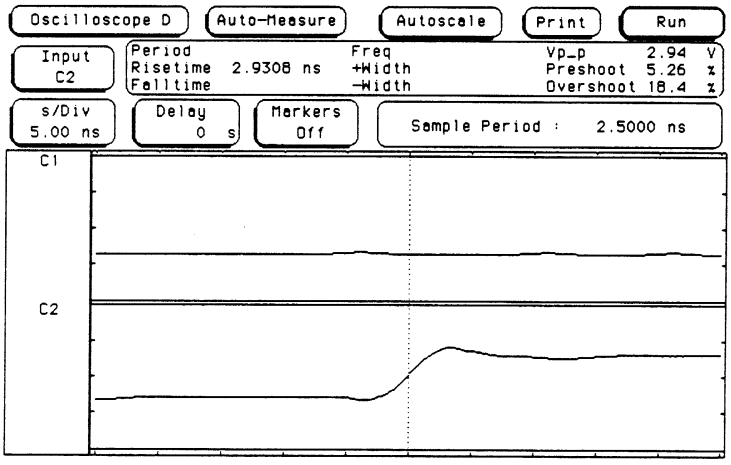


Figure 4-34. Square Wave Response

TABLE OF CONTENTS

REPLACEABLE PARTS

5-1. Introduction 5-1
5-2. Abbreviations 5-1
5-3. Replaceable Parts List 5-1
5-4. Ordering Information 5-1
5-5. Exchange Assemblies 5-1
5-6. Direct Mail Order System 5-2

SECTION V
REPLACEABLE PARTS

5-1. INTRODUCTION

This section contains parts and ordering information for the HP 16530/31A oscilloscope Module. Table 5-1 lists the reference designations and abbreviations used throughout this manual. Table 5-2 lists all replaceable parts by reference designator.

5-2. ABBREVIATIONS

Table 5-1 lists abbreviations used throughout the manual. In some cases two forms of the abbreviations are used, one in all capital letters, the other partially or not capitalized. We did this because the abbreviations in the parts list are always all capitals. However, in other parts of the manual other abbreviation forms are used with both lower and uppercase letters.

5-3. REPLACEABLE PARTS LIST

Table 5-2 lists replaceable parts and is organized as follows:

a. Electrical assemblies in alphanumerical order by reference designation.

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

c. Electrical assemblies and their components in alphanumerical order by reference designation.

The information given for each part consists of the following:

a. Complete reference designation.

b. Hewlett-Packard part number.

c. Total quantity (Qty) of instrument.

d. Description of part.

e. Check digit.

The total quantity for each part is only given once at the first appearance of the part number in the list.

5-4. ORDERING INFORMATION

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

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

5-5. EXCHANGE ASSEMBLIES

Exchange assemblies are available when a repairable assembly is returned to Hewlett-Packard. These assemblies have been set up on the Blue-stripe Exchange program. This allows the customer to exchange the faulty assembly with one that has been repaired, calibrated, and performance verified by the factory. The cost is significantly less than that of a new assembly.

Exchange assemblies are listed in a separate section in the replaceable parts table. They have a part number in the form XXXXX-695XX (where the new parts would be XXXXX-665XX). Before ordering a blue-stripe assembly, check with your local parts or repair organization for procedures.

5-6. DIRECT MAIL ORDER SYSTEM

Within the USA, Hewlett-Packard can supply parts through direct mail order. The advantages are as follows:

a. Direct ordering and shipment from Hewlett Packard Parts Center in Mountain View, California.

b. No maximum or minimum on any mail order (there is a minimum order for parts ordered through local Hewlett Packard offices when orders require billing and invoicing).

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

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

Mail order forms and specific ordering information are available through your local Hewlett Packard offices.

Table 5-1. 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	=picofarads
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	=trimmer
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

Table 5-2. Replaceable Parts

Reference Designation	HP Part Number	CD	Qty.	Description	Mfr Code	Mfr Part Number
	16530-13501	3	1	16530/31A OPER. SYSTEM DISC		
	16530-69501	0	1	EXCHANGE ASSY. TIMEBASE		
	16531-69502	1	1	EXCHANGE ASSY. ACQUISITION		
				HP 16530A		
	0510-0684	9	2	THUMBSCREW RETAINING RING		
	0515-0430	3	3	M3 X 6 PH T10 ENDPLATE SCREW		
	16500-22401	5	2	ENDPLATE THUMBSCREW		
	16500-29101	6	1	GROUND SPRING		
	16530-40501	0	1	CARD ENDPLATE		
	2190-0914	0	2	WASHER-LOCK		
	2950-0035	8	2	NUTH .468-32 .078		
	5959-0291	9	1	SERIAL TAG		
	16530-94301	1	1	LABEL-ANALOG TIMEBASE		
				HP 16531A		
	0510-0684	9	2	THUMBSCREW RETAINING RING		
	0515-0430	3	3	M3 X 6 PH T10 ENDPLATE SCREW		
	10018A	9	2	10:1 DIV PROBE		
	1250-0076	2	2	RIGHT ANGLE BNC ADAPTER		
	16500-22401	5	2	ENDPLATE THUMBSCREW		
	16500-29101	6	1	GROUND SPRING		
	16530-40501	0	1	CARD ENDPLATE		
	16531-61601	6	1	CABLE-ANALOG INTERCON		
	16531-94301	2	1	LABEL-ANALOG ACQUISITION		
	16531-94302	3	1	LABEL-WARNING ANALOG SHIELD		
	2190-0914	0	2	WASHER-LOCK		
	2950-0035	8	2	NUTH .468-32 .078		
	5041-1483	8	4	WIRE MARKER-BLU		
	5959-0291	9	1	SERIAL TAG		

TABLE OF CONTENTS

SERVICE

6-1. Introduction 6-1
6-2. Safety Requirements 6-1
6-3. Recommended Test Equipment 6-1
6-4. Module Block Diagram and Theory Of Operation 6-1
6-5. Acquisition Card Theory Of Operation 6-3
6-6. Timebase Card Theory Of Operation 6-4
6-7. Self Tests 6-5
6-8. Troubleshooting 6-9
6-9. Card Replacement 6-25

SECTION VI
SERVICE

6-1. INTRODUCTION

This section contains information for servicing the HP 16530/31A Scope Module. Included is a block level theory of both cards and procedures for self diagnostics and troubleshooting. If a card is determined faulty, a procedure is provided for replacing the card.

6-2. SAFETY REQUIREMENTS

Specific warnings, cautions, and instructions are placed wherever applicable throughout the manual. These must be observed during all phases of operation, service, and repair of the module. Failure to comply with them violates safety standards of design, manufacture, and intended use of this module. Hewlett-Packard assumes no liability for the failure of the customer to comply with these safety requirements.

6-3. RECOMMENDED TEST EQUIPMENT

Table 1-3 lists recommended test equipment. Any equipment that satisfies the critical specification given in the table may be substituted for the recommended models.

6-4. MODULE BLOCK DIAGRAM AND THEORY OF OPERATION

The following paragraphs contain block level theory of operation. This theory is not intended for component level troubleshooting, rather it is to be used to help isolate a module failure to card level.

For component level troubleshooting, the HP 16530/31A Sevice Data Supplement is required. This supplement contains schematics, component level theory of operation, component locators and a parts list for the oscilloscope module.

The HP 16530/31A Oscilloscope Module consists of one timebase card and one or more acquisition cards. Up to four acquisition cards, a maximum of eight channels, can be connected to a single HP 16530A Timebase Card. See figure 6-1.

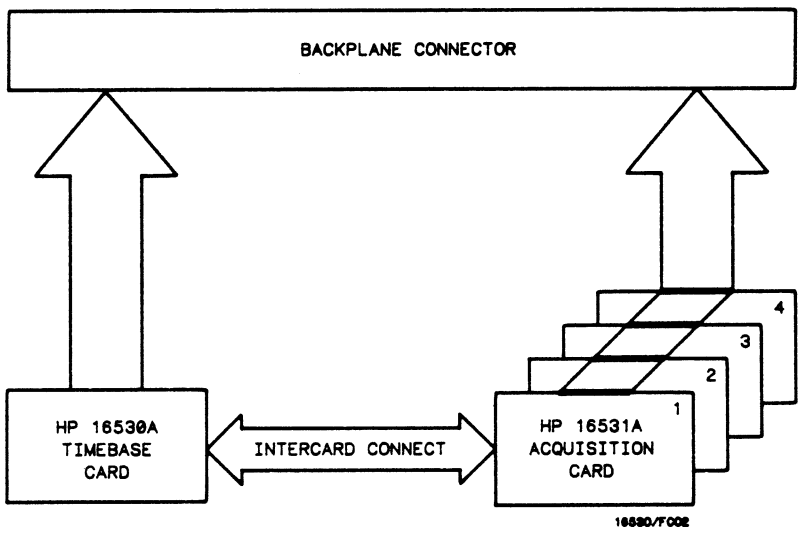


Figure 6-1. HP 16530/31A Oscilloscope Module Block Diagram

The acquisition card has two channels of data acquisition. The input signals are conditioned, converted from analog to digital, and stored in memory. A trigger signal is generated and sent to the timebase card. See figure 6-2.

The timebase card selects and conditions the desired trigger signal and performs trigger delays and self calibration for presice trigger start points. A sample clock is generated and sent to the acquisition card. See figure 6-3.

Trigger and clock signals pass between cards over an intercard connecting cable. External triggers can be input through a BNC connector on the rear panel of the timebase card.

The oscilloscope module and all intermodule functions communicate with the CPU through the backplane connector. All power supplies required by the module are supplied through the backplane connector.

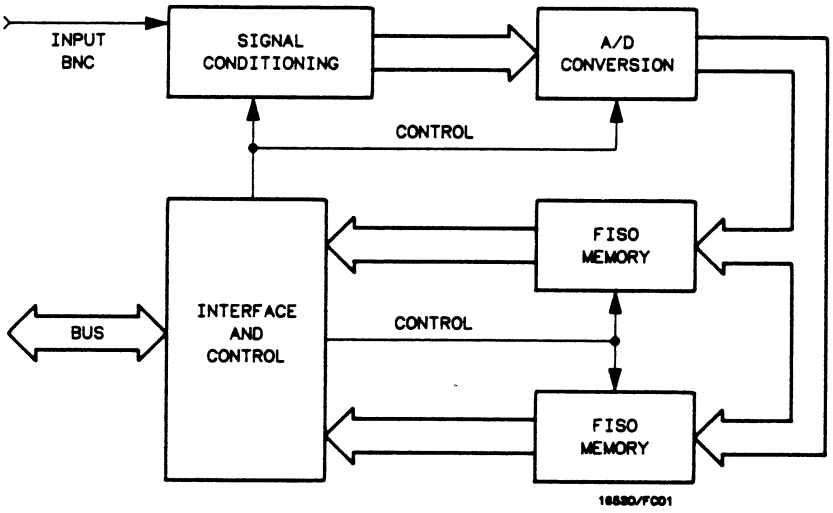


Figure 6-2. Acquisition Card Block Diagram

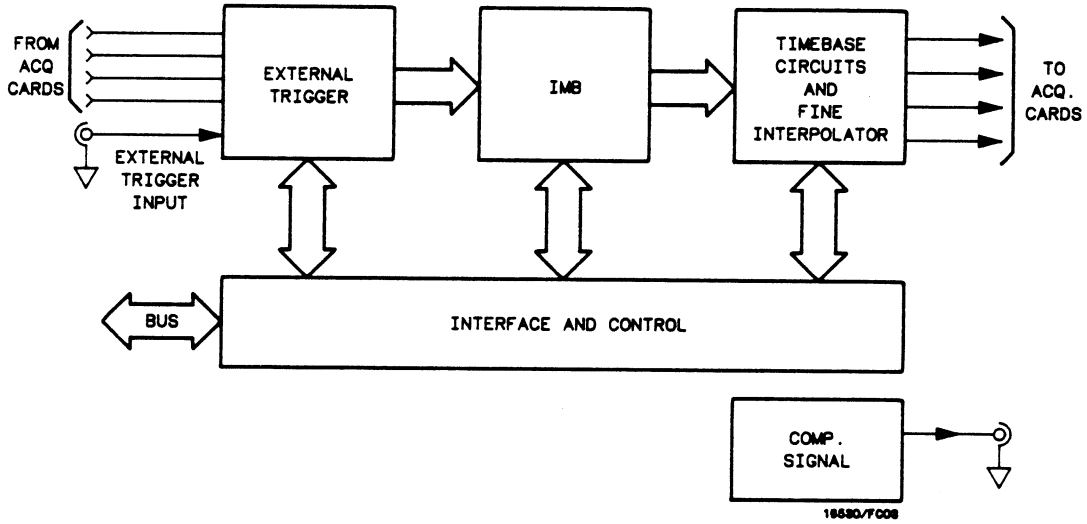


Figure 6-3. Timebase Card Block Diagram

6-5. ACQUISITION CARD THEORY OF OPERATION

Input Signal Conditioning

The input attenuator circuit provides dc coupled 1 MΩ or 50 Ω user selectable input impedance. Input signal attenuation is ÷1 or ÷20.

An impedance converter circuit is used to convert the high input impedance to a low impedance capable of driving the preamp hybrid. Any DC error from the impedance converter is corrected and any user programmed DC offset is introduced at this point.

The preamp hybrid generates differential analog outputs for the A/D drivers and differential digital trigger outputs for the timebase card. Programmable preamp functions are signal gain, attenuation, and trigger level sensitivity.

Analog To Digital Conversion

Differential analog inputs from the preamp hybrid are amplified and converted to a single-ended voltage capable of driving the A/D hybrid. The A/D driver circuit has an overall gain of about 5. There are adjustments for dc offset and high frequency compensation in this circuit.

The A/D converter hybrid digitizes the single-ended analog voltage. This digitized data is demultiplexed into two outputs for the FISO memory.

FISO Memory

The FISO (fast in slow out) memories store the data from the A/D converter outputs. They have three programmable modes of operation:

- Acquisition mode

  During acquisition mode the data from the A/D converter is stored into memory on both rising and falling edges of the master clock.

- Read mode

  In the read mode data that has been stored in memory is read back by the microprocessor in the same sequence that it was stored.

- Test mode

  The microprocessor can select a test mode where a checkerboard pattern is stored into memory and then read back out. This test checks all memory locations.

Interface And Control

Offset, preamplification, attenuation, and trigger level selection interface to the analog circuits by digital to analog converters. System address lines are decoded for memory read and write strobes. FISO memory, and preamp control lines are latched on the acquisition card and a bidirectional buffer interfaces the system data lines.

6-6. TIMEBASE CARD THEORY OF OPERATION

External Trigger

The external trigger signal is input through a rear panel BNC into a user selectable 50 Ω or 1 MΩ input impedance. A user defined DC offset is applied and overvoltage protection is provided. After the external trigger signal has been conditioned, it is ORed with trigger signals from all acquisition cards.

Intermodule Bus (IMB)

The Intermodule bus (IMB) circuitry allows the oscilloscope module to arm/trigger other modules or be armed/triggered by other modules in the system.

Timebase Circuits And Fine Interpolator

The timebase circuit provides gating and calibration signals for the fine interpolator. Counters for pre-trigger delay, post-trigger delay, and memory control are also in this circuit.

The fine interpolator circuit, using the interpolator control lines from the timebase circuit, measures trigger signal position to 50 psec. The circuit is self-calibrating and determines precisely the position of the trigger.

A saw oscillator circuit provides a precise 800 MHz signal for the timebase circuits. It is self adjusting to 160 KHz. RFI protection is integrated into board construction.

Interface And Control

Programmable dc offset is applied to the external trigger signal by a digital to analog converter. Read and write strobes are demultiplexed from address lines and IMB select lines are latched.

6-7. SELF TESTS

The self tests for the HP 16530/31A Oscilloscope Module will identify the improper operation of major functional areas in the module. They are not intended for component level diagnostics. If there are multiple oscilloscope modules, the user must select the specific oscilloscope module to be tested at the main test system menu.

All self tests can be run without access to the interior of the instrument. If a failure is found, the troubleshooting chart in paragraph 6-8 may require the use of the extender board to further isolate the problem to a specific card or cable.

SELF TEST ACCESS PROCEDURE:

This procedure uses the Acquisition Mem Test as an example. During troubleshooting, any or all tests can be used.

a. Disconnect all oscilloscope inputs and turn power switch on.

b. From the startup screen shown in figure 6-4, touch **Configuration** field, then touch **Test.**

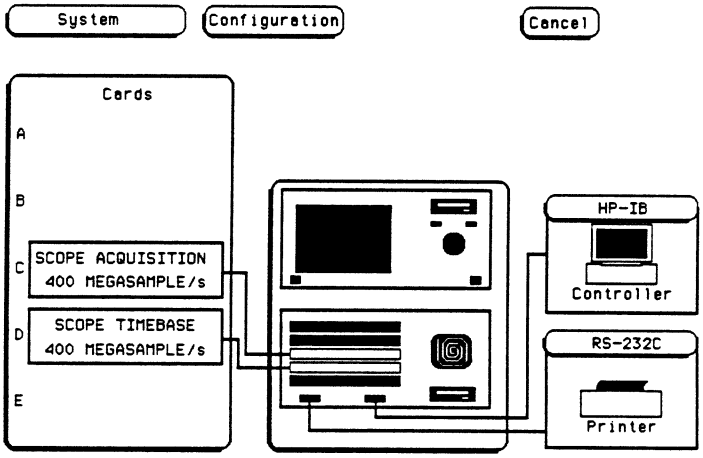


Figure 6-4. Startup Screen

c. Touch box to load **Test System**. See figure 6-5.

Note

The self test software disc must be installed in the disc drive. When the self test software is loaded, the user operating system is lost.

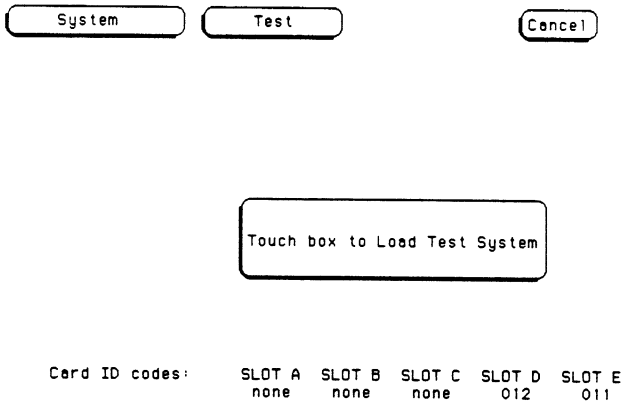


Figure 6-5. Load Test System

d. From test system screen in figure 6-6, touch **Test System**, then touch **Oscilloscope**. (If multiple oscilloscope modules, select the one to be tested)

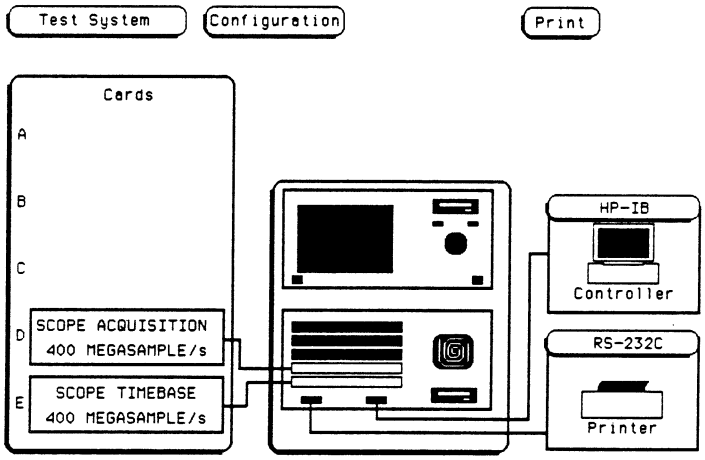


Figure 6-6. Test System Screen

e. Figure 6-7 is the main self test menu. Self tests can be run individually by touching a specific test field, or all tests automatically one time by touching "All Oscilloscope Tests". When "All Oscilloscope Tests" is run, the test status will change to "TESTED". When individual tests are run, the status will change to either "PASSED or FAILED".

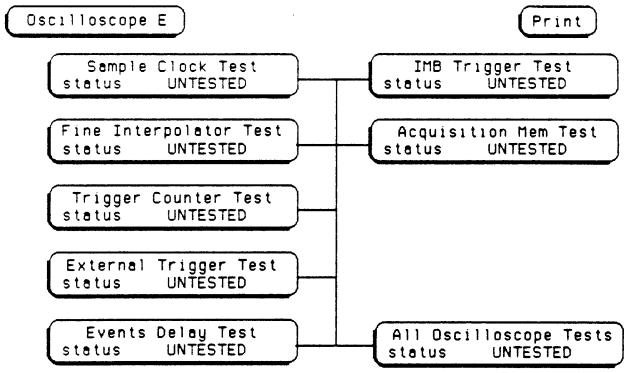


Figure 6-7. Main Test Menu

f. Touch **Acquisition Mem Test.**

g. The individual test run screens, see figure 6-8, give the test name, a brief description of the test, number of test runs, and the number of test failures.

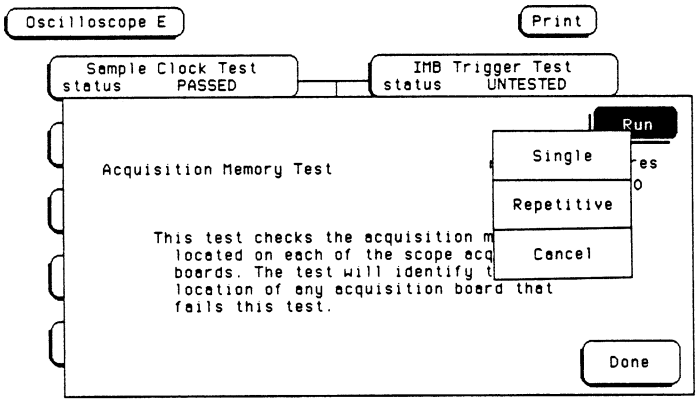


Figure 6-8. Acquisition Mem Test Run Screen

h. Touch **Run**, then drag finger to **Single** or **Repetitive**.

i. During the time a Single run or a Repetitive run is executing, the **Run** field will change to **Stop**.

j. To stop a Repetitive run, touch **Stop**. See figure 6-9

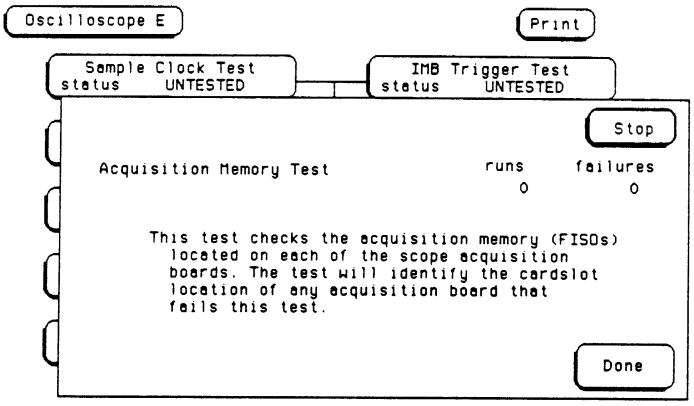


Figure 6-9. Stop Field

k. To exit the self tests, touch the following fields in the numbered sequence below:

1. **Oscilloscope**
2. **Test System**
3. **Configuration**
4. **Exit Test**

l. Touch the box to **Exit Test System**. See figure 6-10.

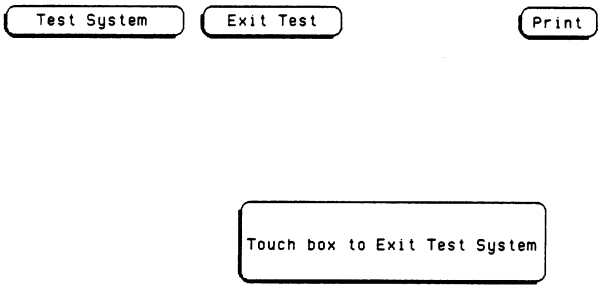


Figure 6-10. Exit Test System

TEST DESCRIPTIONS:

Sample Clock Test

This test verifies that every oscilloscope sample clock can be generated. The test looks at the sample rate decade and frequency divide factors (f/n) generated. This is a test for sample clock occurance only. The sample rate accuracy is checked elsewhere.

Fine Interpolator Test

This test verifies the operation of the fine interpolator on the timebase card at less than 200 MHz and at 200 MHz.

Trigger Counter Test

This test verifies the operation of the pre-trigger (pre-store) counter and the post-store counter on the timebase card. This test also checks the accuracy of the sample clock interval.

External Trigger Test

This test verifies the ability of the timebase card to respond to an external trigger signal.

Events Delay Test

This test verifies the operation of the events delay counter located on the timebase card.

IMB Trigger Test

This test verifies the ability of the timebase card to see and react to the IMB trigger/arm signals.

Acquisition Mem Test

This test checks both channel's FISO memory chips located on the acquisition card.

All Oscilloscope Test

This will automatically increments all tests starting with the first test.

6-8. TROUBLESHOOTING

This troubleshooting flow chart will isolate rnodule failures to card level only. It is not intended for component level troubleshooting. If self tests indicate a failure, begin at the **Start** of the troubleshooting flow chart shown in figure 6-11. When a specific test fails, you will be instructed to replace a faulty card or you will be referred to other flow charts for the isolation of the faulty card or cable.

CAUTION

The effects of ELECTROSTATIC DISCHARGE can damage electronic components. Grounded wriststraps and mats should be used when you perform any kind of service to this instrument or the cards in it.

Troubleshooting Sheet 1

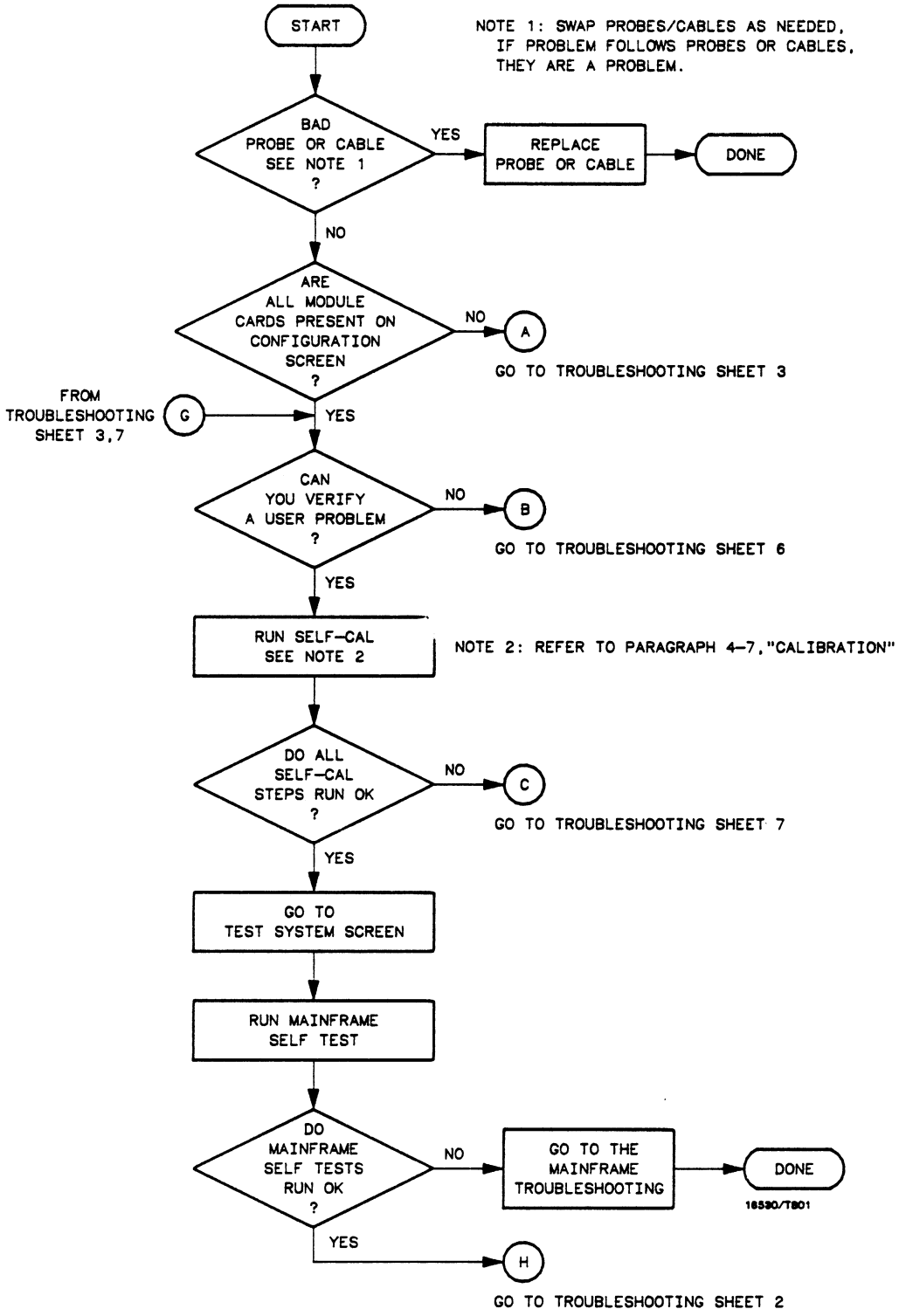


Figure 6-11. Troubleshooting Flow Chart

Troubleshooting Sheet 2

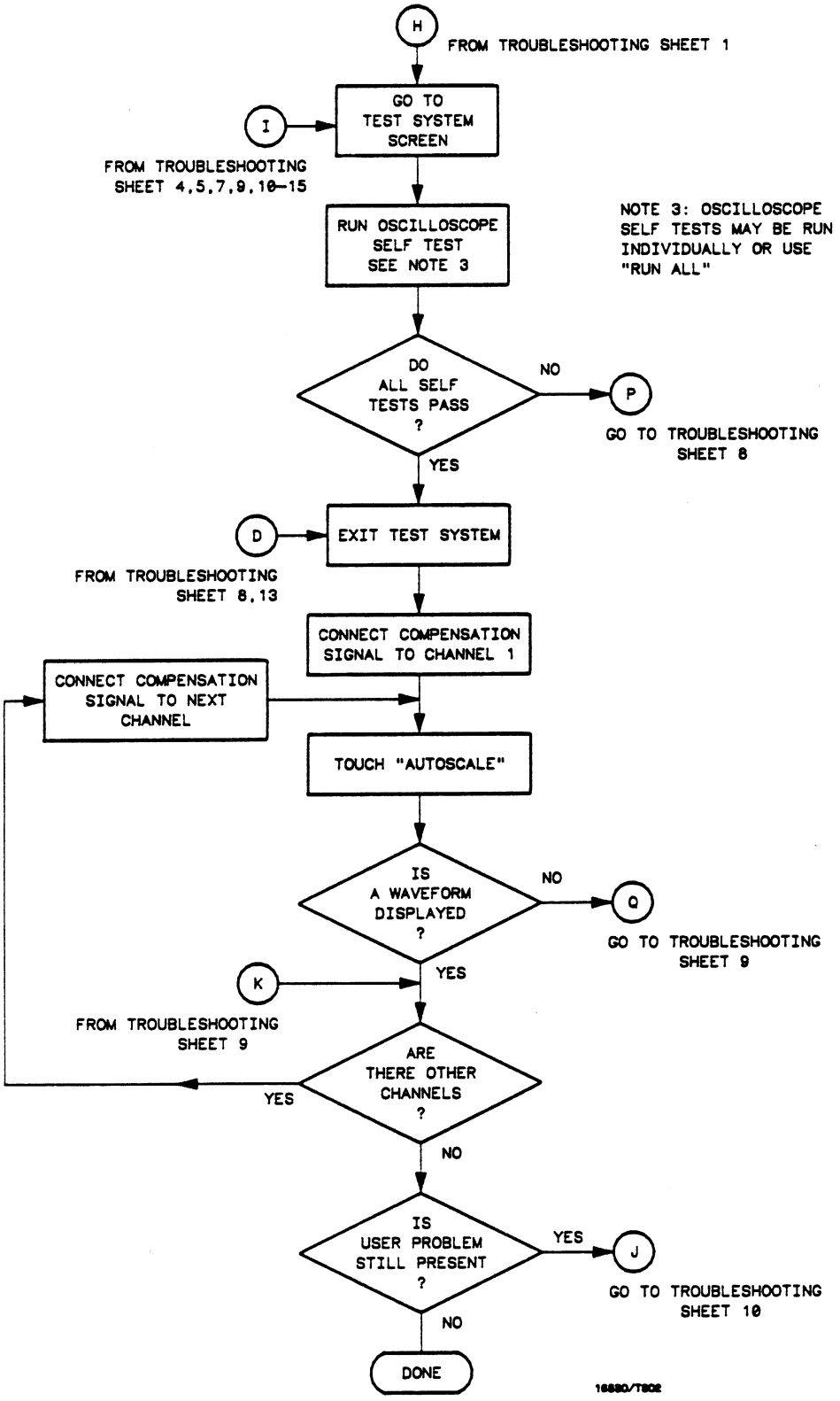


Figure 6-11. Troubleshooting Flow Chart (cont.)

Troubleshooting Sheet 3

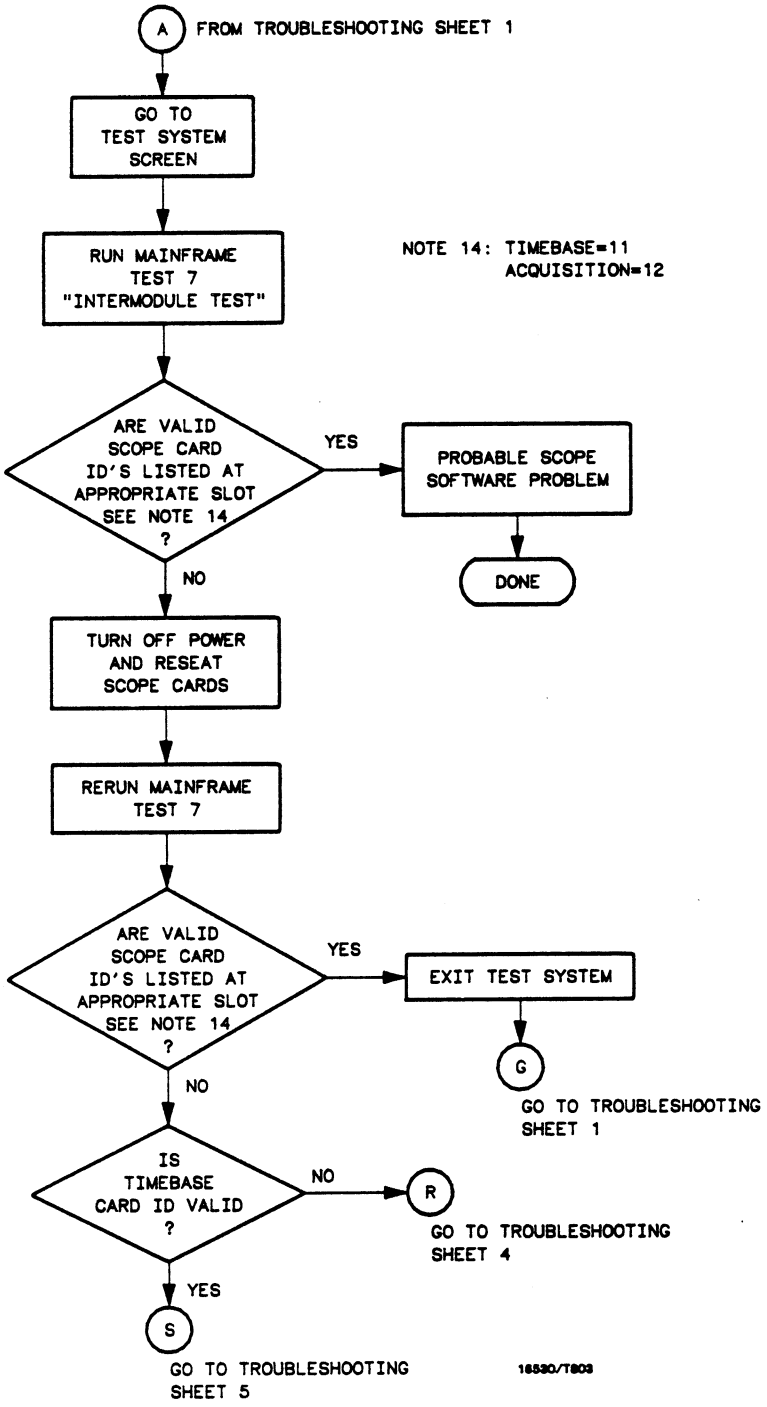


Figure 6-11. Troubleshooting Flow Chart (cont.)

Troubleshooting Sheet 4

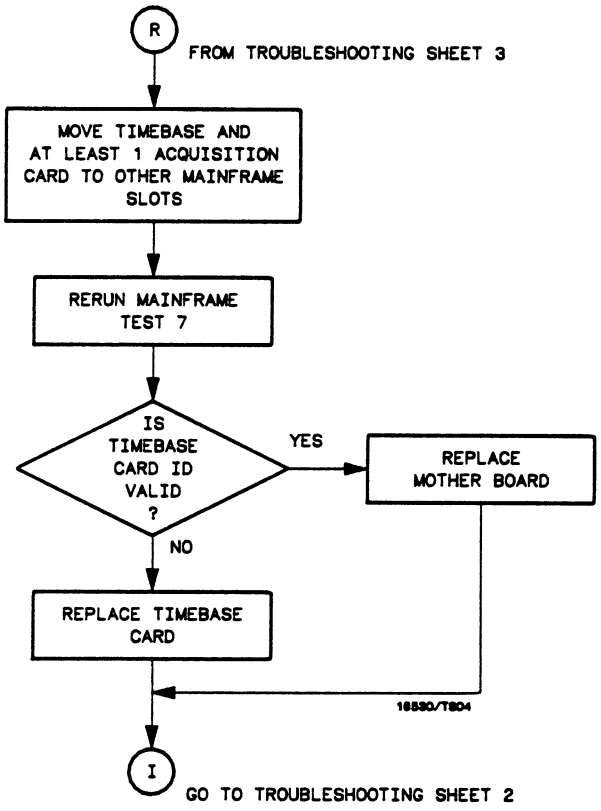


Figure 6-11. Troubleshooting Flow Chart (cont.)

Troubleshooting Sheet 5

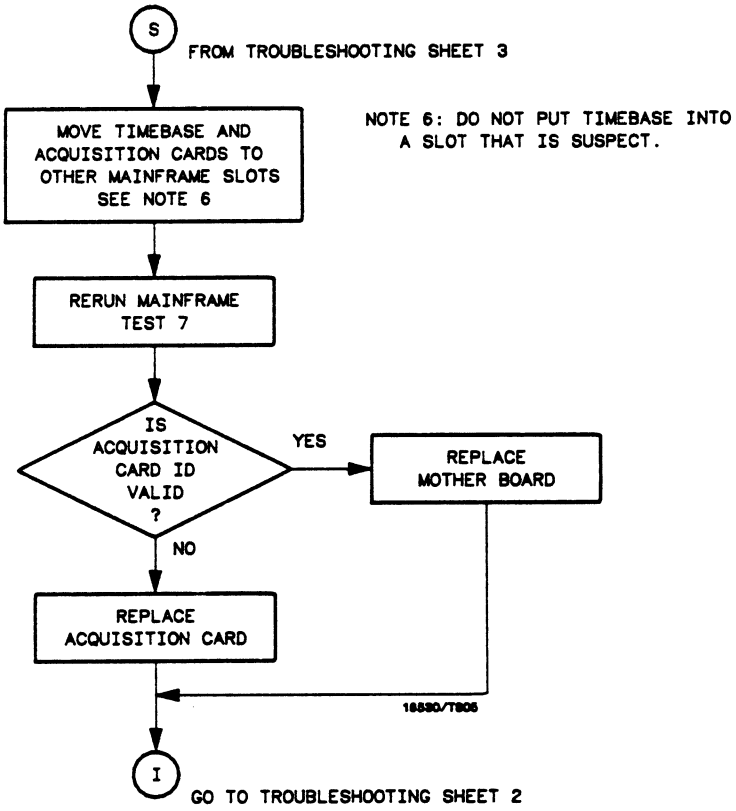


Figure 6-11. Troubleshooting Flow Chart (cont.)

Troubleshooting Sheet 6

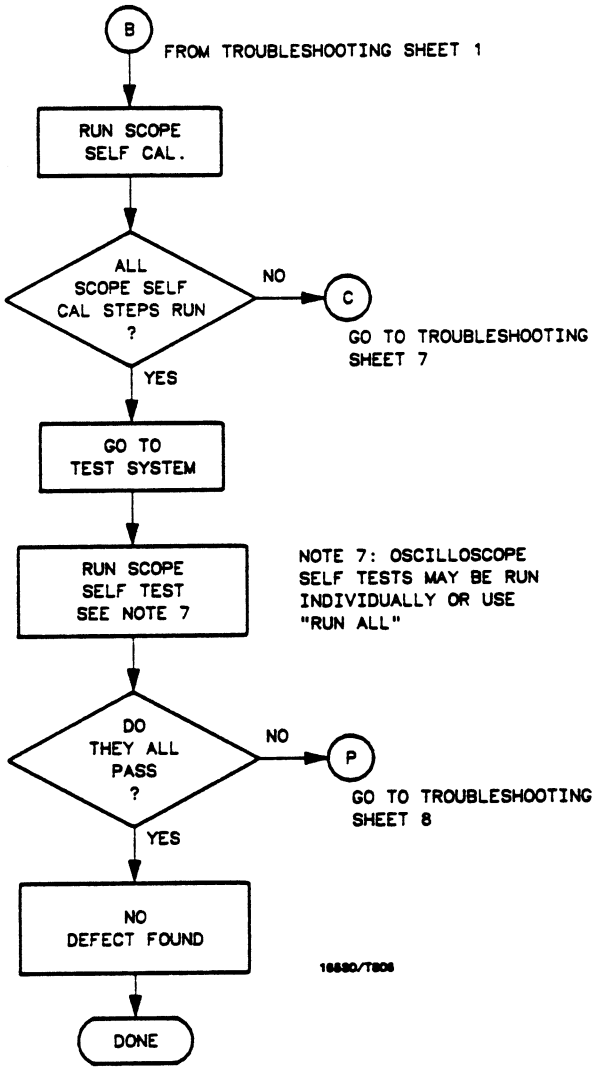


Figure 6-11. Troubleshooting Flow Chart (cont.)

Troubleshooting Sheet 7

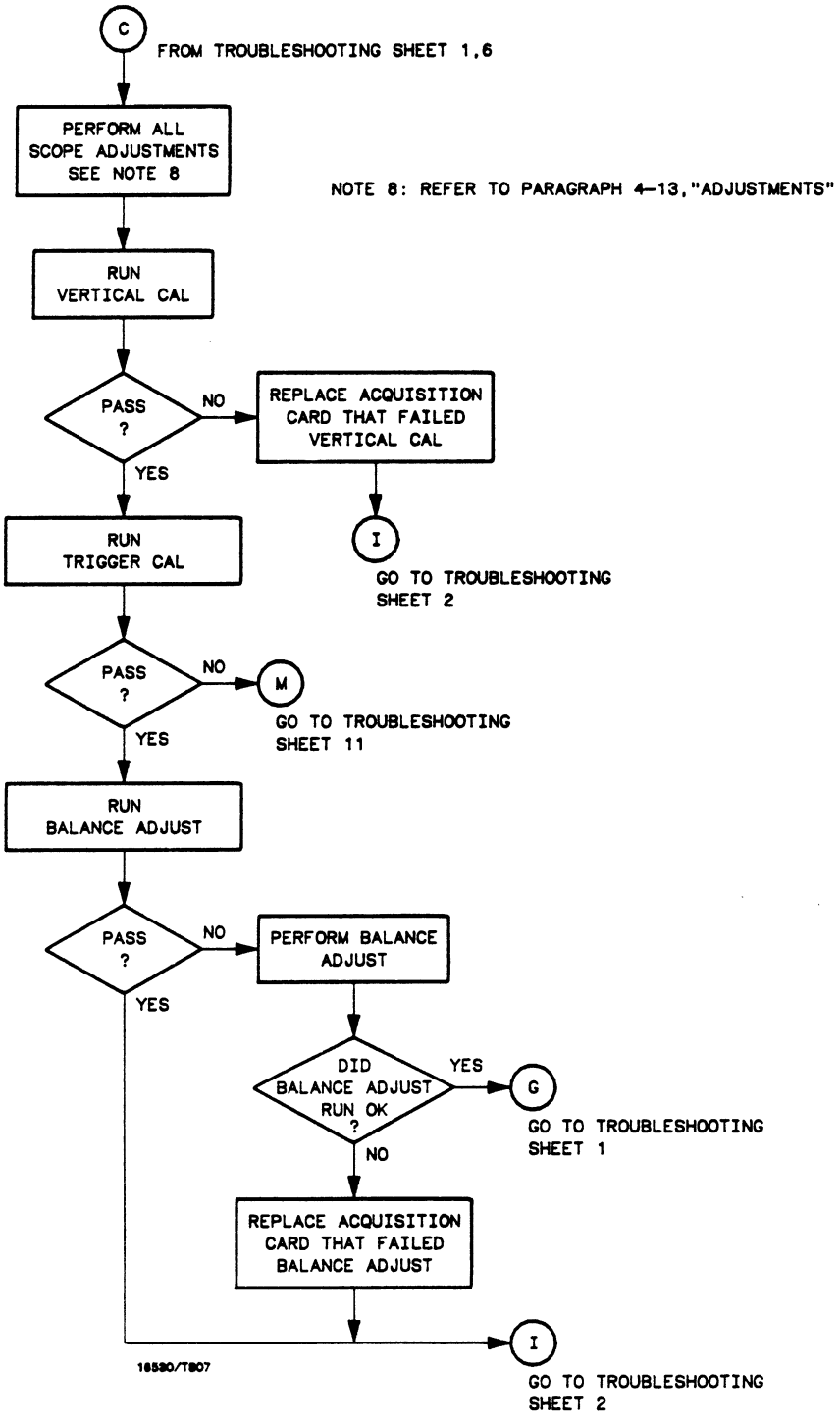


Figure 6-11. Troubleshooting Flow Chart (cont.)

Troubleshooting Sheet 8

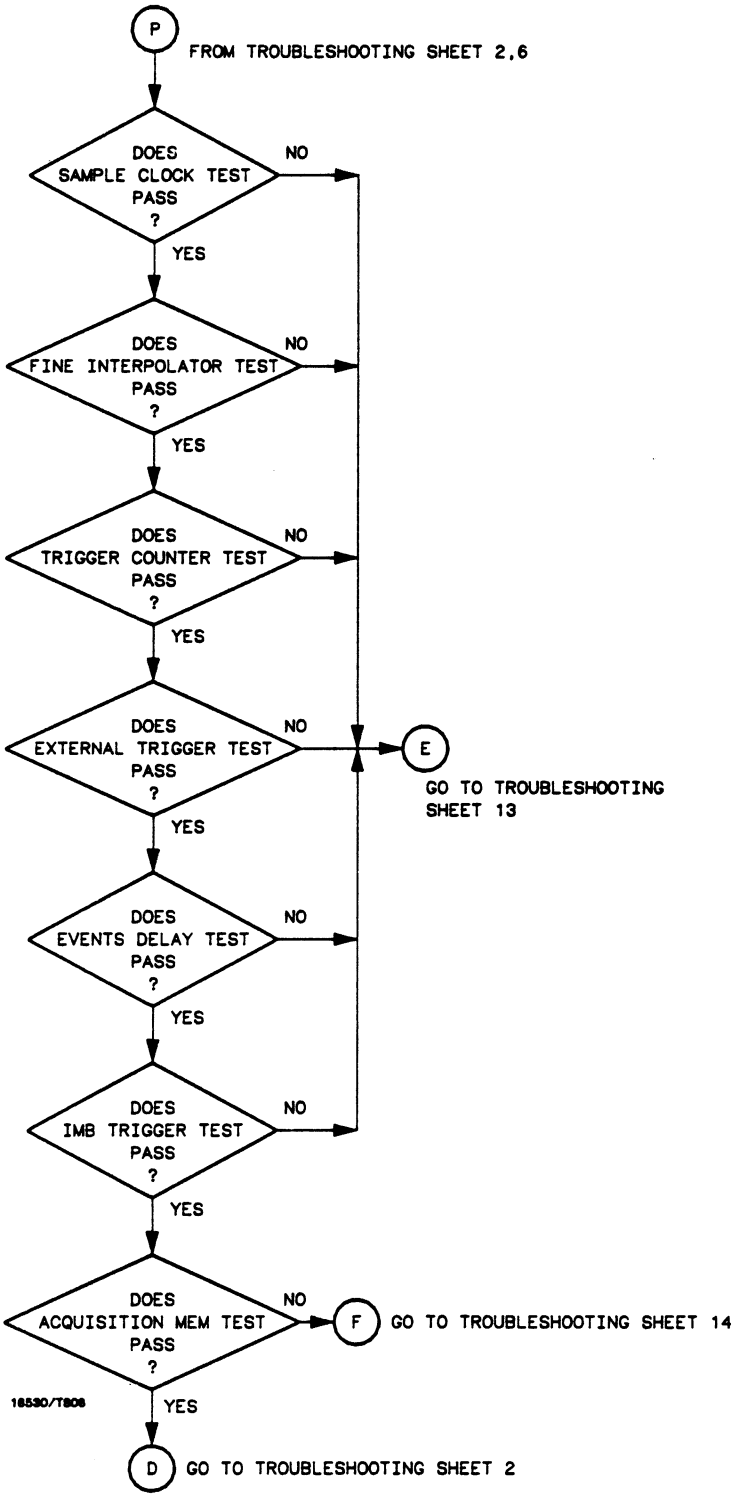


Figure 6-11. Troubleshooting Flow Chart (cont.)

Troubleshooting Sheet 9

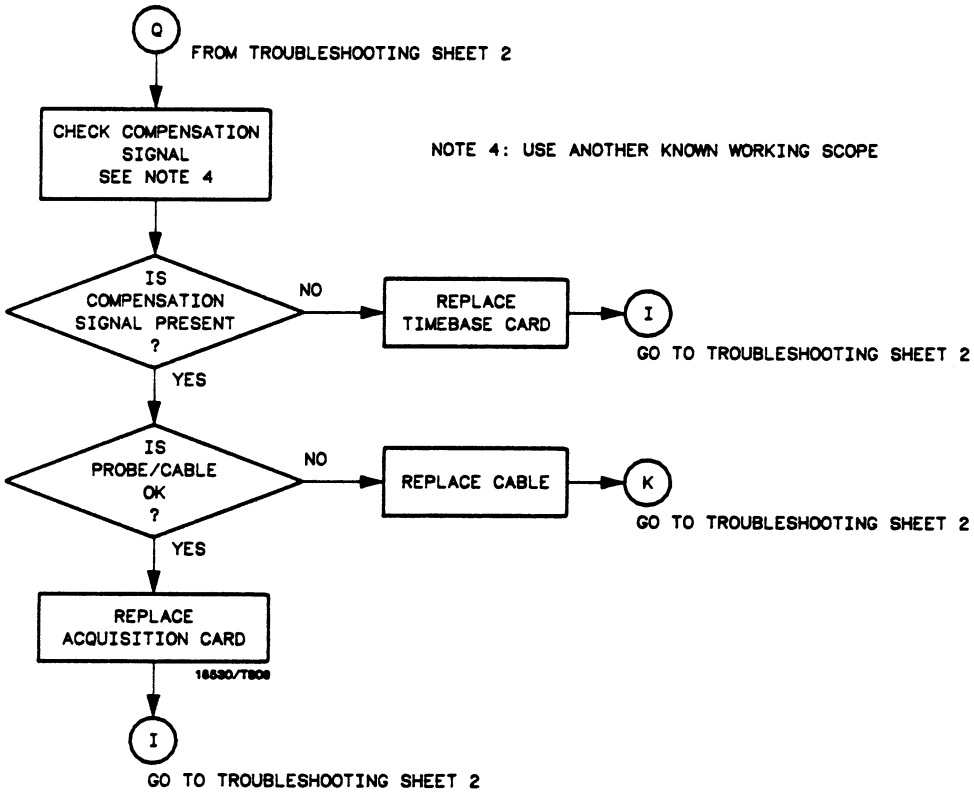


Figure 6-11. Troubleshooting Flow Chart (cont.)

Troubleshooting Sheet 10

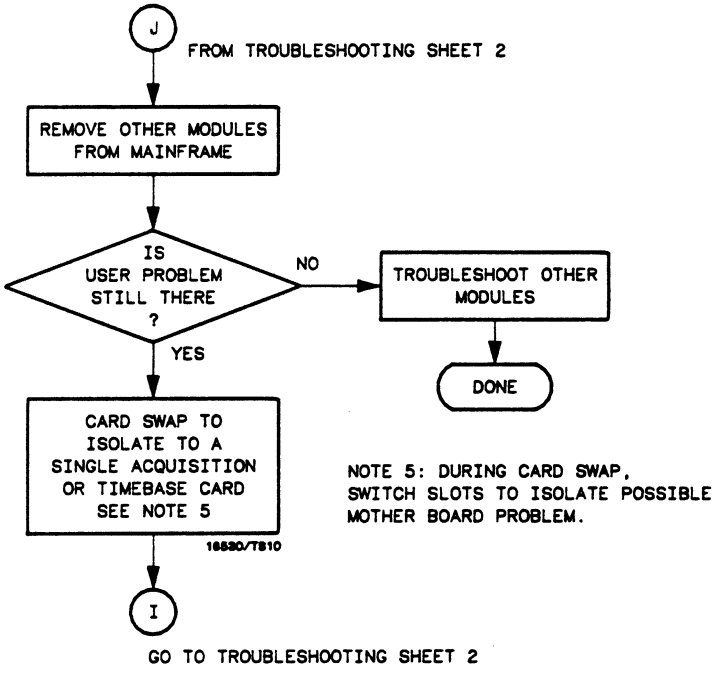


Figure 6-11. Troubleshooting Flow Chart (cont.)

Troubleshooting Sheet 11

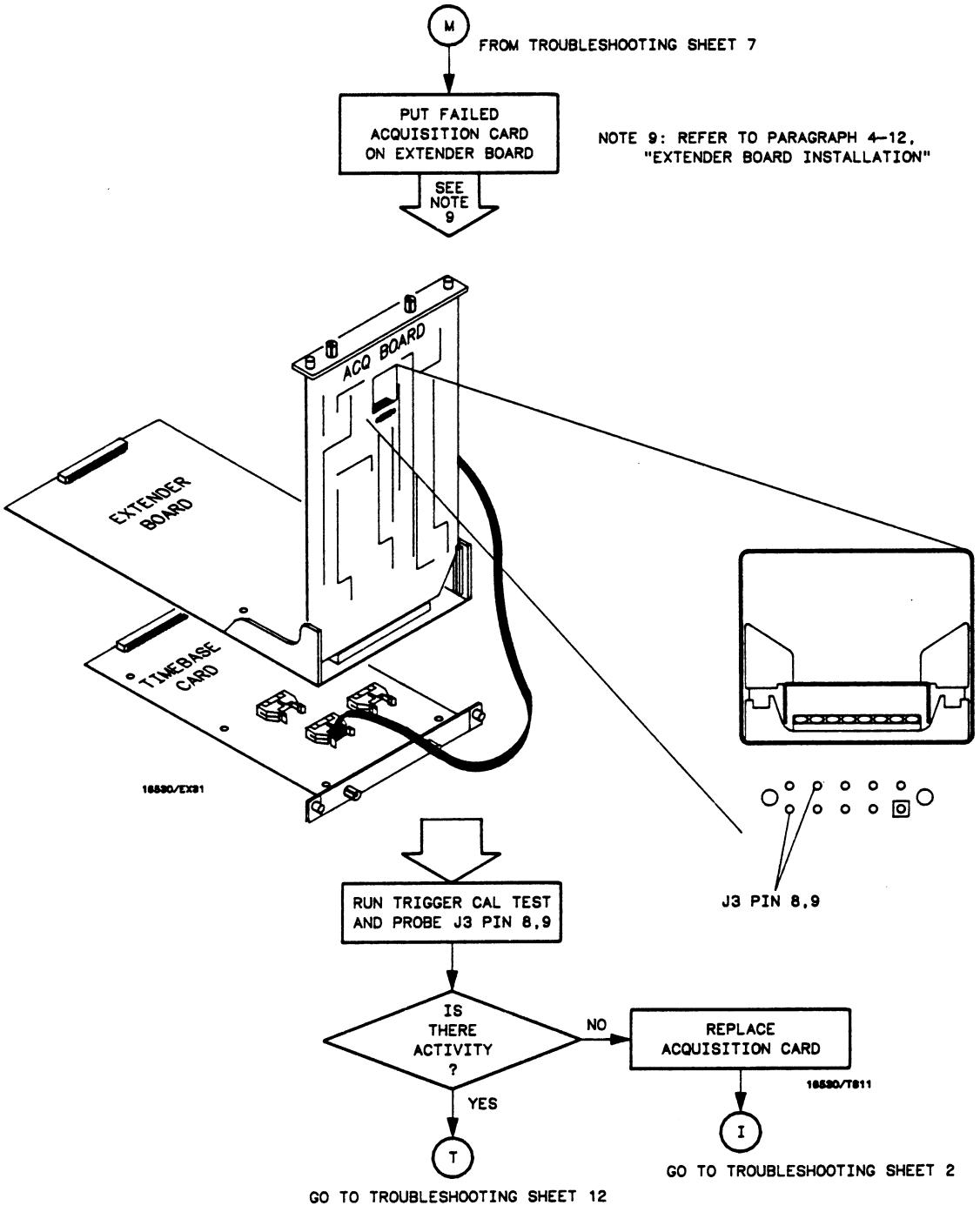


Figure 6-11. Troubleshooting Flow Chart (cont.)

Troubleshooting Sheet 12

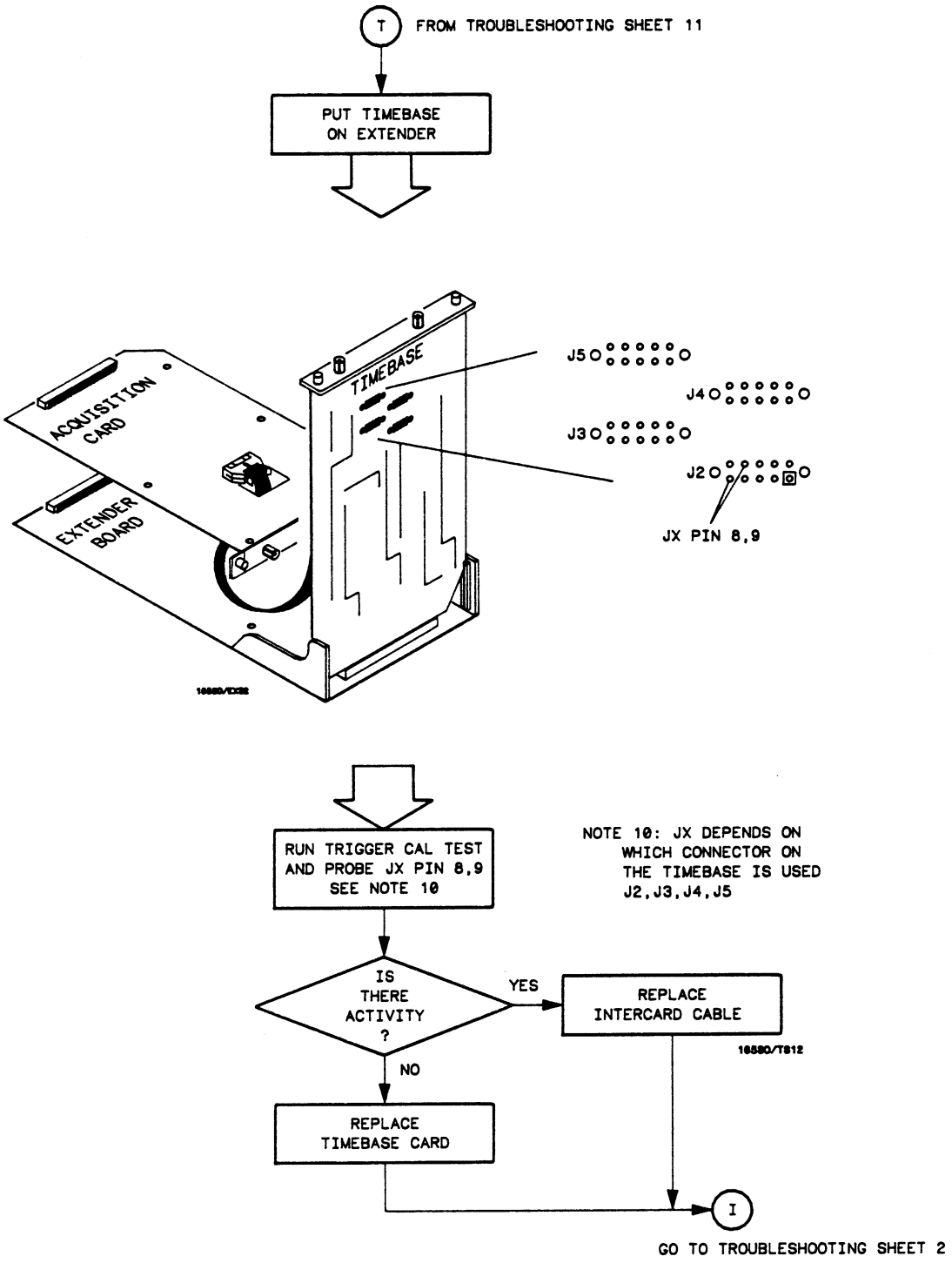


Figure 6-11. Troubleshooting Flow Chart (cont.)

Troubleshooting Sheet 13

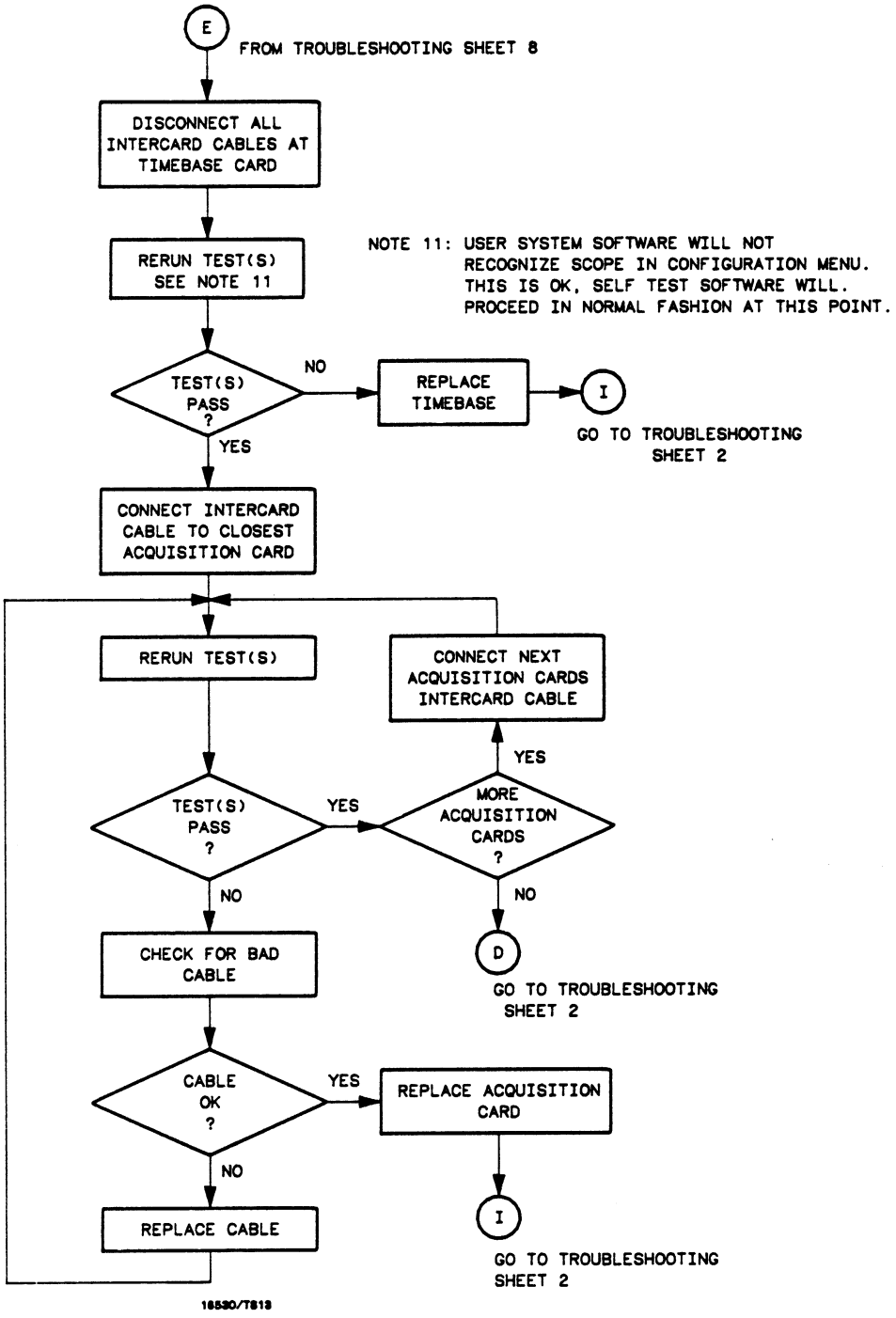


Figure 6-11. Troubleshooting Flow Chart (cont.)

Troubleshooting Sheet 14

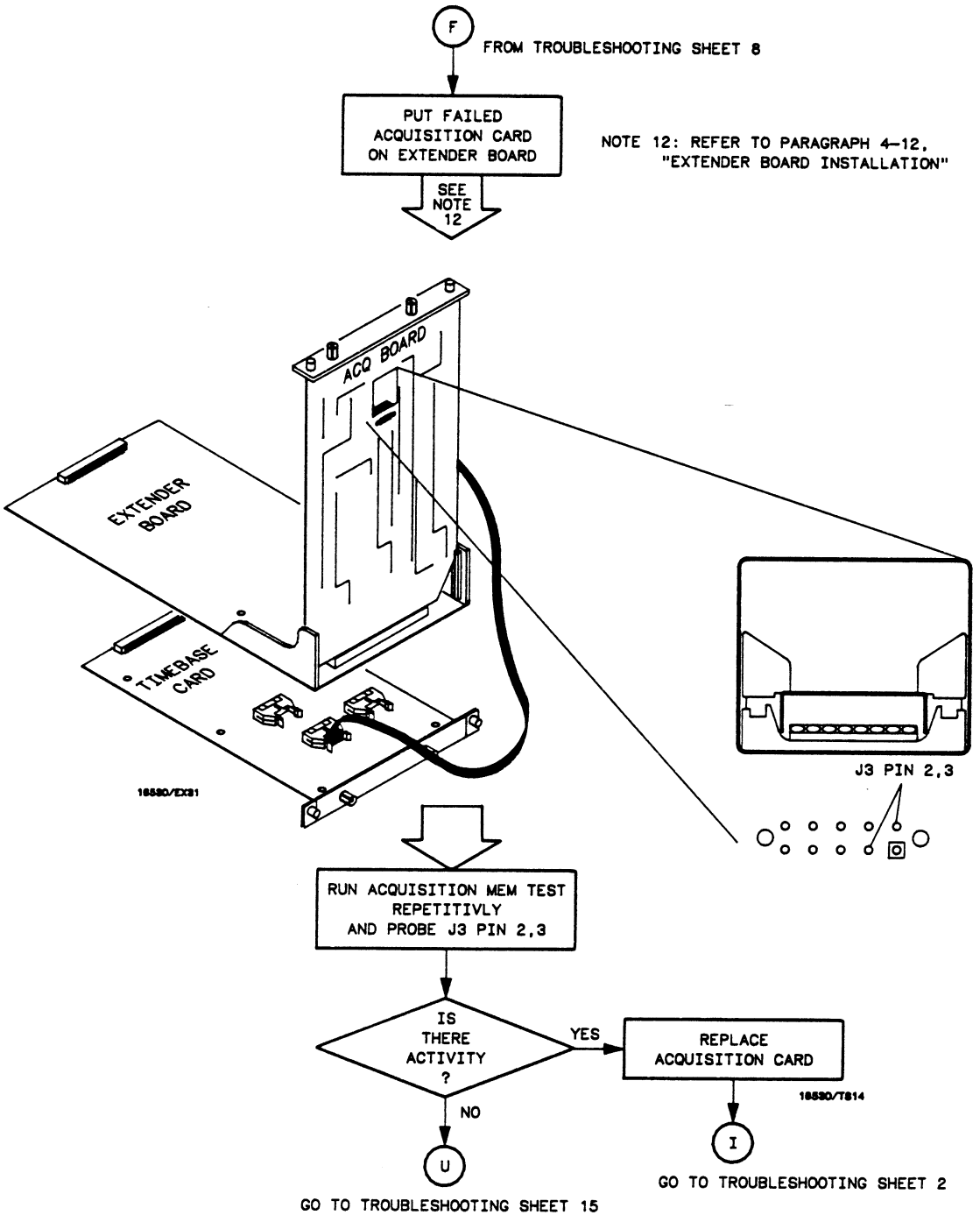


Figure 6-11. Troubleshooting Flow Chart (cont.)

Troubleshooting Sheet 15

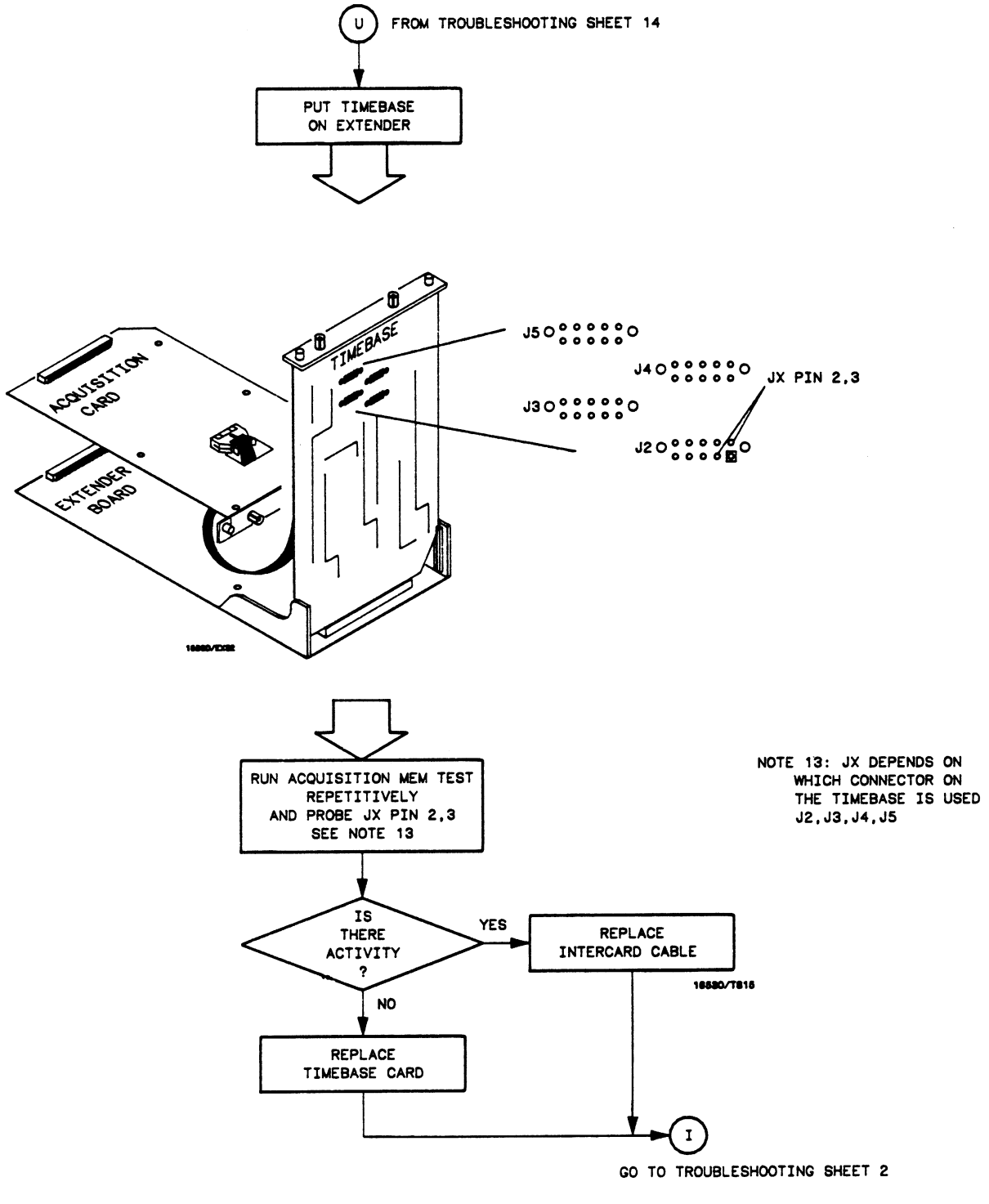


Figure 6-11. Troubleshooting Flow Chart (cont.)

6-9. CARD REPLACEMENT

INSTALLATION CONSIDERATIONS:

- Acquisition cards must be positioned above the timebase card.
- Use one cable per acquisition card. See figure 6-13.
- If there are not enough empty slots to install the module correctly, existing modules must be repositioned in card cage.
- Cards below the slots to be filled by oscilloscope module, do not have to be removed.

CAUTION

The effects of ELECTROSTATIC DISCHARGE can damage electronic components. Grounded wriststraps and mats should be used when you perform any kind of service to this instrument or the cards in it.

PROCEDURE:

a. Turn instrument power switch off, unplug power cord and disconnect any input BNCs.

b. Starting **from the top**, loosen thumb screws on filler panel(s) and card(s).

c. Starting **from the top**, begin pulling card(s) and filler panel(s) out **half way**. See figure 6-12.

CAUTION

Some modules are hooked together by intercard connecting cables.

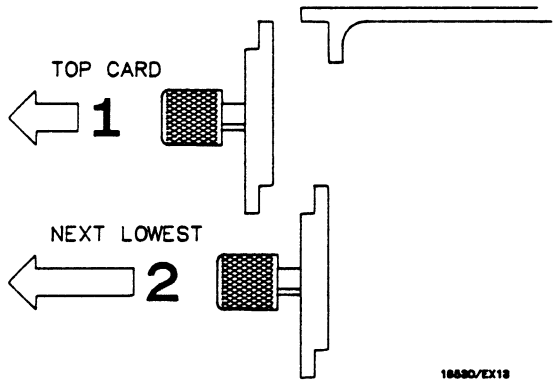


Figure 6-12. Endplate Overlap

d. Remove the HP 16530/31A Oscilloscope Module from the card cage and disconnect the cable(s) from all cards.

e. Replace the faulty card in the module.

f. Note the "INSTALLATION CONSIDERATIONS" on the previous page and use figure 6-13 to review the card configuration and cable connection.

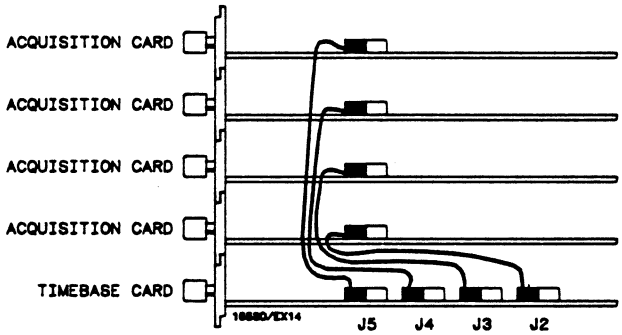


Figure 6-13. Configuration Guide

g. Install one cable per acquisition card into the correct timebase card connector (see figure 6-13), making sure to install the correct cable end. Use figure 6-14 to identify the correct cable end.

h. Lay cable(s) flat and pointing out to rear of card. See figure 6-15.

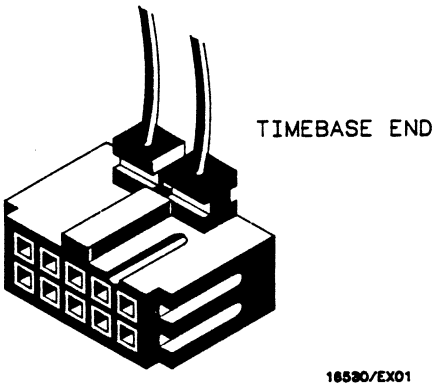


Figure 6-14. Cable End

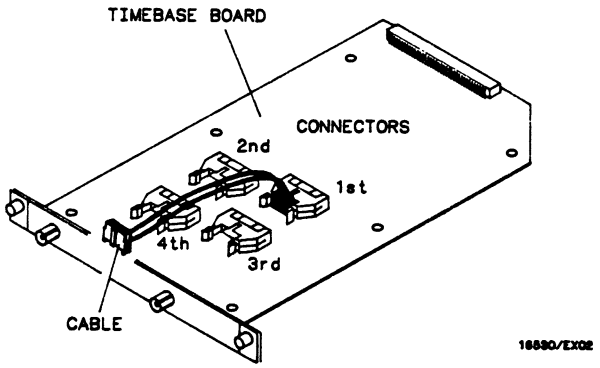


Figure 6-15. Cable Position

i. Slide timebase card approximately **half way** into lowest slot being used for the oscilloscope module.

j. Slide acquisition card in **half way**, feeding cable up through square hole in acquisition card.

k. Plug in other end of cable to connector on acquisition card. See figure 6-16.

l. If you have additional acquisition cards, repeat steps j and k until all cards are in **half way** and all cables are connected.

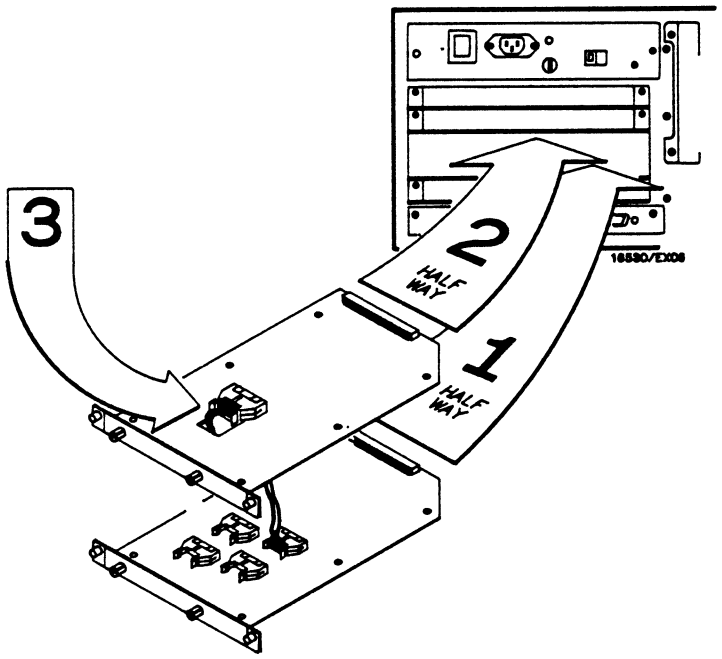


Figure 6-16. Installation Summary

m. Firmly seat bottom card into backplane connector. **Keep applying pressure to the center of card endplate while tightening thumb screws finger tight.**

n. Repeat for all cards and filler panels in a **bottom to top** order. See figure 6-17.

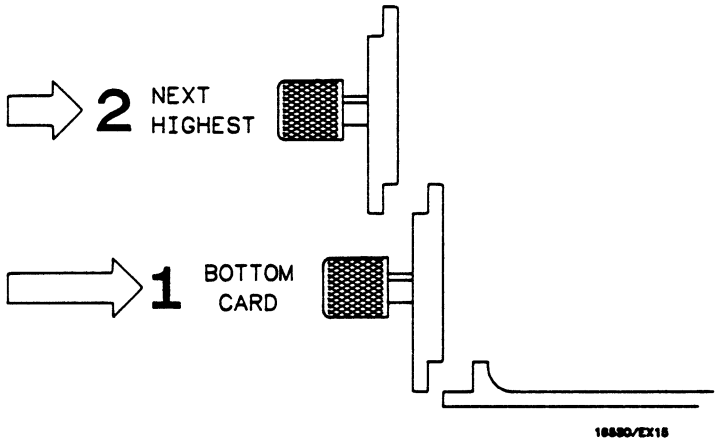


Figure 6-17. Endplate Overhang

o. Any filler panels that are not used should be kept for future use. Filler panels **must** be installed in all unused card slots for correct air circulation.

Artisan Technology Group is an independent supplier of quality pre-owned equipment

Gold-standard solutions

Extend the life of your critical industrial, commercial, and military systems with our superior service and support.

We buy equipment

Planning to upgrade your current equipment? Have surplus equipment taking up shelf space? We'll give it a new home.

Learn more!

Visit us at **artisantg.com** for more info on price quotes, drivers, technical specifications, manuals, and documentation.

Artisan Scientific Corporation dba Artisan Technology Group is not an affiliate, representative, or authorized distributor for any manufacturer listed herein.

We're here to make your life easier. How can we help you today?

(217) 352-9330 | sales@artisantg.com | artisantg.com

ARTISAN® TECHNOLOGY GROUP