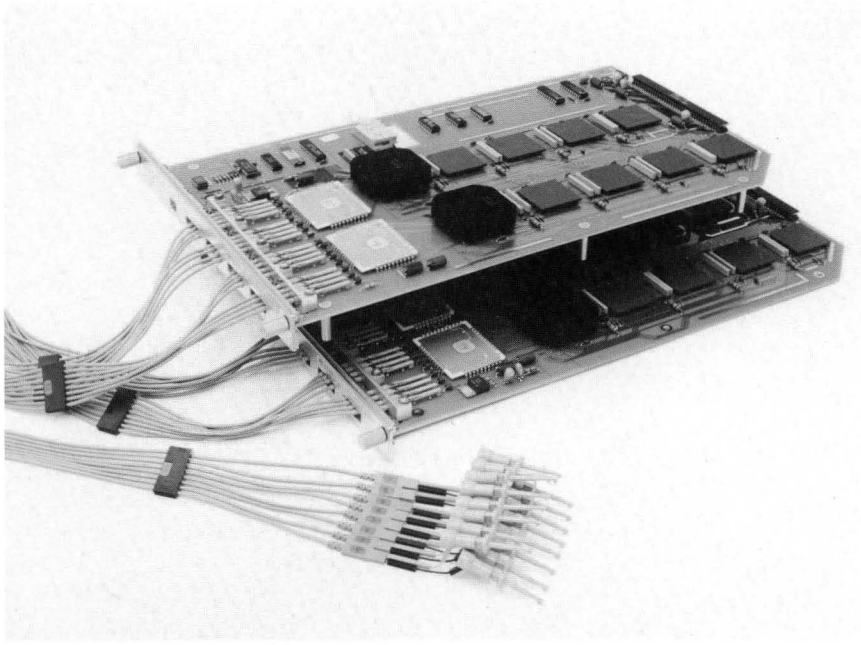
HP 16515A/16516A

1 GHz TIMING ANALYZER MODULE

Service Manual



HEWLETT PACKARD

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SERVICE MANUAL

HP 16515A 1 GHz Timing Analyzer Master Card

And

HP 16516A 1 GHz Timing Analyzer Expansion Card

Manual Part No. 16515-90901
Microfiche Part No. 16515-90801

PRINTED: SEPTEMBER 1988

CERTIFICATION

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

WARRANTY

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

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

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

LIMITATION OF WARRANTY

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

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

EXCLUSIVE REMEDIES

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

ASSISTANCE

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

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

CWA388

SAFETY CONSIDERATIONS

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

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

WARNING

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

SAFETY SYMBOLS

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

Indicates hazardous voltages

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

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

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

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GENERAL INFORMATION

SECTION I
GENERAL INFORMATION

1-1. INTRODUCTION

This service manual contains information for testing and servicing the HP 16515A/16A 1 GHz Timing Analyzer Module. Also included are installation procedures and a list of recommended test equipment.
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 16515A/16A 1 GHz Timing Analyzer Module is contained in the HP 16515A/16A 1 GHz Timing Analyzer Operating and Programming Manual supplied with each module.

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

Listed on the title page of this manual is a Microfiche part number. This number can be used to order 4 X 6 inch microfilm transparencies of the manual. Each microfiche contains up to 96 photoduplicates 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 your system, place this service manual in the 3-ring binder with your Logic Analysis System Service Manual.

1-2. MODULES COVERED BY THIS MANUAL

The information covered in this manual is for the HP 16515A/16A 1 GHz Timing Analyzer Module. If either card has changed, a new card number will be assigned and the manual will be accompanied by a Manual Changes Supplement. This supplement explains the changes and how to adapt the manual to the newer card.

In addition to the change information, the supplement may contain information for correcting errors in the manual. To keep this manual as current and accurate as possible, Hewlett-Packard recommends that you periodically request the latest Manual Changes Supplement.

1-3. 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.

1-4. PRODUCT DESCRIPTION

The HP 16515A/16A 1 GHz Timing Analyzer Module is a high speed timing analyzer with a minimum configuration of 16 channels and is expandable to 32 channels when a HP 16516A Expansion Card is added. The module has passive probing, intermodule triggering and arming capabilities. Some of the main features are:

- 1 GHz timing, providing up to 1 ns single shot resolution.
- 16 channels per HP 16515A Master Card, 16 channels per HP 16516A Expansion Card, and a maximum of 80 channels per HP 16500A.
- 8 Kbits memory per channel.
- Pattern, pattern duration, edge, arm trigger between modules via Intermodule Bus.
- Small lightweight probing.

1-5. ACCESSORIES SUPPLIED

The following accessories are supplied with the HP 16515A/16A 1 GHz Timing Analyzer Module. Quantity one unless shown otherwise.

HP 16515A:

- Operating manual set
- Service manual
- Probe Lead Set Kit (HP 16515-69502) Qty 2
- Probe Assembly (HP 16515-61604) Qty 16
- Grabbers, Set of 20 (HP 5959-0288) Qty 2
- Label Set (HP 16500-94303)

HP 16516A:

- Probe Lead Set Kit (HP 16515-69502) Qty 2
- Probe Assembly (HP 16515-61604) Qty 16
- Grabbers, Set of 20 (HP 5959-0288) Qty 2
- Intercard Connect Cable (HP 16516-61601)
- Screws M3 X 0.5 (HP 0515-1246) Qty 6
- Label Set (HP 16500-94303)

1-6. SPECIFICATIONS AND OPERATING CHARACTERISTICS

Module specifications and operating characteristics are listed in Table 1-1. Specifications are the performance standards against which the module is tested.

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

1-7. RECOMMENDED TEST EQUIPMENT

Equipment required to test and maintain the HP 16515A/16A 1 GHz Timing Analyzer Module is listed in table 1-2. Other equipment may be substituted if it meets or exceeds the critical specifications listed in the table.

Table 1-1. HP 16515A/16A Specifications And Operating Characteristics

HP 16515A/16A SPECIFICATIONS

PROBES

Minimum Swing:

- 500 mV peak-to-peak.

Threshold Accuracy:

- ± 150 mV ± 3.0% over the range 0 volts to + 5 volts.
  ± 150 mV ± 2.0% over the range -3.5 volts to 0 volts.

Dynamic Range:

- ± 7.0 volts

HP 16515A/16A OPERATING CHARACTERISTICS

PROBES

Input RC:

- 10 kΩ ± 2% shunted by approximately 3 pF at the probe tip.

Minimum Input Overdrive:

- 250 mV or 30% of the input amplitude, whichever is greater, above the pod threshold.

Maximum Input Voltage:

- ± 40 volts.

Threshold setting:

- Threshold levels may be defined for each pod individually.

Threshold Range:

- - 3.5 to + 5.0 volts in 0.1 volt increments.

TTL Threshold Preset:

- + 1.5 volts.

ECL Threshold Preset:

- -1.3 volts.

Table 1-1. HP 16515A/16A Specifications And Operating Characteristics (cont.)

ACQUISITION MEMORY

Memory Depth:

- 8192 samples/channel.

Data Channels:

- 2 eight channel pods (16515A).
  4 eight channel pods (16515A/16516A).

Sample Period:

- 1 ns to 1.6 ms dependent on s/Div and delay settings.

TIME INTERVAL ACCURACY *

Timebase Accuracy:

- ± 0.01% of the time interval reading plus:
  ± 500 ps at 250 MHz to 1 GHz sample rate.
  ± 2 ns ≤ 125 MHz sample rate.

Time Interval Accuracy:

- ± Sample Period ± Timebase Accuracy ± (2 ns within pod or 2.5 ns between pods)

TRIGGER

Asynchronous Pattern:

- * Trigger on an asynchronous pattern less than or greater than specified duration, or trigger on a not-equal-to pattern greater than the specified duration. Pattern is the logical AND of specified Low, High, or Don't Care for each assigned channel. If pattern is valid but duration is invalid, there is a 2.6 ns reset time before the instrument is ready to look for the pattern again.

Greater Than Duration :

- Trigger occurs at pattern valid followed by duration expired.

Table 1-1. HP 16515A/16A Specifications And Operating Characteristics (cont.)

Range:

- 2 ns to 507 sample periods for patterns specified within a pod.
  7 ns to 507 sample periods for patterns specified across pods on the same board.
  10 ns to 507 sample periods for patterns specified across boards (16515A and 16516A) within a module.

Resolution:

- 4 sample periods.

Accuracy:

- * ± 2 ns (2 ns setting)
  ± 1 sample period ± :
  2 ns for patterns specified within a pod.
  6 ns specified across pods on the same board.
  8 ns specified across boards within a module.
  (for all other settings)

Less Than Duration:

- * Trigger occurs at the end of the pattern. Patterns specified within a pod must be valid for at least 1.5 ns. Patterns specified across pods on same board must be valid for at least 11 ns. Patterns may not be specified across boards (16515A/16516A).

Range:

- 16 ns to 507 sample periods for patterns specified within a pod.
  20 ns to 507 sample periods for patterns specified across pods on same board.

Resolution:

- 4 sample periods.

Accuracy:

- * ± 1 sample period ± :
  3 ns for patterns specified within a pod and 7 ns for patterns specified across pods on same board.

Edge Trigger:

- Trigger on edge following valid duration of asynchronous pattern. Trigger is the OR of specified rising or falling edges. Less than duration forces edge triggering off.

- * Minimum pulse width: 1.5 ns.

Delay From Trigger To BNC Output Port:

- * Less than 50 ns from the probe tip.

Table 1-1. HP 16515A/16A Specifications And Operating Characteristics (cont.)

DISPLAY FUNCTIONS

Data Display/Entry

Labels

- Channels may be grouped together and given a 6 character name. Up to twenty labels may be assigned with up to 32 channels per label. Primary use is for naming groups of channels such as address, data, and control busses.

Bases:

- Binary, Octal, Decimal, Hexadecimal, ASCII (display only), user-defined symbols.

Activity Indicators:

- Provided in the Format Menu for identifying the current state of input lines as high, low, or changing.

Timing Waveform:

- Interleaved, time-correlated listing of timing waveforms and waveforms from other measurement modules (i.e., another timing analyzer or oscilloscope). Pattern readout of timing waveform at X or O marker in the selected base.

WAVEFORM DISPLAY

Sec/div:

- 1 ns to 1 s adjustable, with 3 digit resolution.

Delay:

- -12.5 s to +53.5 ks.

Accumulate:

- Waveform display is not erased between successive acquisitions.

Overlay Mode:

- Multiple channels can be displayed on one waveform display line. Primary use is to view summary of bus activity.

Maximum Number Of Displayed Waveforms: 24

Marker Functions

Time Interval:

- The X and O markers,shown as dashed lines on the display, measures the time interval between one point on a timing waveform and trigger, two points on the same timing waveform, or two points on different waveforms.

Table 1-1. HP 16515A/16A Specifications And Operating Characteristics (cont.)

Patterns:

- The X and O markers can be used to locate the 0 to 8192 occurrence of a specified pattern before or after trigger. The O marker can also be used to locate the 0 to 8192 occurrences of a pattern before or after the X marker.

Statistics:

- X to O marker statistics are calculated for repetitive acquisitions. Patterns must be specified for both markers, and statistics are updated only when both patterns can be found in an acquisition. Statistics are minimum X to O time, maximum X to O time, average X to O time, and count of valid runs and total runs.

Trigger:

- Displayed as a vertical dashed line in the timing waveform display. Actual location of trigger in memory may vary from marker by ± 4 samples (16515A) and ± 6 samples (16515A/16516A).

ACQUISITION FUNCTIONS

Run:

- Starts acquisition of data in specified trace mode. Single mode acquires data once while repetitive mode repeats single mode acquisitions until STOP is touched or until time interval between two specified patterns is less than or greater than a specified value, or within or outside a specified range.

Stop:

- In single trace mode, or the first run of a repetitive acquisition, STOP halts acquisition and displays the current acquisition data. For subsequent runs in repetitive mode, STOP halts acquisition of data and does not change current display.

Arming:

- By the Run Field or from any other module or the external port-in via the Intermodule Bus.

* These characteristics are true for input signal, VH = -0.90 volts , VL = -1.70 volts, threshold = -1.3 volts, slew rate = 1 V/ns.

Table 1-1. HP 16515A/16A Specifications And Operating Characteristics (cont.)

OPERATING ENVIRONMENT

Temperature:

- Instrument, 0° to 55° C (+32° to 131° F).
  Probe lead sets and cables, 0° to 65° C (+32° to 149° F).

Humidity:

- Instrument, up to 95% relative humidity at +40° C (+104° F).

Altitude:

- To 4600 m (15,000 ft).

Vibration

Operating:

- 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 1-2. Recommended Test Equipment

Instrument	Critical Specification	Recommended Model	Use*
DC VOLTMENTER	3 1/2 DIGIT RESOLUTION	HP 3468A	P,T
PULSE GENERATOR	RINGING ≤ ± 10 % AMPLITUDE ± 10 mV 1.3 µs RISETIME	HP 8161A	P
OSCILLOSCOPE	300 MHz BANDWIDTH	HP 54201	T
POWER SUPPLY	+ 5.30 V TO - 3.72 V OUTPUT; CURRENT 0-0.4 AMP	HP 6216B	P
FUNCTION GENERATOR	SQUARE WAVE ± 7 VOLTS AMPLITUDE; 10 MHz + 5 V TO - 3.5 V OFFSET; < 7 ns RISETIME	HP 8116A	P,T
50 OHM FEEDTHRU		HP 10100C	P,T
BNC TEE	1 MALE, 2 FEMALE	HP 1250-0781	P
BNC Cable	(M-M) 48 INCH QTY 2	HP 10503A	P,T
ADAPTER	BNC (F) TO DUAL BANANA QTY 2	HP 1251-2277	P
GRABBER SET	QTY 1 SET	HP 5959-0288	P,T
PROBE LEAD SET	QTY 1 SET	HP 16515-69502	P,T
EXTENDER BOARD	NO SUBSTITUTE	HP 16500-69004	T
TEST CONNECTOR	BNC (F) PANEL MOUNT	HP 1250-1032	P,T

* A = Adjustments P = Performance Tests T = Troubleshooting

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INSTALLATION

SECTION II
INSTALLATION

2-1. INTRODUCTION

This section explains, how to initially inspect the HP 16515A/16A 1 GHz Timing Analyzer Module, 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 located in Section I.

Procedures for checking electrical performance are in Section III. If the contents of the container are incomplete, there is mechanical damage or defect, or 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 so the carrier can inspect it. 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 the Safety Requirements in Section I before installing or operating this module.

2-4. POWER REQUIREMENTS

All power supplies required for operating the HP 16515A/16A 1 GHz Timing Analyzer Module are supplied to the module through the backplane connector.

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. PROBE ASSEMBLY INSTALLATION

The HP 16515A/16A 1 GHz Timing Analyzer Module comes with probe assemblies installed by the factory. If a probe assembly is to be replaced, refer to "PROBE ASSEMBLY REPLACEMENT" in Section VI of this manual.

2-7. MODULE INSTALLATION

WARNING

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

The HP 16515A 1 GHz Timing Master Card will take up one slot in the card cage. The HP 16516A Expansion Card will require one additional slot directly above the master card. If you are installing the HP 16515A/16A 1 GHz Timing Analyzer Module (one master card or one master card and one expansion card), **follow this procedure**. If you are adding an expansion card to a master card, follow the procedure "ADDING AN EXPANSION CARD" in paragraph 2-8.

CAUTION

The effects of ELECTROSTATIC DISCHARGE can damage electronic components. Use grounded wriststraps and mats when performing any kind of service to this module.

INSTALLATION CONSIDERATIONS:

- A two card module must remain screwed together and installed in two adjacent slots.
- A one card module may be installed in any available slot.
- If previously installed modules prevent proper installation, they must be repositioned in the card cage.
- Cards or filler panels below the empty slots intended for the module installation do not have to be removed.

PROCEDURE:

1. Turn instrument power switch off, unplug power cord and disconnect any input or output connections.
2. Starting **from the top**, loosen thumb screws on filler panel(s) and card(s).

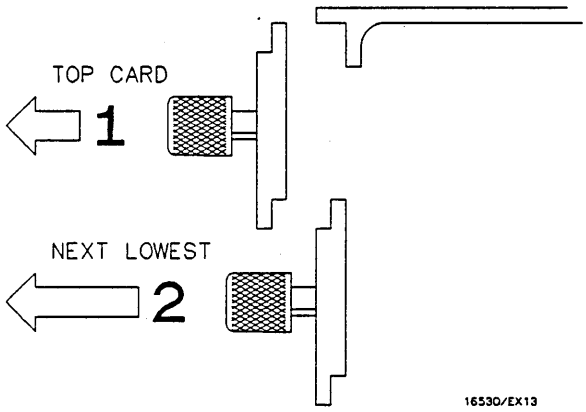
Note

Two card 1 GHz Timing Modules are screwed together. To prevent binding when loosening or tightening thumb screws, use sequence shown in figure 2-2.

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

CAUTION

All multi-card modules will be cabled or screwed together. Care should be taken to pull these cards out together. Refer to the appropriate service books for any specific precautions during installation.



2-1. Endplate Overhang

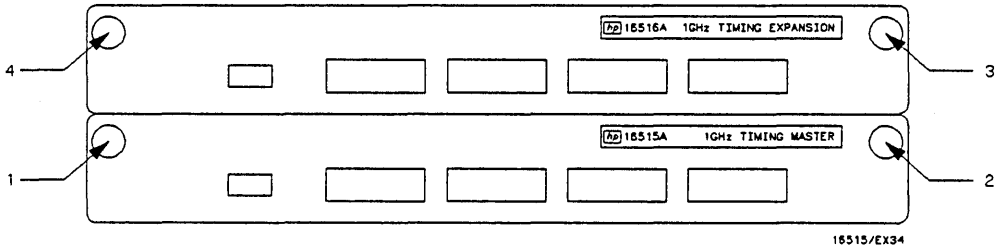
4. If the module consists of one master card, this card can be installed in any available slot. If the module consists of two cards, pick two adjacent slots. Remove the filler panel(s).

5. Slide card(s) approximately **half way** into the slot(s) that you are using for this installation.

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

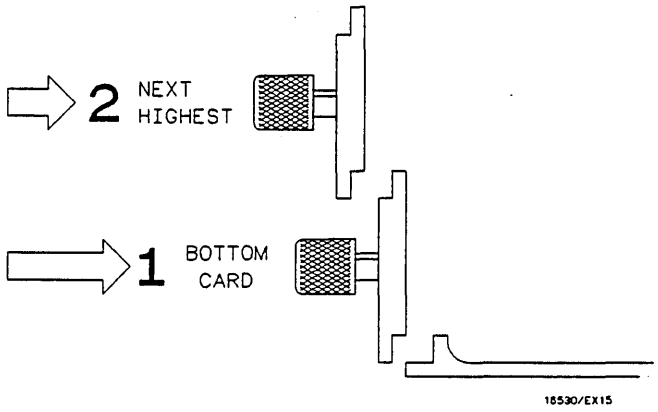
Note

If there are two cards in the timing module, follow the sequence in figure 2-2 for tightening or loosening the thumbscrews.



2-2. Tightening Or Loosening Sequence

7. Repeat step 6 for all cards and filler panels in a **bottom to top** order. See figure 2-3.



2-3. Endplate Overhang

8. 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 AN EXPANSION CARD

This procedure should be used if you are adding an HP 16516A 1 GHz Timing Analyzer Expansion Card to a previously installed HP 16515A 1 GHz Timing Analyzer Master Card.

CAUTION

The effects of ELECTROSTATIC DISCHARGE can damage electronic components. Use grounded wriststraps and mats when performing any kind of service to this module.

INSTALLATION CONSIDERATIONS:

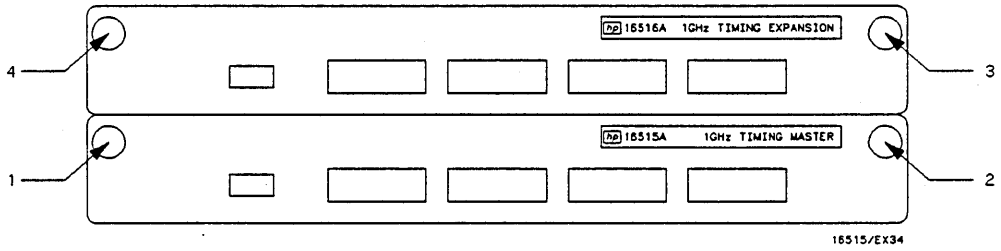
- Cards must be screwed together and installed in two adjacent slots.
- If previously installed modules prevent proper installation, they must be repositioned in the card cage.
- Cards or filler panels below the empty slots intended for the module installation do not have to be removed.

PROCEDURE:

1. Turn instrument power switch off, unplug power cord and disconnect any input or output connections.
2. Starting **from the top**, loosen thumb screws on filler panel(s) and card(s).

Note

Two card 1 GHz Timing Modules are screwed together. To prevent binding when loosening or tightening thumb screws, use sequence shown in figure 2-4.

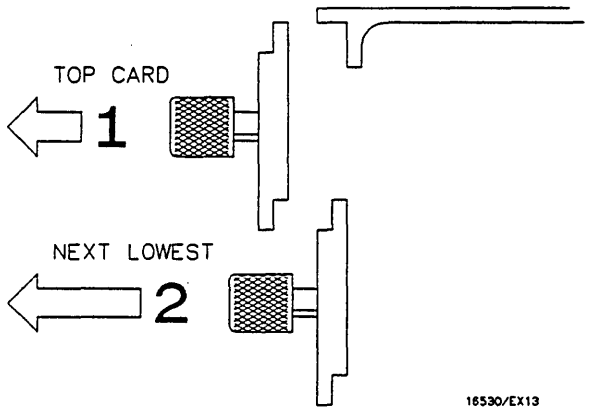


2-4. Tightening Or Loosening Sequence

3. Starting **from the top**, begin pulling card(s) and filler panel(s) out **half way**. See figure 2-5.

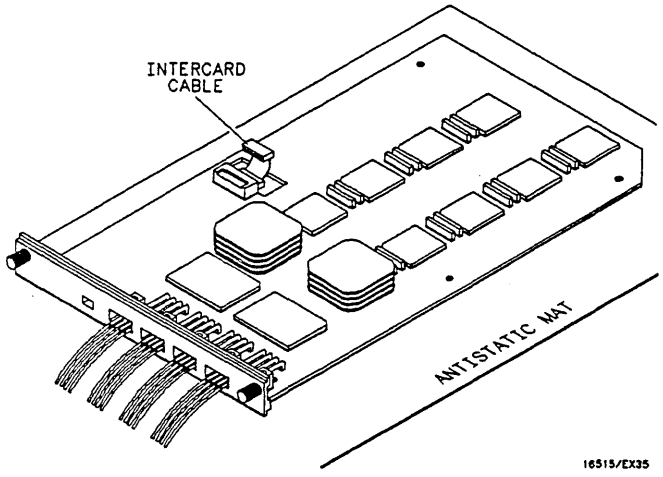
CAUTION

All multi-card modules will be cabled or screwed together. Care should be taken to pull these cards out together. Refer to the appropriate service books for any specific precautions during installation.

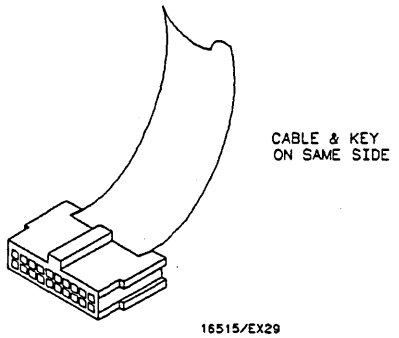


2-5. Endplate Overhang

4. Pull the timing analyzer master card **completely out.**
5. Lay timing analyzer master card on an antistatic mat. See figure 2-6.
6. Connect intercard cable to the timing analyzer master card making sure to use the correct cable end. See figure 2-7.

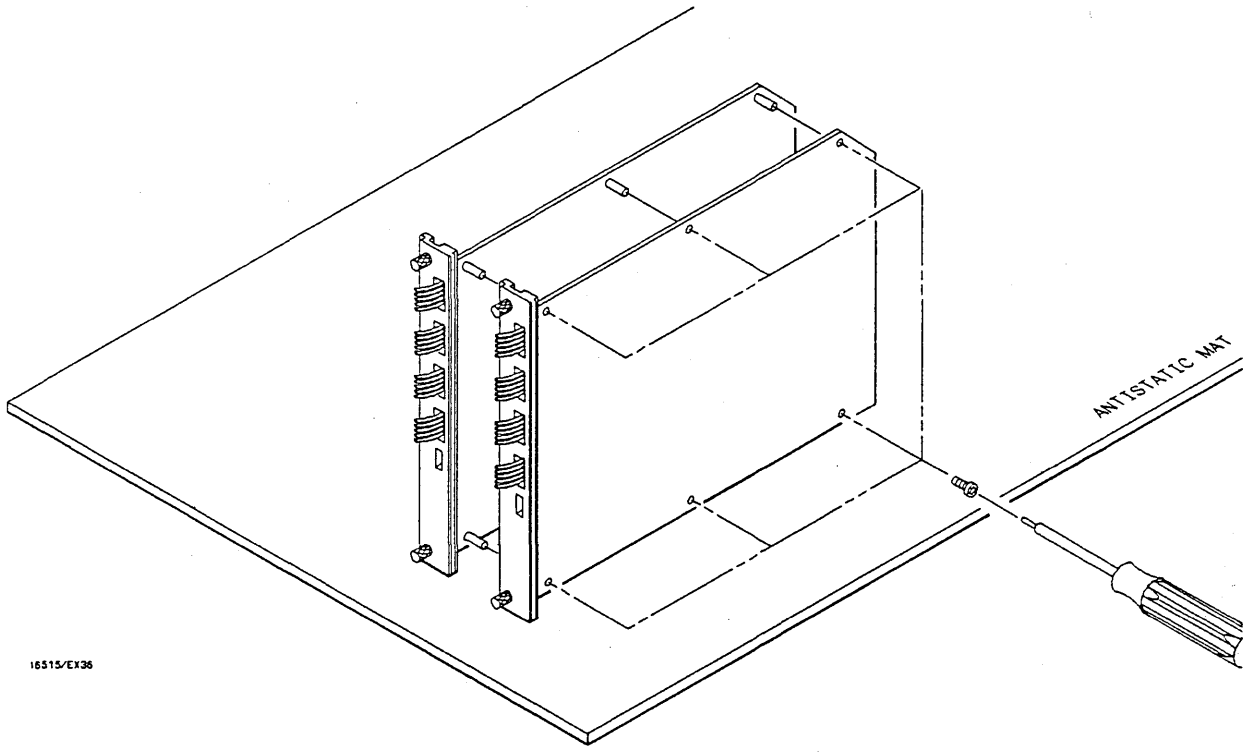


2-6. Card On Mat



2-7. Cable End

7. Fasten the timing analyzer expansion card to the timing analyzer master card using a No. 10 torx ® driver and the six (6) screws furnished with the timing analyzer expansion card. See figure 2-8.



2-8. Cards Fastened Together

8. Connect other end of intercard cable to expansion card.

9. Go to step 4 of paragraph 2-7, "MODULE INSTALLATION", and continue from that point.

2-9. OPERATING ENVIRONMENT

The operating environment is listed in table 1-1. Note the non-condensing humidity limitation. Condensation within the instrument can cause poor operation or malfunction. Protection should be provided against internal condensation. The HP 16515A/16A will operate at all specifications within the temperature and humidity range given in table 1-1. 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

Follow these general instructions 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 with your name and address, the complete board number, and a description of the service required.

TABLE OF CONTENTS

PERFORMANCE TESTS

SECTION III
PERFORMANCE TESTS

3-1. INTRODUCTION

The procedures in this section test the HP 16515A/16A 1 GHz Timing Analyser'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 1-2. 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 on the Performance Test Record (table 3-1) at the end of the procedures. The test record lists all of the tested specifications and their acceptable limits. The results recorded on the test record may be used for comparison in periodic maintenance and troubleshooting or after repairs have been made.

3-4. PERFORMANCE TEST INTERVAL

Periodic performance verification of the HP 16515A/16A 1 GHz Timing Analyzer is required at two year intervals. The instrument's performance should be verified after it has been serviced, or if improper operation is suspected. Further checks requiring access to the interior of the instrument are included in the adjustment section, but are not required for the performance verification.

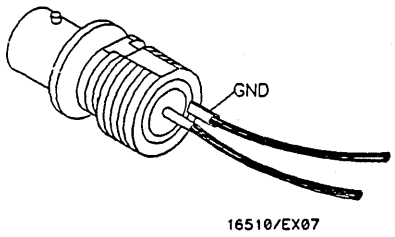
3-5. PERFORMANCE TEST PROCEDURES

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

3-6. TEST CONNECTOR

The performance tests and troubleshooting procedures require connecting pulse generator outputs to probe assembly inputs. Figure 3-1 is a test connector that may be built to allow testing of multiple channels (up to eight at one time). The test connector consists of a BNC connector and two lengths of wire. Connecting more than eight channels to the test connector at a time will induce loading of the circuit and true signal representation will degrade. Test results may not be accurate if more than eight channels are connected to the test connector.

The Hewlett-Packard part number for the BNC connector in figure 3-1 is 1250-1032. An equivalent part may be used in place of the Hewlett-Packard part.



3-1. Test Connector

3-7. Minimum Swing Voltage Test

Description:

This test verifies the minimum swing voltage specification of the input probes and probe hybrid of the HP 16515A and HP 16516A. A square wave input will swing about an ECL level with a precise amplitude of 500 mV. A visual account of approximately one pulse per division with no missing pulses indicates a passed test. One probe (8 channels) is tested at a time.

Specification:

Minimum Swing: 500 mV peak to peak.

Equipment:

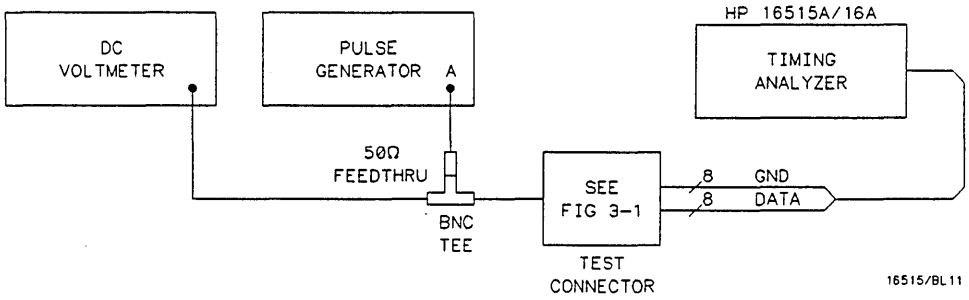
Pulse Generator	HP 8161A
DC Voltmeter	HP 3468A
50 Ohm Feedthru	HP 10100C
BNC Tee	HP 1250-0781
BNC Cable (2)	HP 10503A
Adapter	HP 1251-2277
Test Connector see figure 3-1	

Procedure:

1. Connect the HP 16515A/16A to test equipment as shown in figure 3-2.

Note

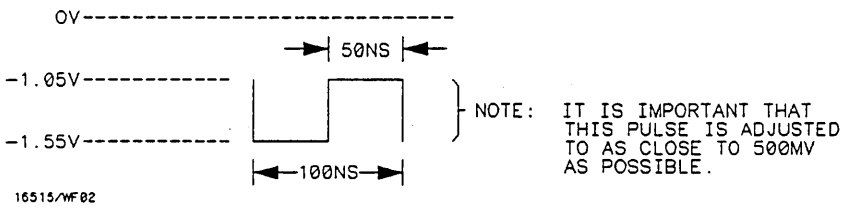
In this setup, eight channels are connected. All ground leads must be grounded to ensure accurate test results.



3-2. Equipment Setup To Verify DC Levels

2. Turn instrument power on.

3. Set pulse generator for the output in figure 3-3.



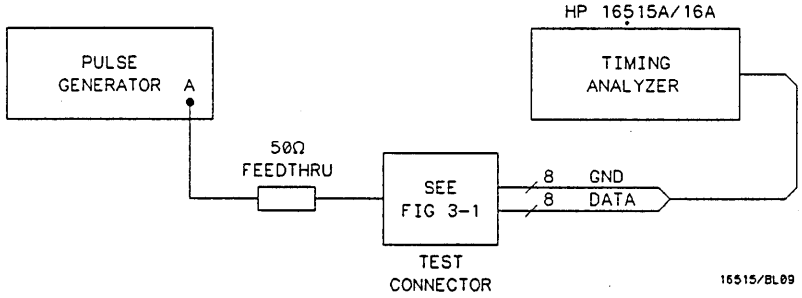
3-3. Pulse Generator Output

Settings for HP 8161A:

Parameter	Output A	Output B
Period (PER)	100 ns	—
Width (WID)	50 ns	50 ns
Leading Edge (LEE)	1.3 ns	1.3 ns
Trailing Edge (TRE)	1.3 ns	1.3 ns
High Level (HIL)	-1.05 V	-1.05 V
Low Level (LOL)	-1.55 V	-1.55 V
Delay (DEL)	0 ns	0 ns
Output Mode	ENABLE	DISABLE
Output	COMPL	—

Input Mode is set to GATE.

4. Adjust High Level (HIL) of pulse, if necessary, until voltmeter reads - 1.05 V.
5. Change channel A output to **NORM**, then adjust Low Level (LOL) of pulse, if necessary, until voltmeter reads - 1.55 V.
6. Set pulse generator Input Mode to **NORM**.
7. Turn instrument power off and connect HP 16515A/16A to test equipment as shown in figure 3-4.



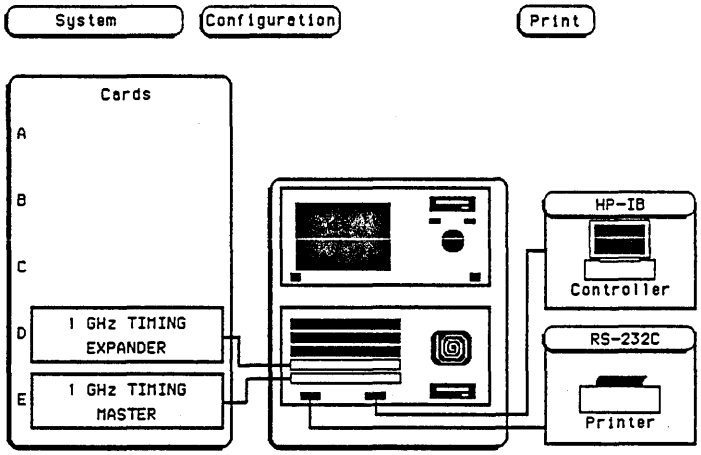
3-4. Equipment Setup For Test

8. Turn instrument power on.

9. From the startup screen shown in figure 3-5, touch the following fields in the ordered sequence below:

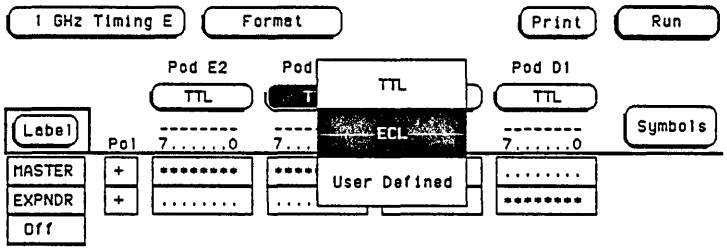
   a. **System**

   b. **1 GHz Timing** (If multiple timing modules, select the one to be tested.)



3-5. Startup Screen

10. In the Format screen, touch pod threshold field as shown in figure 3-6, then touch **ECL.** Repeat for all pods.



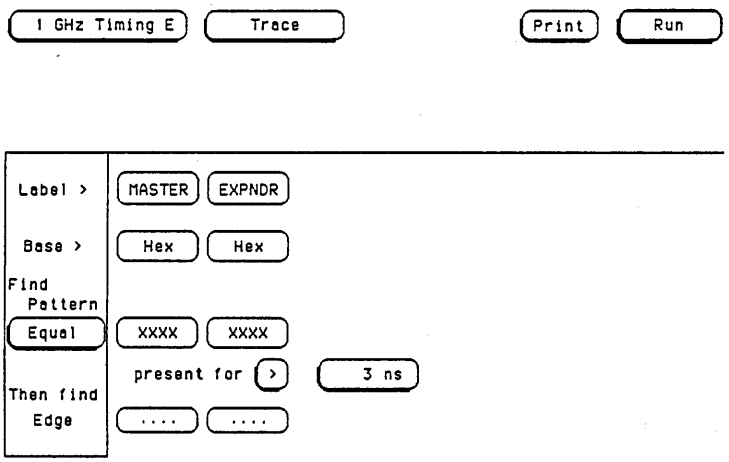
3-6. Pod Threshold Field In Format Screen

Note

The labels default to A and B. For illustration purposes, these were set to A = MASTER and B = EXPNDR.

11. From the Format screen touch **Format**, then touch **Trace.**

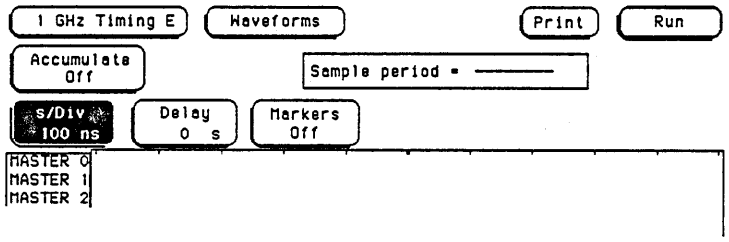
12. Set Trace screen as shown in figure 3-7.



3-7. Trace Screen

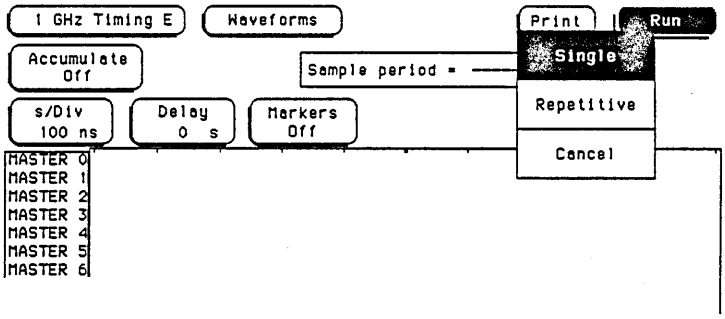
13. From the Trace screen, touch **Trace,** then touch **Waveforms.**

14. In the Waveforms screen, shown in figure 3-8, set the **s/Div** to 100 ns.



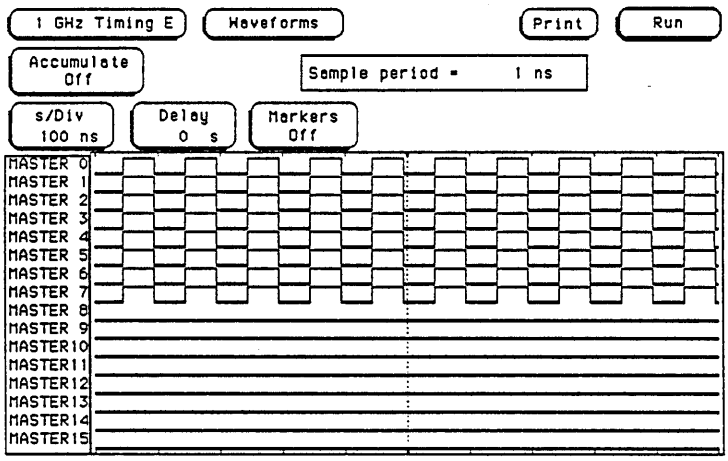
3-8. Waveforms Screen

15. Touch **Run,** then drag finger to **Single.** See figure 3-9.



3-9. Run-Single Field

16. The resulting waveforms should look like figure 3-10. Adjust the delay to line up pulse edge with center screen graticule. There should be approximately 1 pulse per division with no missing pulses.



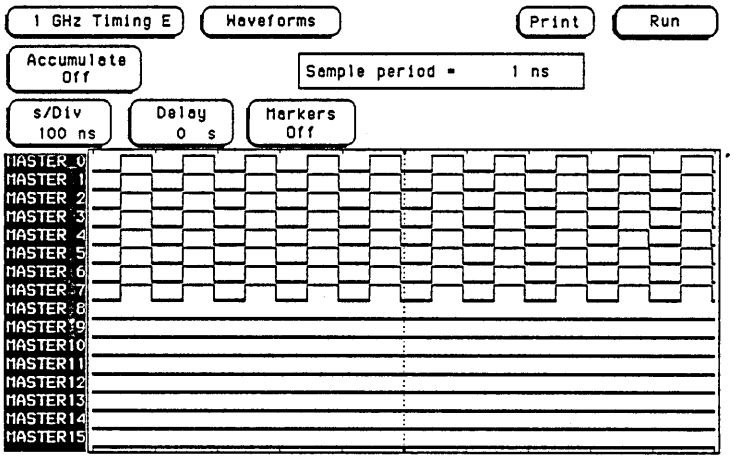
3-10. Test Waveforms

17. Disconnect probe assemblies from master pod 1 and connect master pod 2.

18. Repeat steps 15 and 16 for pod 2 probe assemblies.

19. If there is an HP 16516A 1 GHz Timing Analyzer Expansion Card in the module, continue with steps 20 through 23.

20. In the Waveforms screen touch the input **Label** field as shown in figure 3-11.



3-11. Input Label Field

21. In the Waveforms screen touch the following fields in the ordered sequence below:

    a. **Action Insert** (toggles to Replace)

    b. **EXPNDR** (or **B** if labels are left at default)

    c. **Done**

Note

The labels default to A and B. For illustration purposes, these were set to A = MASTER and B = EXPNDR.

22. Connect expander pod 1 probe assemblies and repeat steps 15 and 16.

23. Connect expander pod 2 probe assemblies and repeat steps 15 and 16.

3-8. Threshold Accuracy Test

Description:

This test verifies the threshold accuracy within the two ranges stated in the specification. Threshold levels set at specified limits are applied. A passed test will show the correct logic state for the dc level input with respect to the programmed threshold. One pod (8 channels) is tested at a time.

Specification:

± 150 mV ± 3.0% over the range of 0 V to + 5 V.
± 150 mV ± 2.0% over the range - 3.5 V to 0 V.

Equipment:

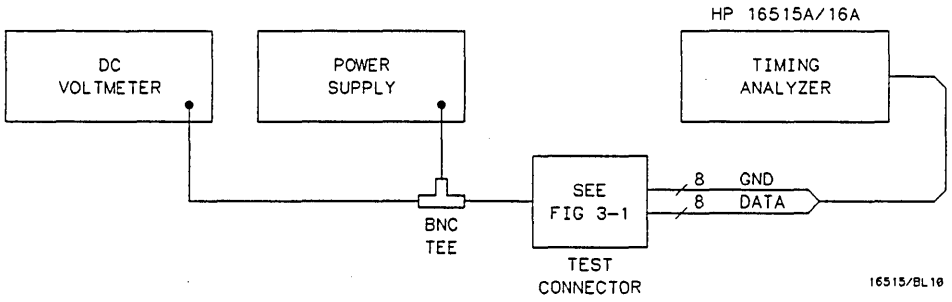
Power Supply ..... HP 6216B
DC Voltmeter ..... HP 3468A
BNC Tee ..... HP 1250-0781
Adapter (2) ..... HP 1251-2277
BNC Cable (2) ..... HP 10503A
Test Connector see figure 3-1

Procedure:

1. Connect the HP 16515A/16A and test equipment as in figure 3-12.

Note

In this setup, eight channels are connected at a time. All ground leads must be grounded to ensure accurate test results.



3-12. Test Equipment Setup

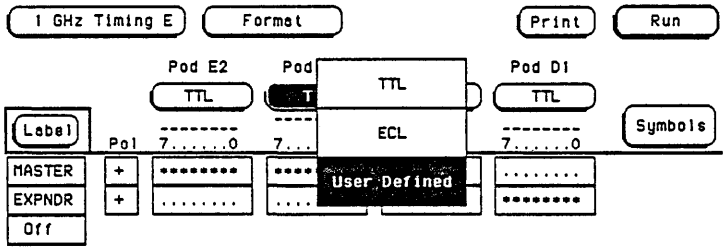
2. Turn instrument power on.

3. From the startup screen shown in figure 3-5 of previous test, touch the following fields in the ordered sequence below:

   a. **System**

   b. **1 GHz Timing** (If multiple HP 16515A/16A modules, pick the one to test.)

4. In the Format screen, touch pod threshold field for the pod under test. See figure 3-13.



3-13. Pod Threshold Field

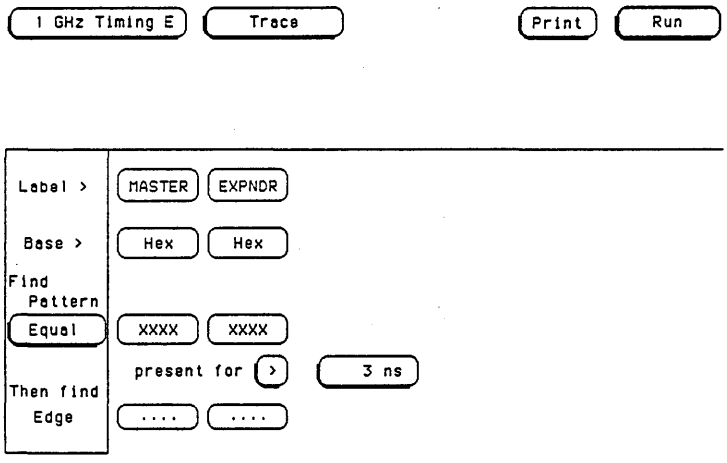
Note

The labels default to A and B. For illustration purposes, these were set to A = MASTER and B = EXPNDR.

5. Touch **User Defined** and using keypad, set threshold to **+ 5 Volts**, then touch **DONE.**

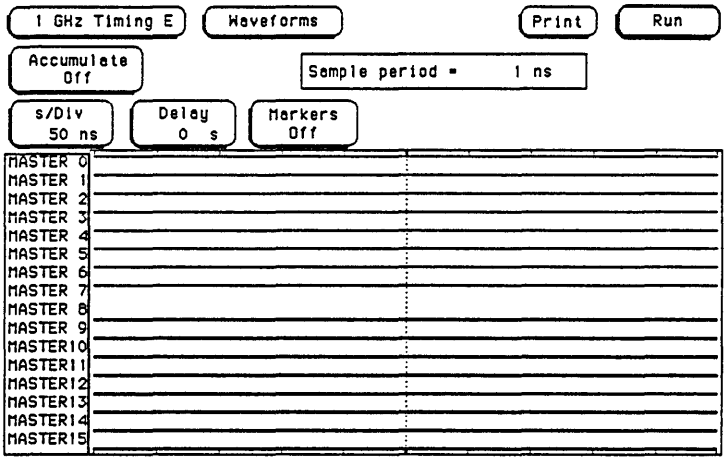
6. From the Format screen, touch **Format**, then touch **Trace.**

7. Set Trace screen as shown in figure 3-14.



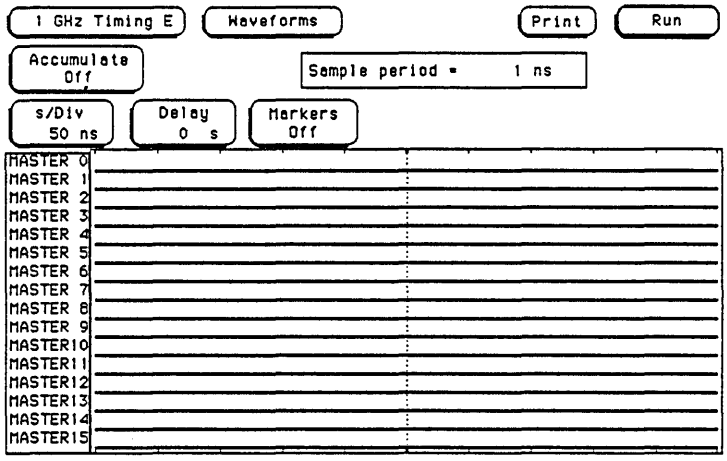
3-14. Trace Screen

8. From the Trace screen touch **Trace**, then touch **Waveforms**.
9. In the Waveforms screen set the **s/Div** to 50 ns.
10. Set power supply to output + 5.30 Volts.
11. Touch **Run** then drag finger to **Single**.
12. Data displayed on Waveforms screen will be all high for probes under test. See figure 3-15.



3-15. Waveform Data

13. Adjust power supply for an output of + 4.70 Volts, then touch **Run**.
14. Data displayed on Waveforms screen will be all low for probes under test. See figure 3-16.



3-16. Waveform Data

15. Touch **Waveforms**, then touch **Format**. In the Format screen, select pod threshold field for the pod under test, then touch **User Defined** threshold and set to - 3.5 Volts.
16. Adjust power supply for an output of - 3.28 Volts.

17. Touch **Format** then touch **Waveforms.**

18. In the Waveforms screen, touch **Run.**

19. Data displayed on the Waveforms screen will be all high for probes under test as in previous figure 3-15.

20. Adjust power supply for an output of - 3.72 Volts, then touch **Run.**

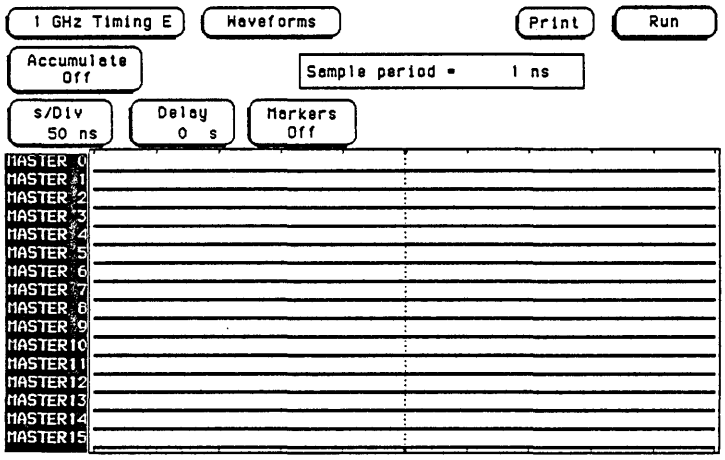
21. Data displayed on the Waveforms screen will be all low for probes under test as in previous figure 3-16.

22. Disconnect master pod 1 probes and connect master pod 2 probes to test connector.

23. Touch **Waveforms**, then touch **Format** and repeat steps 4 through 21 for master pod 2.

24. If there is an HP 16516A 1 GHz Timing Analyzer Expansion Card in the module, continue with steps 25 through 27.

25. In the Waveforms screen, touch the Label field as shown in figure 3-17.



3-17. Label Field

26. In the Waveforms Selection screen, touch the following fields in the ordered sequence below:

    a. **Action Insert** (toggles to Replace)

    b. **Expndr** (or **B** if label field is left at default)

    c. **Done**

27. Touch **Waveforms**, then touch **Format** and repeat steps 4 through 21 for expansion pod 1 and expansion pod 2.

3-9. Dynamic Range Test

Description:

This test verifies the dynamic range of each pod by ensuring that probe assemblies do not saturate. A square wave with dc levels set at specified limits is applied. A visual account of one positive pulse per division at a duty cycle of approximately 50 ns ± 4 ns indicates a passed test.

Specification:

Dynamic Range: ± 7 Volts.

Equipment:

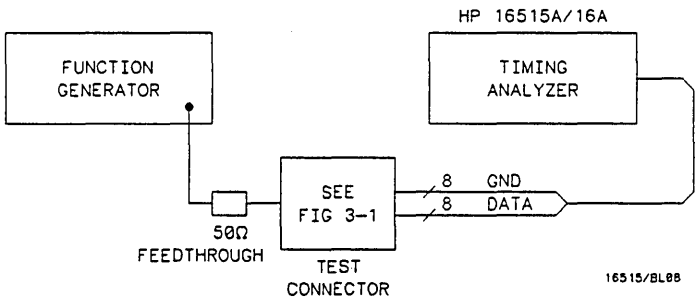
Function Generator ..... HP 8116A
BNC Cable ..... HP 10503A
50 Ohm Feedthru ..... HP 10100C
Test Connector see figure 3-1

Procedure:

1. Connect the HP 16515A/16A and test equipment as in figure 3-18.

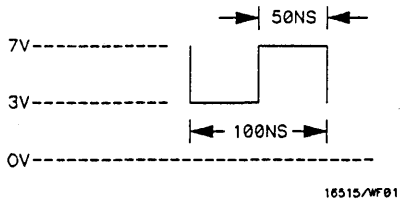
Note

In this setup, eight channels are connected at a time. All ground leads must be grounded to ensure accurate test results.



3-18. Test Equipment Setup

2. Set function generator output for a 10 MHz square wave as shown in figure 3-19.



3-19. Square Wave Pulse

Setting for HP 8116A:

Parameter	Setting
Mode	NORM
Waveform	Square Wave
Frequency	10 MHz
Duty Cycle	50 %
High Level (HIL)	+ 7 Volts
Low Level (LOL)	+ 3 Volts
Output Mode	ENABLE

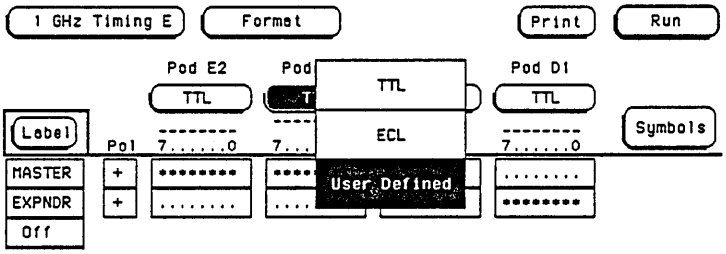
3. Turn instrument power on.

4. From the startup screen shown in figure 3-5 in previous test, touch the following fields in the ordered sequence below:

   a. **System**

   b. **1 GHz Timing** (If multiple timing modules, pick the one to test)

5. In the Format screen, touch pod threshold field for pod under test. See figure 3-20.

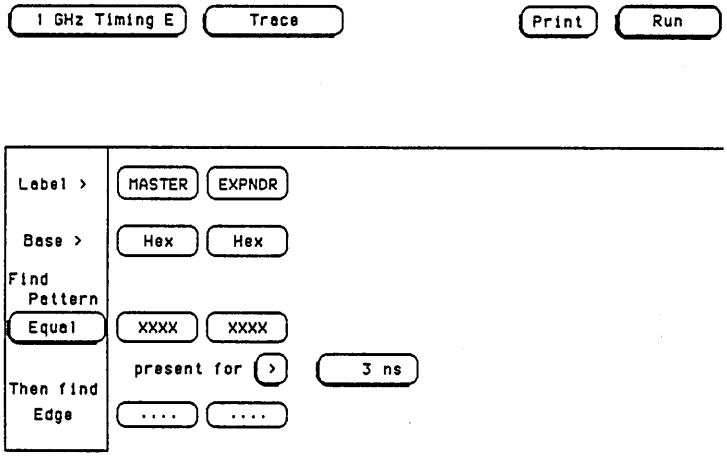


3-20. Pod Threshold Field

6. Touch **User Defined** and set threshold, using pop-up keypad, to **+ 5 Volts**, then touch **DONE.**

7. From the Format screen, touch **Format**, then touch **Trace.**

8. Set Trace screen as shown in figure 3-21.

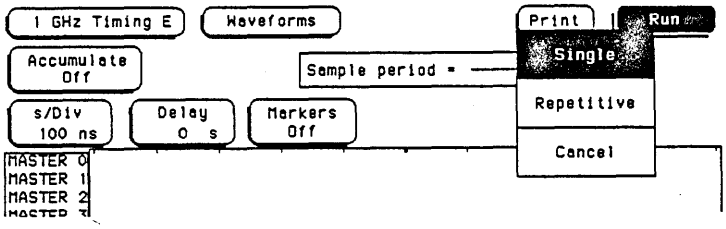


3-21. Trace Screen

9. From the Trace screen touch **Trace**, then touch **Waveforms.**

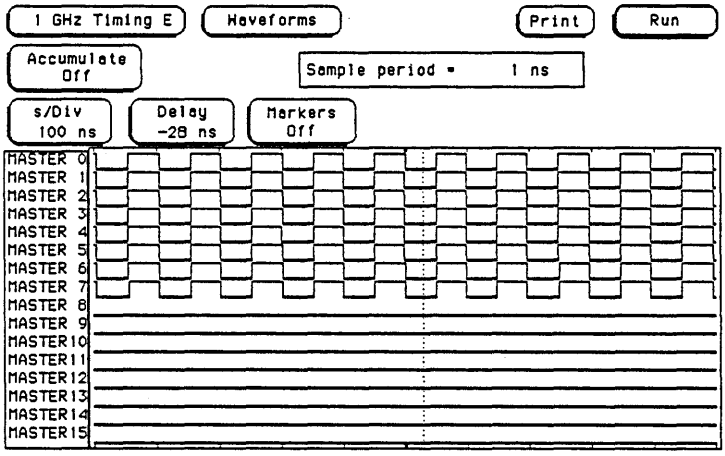
10. In the Waveforms screen set the **s/Div** to 100 ns.

11. Touch **Run** then drag finger to **Single**. See figure 3-22.



3-22. Run-Single Field

12. The resulting waveforms should look like figure 3-23. Adjust the delay to line up pulse edge with center screen graticule. There should be 1 pulse per division at a duty cycle of approximately 50 %.



3-23. Waveform Data

Note

Nonsaturated input channels will display a positive pulse width of 50 ns ± 4 ns.

13. Adjust function generator LOL to -7 volts and the HIL to 0 volts.

14. Touch **Waveforms**, then touch **Format.**

15. In the Format screen, touch the pod threshold field for pod under test and select **User Defined.** Set threshold for **- 3.5 Volts.**

16. Touch **Format**, then touch **Waveforms.**

17. In the waveforms screen touch **Run.**

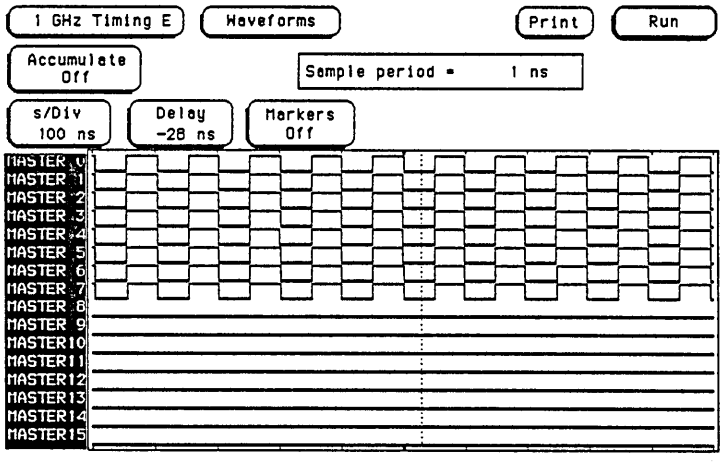
18. The resulting waveform should look like the previous figure 3-23.

19. Disconnect master pod 1 probes and connect master pod 2 probes to the test connector.

20. Touch **Waveforms**, then touch **Format.** Reset function generator as in step 2 and repeat steps 5 through 18.

21. If there is an HP 16516A Expansion Card in the module, continue with steps 22 through 24.

22. In the Waveforms screen, touch the Label field as shown in figure 3-24.



3-24. Label Field

23. In the Waveforms Selection screen, touch the following fields in the ordered sequence below:

    a. **Action Insert** (toggles to Replace)

    b. **Expndr** (or **B** if label field is left at default)

    c. **Done**

24. Touch **Waveforms**, then touch **Format.** Reset function generator as in step 2 and repeat steps 5 through 20 for expansion pod 1 and expansion pod 2.

Table 3-1. Performance Test Record

Hewlett-Packard	Tested By_____
Model 16515A/16A	Work Order No._____
1 GHz Timing Analyzer	Date Tested_____
Board No._____	

Paragraph	Test	Results	
3-7	Minimum Swing Voltage	Passed	Failed
	Master Pod 1 (0-7)	_____	_____
	Master Pod 2 (8-15)	_____	_____
	Expndr Pod 1 (0-7)	_____	_____
	Expndr Pod 2 (8-15)	_____	_____
3-8	Threshold Accuracy	Passed	Failed
	Threshold setting: + 5 Volts		
	Master Pod 1 (0-7)	_____	_____
	Master Pod 2 (8-15)	_____	_____
	Expndr Pod 1 (0-7)	_____	_____
	Expndr Pod 2 (8-15)	_____	_____
	Threshold setting: - 3.5 Volts		
	Master Pod 1 (0-7)	_____	_____
	Master Pod 2 (8-15)	_____	_____
	Expndr Pod 1 (0-7)	_____	_____
	Expndr Pod 2 (8-15)	_____	_____

Table 3-1. Performance Test Record

Paragraph	Test	Results
3-9	Dynamic Range	Passed Failed
	Master Pod 1 (0-7)	_____ _____
	Master Pod 2 (8-15)	_____ _____
	Expndr Pod 1 (0-7)	_____ _____
	Expndr Pod 2 (8-15)	_____ _____

SECTION IV
ADJUSTMENTS

4-1. ADJUSTMENT AND CALIBRATION

This section normally provides information on when to calibrate, how to calibrate, and how to adjust the module. The HP 16515A/16A Timing Analyzer Module has no adjustments and requires no calibration.

TABLE OF CONTENTS

REPLACEABLE PARTS

SECTION V
REPLACEABLE PARTS

5-1. INTRODUCTION

This section contains parts and ordering information for the HP 16515A/16A 1 GHz Timing Analyzer Module. Table 5-1 lists the reference designators 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. This was done 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:

- Electrical assemblies in alphanumerical order by reference designation.
- Chassis-mounted parts in alphanumerical order by reference designation.
- Electrical assemblies and their components in alphanumerical order by reference designation.

The information given for each part consists of the following:

- Complete reference designation.
- Hewlett-Packard part number.
- Total quantity (Qty) per instrument.
- Description of part.
- 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 an 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 an exchange 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:

- Direct ordering and shipment from Hewlett-Packard Parts Center in Mountain View, California.
- 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).
- Prepaid transportation (there is a small handling charge for each order).
- No invoices - to provide these advantages, check or money order must accompany each order. Mail order forms and specific ordering information are available through your local Hewlett-Packard offices.

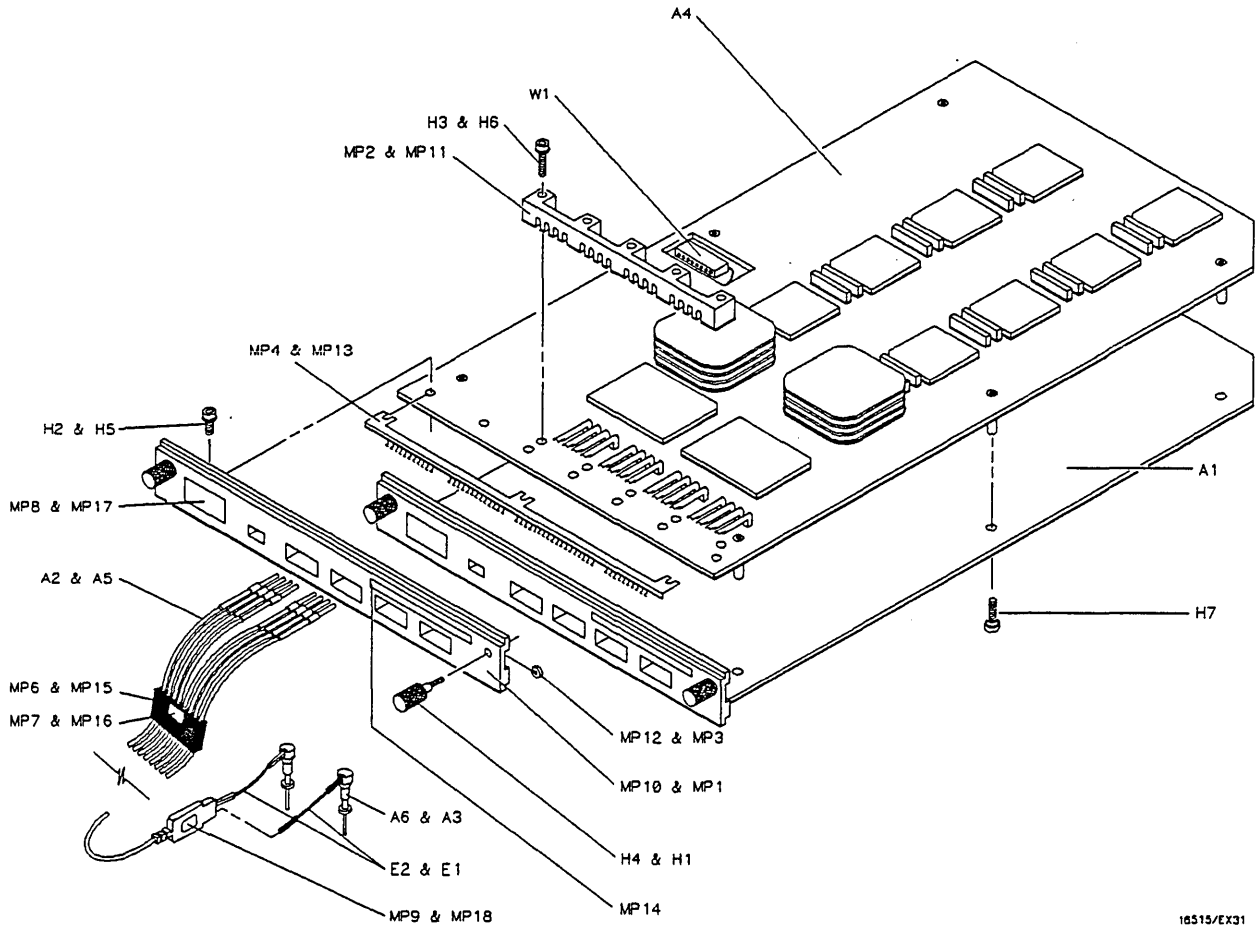
Table 5-1. Reference Designator and Abbreviations

REFERENCE DESIGNATOR

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

ABBREVIATIONS

A	= amperes	DWL	= dowel	MFR	= manufacturer	RND	= Round
A/D	= analog-to-digital	ECL	= emitter coupled logic	MICPROC	= microprocessor	ROM	= read-only memory
AC	= alternating current	ELAS	= elastomeric	MINTR	= miniature	RPG	= rotary pulse generator
ADJ	= adjust(ment)	EXT	= external	MISC	= miscellaneous	RX	= receiver
AL	= aluminum	F	= farads;metal film (resistor)	MLD	= molded	S	= Schottky-clamped; seconds(time)
AMPL	= amplifier	FC	= carbon film/ composition	MM	= millimeter	SCR	= screw;silicon controlled rectifier
ANLG	= analog	FD	= feed	MO	= metal oxide	SEC	= second(time);secondary
ANSI	= American National Standards Institute	FEM	= female	MTG	= mounting	SEG	= segment
ASSY	= assembly	FF	= flip-flop	MTLC	= metallic	SEL	= selector
ASTIG	= astigmatism	FL	= flat	MUX	= multiplexer	SGL	= single
ASYNCHRO	= asynchronous	FM	= foam;from	MW	= milliwatt	SHF	= shift
ATTEN	= attenuator	FR	= front	N	= nano(10-9)	SI	= silicon
AWG	= American wire gauge	FT	= gain bandwidth product	NC	= no connection	SIP	= single in-line package
BAL	= balance	FW	= full wave	NMOS	= n-channel metal-oxide-semiconductor	SKT	= skirt
BCD	= binary-code decimal	FXD	= fixed	NPN	= negative-positive-negative	SL	= slide
BD	= board	GEN	= generator	NPRN	= neoprene	SLDR	= solder
BFR	= buffer	GND	= ground(ed)	NRFR	= not recommended for field replacement	SLT	= slot(ted)
BIN	= binary	GP	= general purpose	NSR	= not separately replaceable	SOLD	= solenoid
BRDG	= bridge	GRAT	= graticule	NUM	= numeric	SPCL	= special
BSHG	= bushing	GRV	= groove	OBD	= order by description	SQ	= square
BW	= bandwidth	H	= henries;high	OCTL	= octal	SREG	= shift register
C	= ceramic;cermet (resistor)	HD	= hardware	OD	= outside diameter	SRQ	= service request
CAL	= calibrate;calibration	HDND	= hardened	OP AMP	= operational amplifier	STAT	= static
CC	= carbon composition	HG	= mercury	OSC	= oscillator	STD	= standard
CCW	= counterclockwise	HGT	= height	P	= plastic	SYNCHRO	= synchronous
CER	= ceramic	HLCL	= helical	P/O	= part of	TA	= tantalum
CFM	= cubic feet/minute	HORIZ	= horizontal	PC	= printed circuit	TBAX	= tubeaxial
CH	= choke	HP	= Hewlett-Packard	PCB	= printed circuit board	TC	= temperature coefficient
CHAM	= chamfered	HP-IB	= Hewlett-Packard Interface Bus	PD	= power dissipation	TD	= time delay
CHAN	= channel	HR	= hour(s)	PF	= picofarads	THD	= thread(ed)
CHAR	= character	HV	= high voltage	PI	= plug in	THK	= thick
CM	= centimeter	HZ	= Hertz	PL	= plate(d)	THRU	= through
CMOS	= complementary metal-oxide-semiconductor	I/O	= input/output	PLA	= programmable logic array	TP	= test point
CMR	= common mode rejection	IC	= integrated circuit	PLST	= plastic	TPG	= tapping
CNDCT	= conductor	ID	= inside diameter	PNP	= positive-negative-positive	TPL	= triple
CNTR	= counter	IN	= inch	POLYE	= polyester	TRANS	= transformer
CON	= connector	INCL	= include(s)	POS	= positive;position	TRIG	= trigger(ed)
CONT	= contact	INCAND	= incandescent	POT	= potentiometer	TRMR	= trimmer
CRT	= cathode-ray tube	INP	= input	POZI	= pozidrive	TRN	= turn(s)
CW	= clockwise	INTEN	= intensity	PP	= peak-to-peak	TTL	= transistor-transistor
D	= diameter	INTL	= internal	PPM	= parts per million	TX	= transmitter
D/A	= digital-to-analog	INV	= inverter	PRCN	= precision	U	= micro(10-6)
DAC	= digital-to-analog converter	JFET	= junction field-effect transistor	PREAMP	= preamplifier	UL	= Underwriters Laboratory
DARL	= darlington	JKT	= jacket	PRGMBL	= programmable	UNREG	= unregulated
DAT	= data	K	= kilo(103)	PRL	= parallel	VA	= voltampere
DBL	= double	L	= low	PROG	= programmable	VAC	= volt,ac
DBM	= decibel referenced to 1mW	LB	= pound	PSTN	= position	VAR	= variable
DC	= direct current	LCH	= latch	PT	= point	VCO	= voltage-controlled oscillator
DCDR	= decoder	LCL	= local	PW	= potted wirewound	VDC	= volt,dc
DEG	= degree	LED	= light-emitting diode	PWR	= power	VERT	= vertical
DEMUX	= demultiplexer	LG	= long	R-S	= reset-set	VF	= voltage,filtered
DET	= detector	LI	= lithium	RAM	= random-access memory	VS	= versus
DIA	= diameter	LK	= lock	RECT	= rectifier	W	= watts
DIP	= dual in-line package	LKWR	= lockwasher	RET	= retainer	W/	= with
DIV	= division	LS	= low power Schottky	RF	= radio frequency	W/O	= without
DMA	= direct memory access	LV	= low voltage	RGLTR	= regulator	WW	= wirewound
DPDT	= double-pole, double-throw	M	= mega(106);megohms; meter(distance)	RGTR	= register	XSTR	= transistor
DRC	= DAC refresh controller	MACH	= machine	RK	= rack	ZNR	= zener
DRVR	= driver	MAX	= maximum	RMS	= root-mean-square	oC	= degree Celsius (Centigrade)
						oF	= degree Fahrenheit
						oK	= degree Kelvin



5-1. Parts Identification

Table 5-2. Replaceable Parts List

Reference Designator	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
	16515-13510	4	1	HP 16515A/16A Oper System Disc		
	16515-69501	1	1	HP 16515A Exchange Assy.		
	16516-69501	2	1	HP 16516A Exchange Assy.		
				HP 16515A		
A1	16515-66501	5	1	Board Assembly		
A2	16515-61604	9	16	Probe Assembly		
A3	5959-0288	4	2	Grabber Assembly Set Qty 20		
E1	16515-69502	2	2	Probe Lead Set Kit		
H1	16500-22401	5	2	Endplate Thumbscrew		
H2	0515-0430	3	3	M3 X 6 PH T10 Endplate Screw		
H3	0515-0665	6	4	M3 X 14 PH T10 Retainer Screw		
MP1	16515-40503	3	1	Card Endplate		
MP2	16515-01201	6	1	Probe Assembly Retainer		
MP3	0510-0684	9	2	Thumbscrew Retaining Ring		
MP4	16500-29101	6	1	Ground Spring		
MP5	16515-94302	3	1	Timing Master Label		
MP6	16515-43102	4	2	Probe ID Clip		
MP7	16500-94303	7	1	Probe ID Clip Label Set		
MP8	5959-0291	9	1	Serial Tag		
MP9	16515-94303	4	1	Probe Assembly Label Set		
				HP 16516A		
A4	16516-66501	6	1	BoardAssembly		
A5	16515-61604	9	16	Probe Assembly		
A6	5959-0288	4	2	Grabber Assembly Set Qty 20		
E2	16515-69502	2	2	Probe Lead Set Kit		
H4	16500-22401	5	2	Endplate Thumbscrew		
H5	0515-0430	3	3	M3 X 6 PH T10 Endplate Screw		
H6	0515-0665	6	4	M3 X 14 PH T10 Retainer Screw		
H7	0515-1246	1	6	M3 X 0.5 Mach. Card Screw		
MP10	16515-40503	3	1	Card Endplate		
MP11	16515-01201	6	1	Probe Assembly Retainer		
MP12	0510-0684	9	2	Thumbscrew Retaining Ring		
MP13	16500-29101	6	1	Ground Spring		
MP14	16516-94301	4	1	Timing Expansion Label		
MP15	16515-43102	4	2	Probe ID Clip		
MP16	16500-94303	7	1	Probe ID Clip Label Set		
MP17	5959-0291	9	1	Serial Tag		
MP18	16515-94303	4	1	Probe Assembly Label Set		
W1	16516-61601	7	1	Ribbon Cable Assembly		

TABLE OF CONTENTS

SERVICE

SECTION VI
SERVICE

6-1. INTRODUCTION

This section contains information for servicing the HP 16515A/16A 1 GHz Timing Analyzer Module. Included is a block level theory and procedures for module level self diagnostics and troubleshooting. If the module or a probe assembly is determined faulty, procedures are provided for module and probe assembly replacement.

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 1-2 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 16515A/16A Service Data Supplement is required. This supplement contains schematics, component level theory of operation, component locaters and a parts list for the HP 16515A/16A 1 GHz Timing Analyzer Module.

The HP 16515A 1 GHz Timing Analyzer Master Card is a one board, 16 channel timing analyzer. It can sample data at up to a 1 GHz rate and be expanded by 16 channels to a total of 32 channels when a HP 16516A 1 GHz Timing Expansion Card is added. See figure 6-1.

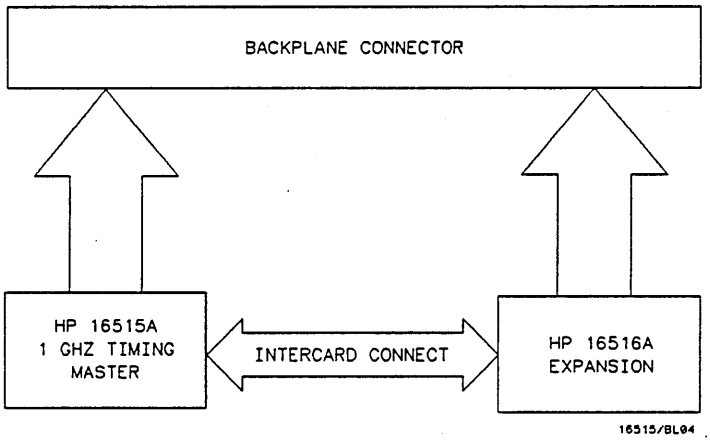


Figure 6-1. Module Block Diagram

HP 16515A Master Card

INTERFACE AND IMB

The microprocessor interface circuits include the system data transceiver, decoders for module control lines, a card ID latch, and intermodule bus (IMB) circuits. The IMB enables the timing analyzer module to trigger/arm other modules or be triggered/armed by the state of another module in the mainframe.

PROBES

The probes are a passive design. Each of the two probe pods contains 8 data input lines with grounding at the probe tips.

POD LOADING AND COMPARATORS

Input data from the probe pods are loaded by an RC network and compared to a pod threshold. The comparators then translate the input signals to ECL levels.

TIMEBASE, TRIGGER AND MEMORY

The timebase is comprised of three major interactive components. Collectively they generate sample clocks and control prestore and poststore delays.

The two 8 channel acquisition circuits are identical except for the operation of the trigger circuitry. One acquisition chip is the designated control chip. While pattern and edge detection is performed on unsampled data for each 8 channel data slice, the results are combined in the control chip. The control chip then performs duration count and final trigger detection for the module.

Data is sampled on both edges of the sample clock. The maximum sample clock rate of 500 MHz will in effect sample at 1 GHz. After sampling, the data is slowed down by a factor of four and is stored in memory.

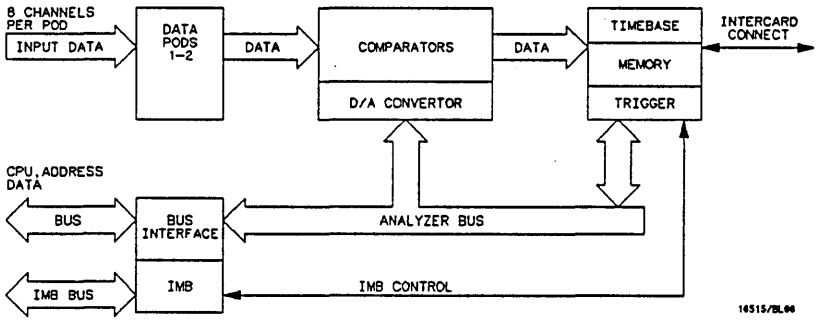


Figure 6-2. HP 16515A 1 GHz Timing Master Block Diagram

HP 16516A Expansion Card

INTERFACE

The microprocessor interface circuits are minimal. They include a system data transceiver and a card ID latch. The clock and control lines are brought onto the expansion card through the intercard connect cable or decoded from the system backplane.

PROBES

The probes are identical to the master card probing scheme. Each probe pod contains 8 data input lines with grounding at the probe tip.

POD LOADING AND COMPARATORS

Input data from the probe pods are loaded by an RC network and compared to a pod threshold. The comparators then translate the input signals to ECL levels.

TRIGGER AND MEMORY

The two 8 channel acquisition circuits are identical. Pattern and edge detection are performed on unsampled data for each 8 channel data slice and the results are transmitted to the control chip on the master card.

Data is sampled on both edges of the sample clock. The maximum sample clock rate of 500 MHz will in effect sample at 1 GHz. After sampling, the data is slowed down by a factor of four and is stored in memory.

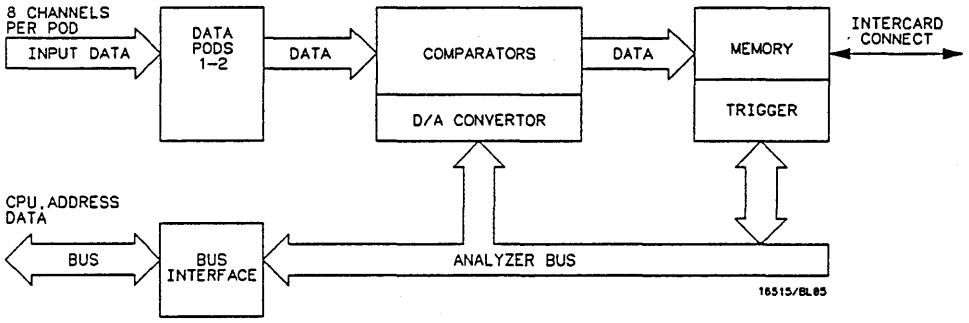


Figure 6-3. HP 16516A 1 GHz Timing Expansion Block Diagram

6-5. SELF TESTS

Self tests for the HP 16515A/16A 1 GHz Timing Analyzer 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 timing modules, each must be selected for testing 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 flowchart in paragraph 6-6 will instruct you to change one or both cards in the module, a probe assembly, or the intercard cable.

The following procedure outlines how to access, run, and exit the self tests utilities. One test is used as an example in the procedure. Individual test definitions appear at the end of the test procedure.

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.

Self Test Access Procedure:

1. Disconnect all inputs and turn power switch on.
2. From the startup screen shown in figure 6-4, touch **Configuration** field, then touch **Test.**

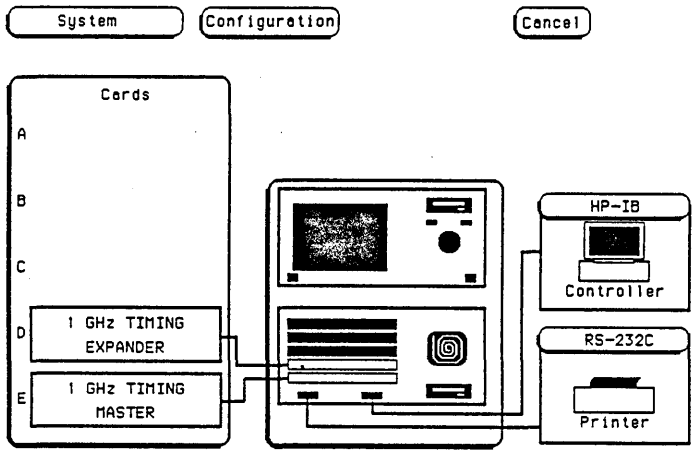


Figure 6-4. Startup Screen

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

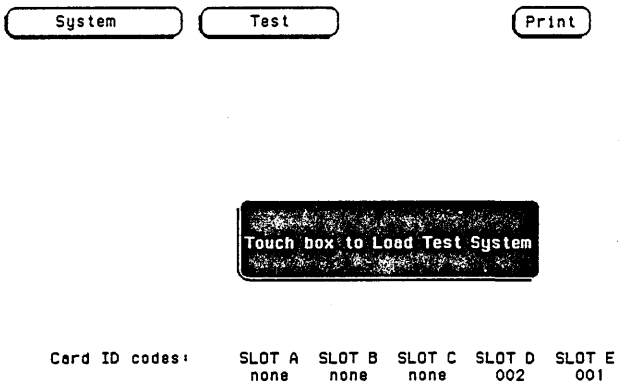


Figure 6-5. Load Test System

4. From test screen in figure 6-6, touch **Test System**, then touch **1 GHz Timing.** (If multiple 1 GHz Timing modules, select the one to be tested)

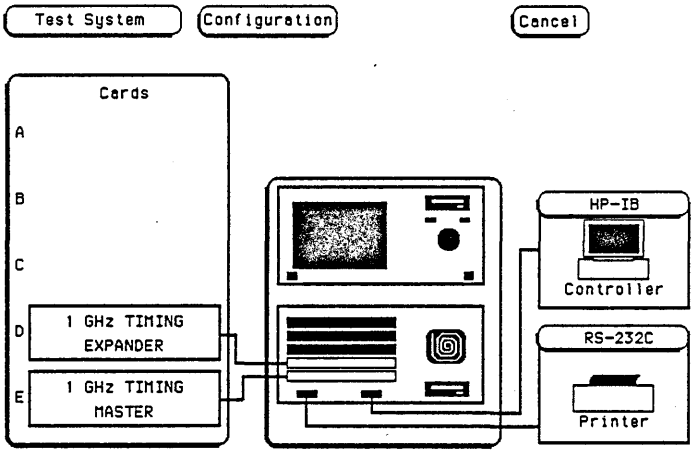


Figure 6-6. Test System Screen

5. Figure 6-7 is the main self test menu. Self tests can be run individually by touching a specific test field, or altogether by touching "All 16515/16 Tests". When "All 16515/16 Tests" is run, the test status will change to "TESTED". When individual tests are run, the status will change to either "PASSED or FAILED".

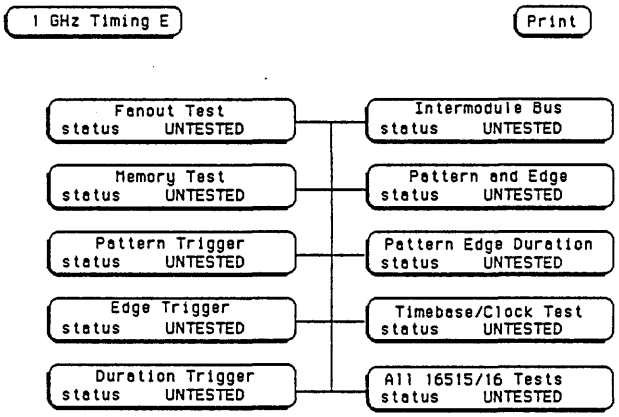


Figure 6-7. Main Test Menu

6. Touch **Fanout Test**

7. An individual test run screen, see figure 6-8, will give the test name, a brief description of the test, number of test runs, and test failures for each slot/pod .

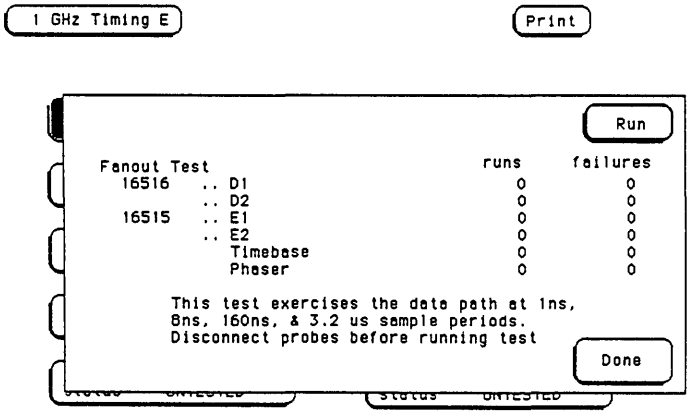


Figure 6-8. Fanout Test Run Screen

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

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

10. To stop a Repetitive run, touch **Stop**. See figure 6-9. To exit the test touch **Done.**

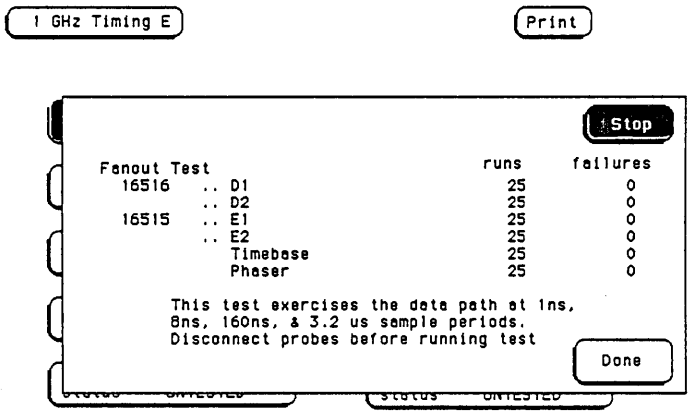


Figure 6-9. Stop Field

11. Select the next test from the main test menu.
12. Repeat steps 8 through 11 until all tests are run.
13. To exit the self tests, touch the following fields in the numbered sequence below:
    1. **1 GHz Timing**
    2. **Test System**
    3. **Configuration**
    4. **Exit Test**
14. Touch the box to **Exit Test System.** See figure 6-10.

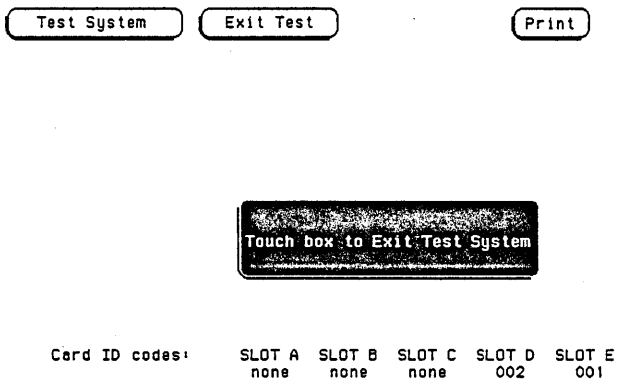


Figure 6-10. Exit Test System

Test Descriptions:

Some individual self test screens show run/failure information for the mainframe slot followed by the pod number. An example of this is, mainframe *slot D* and *pod 1* will show up on test screen as *D1*. Self test failures for circuits or components common to all probe pods will be registered under their own description as well as a slot/pod failure.

Fanout Test:

This is a functional test of the acquisition chips, memory chips, comparators and timebase system. At sample periods of 1 G, 125 M, 6.25 M, and 312.5 k samples/sec, the threshold is set to minimum and a full memory is acquired and read back. Then the threshold is set to maximum and the procedure is repeated. Memory chip failures are shown by physical location with the lower case letters *a* through *d*. Test information on memory chip location, timebase, and phaser is used by the HP service center for more detailed failure analysis.

Memory Test:

This test checks the memory chips (eight on 16515A and eight on 16516A) by clocking a checkerboard pattern into memory at a 1GHz rate. The CPU then reads the memory to verify the appropriate pattern stored. Memory chip failures are shown by physical location with the lower case letters *a* through *d*. Test information on memory chip location and the phase generator is used by the HP service center for more detailed failure analysis.

Pattern Trigger Test:

This test checks the pattern trigger capabilities and consists of three parts.

1. Each data channel in succession is programmed to detect a "1" while the other channels are "don't care".

2. Each data channel in succession is programmed to detect a "0" while the other channels are "don't care".

3. Data channel 0 of pod 1 is programmed to detect a "not equal 1" while the other channels are "don't care".

Failing channels are designated by a "#" (pound) while those passing will be indicated by a "." (dot). Status bit information and the trigger numbers next to the 16515 label are is used by the HP service center for more detailed failure analysis.

Edge Trigger Test:

This test checks the edge trigger capabilities and consists of two parts.

1. Each data channel in succession is programmed to detect a rising edge, while the other channels are "don't care".

2. Each data channel in succession is programmed to detect a falling edge, while the other channels are "don't care".

Failing channels are designated by a "#" (pound) while those passing will be indicated by a "." (dot). Status bit information and the trigger numbers next to the 16515 label are used by the HP service center for more detailed failure analysis.

Duration Trigger Test:

This test checks the greater than and less than pattern duration circuitry and consists of two parts.

1. Data channel 0 of pod 1 is programmed to detect a "1" pattern of greater than 20 μs duration.

2. Data channel 0 of pod 1 is programmed to detect a "1" pattern of less than 20 μs duration

Pvd (prestore valid) bit and Imc (low measurement complete) bit information is used by the HP service center for more detailed failure analysis.

Intermodule Bus Test:

This test exercises the intermodule bus interface. The timing analyzer is programmed to trigger on "don't care", armed by the IMB. The IMB is then triggered by the CPU. Pvd (prestore valid) bit and Imc (low measurement complete) bit information is used by the HP service center for more detailed failure analysis.

Pattern And Edge Test:

This test ensures that the pattern and edge detectors interact properly. Data channel 0 on pod 2 is programmed to detect a "1" pattern. Data channel 0 on pod 1 is programmed to detect a rising edge. The sample rate is set to 1 Gsamples/sec and duration is set to minimum. A trigger should occur on the second rising edge of channel 0 on pod 1. Lmc (low measurement complete) bit information is used by the HP service center for more detailed failure analysis.

Pattern Edge Duration Test:

This test ensures the pattern, edge, and duration interact properly. The triggers are programmed the same as in the pattern and edge test, with the greater than duration set to 20 μs and a sample rate of 80 ns. Pvd (prestore valid) bit and Imc (low measurement complete) bit information is used by the HP service center for more detailed failure analysis.

Timebase/Clock Test:

This test exercises the operation of the oscillator, timebase, and sync/mux chips. The test consists of two parts.

1. At a clock rate of 625 Hz, the high time and low time of the sample clock is recorded and the delta is compared to nominal.

2. The prestore counter is loaded with 30000 and the sample clock is set for 16 ns period. The time until the pvd (prestore valid) bit comes true is measured and compared to nominal.

All 16515/16 Tests:

When this test is selected, all tests are run automatically one time.

6-6. TROUBLESHOOTING

If self tests indicate a failure, begin at the **START** of the troubleshooting flow chart shown in figure 6-11. If you are troubleshooting a one card module (HP 16515A master), start on troubleshooting sheet 1. If you are troubleshooring a two card module (HP 16515A and HP 16516A), start on troubleshooting sheet 2.The flowchart will instruct you to replace a faulty card, probe assembly or cable, or refer you to other flow charts for a further isolation process.

HP 16515A STANDALONE MAIN TROUBLESHOOTING FLOWCHART

Troubleshooting Sheet 1

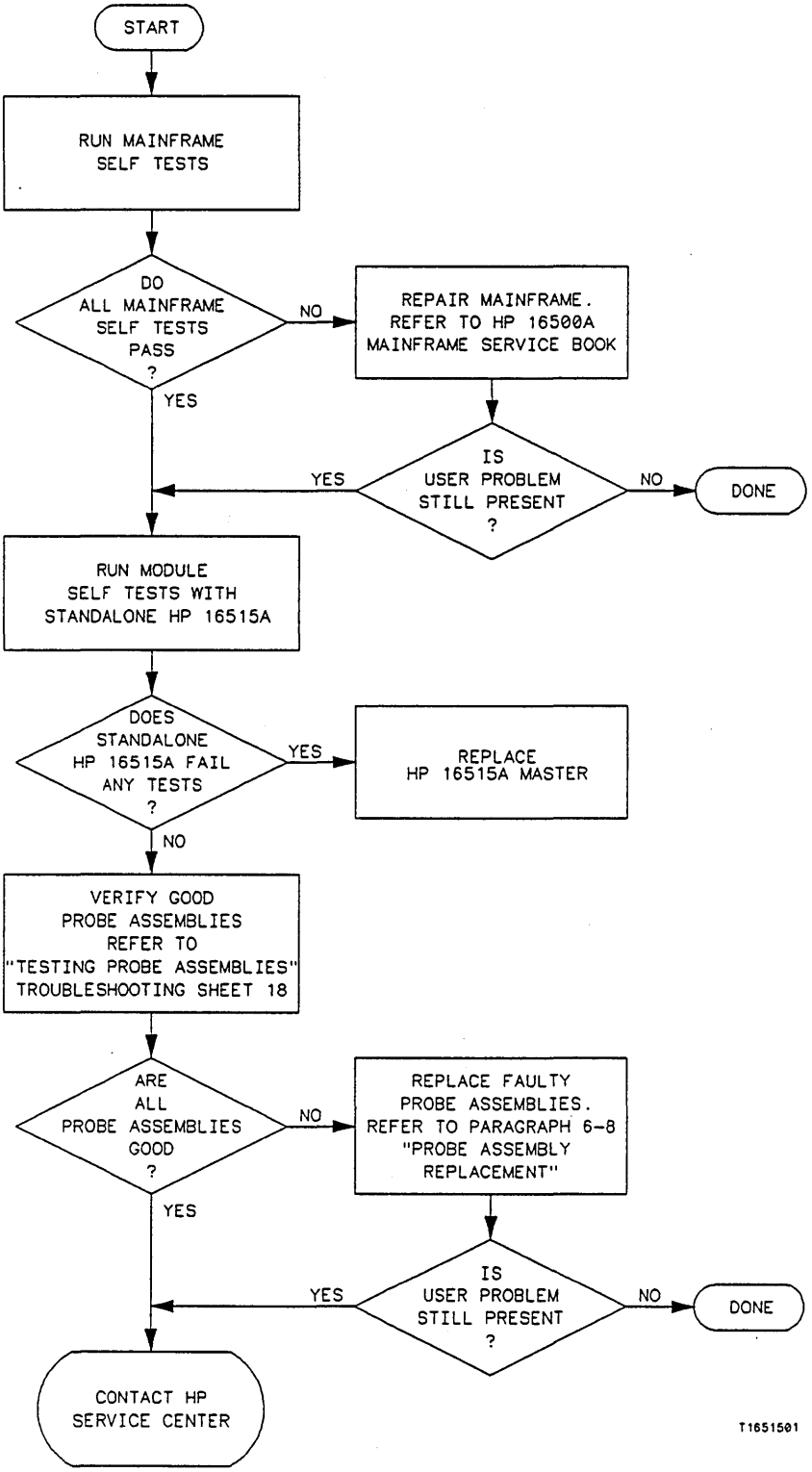


Figure 6-11. Troubleshooting Flowchart

HP 16515A/16516A MAIN TROUBLESHOOTING FLOWCHART

Troubleshooting Sheet 2

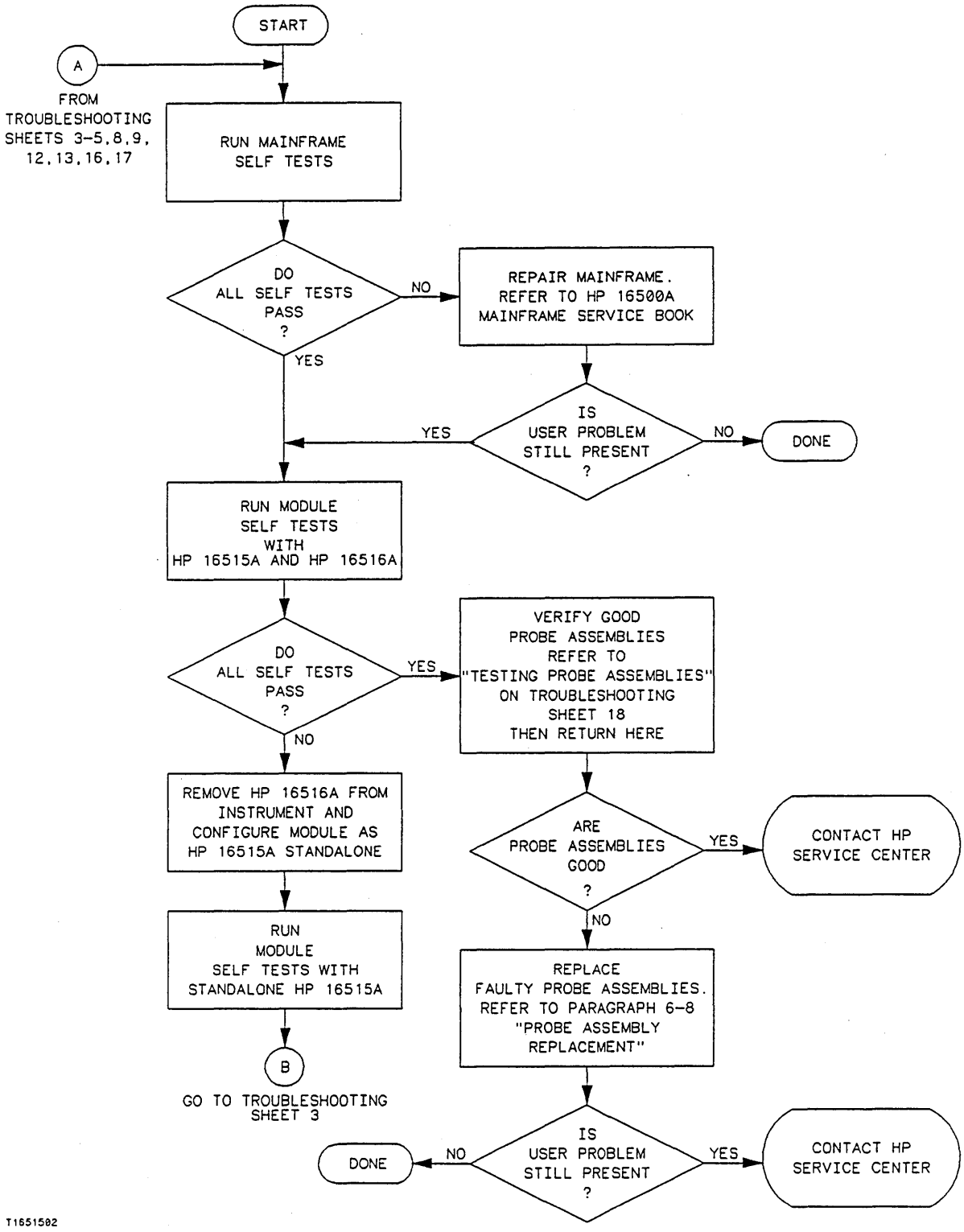


Figure 6-11. Troubleshooting Flowchart

HP 16515A/16516A MAIN TROUBLESHOOTING FLOWCHART

Troubleshooting Sheet 3

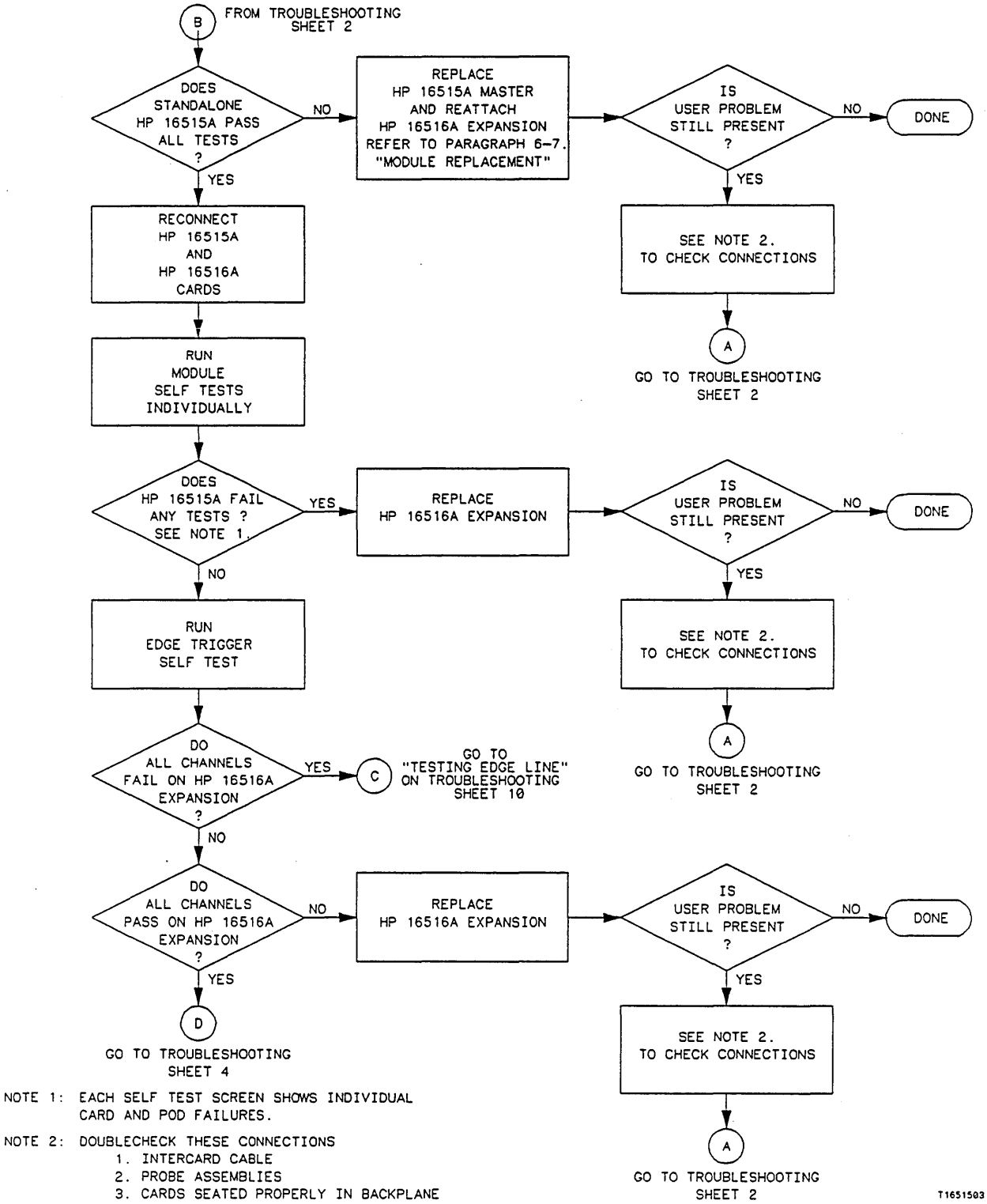


Figure 6-11. Troubleshooting Flowchart

HP 16515A/16516A MAIN TROUBLESHOOTING FLOWCHART

Troubleshooting Sheet 4

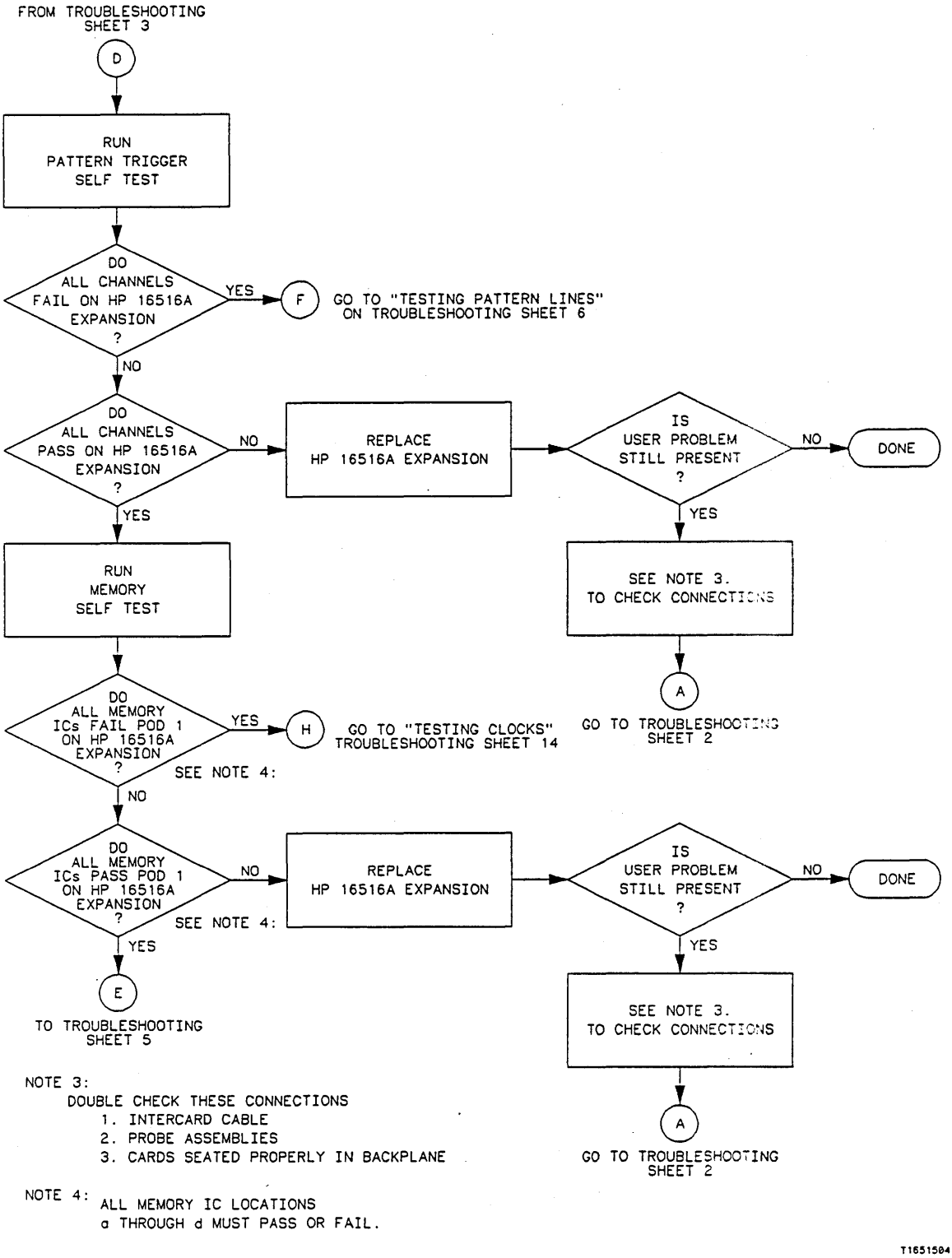


Figure 6-11. Troubleshooting Flowchart

HP 16515A/16516A MAIN TROUBLESHOOTING FLOWCHART

Troubleshooting Sheet 5

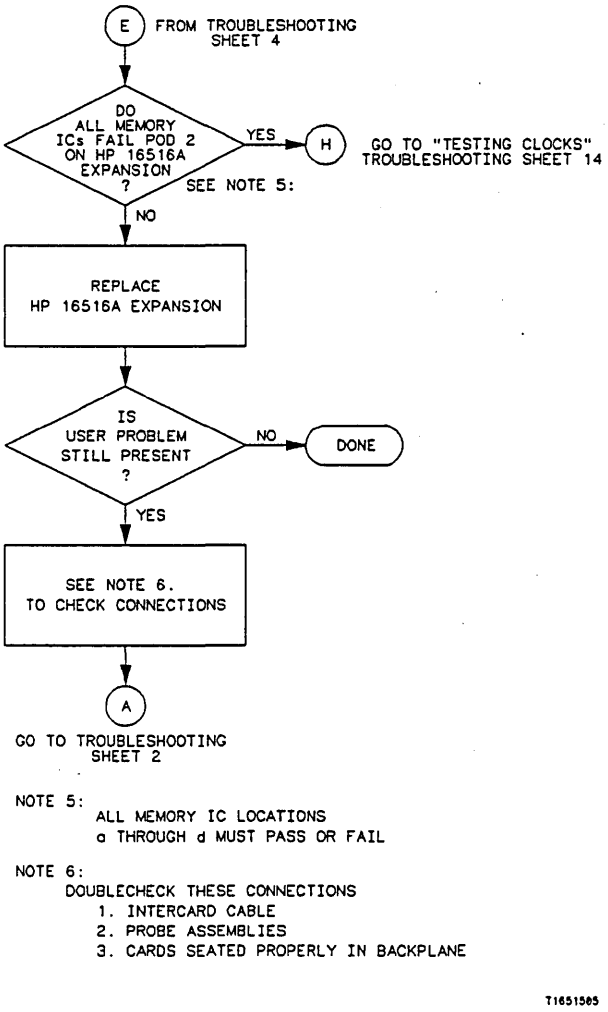


Figure 6-11. Troubleshooting Flowchart

TESTING PATTERN LINES

Troubleshooting Sheet 6

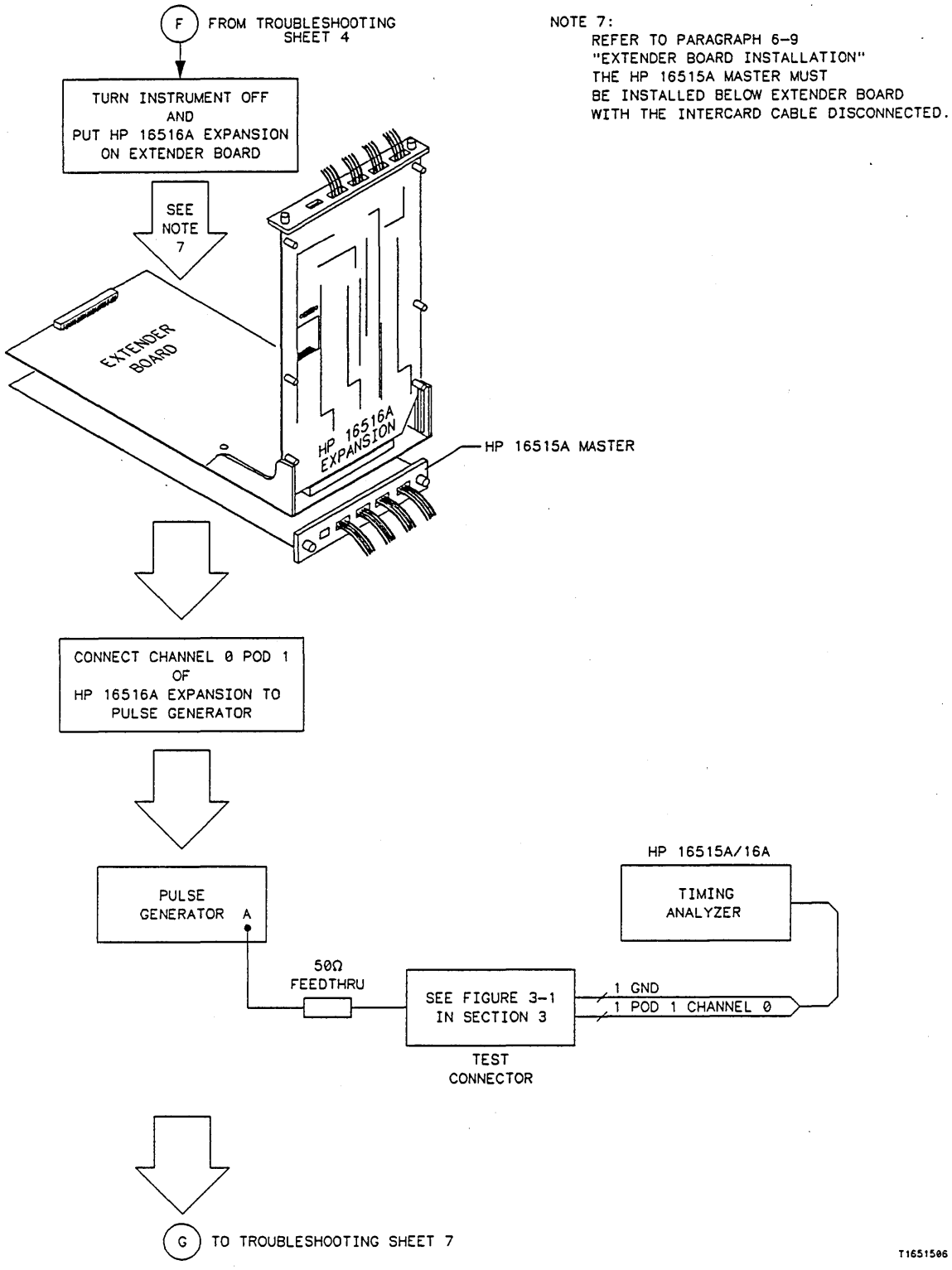


Figure 6-11. Troubleshooting Flowchart

TESTING PATTERN LINES

Troubleshooting Sheet 7

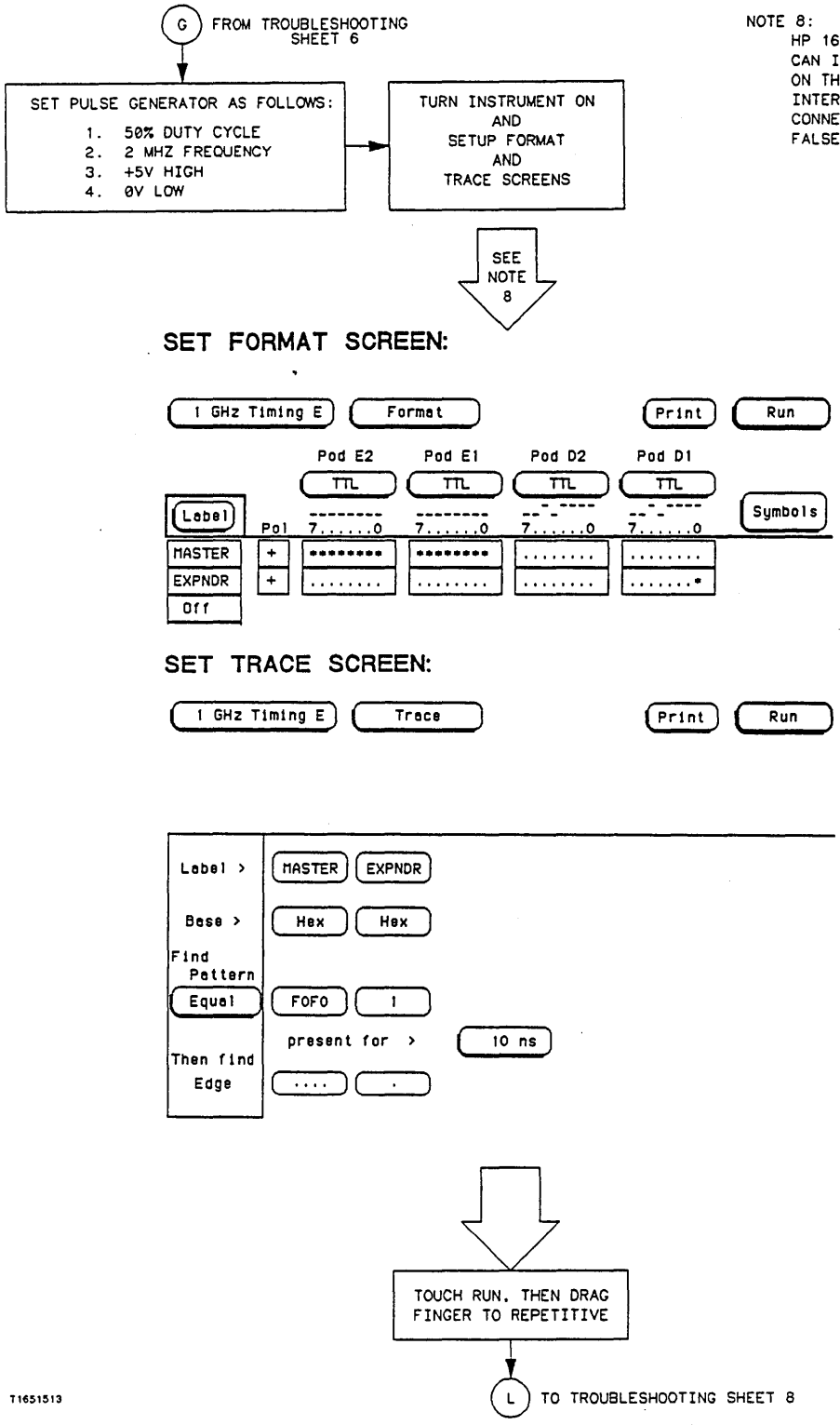


Figure 6-11. Troubleshooting Flowchart

TESTING PATTERN LINES

Troubleshooting Sheet 8

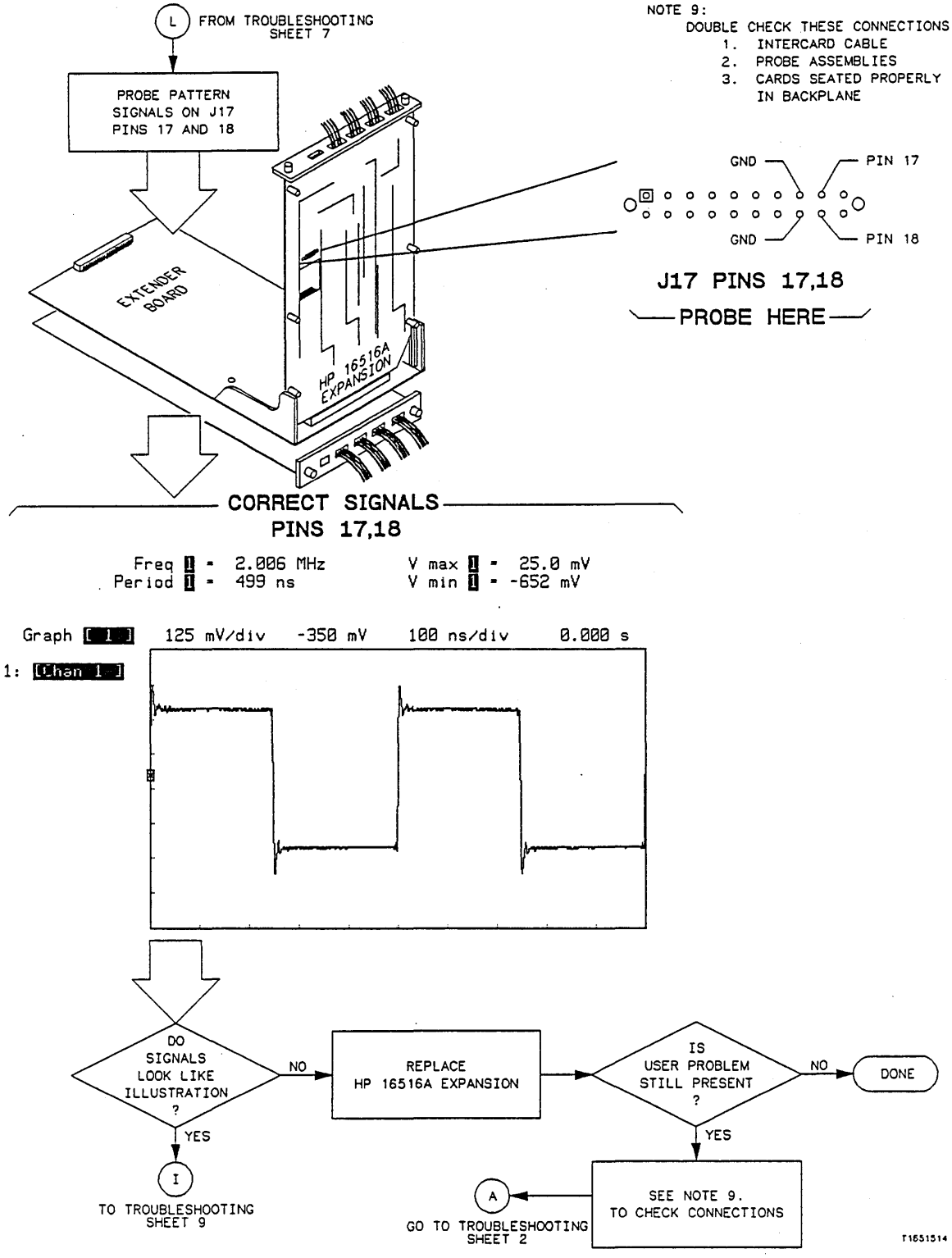
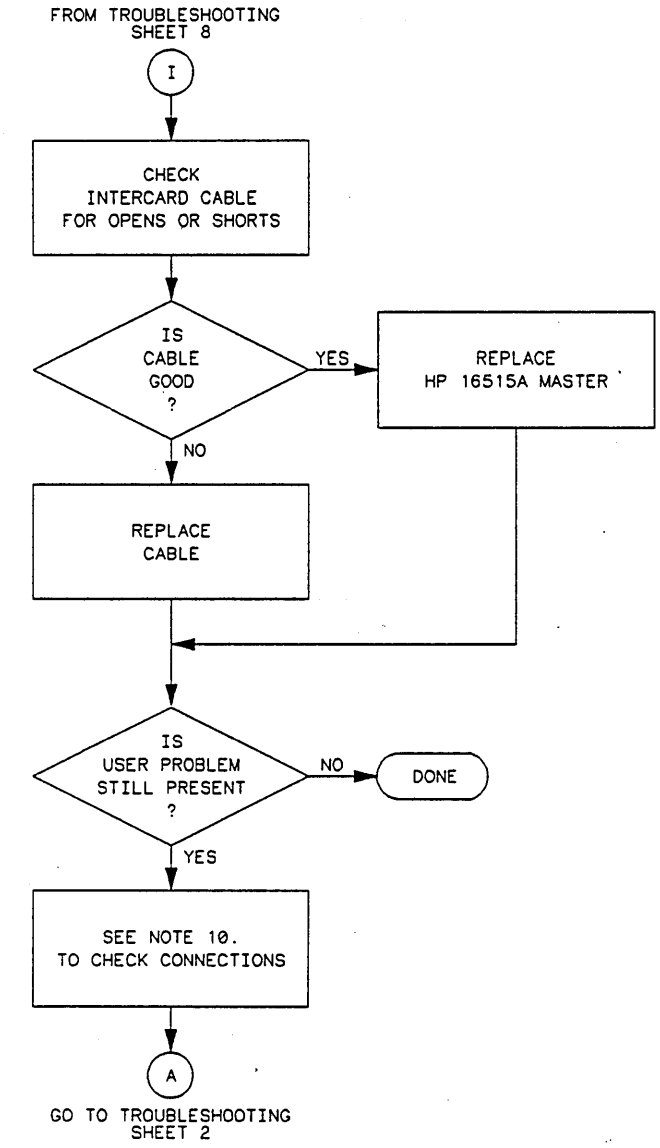


Figure 6-11. Troubleshooting Flowchart

TESTING PATTERN LINES

Troubleshooting Sheet 9



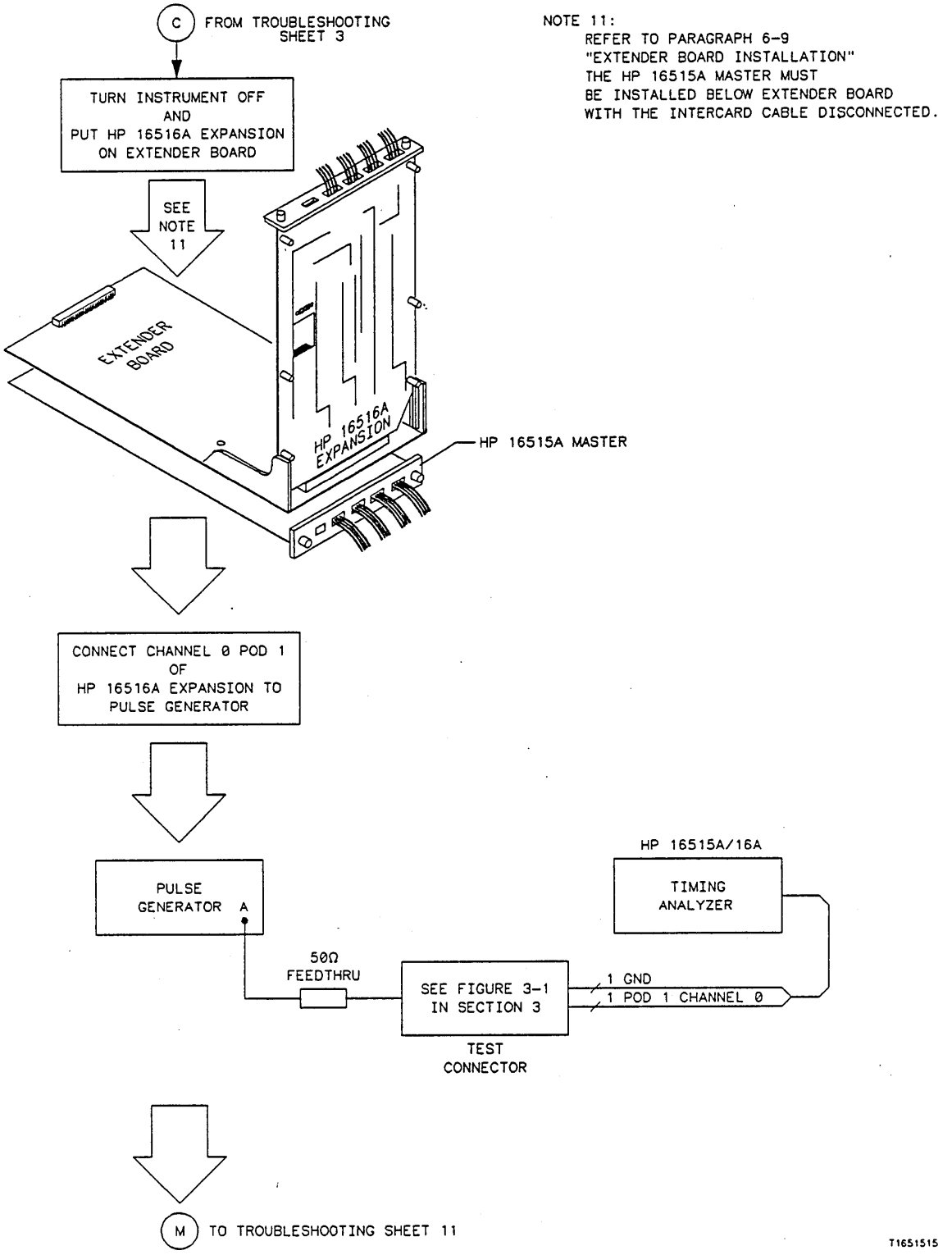
NOTE 10:
DOUBLE CHECK THESE CONNECTIONS
1. INTERCARD CABLE
2. PROBE ASSEMBLIES
3. CARDS SEATED PROPERLY IN BACKPLANE

T1651507

Figure 6-11. Troubleshooting Flowchart

TESTING EDGE LINES

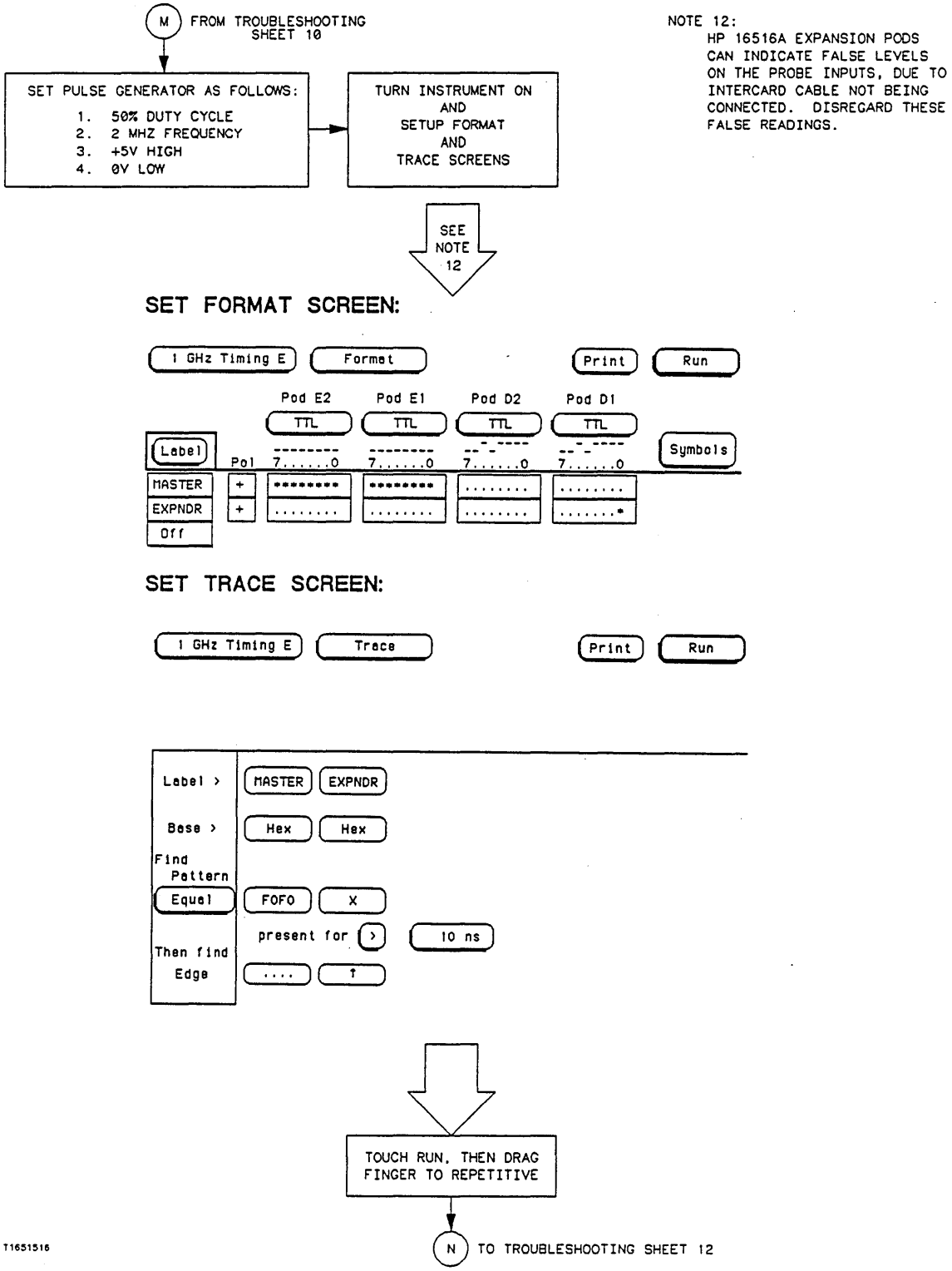
Troubleshooting Sheet 10



NOTE 11:
REFER TO PARAGRAPH 6-9
"EXTENDER BOARD INSTALLATION"
THE HP 16515A MASTER MUST
BE INSTALLED BELOW EXTENDER BOARD
WITH THE INTERCARD CABLE DISCONNECTED.

TESTING EDGE LINES

Troubleshooting Sheet 11



TESTING EDGE LINES

Troubleshooting Sheet 12

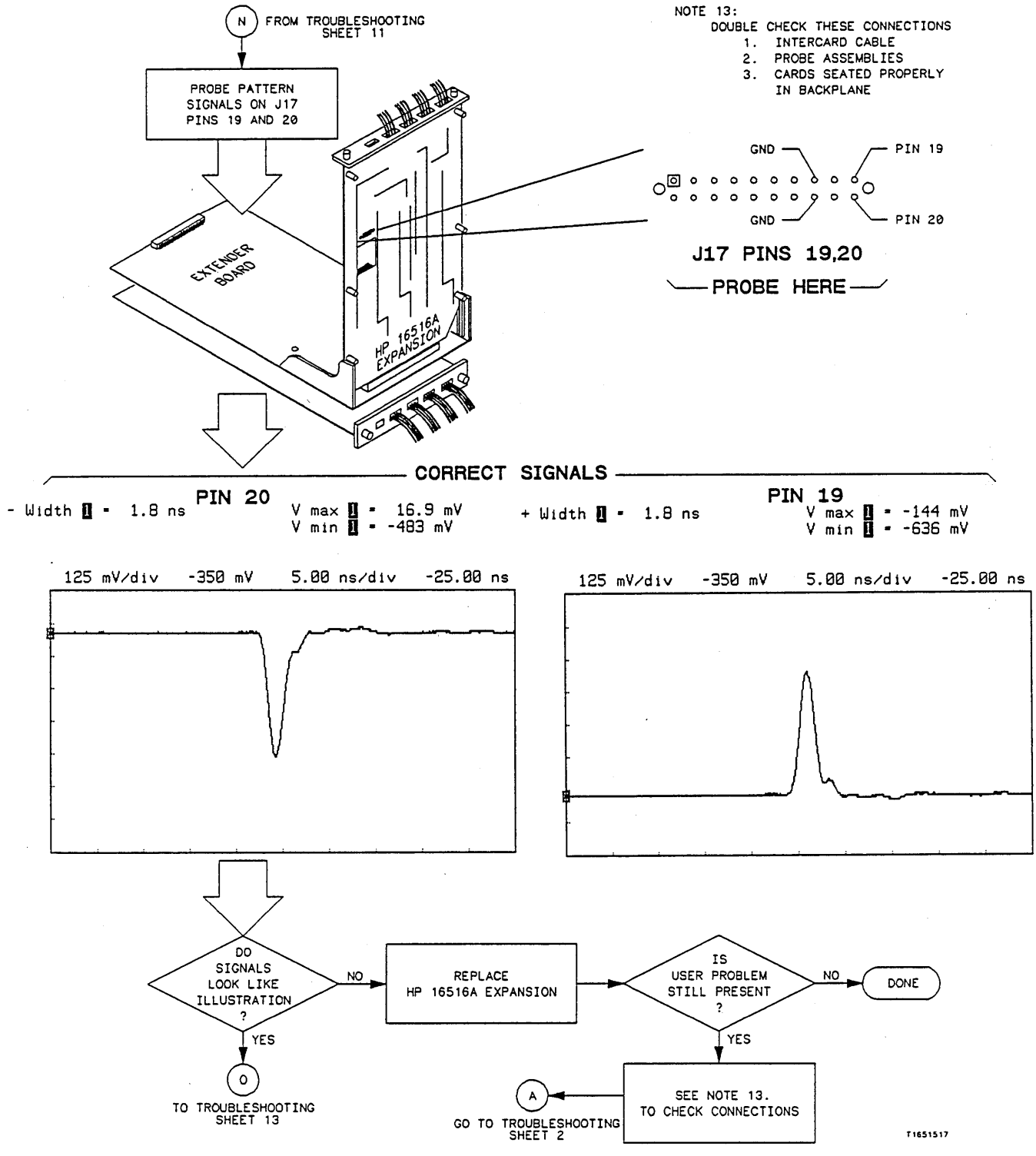
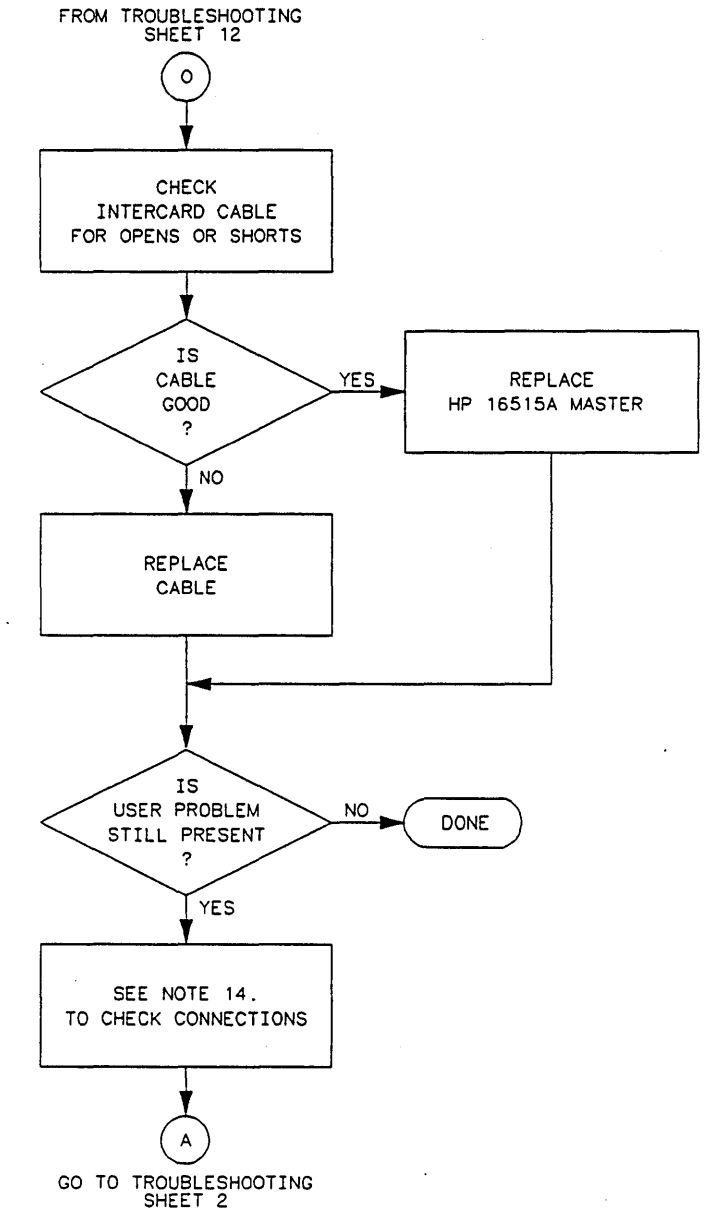


Figure 6-11. Troubleshooting Flowchart

TESTING EDGE LINES

Troubleshooting Sheet 13



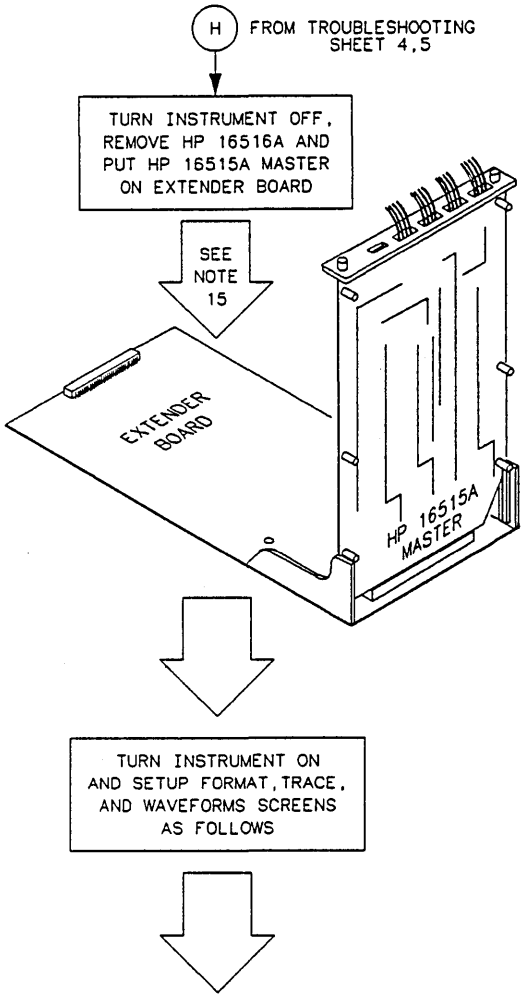
NOTE 14:
DOUBLE CHECK THESE CONNECTIONS
1. INTERCARD CABLE
2. PROBE ASSEMBLIES
3. CARDS SEATED PROPERLY IN BACKPLANE

T1651518

Figure 6-11. Troubleshooting Flowchart

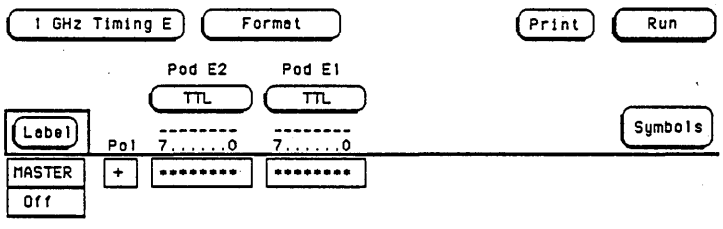
TESTING CLOCKS

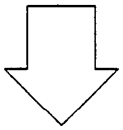
Troubleshooting Sheet 14



NOTE 15:
REFER TO PARAGRAPH 6-9
"EXTENDER BOARD INSTALLATION"

SET FORMAT SCREEN:





P TO TROUBLESHOOTING SHEET 15

T1651519

TESTING CLOCKS

Troubleshooting Sheet 15

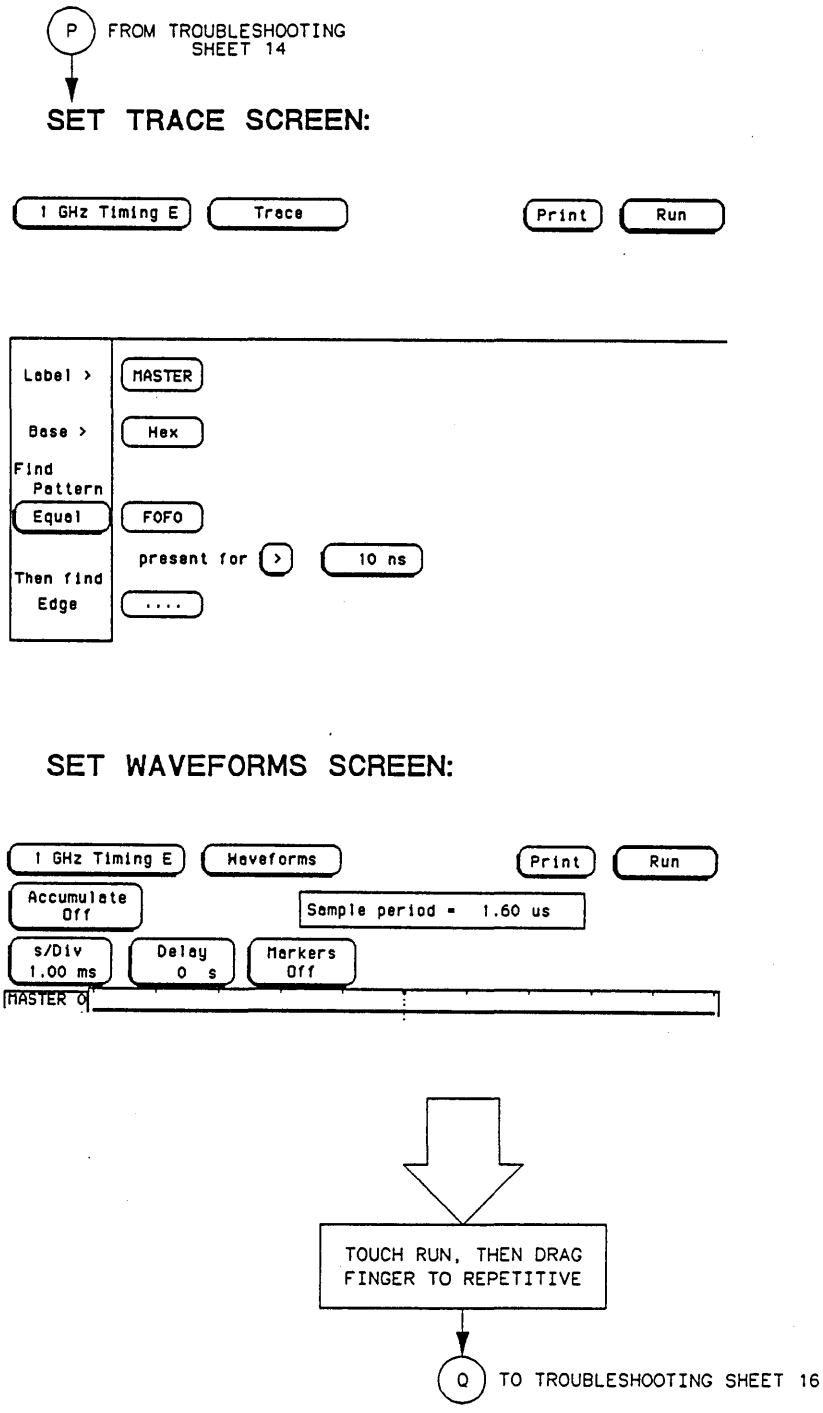


Figure 6-11. Troubleshooting Flowchart

TESTING CLOCKS

Troubleshooting Sheet 16

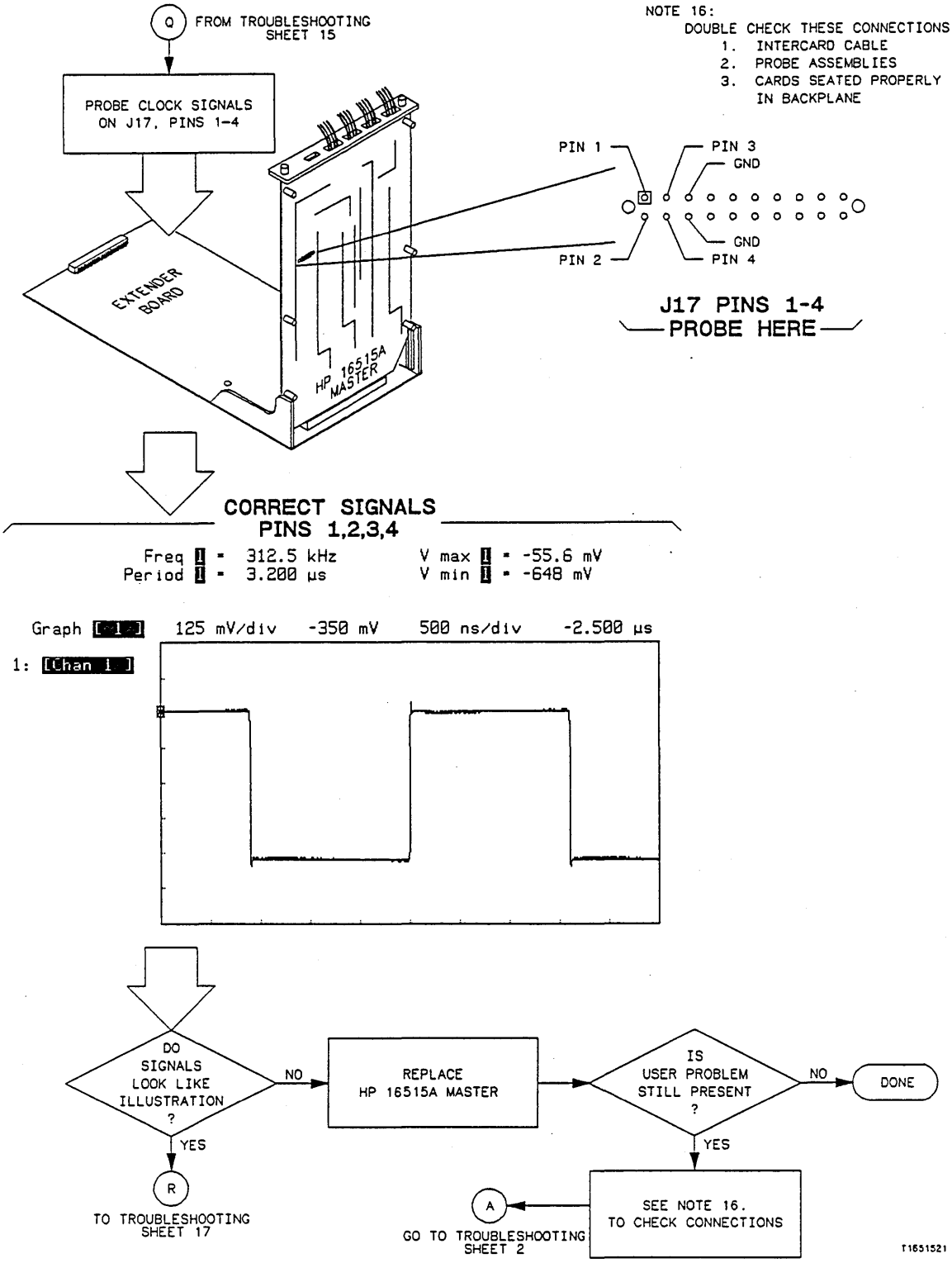
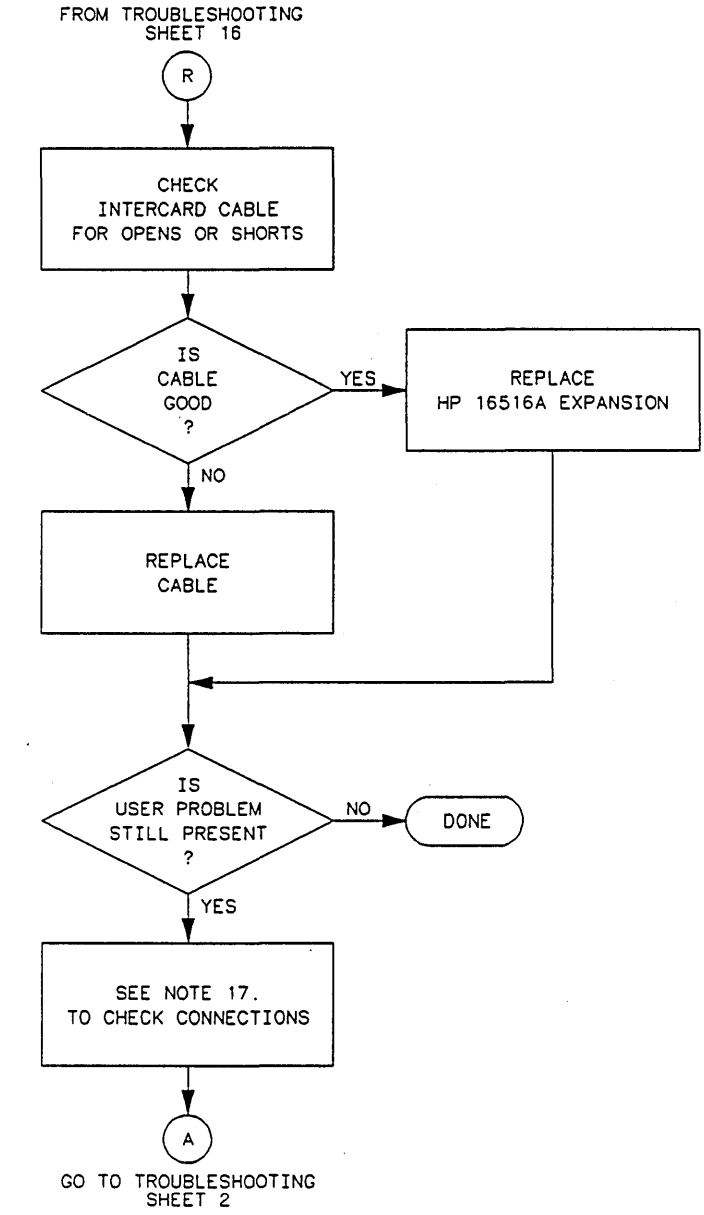


Figure 6-11. Troubleshooting Flowchart

TESTING CLOCKS

Troubleshooting Sheet 17



NOTE 17:
DOUBLE CHECK THESE CONNECTIONS
1. INTERCARD CABLE
2. PROBE ASSEMBLIES
3. CARDS SEATED PROPERLY IN BACKPLANE

T1651522

Figure 6-11. Troubleshooting Flowchart

TESTING PROBE ASSEMBLIES

Troubleshooting Sheet 18

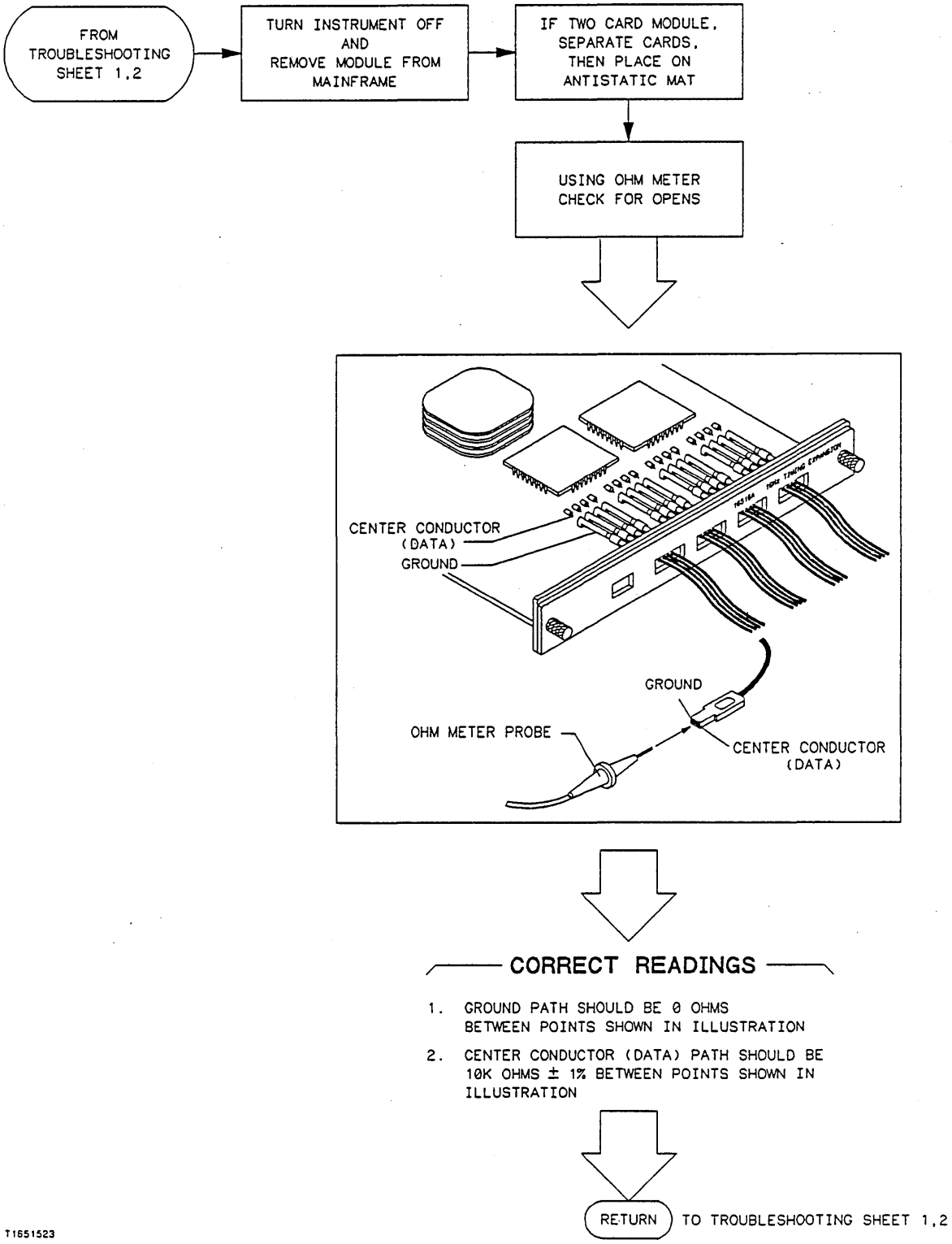


Figure 6-11. Troubleshooting Flowchart

6-7. MODULE REPLACEMENT

CAUTION

The effects of ELECTROSTATIC DISCHARGE can damage electronic components. Use grounded wriststraps and mats when performing any kind of service to this module.

Installation Considerations:

- A two card module must remain screwed together and installed in two adjacent slots.
- A one card module may be installed in any available slot.
- If previously installed modules prevent proper installation, they must be repositioned in the card cage.
- Cards or filler panels below the slot(s) intended for module installation do not have to be removed.
- The probe assemblies do not have to be removed to install the module.

Procedure:

1. Turn instrument power switch off, disconnect power cord and any input or output connections.
2. Starting **from the top**, loosen thumb screws on filler panel(s) and card(s).

Note

Two card 1 GHz Timing Modules are screwed together. To prevent binding when loosening or tightening thumbscrews, use sequence shown in figure 6-12.

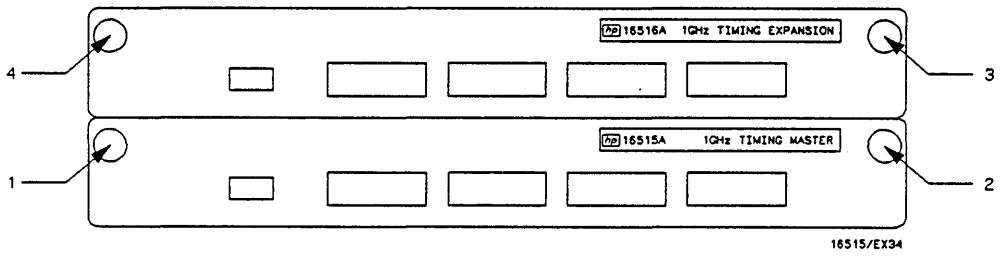


Figure 6-12. Tightening Or Loosening Sequence

3. Starting **from the top**, begin pulling card(s) and filler panel(s) out **half way**. See figure 6-13.

CAUTION

All multi-card modules will be cabled or screwed together. Care should be taken to pull these cards out together. Refer to the appropriate service manual for any specific precautions during installation.

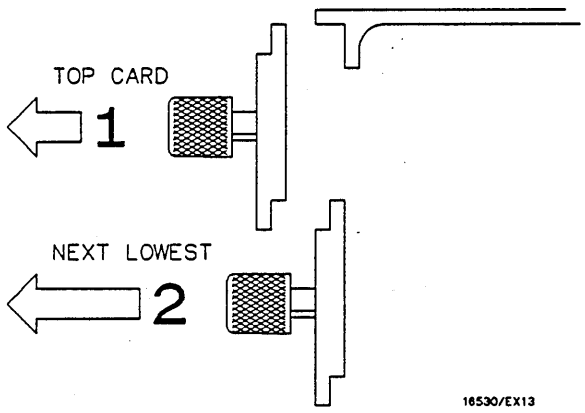


Figure 6-13. Endplate Overhang

4. Pull the faulty timing module completely out.

5. If this is a two card module, lay cards on antistatic mat, disconnect intercard cable and using a No. 10 torx ®, remove screws. See figure 6-14.

6. Replace faulty card with known good replacement card, reconnect intercard cable and screw module back together.

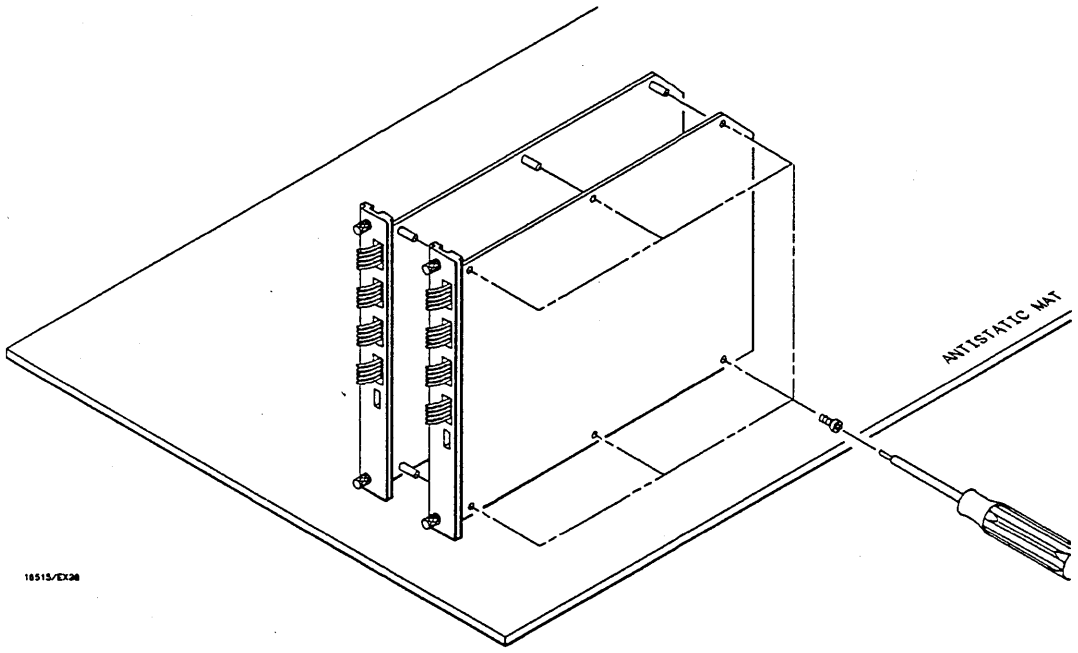


Figure 6-14. Screw Removal

7. To reinstall module, lay probe assemblies flat and pointing out to the rear of card. See figure 6-15.

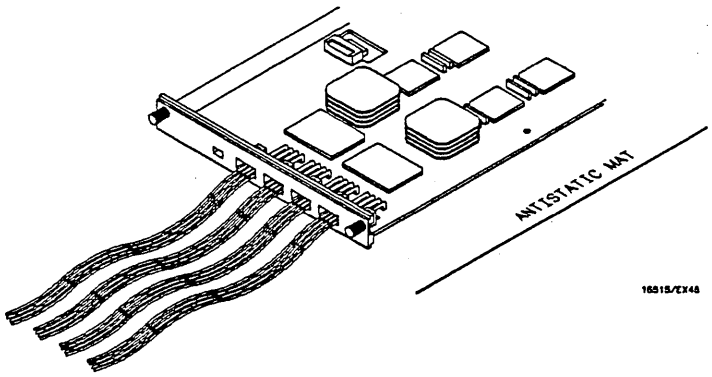


Figure 6-15. Cable Position

8. Slide module **half way** into mainframe card slot(s).

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

Note

Two card 1 GHz Timing Modules are screwed together. To prevent binding when loosening or tightening thumbscrews, use sequence shown in figure 6-16.

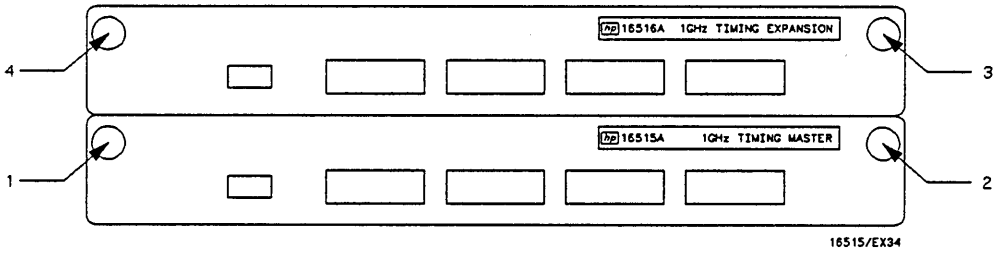


Figure 6-16. Tightening Or Loosening Sequence

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

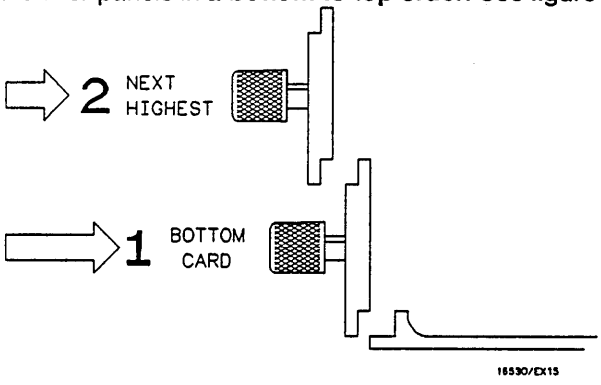


Figure 6-17. Endplate Overhang

6-8. PROBE ASSEMBLY REPLACEMENT

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:

- New probe assemblies must be completely discharged during installation.
- Two card modules must be separated before probe assemblies can be changed on the HP 16515A master.

Procedure:

1. Turn the instrument power switch off, unplug power cord and disconnect any input or output connections.
2. Starting **from the top**, loosen thumb screws on all filler panel(s) and card(s).

Note

Two card 1 GHz Timing Modules are screwed together. To prevent binding when loosening or tightening thumbscrews, use sequence shown in figure 6-18.

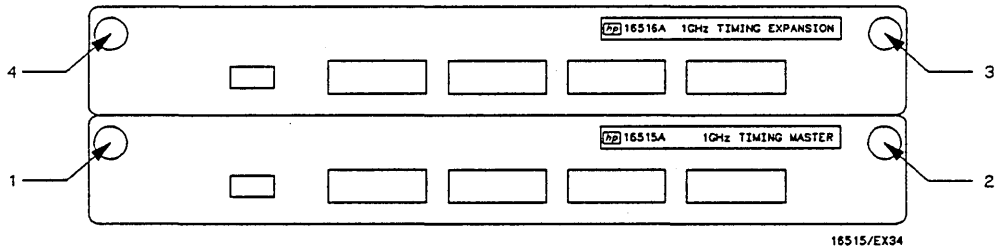


Figure 6-18. Tightening Or Loosening Sequence

3. Starting **from the top**, begin pulling all filler panel(s) and card(s) out **half way**. See figure 6-19.

CAUTION

All multi-card modules will be cabled or screwed together. Care should be taken to pull these cards out together. Refer to the appropriate service manual for any specific precautions during installation.

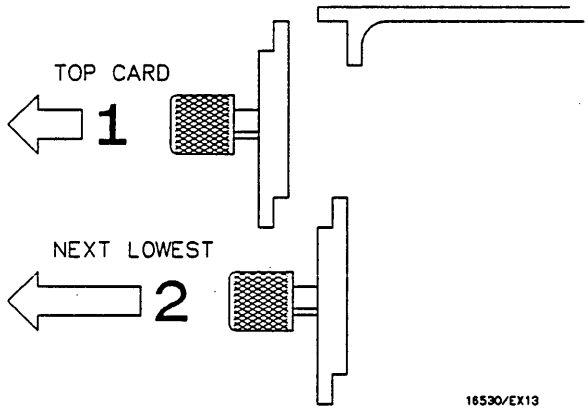


Figure 6-19. Endplate Overhang

4. Pull timing module to be serviced completely out.

5. Lay card(s) on antistatic mat with probe assemblies flat and pointing out to rear of card. See figure 6-20.

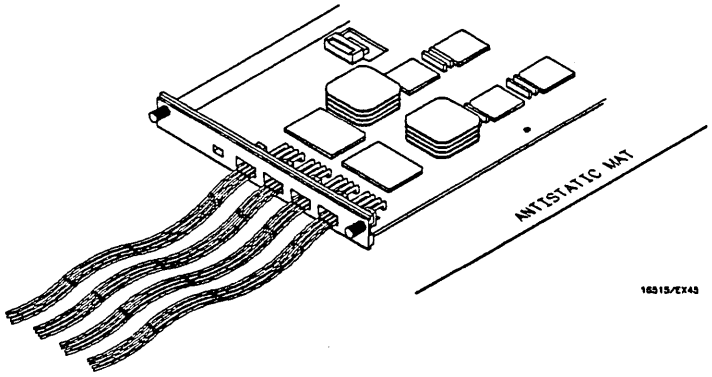


Figure 6-20. Cable Position

6. If this is a two card module, and the bad probe assembly is on the HP 16515A Master, disconnect intercard cable and using a No. 10 torx ® driver, remove the six (6) screws holding cards together. See figure 6-21.

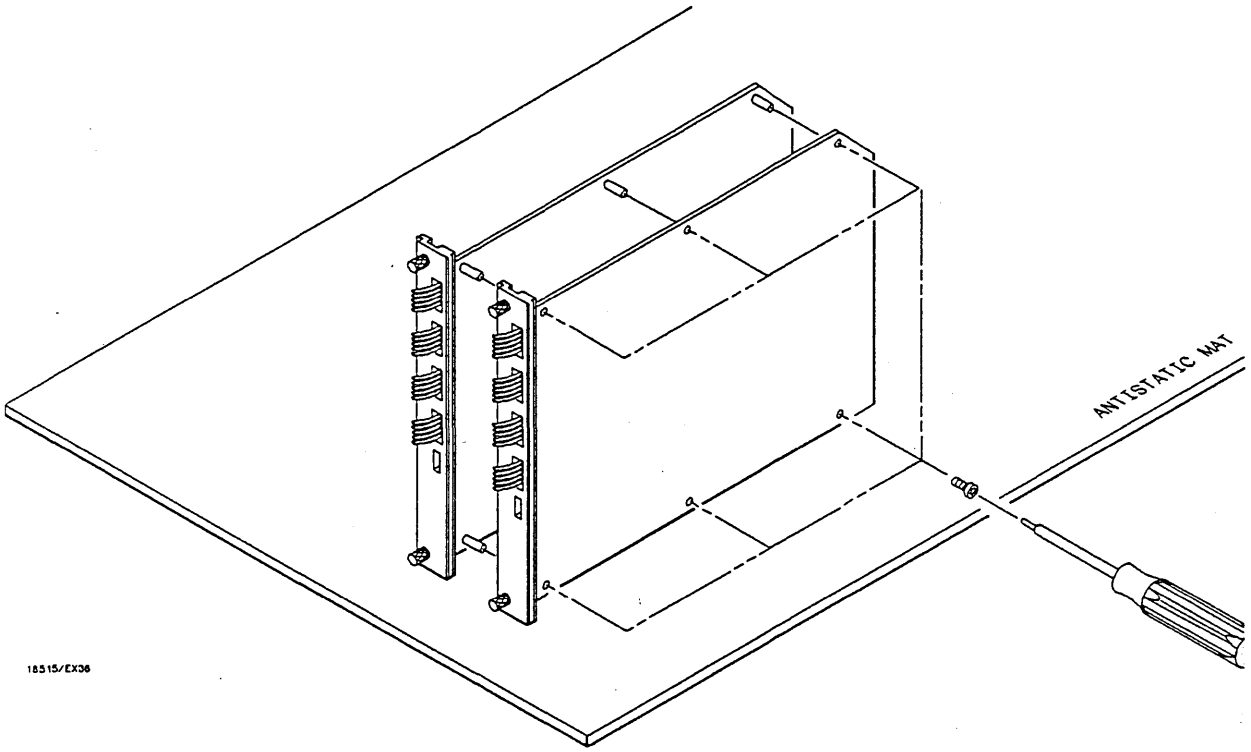


Figure 6-21. Screw Removal

7. Using a No. 10 torx ® driver, remove four screws that hold probe assembly retainer onto card. See figure 6-22.

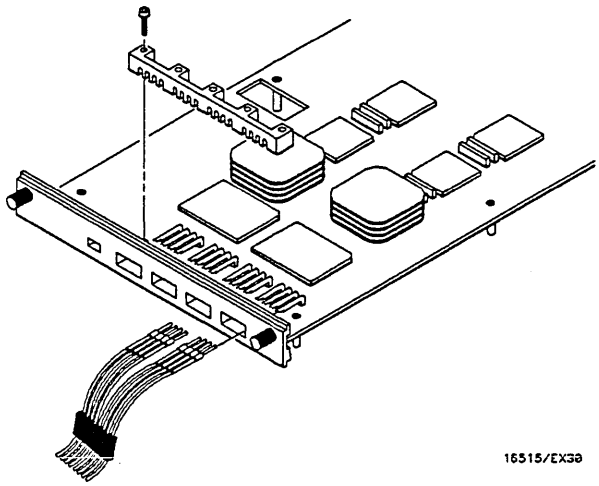
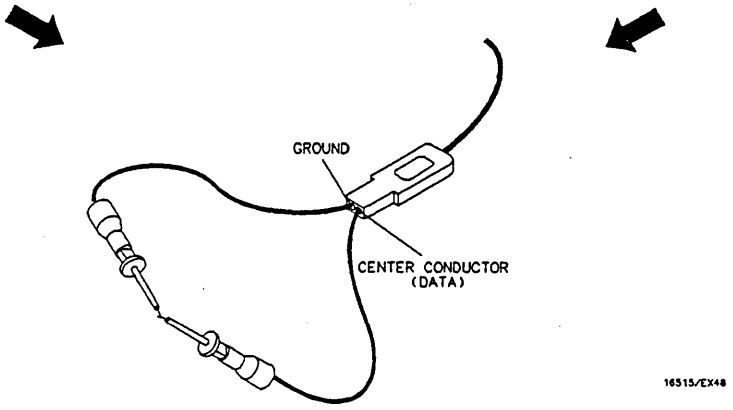


Figure 6-22. Cable And Retainer Removal

8. Remove probe assembly(s) from card connector(s) by lifting up on strain relief tab, then pulling them straight back.

CAUTION

The long lengths of coaxial cabling in the probe assemblies can build up an electrostatic potential that can damage the probe circuitry on the card. Discharge new probe assemblies completely by shorting the center conductor (data) and ground inputs together with grabbers while connecting to card.



9. Install new probe assembly(s). See figure 6-22, and **read** the above caution.

10. Install probe assembly retainer.

11. If this is a two card module, connect the intercard cable and screw module together.

12. At this point go to step 7 of paragraph 6-7, "MODULE REPLACEMENT", and continue installation of module.

6-9. EXTENDER BOARD INSTALLATION

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 empty slot may be used in the card slot.
- When the HP 16516A Expansion Card is placed on the extender board, the HP 16515A Master must be installed directly below extender board.
- Cards or filler panels below the slot(s) intended for extender board installation do not have to be removed.

Procedure:

1. Turn instrument power switch off, unplug power cord and disconnect any input connections.
2. Starting **from the top**, loosen thumb screws on filler panel(s) and card(s).

Note

Two card 1 GHz Timing Modules are screwed together. To prevent binding when loosening or tightening thumbscrews, use sequence shown in figure 6-23.

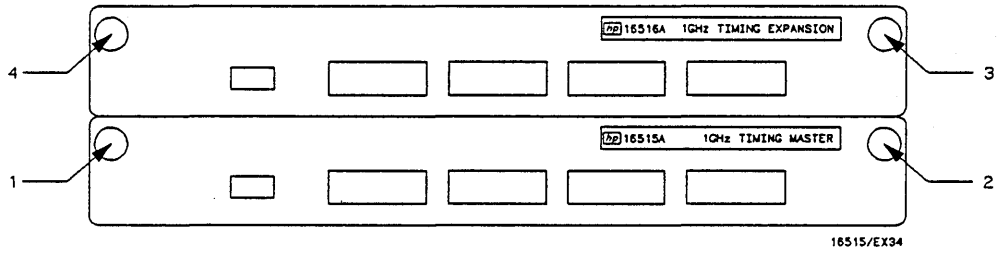


Figure 6-23. Tightening Or Loosening Sequence

3. Starting **from the top**, begin pulling filler panel(s) and card(s) out **half way**. See figure 6-24.

Note

All multi-card modules will be cabled or screwed together. Care should be taken to pull these cards out together. Refer to the appropriate service manual for any specific precautions.

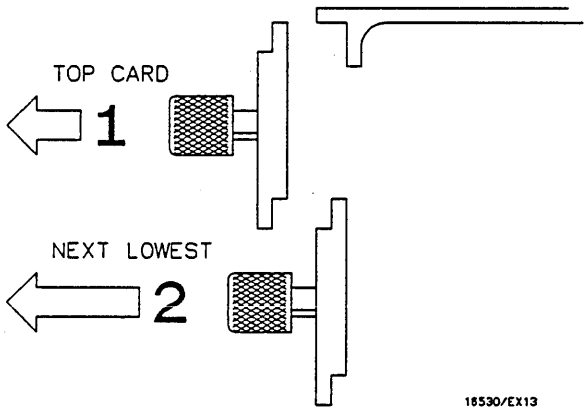


Figure 6-24. Endplate Overhang

4. Pull timing module to be serviced completely out.

5. Lay module card(s) on antistatic mat with probe assemblies(s) flat and pointing out to rear of card. See figure 6-25.

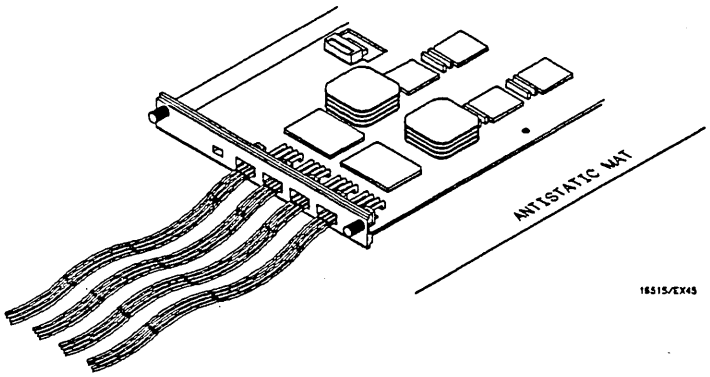


Figure 6-25. Cable Position

6. If this is a two card module disconnect intercard cable and using a No. 10 torx ®, remove the six (6) screws holding cards together. See figure 6-26.

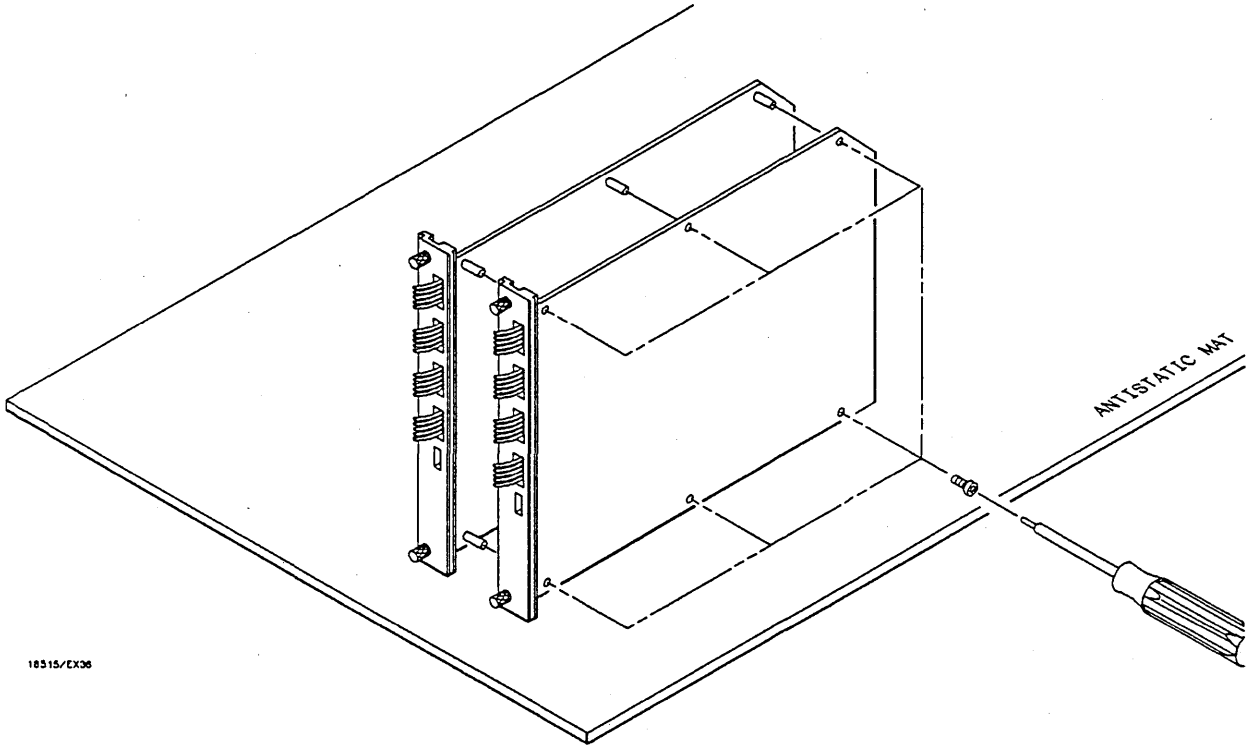


Figure 6-26. Screw Removal

7. Slide extender board completely into card cage slot making sure it is firmly seated into the back-plane connector. If the HP 16516A Expansion Card is placed on the extender board, the HP 16515A Master must be placed in the card slot directly below the extender board.

8. Plug the card to be seviced into the extender board. See figure 6-27.

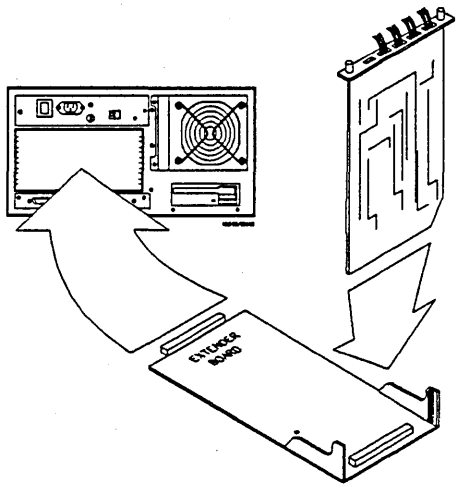


Figure 6-27. Installation Summary

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