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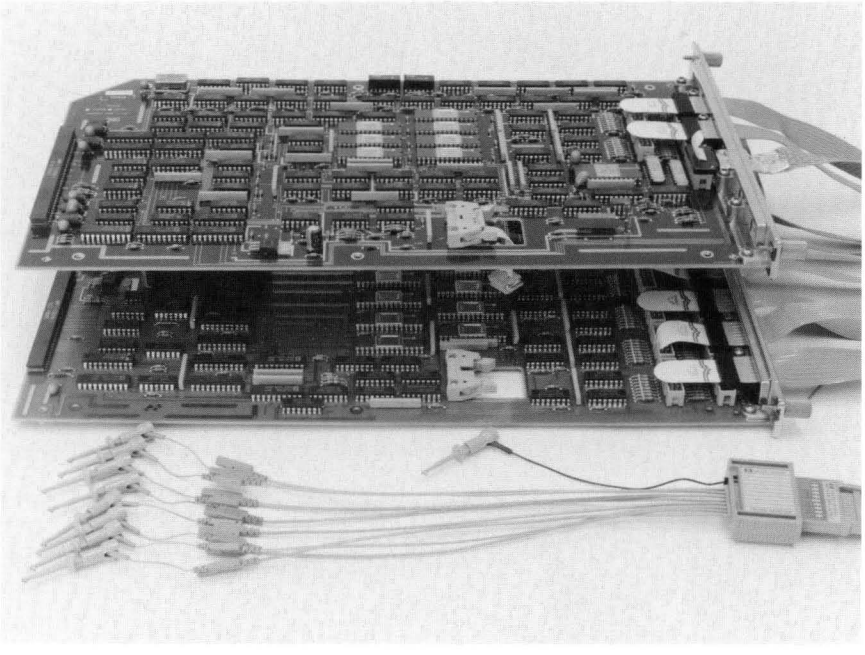
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# HP 16520A/16521A

## PATTERN GENERATION MODULE

## Service Manual



HEWLETT PACKARD

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HEWLETT PACKARD

# SERVICE MANUAL

# HP 16520A 50 MBit/s Pattern Generator Master Card

## AND

# HP 16521A 50 MBit/s Pattern Generator Expansion Card

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**CWA584**

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# SAFETY CONSIDERATIONS

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

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

**WARNING**

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

**SAFETY SYMBOLS**



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



Indicates hazardous voltages.



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

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

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

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# SECTION I
# GENERAL INFORMATION

## 1-1. INTRODUCTION

This service manual contains information for testing, adjusting, and servicing the HP 16520A 50 MBit/s Pattern Generator Card, and the HP 16521A 50 MBit/s Pattern Generator Expansion Card. This manual is divided into six sections as follows:

I - General Information

II - Installation

III - Performance Tests

IV - Adjustments

V - Replaceable Parts

VI - Service

Information for operating, programming, and interfacing the HP 16520A/16521A Pattern Generator Module is contained in the HP 16520/16521A Pattern Generator Operating and Programming Manual supplied with each module.

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

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

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

## 1-2. MODULES COVERED BY THIS MANUAL

The information covered in this manual is for the HP 16520A/16521A Pattern Generator Module. If either of the two cards in the module have 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.



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## 1-4. PRODUCT DESCRIPTION

The HP 16520A/16521A Pattern Generator Module is a general purpose digital stimulus. The module consists of one master card or one master card and one or more expansion cards. The HP 16520A master card offers the minimum configuration of 12 data and three strobe channels, a clock out channel and three dedicated input qualifier channels.
The HP 16521A Expansion Card offers expandability with 48 additional data out channels. Up to four expansion boards (192 channels) can be connected to a single master board. Some of the module's main features are:

- Three strobe output channels (10 ns minimum resolution)
- Three input qualifier channels, and one input clock
- 50 MBit/s programmable pattern generatation
- 4 k bit per channel memory depth
- Expandable to 204 data out channels (1 HP 16520A and 4 HP 16521As)
- TTL and ECL interface levels
- Internally available clock rates between 5 kHz and 50 MHz
- Intermodule trigger capability

## 1-5. ACCESSORIES SUPPLIED

The following accessories are supplied with the HP 16520A/16521A Pattern Generator Module. Quantity one unless shown otherwise.

HP 16520A:

- Operating and Programming Manual Set
- Service Manual
- Lead Set Qty 2 (HP 10347A purple tip)
- Input Qualifier Probe Kit (HP 16520-69501 grey tip)
- Intercard Connecting Cable Kit (HP 16521-88701)
- Input Qualifier Probe Cable (HP 16520-61601)
- 8 Channel Data Probe Cable (HP 16520-61602)
- Clock Probe Cable (HP 16520-61603)

HP 16521A:

- 8 Channel Data Probe Cables (HP 16520-61602) Qty 6

## 1-6. ACCESSORIES AVAILABLE

- 8 Channel ECL Differential Driver Pod (HP 10345A)
- 8 Channel TTL Tristate Buffer Pod (HP 10346A)
- Grabbers (HP 5959-0288 Qty 20)
- Service Data Supplement (16520-90903)

## 1-7. SPECIFICATIONS

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

## 1-8. OPERATING CHARACTERISTICS

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

## 1-9. RECOMMENDED TEST EQUIPMENT

Equipment for testing and maintaining the HP 16520A/16521A Pattern Generator Module is listed in table 1-3. Other equipment may be substituted if it meets or exceeds the critical specifications listed in the table.



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*Table 1-1. HP 16520/21A Specifications.*

## HP 16520A/21A SPECIFICATIONS

### CLOCK SOURCES (HP 16520A ONLY)

**INTERNAL CLOCK**

**Clock Period:** Programmable from 20 ns to 200 μs in a 1-2-5 sequence.

**Data Period Accuracy:** ± 2% (of period) ± 1 ns

**EXTERNAL CLOCK** (provided by user)

**Input Clock Period:**

1 Hz to 50 MHz (20 ns min period) ECL or TTL, internal frequency divide (/1, /5, or /10) provided.

**Duty cycle:** 10 ns minimum high time, 10 ns minimum low time

### STROBES (HP 16520A ONLY)

**Number of Strobes:** 3 (ECL or TTL)

**Bits/Channel:** 4095

**Maximum Bit Rate:** 20 MBit/s (50 ns Period)

**Edge Placement:**

≤ 10 MBits/s: tenths of period
> 10 MBits/s to 20 MBits/s: fifths of Period
(DELAY + WIDTH ≤ PERIOD)

Minimum delay is 0/10 (0/5), maximum delay is 9/10 (4/5) data period. Minimum width is 1/10 (1/5) of data period, maximum width is the data period (values in parentheses apply to 20 MBits/s timebase setting).

If strobes are desired while operating with external clock, the data rate will be divided to 1/5 or 1/10 the external clock rate.



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*Table 1-2. HP 16520/21A Operating Characteristics*

## HP 16520/21A OPERATING CHARACTERISTICS

### OUTPUT

Eight channel pods can be assigned as either standard ECL or TTL levels.
All characteristics are valid at the probe tip.

| PARAMETER | ECL | TTL |
|---|---|---|
| VOH (steady state)<br>VOL (steady state) | - 0.98V<br>- 1.55V | 2.7V<br>0.6V |
| Risetime/<br>Falltime (typ) | 2.3 ns<br>(-0.98 V to -1.55 V) | 2.5 ns<br>( 0.6 V to 2.7 V) |
| Channel-to-<br>channel Skew*<br>(same card) | <= 5 ns | <= 5 ns |
| Channel-to-<br>channel Skew*<br>(card-to-card) | <10 ns | <10 ns |
| No. of std loads | 3 (10 KH ECL,<br>@ Vnh=150 mV) | 3 (LSTTL, @ Vnl=250 mV) |

(Output measurements made into a load consisting of 10 kΩ in series shunted with 10 pF to ground.)

(*) Skew measured at (+1.6 V) TTL and (-1.3 V) ECL levels.



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*Table 1-2. HP 16520/21A Operating Characteristics (cont.)*

## DATA CAPACITY

| PARAMETER | HP 16520A | HP 16521A |
|---|---|---|
| Number Data Channels | 12 | 48 |
| Bits Per Channel | 4095 | 4095 |
| Maximum Bit Rate | 50 MBit/s NRZ<br>(20 ns Period) | 50 MBit/s NRZ<br>(20 ns Period) |

## INPUT (HP 16520A only)

**Maximum Input Voltage:** ± 40V

**Input Impedance:** 100 kΩ, 8 pF

**External Clock-in to Clock-out delay:** 50 ns

| PARAMETER | ECL | TTL |
|---|---|---|
| Vih (min)<br>Vil (max) | -0.91V<br>-1.69V | 2.08V<br>1.12V |



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*Table 1-2. HP 16520/21A Operating Characteristics (cont.)*

## EDITING FUNCTION

**Program Listing:** DELETE, MERGE , COPY, INSERT

## LISTING BASES

Binary, octal, decimal, hexdecimal, and symbol

## STEP MODE

Single-step program execution in 1 to 999 program line steps, from a break.

## DATA INSTRUCTION SET

**BREAK:** Stops program execution, last data vector is held at output.

**REPEAT:** Repeats vector up to 256 times.

**WAIT IMB:** Wait for intermodule trigger.

**WAIT EXTERNAL:**

Wait for user-defined 3-bit pattern on external input pod to become true. No data cycle latency when pattern is true between 30 ns and 0 ns before next clock edge.

**SIGNAL IMB:**

Arms other measurement cards.

**MACRO:**

Four different macros may be defined and inserted as needed. Six character labels may be defined for each macro. Macros contain REPEAT, WAIT EXTERNAL, WAIT IMB, BREAK, and SIGNAL IMB instructions.



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*Table 1-2. HP 16520/21A Operating Characteristics (cont.)*

## CURRENT DRAW PER CARD

**HP 16520A:** 0.7 amp @ 5V
**HP 16521A:** 0.8 amp @ 5V

## OPERATING ENVIRONMENT

**Temperature:**

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

**Humidity:**

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

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

**Vibration:**

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

Non-operating:

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



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*Table 1-3. Recommended Test Equipment.*

| INSTRUMENT | CRITICAL SPECIFICATIONS | RECOMMENDED MODEL | USE* |
|---|---|---|---|
| Oscilloscope | 200 MHz Bandwidth | HP 54201A | P,T |
| Multimeter | 3 1/2 digit Resolution | HP 3468A | A |
| BNC Adapter | Qty 2 | HP 1250-1032 | P |
| 50 Ohm Feedthru | Qty 1 | HP 10100C | P |
| Probe Lead Set | Qty 2 | HP 10347A | P |
| Grabbers | Qty 4 | HP 6969-0288 | P |
| Pulse Generator | 100 KHz Repetition Rate<br>Overshoot: 5% of Amp. | HP 8161A | P |
| Extender Board | No Substitute | HP 16500-69004 | A,T |
| BNC Cable | (m-to-m) 9 inch (Qty2) | HP 10502A | P |
| * P=Performance Tests A=Adjustments T=Troubleshooting | | | |



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# SECTION II
# INSTALLATION

## 2-1. INTRODUCTION

This section explains, how to initially inspect the HP 16520/21A Pattern Generator 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 SUPPLIES" 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 inspection 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 in Section I before installing or operating this module.*

## 2-4. POWER REQUIREMENTS

All power supplies required for operating the HP 16520/21A Pattern Generator Module are supplied to the module through the backplane connenctor.

## 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 CABLE INSTALLATION

The HP 16520/21A Pattern Generator Module comes with probe cables installed by the factory. If a cable is to be switched between TTL and ECL, refer to "PROBE CABLE REPLACEMENT" in Section VI of this manual.

## 2-7. INSTALLATION

**CAUTION**

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

The HP16520A Pattern Generator Card will take up one slot in the card cage. For every HP 16521A Expansion Card you connect to the HP 16520A Pattern Generator Card you will need an additional slot. A maximum of four expansion cards may be connected to the HP 16520A Pattern Generator Card. Installation procedures for the module and additional expansion cards are shown step-by-step in paragraphs 2-6 and 2-7.



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## 2-8. MODULE INSTALLATION

If you are installing the HP 16520/21A Pattern Generator Module (one master card or one master card and one or more expansion cards), **follow this procedure.** If you are adding more expansion cards to an existing module, follow the procedure "ADDING EXPANSION CARDS" in paragraph 2-9.

**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 or filler panels below the empty slots intended for the module installation do not have to be removed.
- You will need only one intercard connecting cable for any installation configuration.
- If previously installed modules prevent proper installation, they must be repositioned in the card cage. See figure 2-1.
- To maintain the channel-to-channel skew and adequate intercard signal quality, the shortest intercard connecting cable should be used and the expansion cards should be no more than two slots away from the master card. See figure 2-1.

Figure 2-1 is a guide in choosing the correct intercard connecting cable and illustrates the expansion card position relative to the master card. Use this guide at step d in the following procedure.

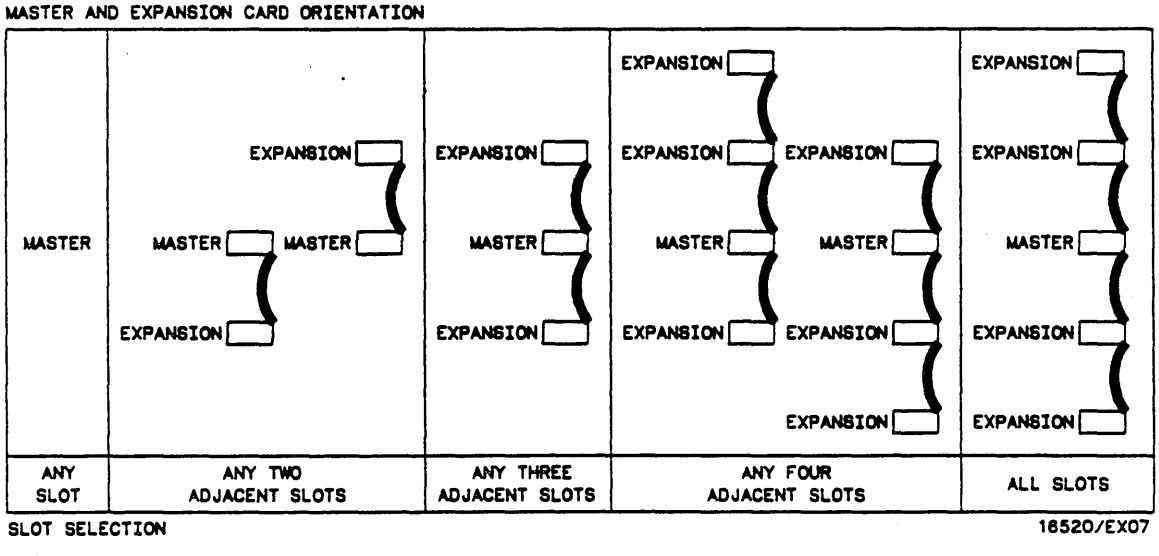



*Figure 2-1. Installation Guide*



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**PROCEDURE:**

a. Turn instrument power switch off, unplug power cord and disconnect any input or output connections.

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

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

CAUTION

*All multi-card modules will be cabled together. Care should be taken to pull these cards out together.*

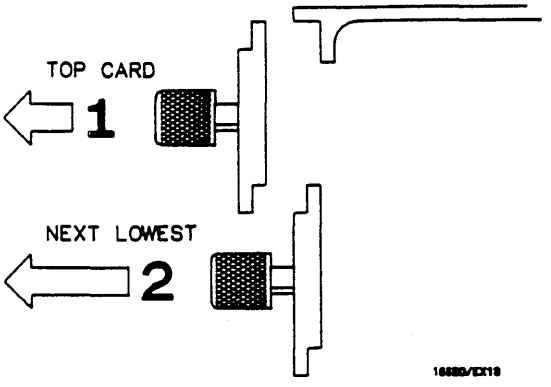



*Figure 2-2. Endplate Overlap*

d. If the module consists of one master card, this card can be installed in any available slot. If the module consists of multiple cards, use figure 2-1 and figures 2-3 through 2-6 to plan your card configuration.



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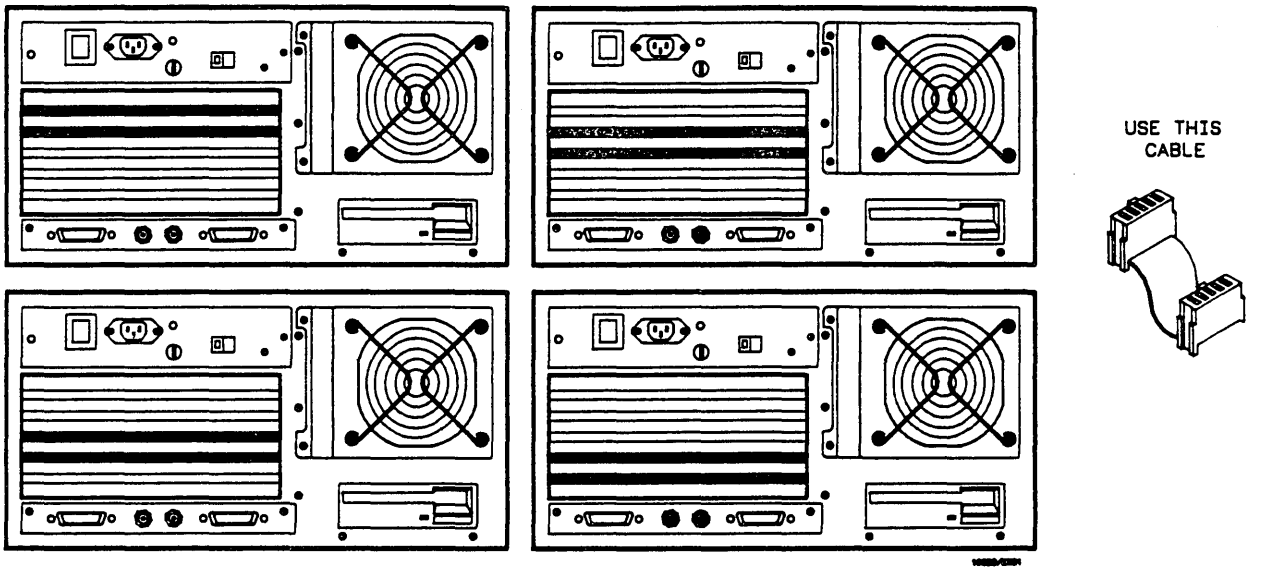



*Figure 2-3. One Master and One Expansion Card*

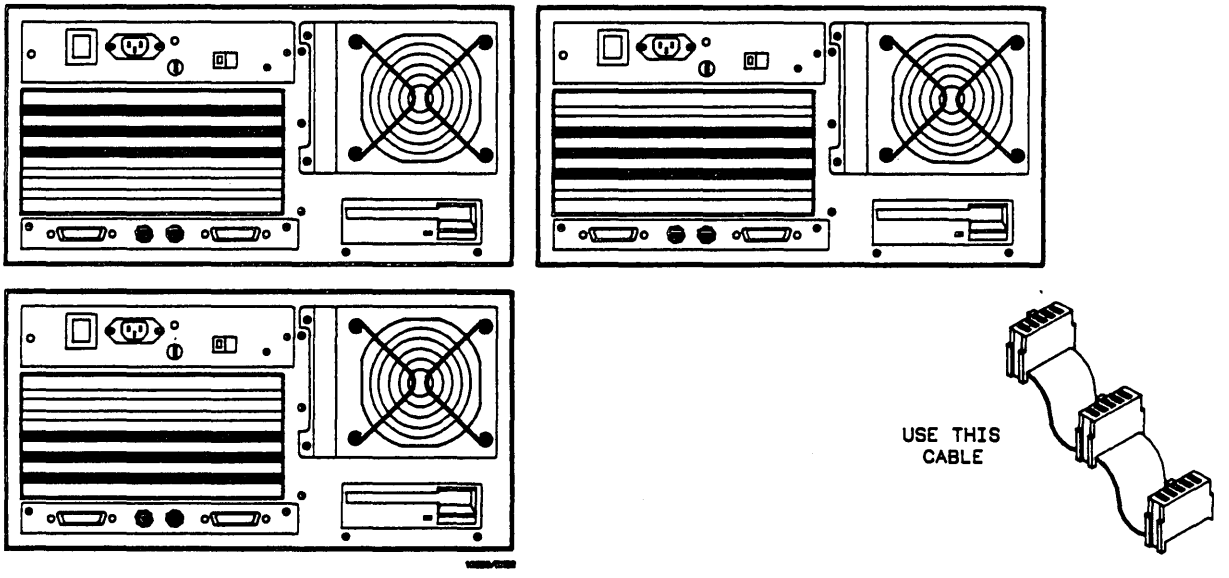



*Figure 2-4. One Master and Two Expansion Cards*



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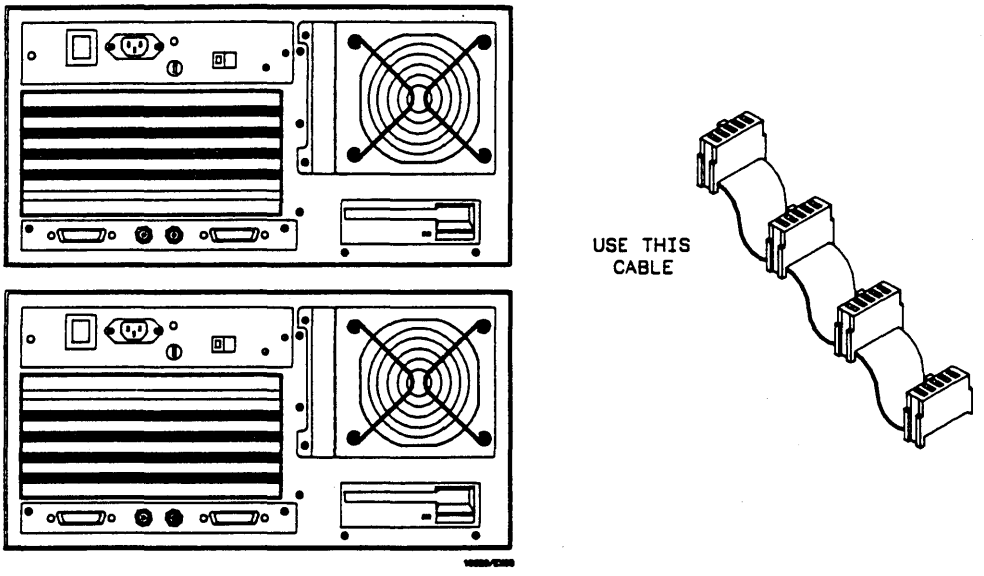



*Figure 2-5. One Master and Three Expansion Cards*

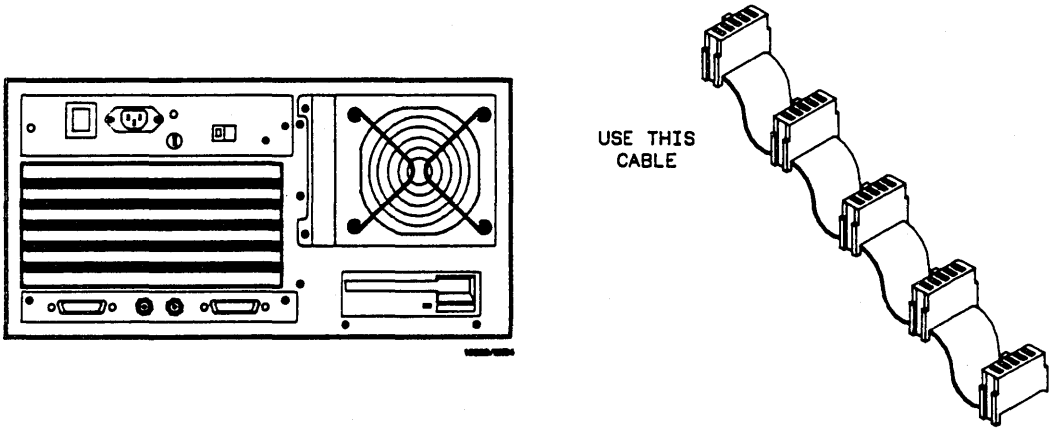



*Figure 2-6. One Master and Four Expansion Cards*



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e. Insert correct end of appropriate intercard connecting cable into connector on bottom card of configuration. See figure 2-7.

f. Lay cable flat and pointing out to the rear of card. See figure 2-8.

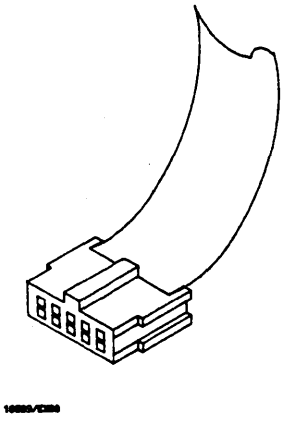


*Figure 2-7. Cable End*

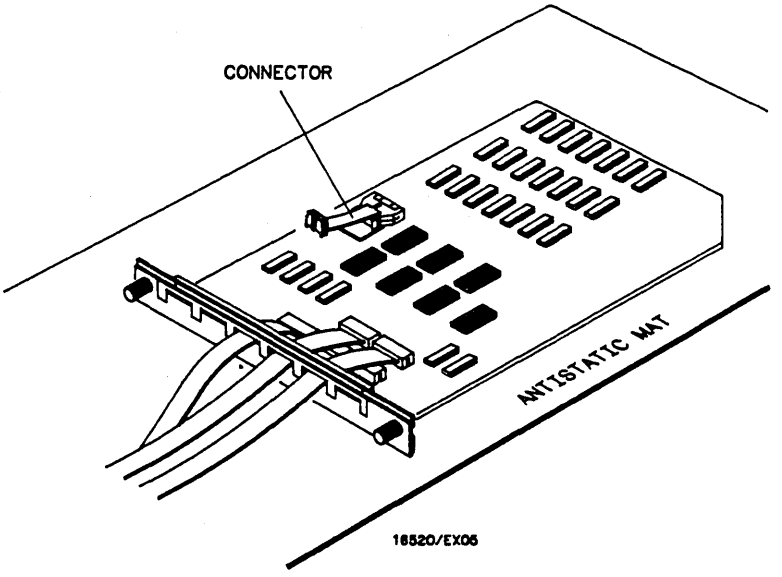



*Figure 2-8. Cable Position*

g. Slide card approximately **half way** into lowest slot that you are using for this installation.

h. Slide next card **half way** into next highest slot, feeding the intercard connecting cable up through the hole.

i. Insert appropriate connector into second card.

j. If there are more cards to install, repeat steps h through i until all cards are in place.



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

l. Repeat for all cards and filler panels in a **bottom to top** order. See figure 2-9.

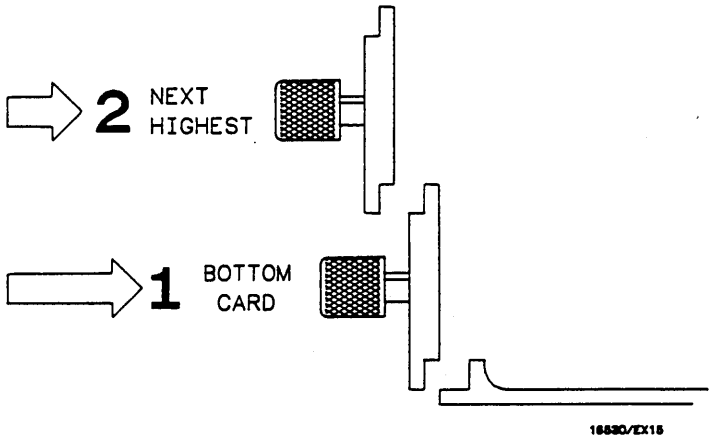



*Figure 2-9. Endplate Overlap*

m. 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.



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## 2-9. ADDING EXPANSION CARDS

This procedure should be used if you are adding expansion cards to a previously installed pattern generator module.

**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 or filler panels below the empty slots intended for the module installation do not have to be removed.
- You will only need one intercard connecting cable for any installation configuration.
- If previously installed modules prevent proper installation, they must be repositioned in the card cage. See figure 2-11.
- To maintain the channel-to-channel skew and adequate intercard signal quality, the shortest intercard connecting cable should be used and the expansion cards should be no more than two slots away from the master card. See figure 2-11.

**PROCEDURE:**

a. Turn instrument power switch off, unplug power cord and disconnect any input or output connections.

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

c. Starting **from the top**, begin pulling card(s) and filler panel(s) out **half way**. See figure 2-10.



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**CAUTION**

*All multi-card modules will be cabled together. Care should be taken to pull these cards out together.*

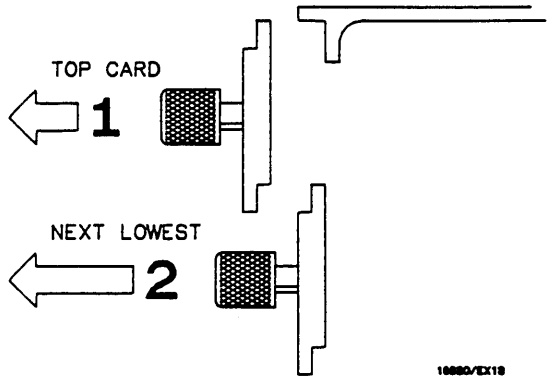



*Figure 2-10. Endplate Overlap*

d. Pull all cards in pattern generator module **completely out.**

e. Disconnect intercard connecting cable from all cards.

f. Use figure 2-11 and figures 2-3 through 2-6 to plan the new configuration and to select the proper intercard connecting cable.

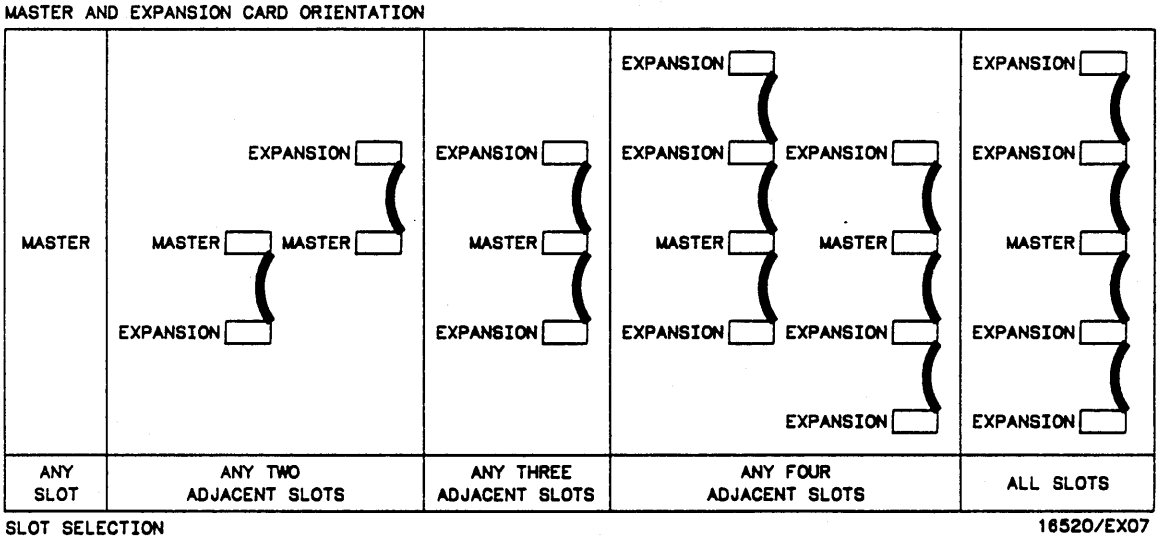



*Figure 2-11. Configuration Guide*

g. Go to step "e" of the procedure "MODULE INSTALLATION" in paragraph 2-8 and continue from that point.



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## 2-10. OPERATING ENVIRONMENT

The operating environment is listed in table 1-2. 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 16520/21A will operate at all specifications within the temperature and humidity range given in table 1-2. However, reliability is enhanced by operating the instrument within the following ranges.

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

## 2-11. 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.

## 2-12. 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.

## 2-13. 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.



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# SECTION III
# PERFORMANCE TESTS

## 3-1. INTRODUCTION

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

## 3-2. RECOMMENDED TEST EQUIPMENT

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

## 3-3. TEST RECORD

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

## 3-4. PERFORMANCE TEST INTERVAL

Periodic performance verification of the HP 16520/21A Pattern Generator Module is required at two year intervals. The instrument's performance should be verified after it has been serviced, or if improper operation is suspected. Calibration should be performed before any performance verification tests. Further checks requiring access to the interior of the instrument are included in the adjustment section, but are not required for the performance verification.

## 3-5. PERFORMANCE TEST PROCEDURES

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



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## 3-6. Data Period Accuracy Test

**SPECIFICATION:** ± 2% (of period) ± 1ns

**EQUIPMENT:**

| | |
|---|---|
| Oscilloscope | HP 54201A |
| BNC Cable | HP 10502A |
| BNC Adapter | HP 1250-1032 |
| Probe Lead Set | HP 10347A |
| Grabber (2) | HP 5959-0288 |

**DESCRIPTION:**

The purpose of this test is to verify the data period accuracy of the internal clock at its slowest and fastest clock ranges. (For best results, terminate into 10 kΩ, 10 pF)

**PROCEDURE:**

a. Connect data output channel 0 and the corresponding ground from a selected output data cable, to the oscilloscope as shown in figure 3-1. The output cables can be internally connected for either TTL or ECL.

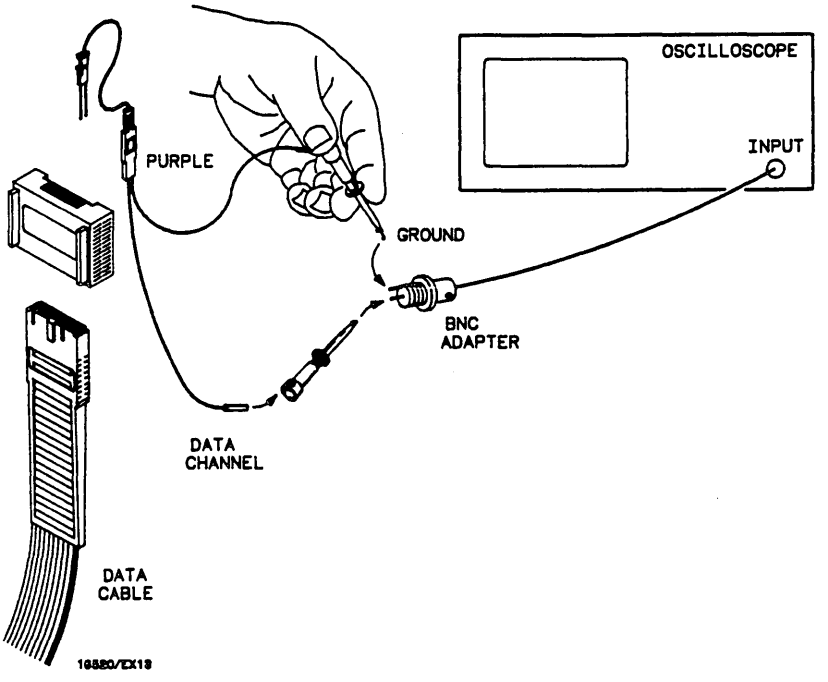



*Figure 3-1. Data Period Accuracy Test Equipment Hookup*

b. Apply power to the HP 16500A and wait for system bootup.



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c. From the startup screen shown in figure 3-2, touch the following fields in the sequence below:

1. **System**

2. **Pattern Gen** (If multiple HP 16520A Cards, pick one to be tested)

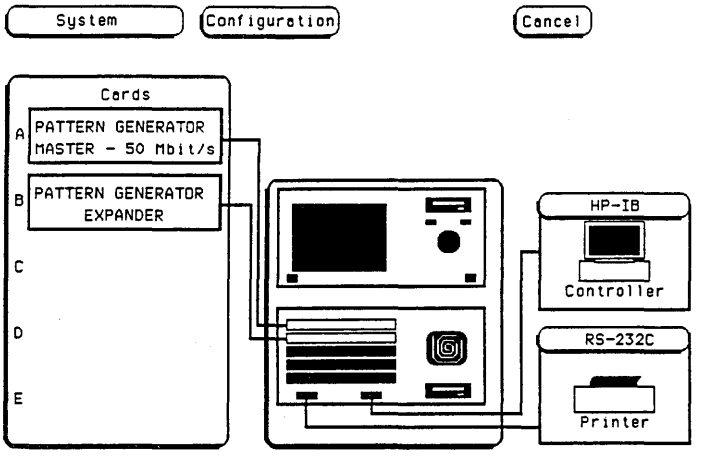



*Figure 3-2. Startup Screen*

d. In the Format screen, touch **Clock** field and set to Internal as shown in figure 3-3.

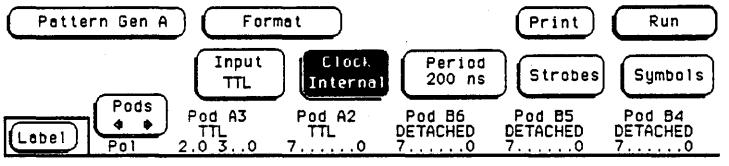



*Figure 3-3. Clock Field*



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e. Touch **Period** and set Internal clock to 200 μs as shown in figure 3-4.

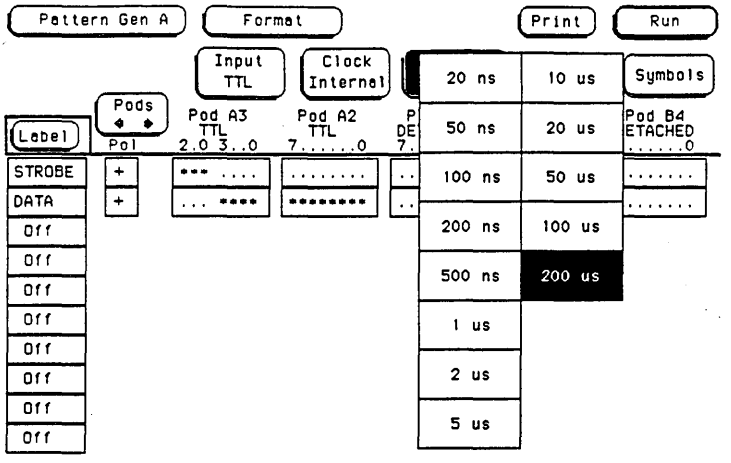



Figure 3-4. Clock Period Screen

f. Touch channel assignment field for the selected input cable. See figure 3-5.

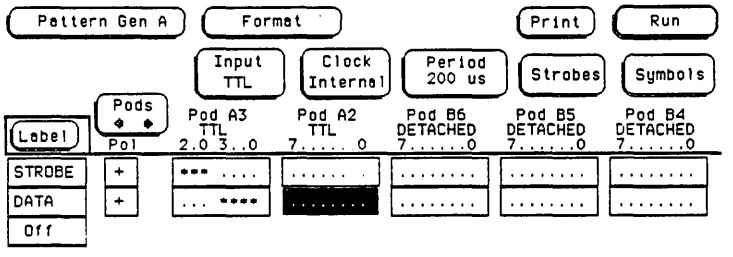



*Figure 3-5. Channel Assignment Field*

g. Select data output channel 0 as shown in figure 3-6. Touch **Done.**

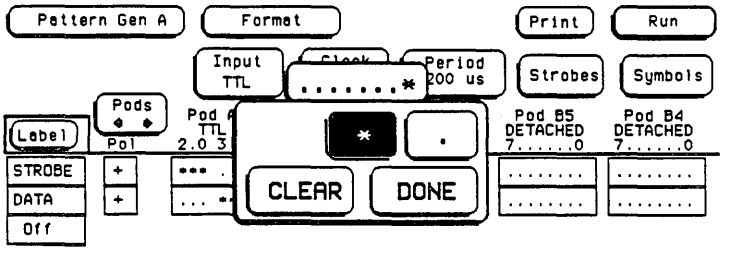



*Figure 3-6. Data Channel Select*

h. Touch **Format**, then touch **Listing.**



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i. From the listing screen, program the pattern generator as follows:

1. Touch program field as shown in figure 3-7.

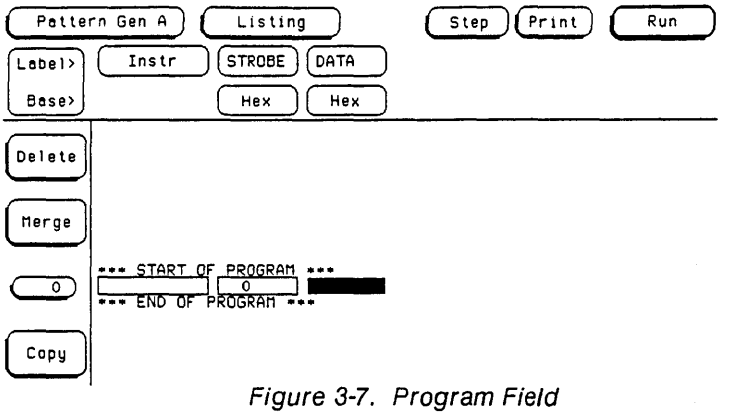



*Figure 3-7. Program Field*

2. Touch **1** as shown in figure 3-8, then touch **Done.**

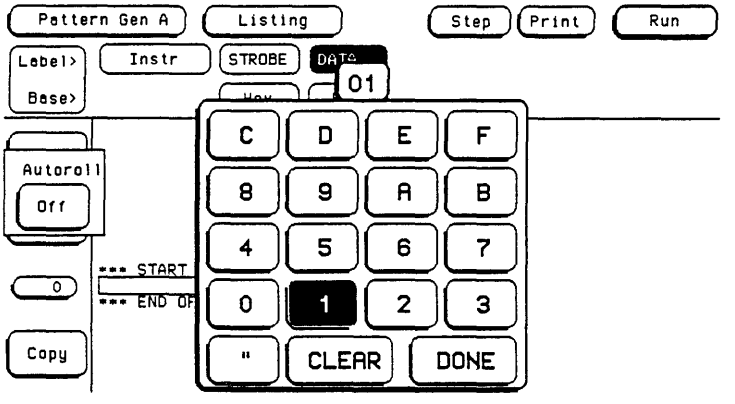



*Figure 3-8. Numeric Entry*

3. Touch **Insert** as shown in figure 3-9.

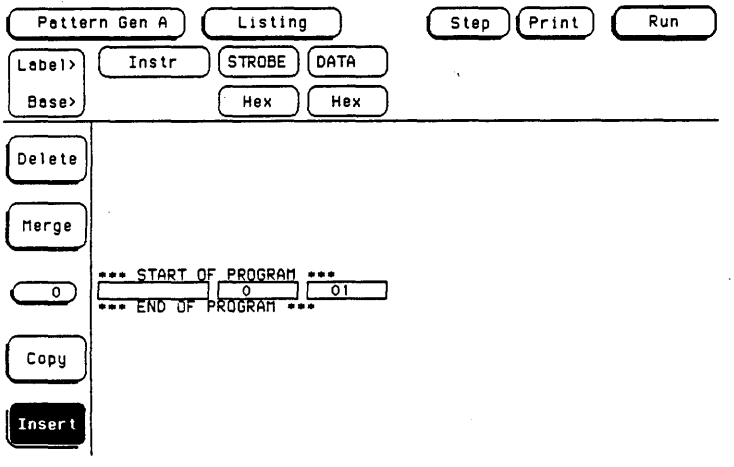



*Figure 3-9. Insert New Program Line*



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4. Touch program field as shown in figure 3-10.

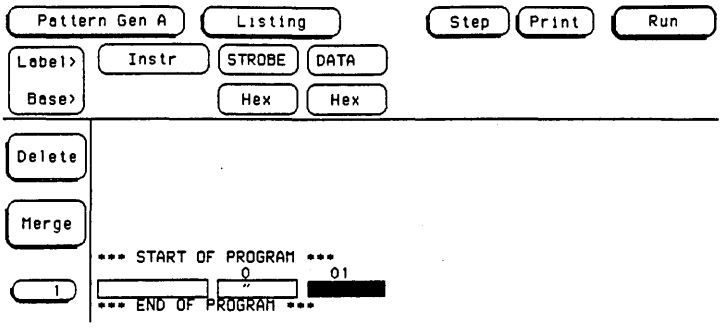



*Figure 3-10. Program Field*

5. Enter **0**s as shown in figure 3-11, then touch **Done**.

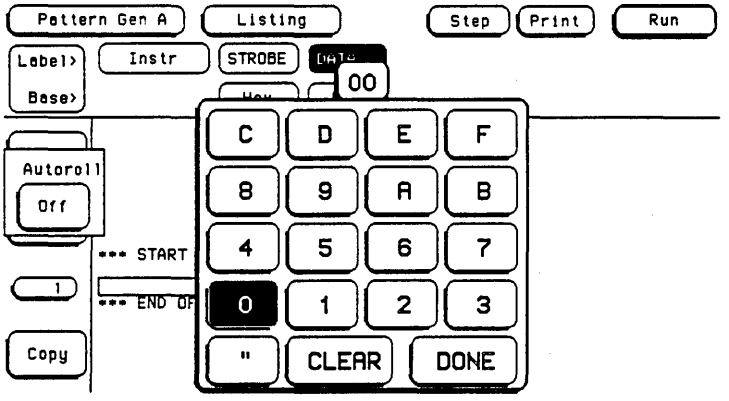



*Figure 3-11. Numeric Entry*

6. Repeat steps 1 through 5 until there is a short program starting with a one (1) and ending with a zero (0). See figure 3-12.

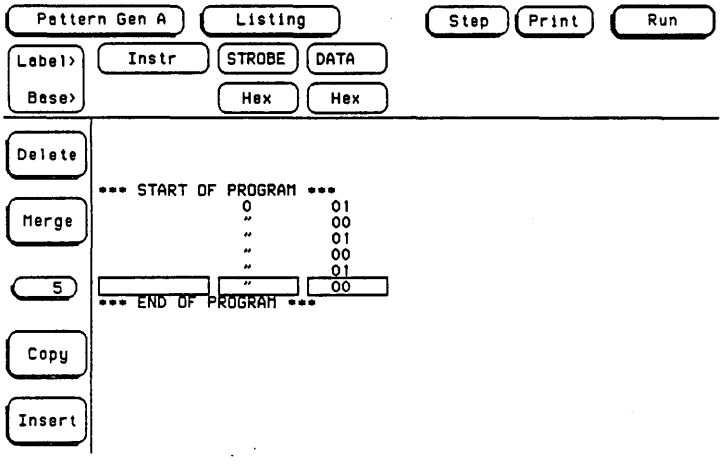



*Figure 3-12. Example Program*



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j. Touch **Run**, then drag finger to **Repetitive** as shown in figure 3-13.

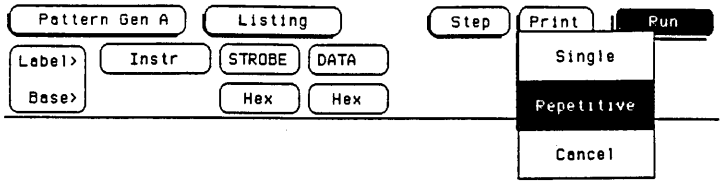



*Figure 3-13. Run Repetitive Mode*

k. Using the oscilloscope, measure pulse period at 50% point on waveform.

l. The pulse high time and low time should each measure between 196 μs and 204 μs.

m. Touch **Stop**.

n. Touch **Listing**, then touch **Format**.

o. Touch **Period**.

p. Change period to 20 ns.

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

r. Using the oscilloscope, measure pulse period at 50% point on waveform.

s. Pulse high time and low time should each measure between 18.6 ns and 21.4 ns.

t. Touch **Stop**.

**Note**

*This test arbitrarily selects data channel 0 on one of the data output cables. If desired, other output channels and cables may be substituted or added to this procedure.*



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## 3-7. Duty Cycle Test

**SPECIFICATION:** 10 ns minimum high time; 10 ns minimum low time

**EQUIPMENT:**

| | |
|---|---|
| Oscilloscope | HP 54201A |
| Pulse Generator | HP 8116A |
| BNC Cable (2) | HP 10502A |
| BNC Adapter (2) | HP 1250-1032 |
| 50 Ohm Feedthru | HP 10100C |
| Probe Lead Set | HP 10347A |
| Grabbers (4) | HP 5959-0288 |

**DESCRIPTION:**

The purpose of this test is to verify that the internal clock circuits will respond to the minimum high and low times of the user supplied clock. (For best results, terminate into 10 kΩ, 10 pF)

**PROCEDURE:**

a. Connect test equipment as shown in figure 3-14.

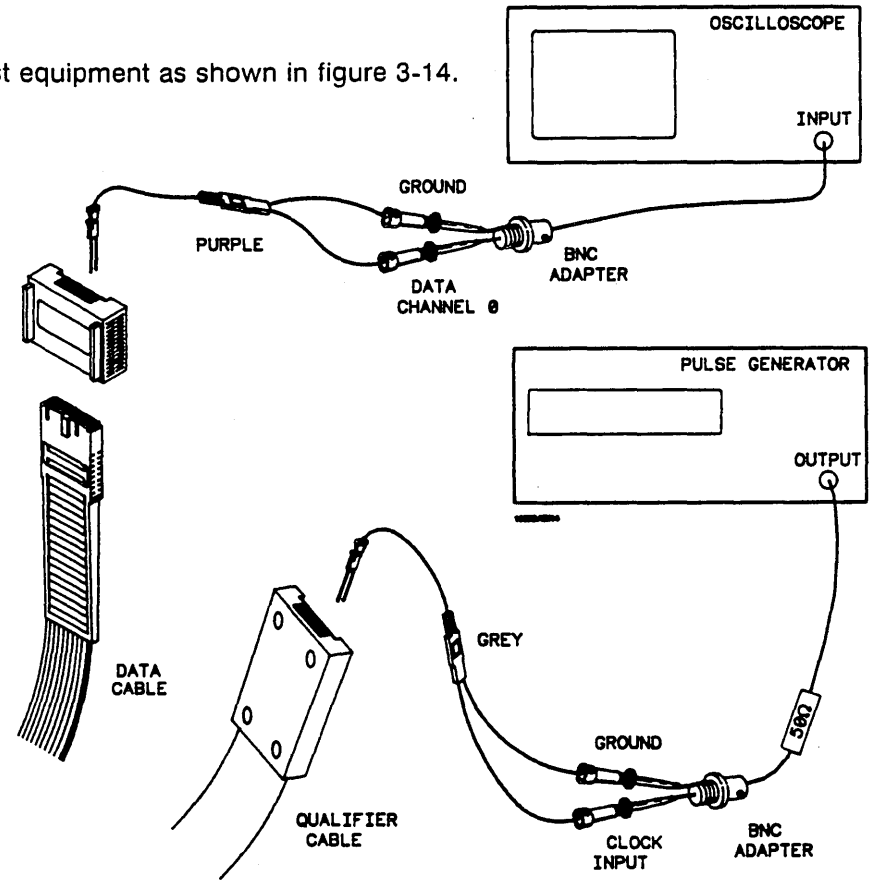



*Figure 3-14. Duty Cycle Test Equipment Hookup*

b. Apply power to the 16500A and wait for system bootup.

c. Set pulse generator for a 50 MHz square wave, 50% duty cycle, and an amplitute of 5 Volts.



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d. From the startup screen shown in figure 3-15, touch the following field in the ordered sequence below:

1. **System**

2. **Pattern Gen** (If multiple HP 16520A Cards, pick one to be tested)

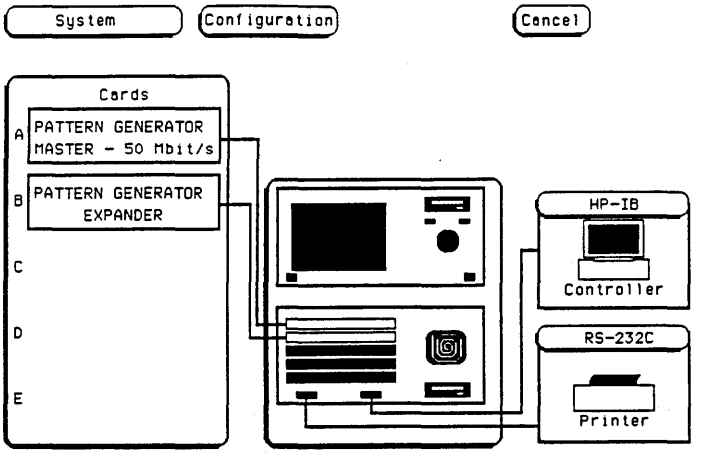



*Figure 3-15. Startup Screen*

e. Touch **Input** field to set input level to TTL as shown in figure 3-16.

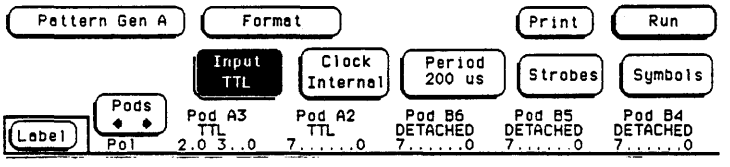



*Figure 3-16. Set TTL Level*

f. Touch **Clock** field and set to External as shown in figure 3-17.

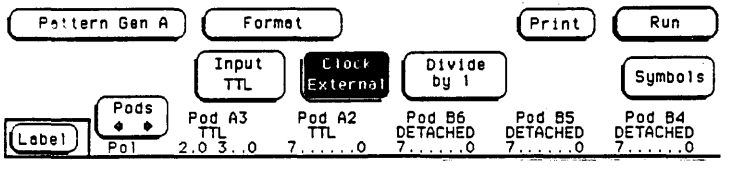



*Figure 3-17. Clock Field*



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g. Touch **Divide** field and set to **By 1**. See figure 3-18.

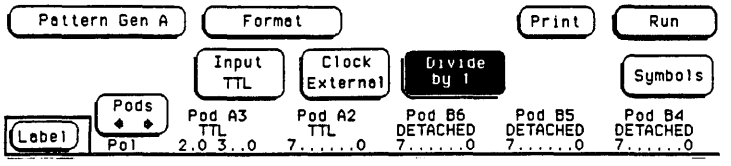



*Figure 3-18. Divide By 1 Field*

h. Touch channel assignment field for the selected output pod. See figure 3-19.

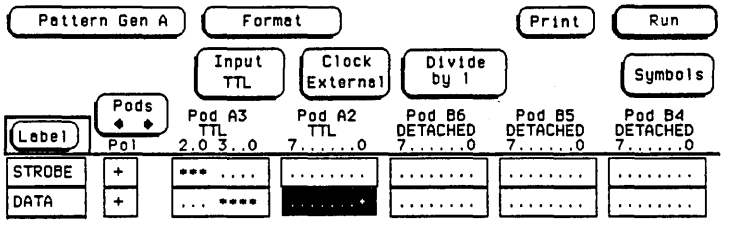



*Figure 3-19. Channel Assignment Field*

i. Select data output 0 as shown in figure 3-20. Touch **Done.**

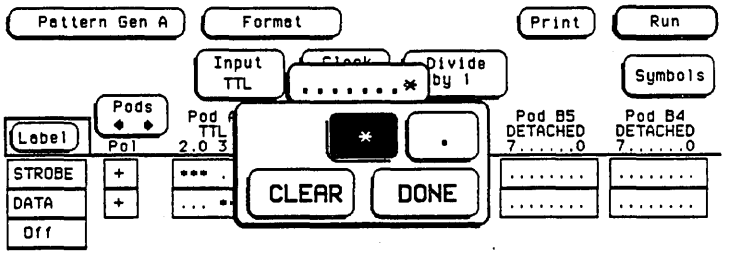



*Figure 3-20. Data Output Select*

j. Touch **Format**, then touch **Listing.**



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k. Perform step i in paragraph 3-6, "DATA PERIOD ACCURACY TEST" for a program as shown in figure 3-21.

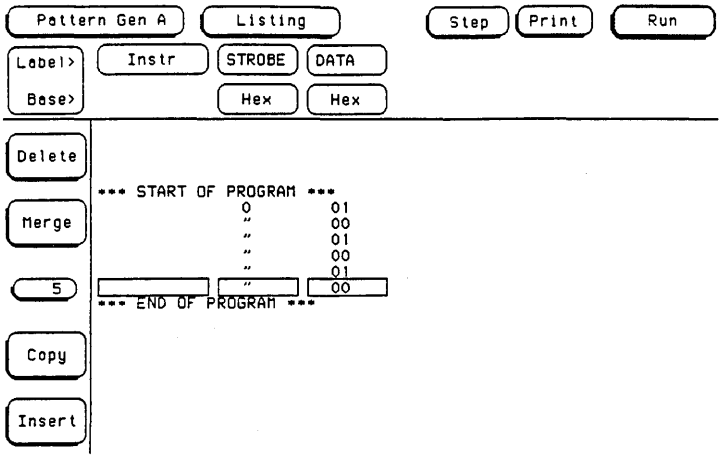



*Figure 3-21. Example Program*

l. Touch **Run**, then drag finger to **Repetitive** a shown in figure 3-22.

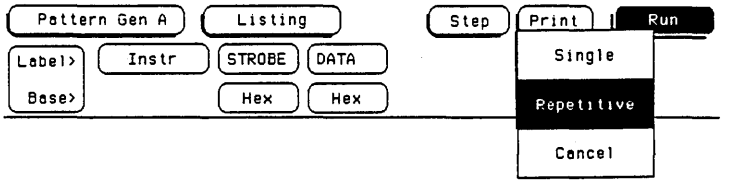



*Figure 3-22. Run Repetitive Mode*

m. Set oscilloscope timebase to display a pulse stream.

n. Look for a 25 MHz square wave pulse stream with approximatly 20 ns low times and 20 ns high times. See figure 3-23. The presence of a consistent pulse stream verifys the external clock circuits are working.

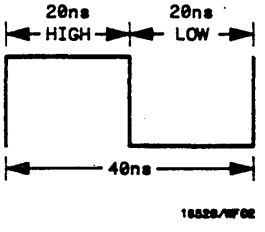



*Figure 3-23. 25 MHz Square Wave*

o. Touch **Stop**.



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*Table 3-1. Performance Test Record*

Hewlett-Packard
Model 16520/21A
Pattern Generator Card

Tested by _____

Work Order No. _____

Date Tested _____

Board No. _____

Recommended Calibration

Interval 24 Months

| Paragraph No | Test | Results |
|---|---|---|
| 3-5 | Data Period Accuracy @ 200 us | Minimum = 196 us<br>Maximum = 204 us<br>Actual _____ |
| | Data Period Accuracy @ 20 ns | Minimum = 18.6 ns<br>Maximum = 21.4 ns<br>Actual _____ |
| 3-6 | Duty Cycle | Is pulse stream visible ?<br>Yes<br>No _____ |



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# SECTION IV
# ADJUSTMENTS

## 4-1. INTRODUCTION

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

## 4-2. CALIBRATION INTERVAL

To maintain proper operation of the HP 16520/21A Pattern Generator Module, calibration should be performed at approximately two year intervals when the instrument is being used under normal operating conditions. If the instrument is used more than one shift per day, it may have to be calibrated more often.

New modules are preadjusted at the factory to meet the specifications listed in Section 1 of this manual. Before any adjustments are made to the module, the performance tests in Section III should be done. If the performance tests are within specifications, then adjustments are not necessary. If adjustments are necessary, refer to the safety summary at the front of this manual.

## 4-3. 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.

## 4-4. RECOMMENDED TEST EQUIPMENT

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

## 4-5. EXTENDER BOARD INSTALLATION

Before any adjustments or calibration checks are done, the HP 16520A Card must be installed on an extender board. The procedure for this installation is on the next page.



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## Extender Board Installation (cont.)

**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:**

- The extender board may be installed in any available slot in the card cage.
- Cards below the slot used by the extender board do not have to be removed.
- The probe cables do not have to be removed to adjust the HP 16520A Card.

**PROCEDURE:**

a. Turn instrument power switch off, unplug power cord and disconnect any input or output connections.

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

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

**CAUTION**

*All multi-card modules will be cabled together. Care should be taken to pull these cards out together.*

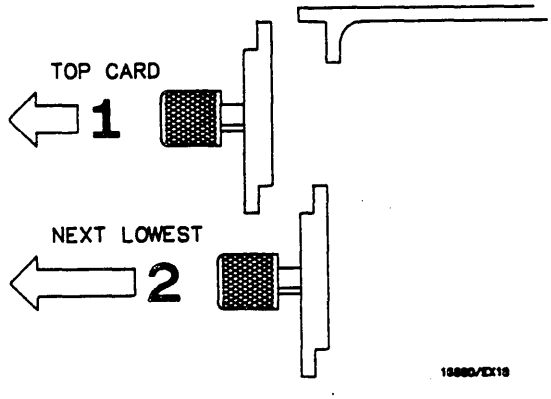



*Figure 4-1. Card Endplate Overlap*

d. Pull module (one or more cards) to be serviced completely out and disconnect intercard connecting cable from the card(s).



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e. Push all other cards part way into the card cage, but **not completely in** so they won't be in your way when you install the extender board.

f. Slide extender board completely into card cage making sure it is firmly seated in backplane connecter.

g. Plug HP 16520A Card into extender board. See figure 4-2.

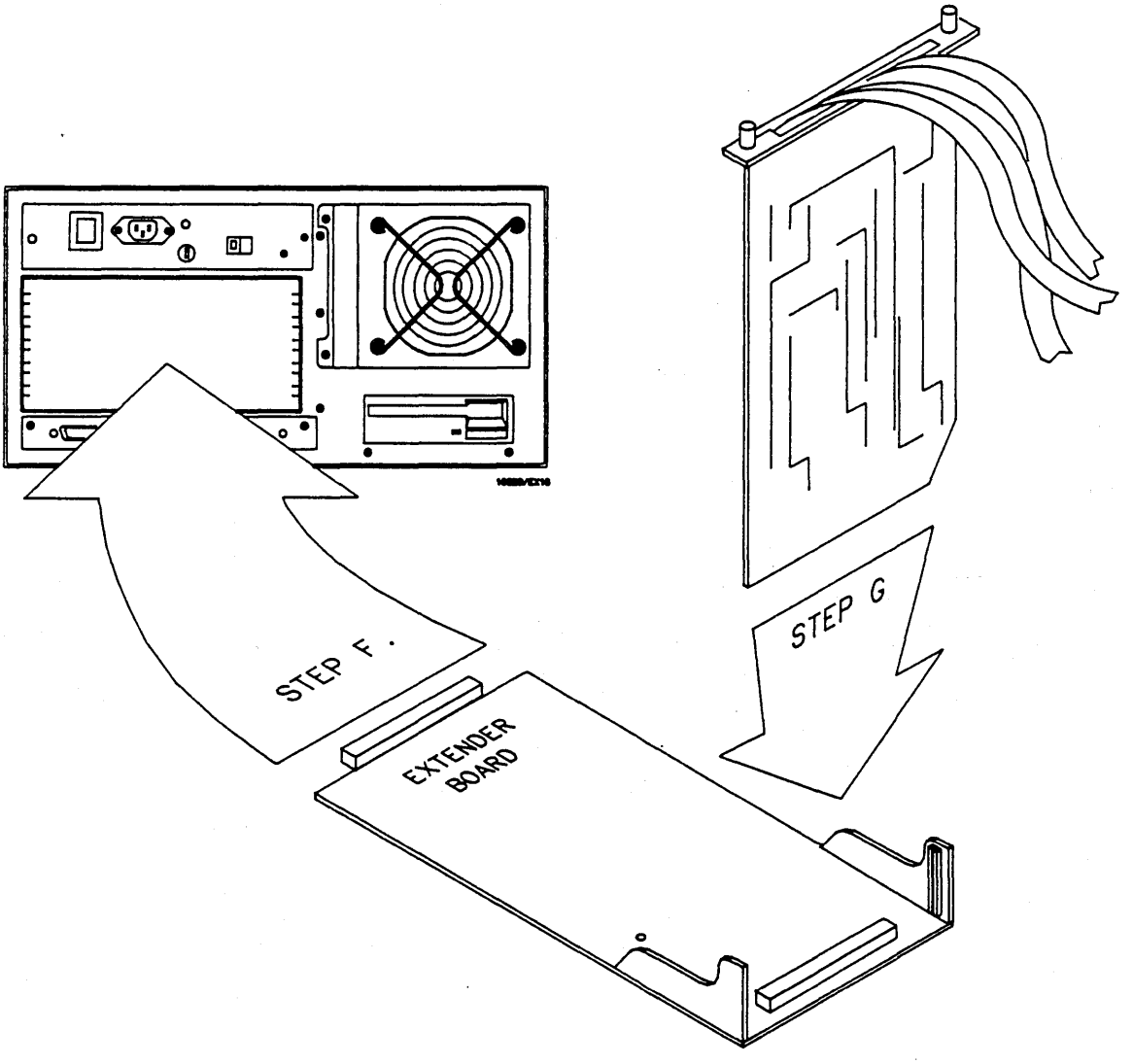



*Figure 4-2. Extender Board and Module*



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## 4-6. INSTRUMENT WARMUP

Always adjust and check the calibration of the instrument at its environmental ambient temperature and after a 15 minute warm-up.

## 4-7. ADJUSTMENT AND CALIBRATION CHECK

There is one calibration check on the HP 16520A card. If calibration is out, there will be one adjustment to make. This reference is preset at the factory and normally **should not** need adjustment. If, after referring to paragraph 3-4, "PERFORMANCE TEST INTERVAL", the reference voltage is suspected as a problem, perform the following procedure.

**DESCRIPTION:**

This procedure will check and adjust the +5 Volt reference for the D/A converter.

**EQUIPMENT:**

Multimeter ..... HP 3468A

**PROCEDURE:**

a. Connect the positive lead from the multimeter to TP1 and the negative lead to TP2. For the location of the test points and the adjustable resistor, refer to figure 4-3.

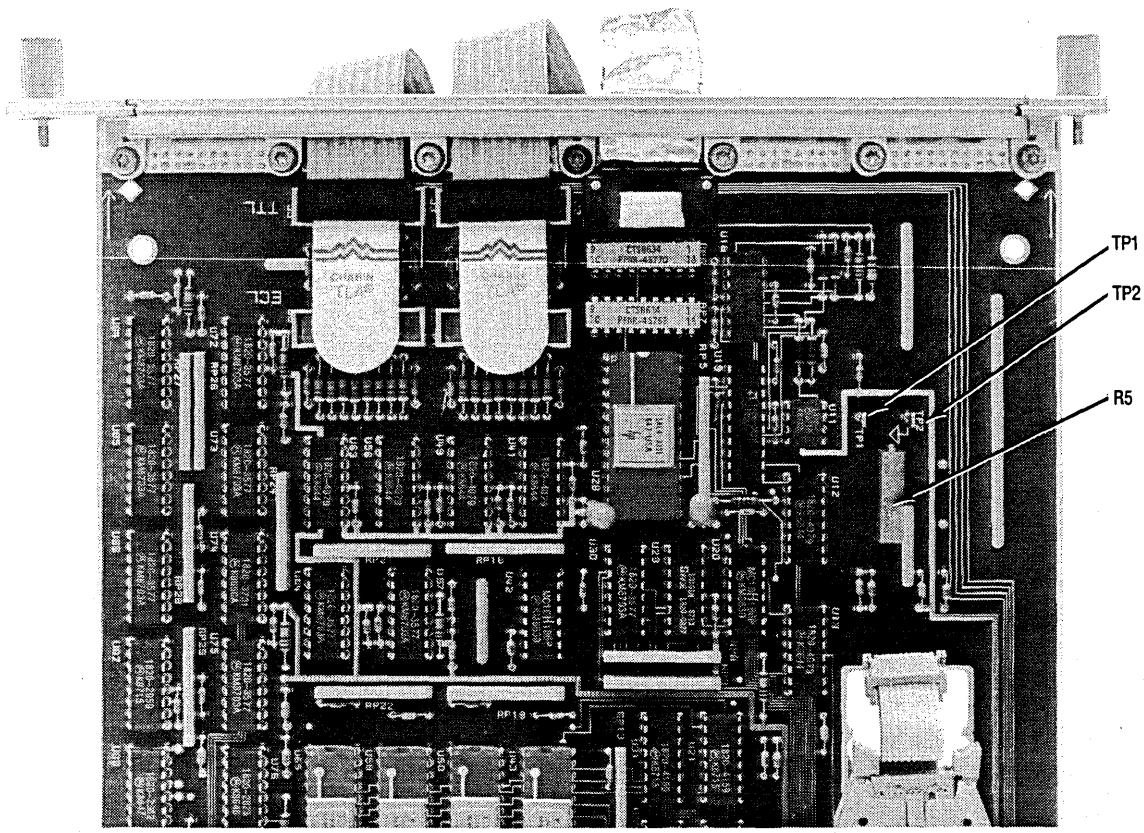



*Figure 4-3. Adjustment Pot Location*



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b. Set the multimeter to autorange and DC Volts.

c. Plug power cord in, turn instrument power on, and wait for system bootup.

d. From the startup screen shown in figure 4-4, touch the following fields in order:

1. **System**
2. **Pattern Gen** (If multiple HP 16520A cards, pick the one to be adjusted)
3. **Format**
4. **Listing**

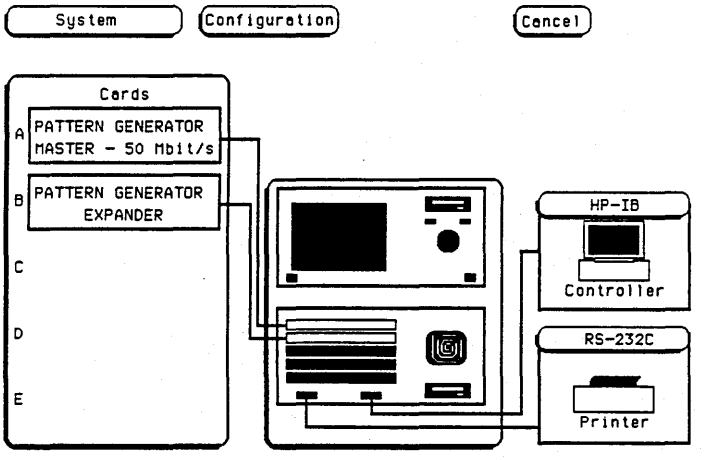



*Figure 4-4. Startup Screen*

e. Touch **Delete**. See figure 4-5.

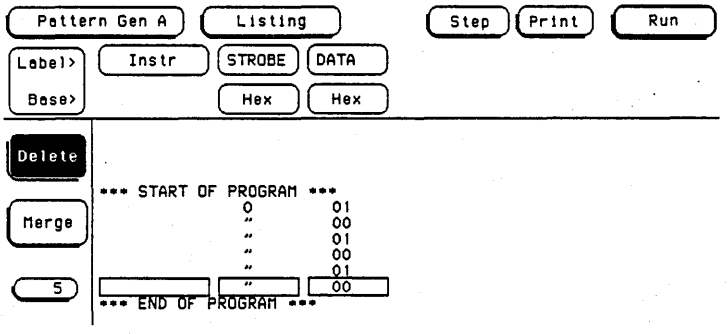



*Figure 4-5. Delete Field*



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f. Rotate knob counter clockwise until "START OF PROGRAM" comes down to midscreen and the program line field shows 0. See figure 4-6.

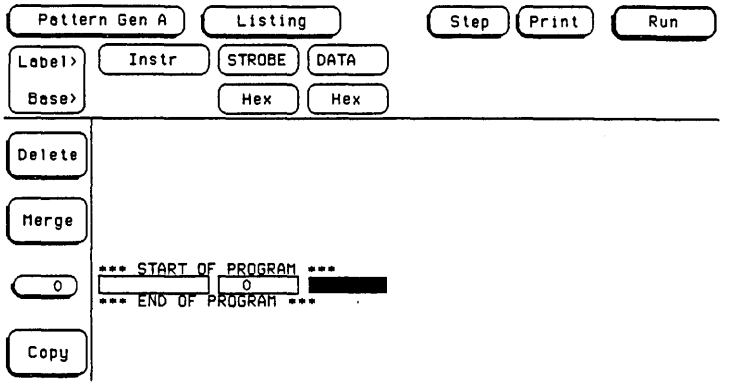



*Figure 4-6. Program Line Field*

g. Touch **Execute**, **Listing**, then **Format**.

h. Touch **Input**, then touch **User Defined**. See figure 4-7. Set level to +9.9 Volts, then touch **Done**.

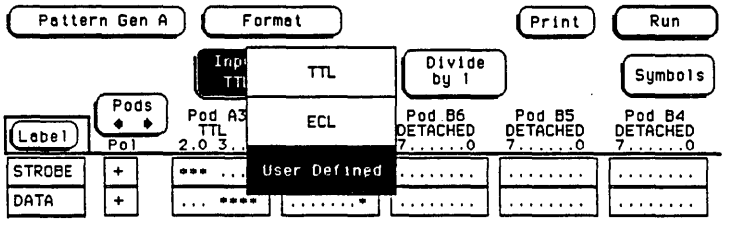



*Figure 4-7. User Defined Field*

i. Touch **Clock** to set clock source to internal. See figure 4-8.

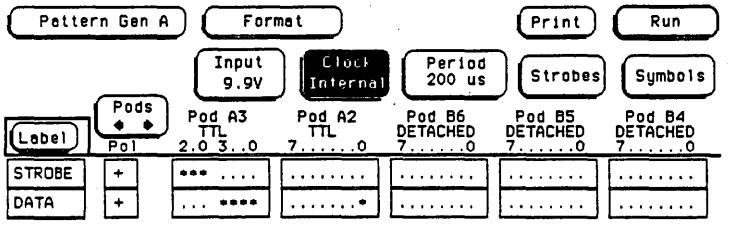



*Figure 4-8. Internal Clock*



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j. Touch **Period**, then **200 ns**. See figure 4-9.

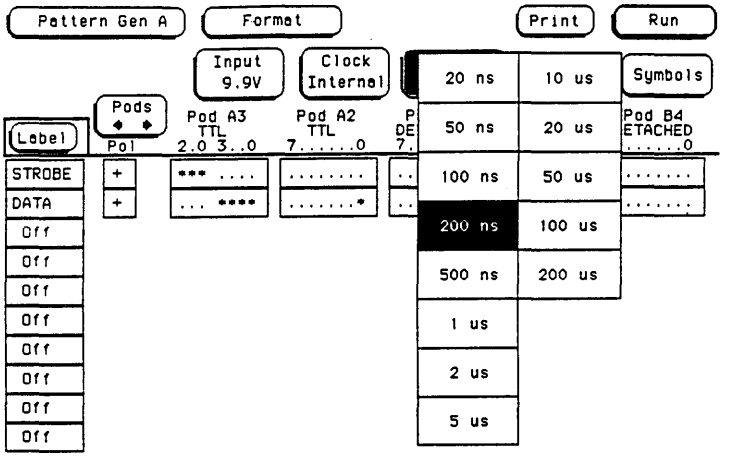



*Figure 4-9. Period Selection*

k. Touch **Run**, then drag finger to **Single**. See figure 4-10.

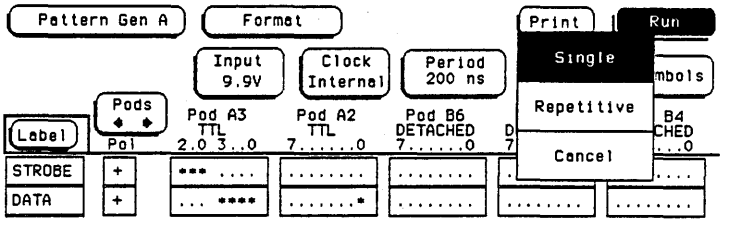



*Figure 4-10. Run-Single Selection*

**Note**

After you have started the pattern generator, the **Run** field will change to **Stop**, then very quickly change back to **Run**. This is the point the measurement is taken.

l. Read the voltage displayed.

m. With a non-metallic adjustment tool, adjust the variable resistor R5 until the multimeter reads 0.99 Volts (± 0.001 V).

n. Set user defined level to -9.9 Volts and touch **Run**.



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o. Read the voltage displayed and note the difference between this reading and -0.99 Volts. Adjust R5 so this difference in halved (± 0.001 V).

Examples:

If reading is + 0.95 V, the difference is .04 V. Adjust R5 for + 0.97 V.

If reading is + 0.97 V, the difference is .02 V. Adjust R5 for + 0.98 V.

p. Turn off instrument power, unplug power cable and disconnect all test equipment.

q. Remove the HP 16520A Card from the extender board.

r. At this point in the procedure, if you have multiple HP 16520A Cards to adjust, plug in the next HP 16520A card and repeat steps a through q.

s. If you have completed the adjustment on the HP 16520A Card(s), remove extender board.

t. To reinstall the pattern generator module, go to steps d through m of paragraph 2-8, "MODULE INSTALLATION".



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# SECTION V
# REPLACEABLE PARTS

## 5-1. INTRODUCTION

This section contains parts and ordering information for the HP 16520/21A Pattern Generator 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. We did this because the abbreviations in the parts list are always all capitals. However, in other parts of the manual other abbreviation forms are used with both lower and uppercase letters.

## 5-3. REPLACEABLE PARTS LIST

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

a. Electrical assemblies in alphanumerical order by reference designation.

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

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

The information given for each part consists of the following:

a. Complete reference designation.

b. Hewlett-Packard part number.

c. Total quantity (Qty) of instrument.

d. Description of part.

e. Check digit.

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

## 5-4. EXCHANGE ASSEMBLIES

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

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

## 5-5. 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.



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## 5-6. DIRECT MAIL ORDER SYSTEM

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

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

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

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

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

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



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*Table 5-1. Reference Designators and Abbreviations.*

**REFERENCE DESIGNATORS**

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

**ABBREVIATIONS**

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



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*Table 5-2. Replaceable Parts*

| Reference Designation | HP Part Number | CD | Qty. | Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| | 16520-13501 | 1 | 1 | HP 16520/21A OPER. SYS. DISC | | |
| | 16520-69502 | 9 | 1 | HP 16520A EXCHANGE ASSY. | | |
| | 16521-69501 | 9 | 1 | HP 16521A EXCHANGE ASSY. | | |
| | | | | **HP 16520A** | | |
| | 16520-61601 | 1 | 1 | INPUT QUALIFIER PROBE CABLE | | |
| | 16520-61602 | 3 | 1 | 8 CHANNEL DATA CABLE | | |
| | 16520-61603 | 5 | 1 | CLOCK PROBE CABLE | | |
| | 16520-69501 | 8 | 1 | INPUT QUAL. PROBE KIT GREY | | |
| | 16515-40501 | 0 | 1 | REAR PANEL STM | | |
| | 16515-40502 | 2 | 1 | CLAMP-PANEL | | |
| | 16500-22401 | 5 | 2 | PANEL SCREW | | |
| | 16520-62102 | 1 | 1 | LEAD SET PURPLE 10347A | | |
| | 0515-0430 | 3 | 3 | MSPH M3 6 SMS10 | | |
| | 0515-0665 | 6 | 4 | M3 X 14 PH T10 | | |
| | 0510-0684 | 9 | 2 | RETAINING RING | | |
| | 16500-29101 | 6 | 1 | GROUND SPRING | | |
| | 16520-94305 | 1 | 1 | PATT. GEN LABEL | | |
| | 16500-41201 | 3 | 3 | RIBBON CABLE ID CLIP | | |
| | 5959-0291 | 9 | 1 | SERIAL TAG | | |
| | | | | **HP 16521A** | | |
| | 16520-61602 | 3 | 6 | 8 CHANNEL DATA CABLE | | |
| | 16500-41201 | 3 | 6 | RIBBON CABLE ID CLIP | | |
| | 16521-68701 | 1 | 1 | INTERCARD CONNECT CABLE KIT | | |
| | 0515-0430 | 3 | 3 | MSPH M3 6 SMS10 | | |
| | 0515-0665 | 6 | 4 | M3 X 14 PH T10 | | |
| | 0510-0684 | 9 | 2 | RETAINING RING | | |
| | 16500-29101 | 6 | 1 | GROUND SPRING | | |
| | 16521-94308 | 2 | 1 | PATT. GEN. EXP LABEL | | |
| | 16515-40501 | 0 | 1 | REAR PANEL STM | | |
| | 16515-40502 | 2 | 1 | CLAMP-PANEL | | |
| | 16500-22401 | 5 | 2 | PANEL SCREW | | |
| | 5959-0291 | 9 | 1 | SERIAL TAG | | |



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# SECTION VI
# SERVICE

## 6-1. INTRODUCTION

This section contains information for servicing the HP 16520/21A Pattern Generator Module. Included is a block level theory of both cards and procedures for self diagnostics and troubleshooting. If a card or cable is determined faulty, procedures are provided for replacing the card or cable.

## 6-2. SAFETY REQUIREMENTS

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

## 6-3. RECOMMENDED TEST EQUIPMENT

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

## 6-4. MODULE BLOCK DIAGRAM AND THEORY OF OPERATION

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

For component level troubleshooting, the HP 16520/21A Service Data Supplement is required. This supplement contains schematics, component level theory of operation, component locators and a parts list for the pattern generator module.

The HP 16520/21A Pattern Generator Module consists of one master card or one master card and one or more expansion cards. Up to four HP 16521A Expansion Cards can be connected to a single HP 16520A Pattern Generator Card for a total of 204 data output channels. See figure 6-1.

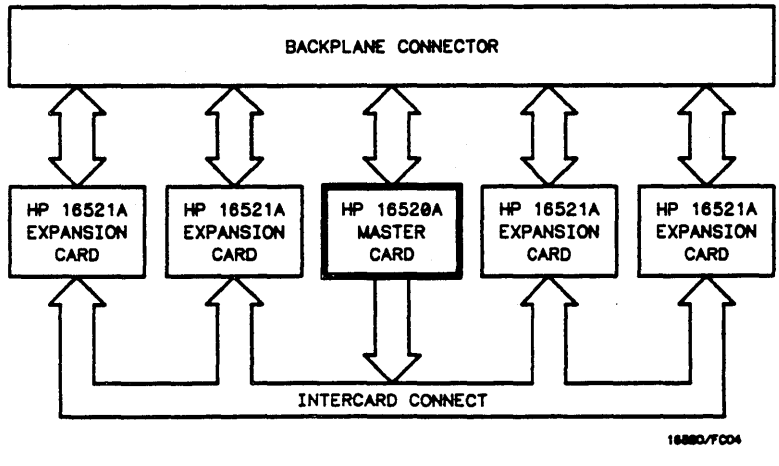



*Figure 6-1. HP 16520/21A Pattern Generator Module Block Diagram*



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The HP 16520A Pattern Generator card is a stand alone digital stimulus card with 12 data output lines, 3 user defined strobes, and external inputs. The user stimulus program (up to 4k lines) is executed and controlled by the pattern generator master card.

The HP 16521A Pattern Generator Expansion Card is a 48 channel expander that extends the data channel width of the pattern generator master card. The pattern generator expansion card has only program data RAM (4k deep).

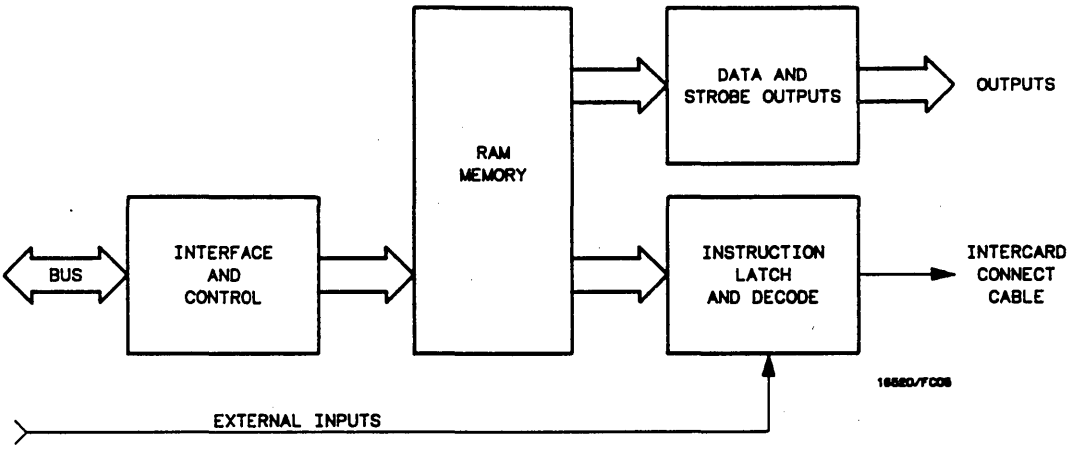



*Figure 6-2. Pattern Generator Master Block Diagram*

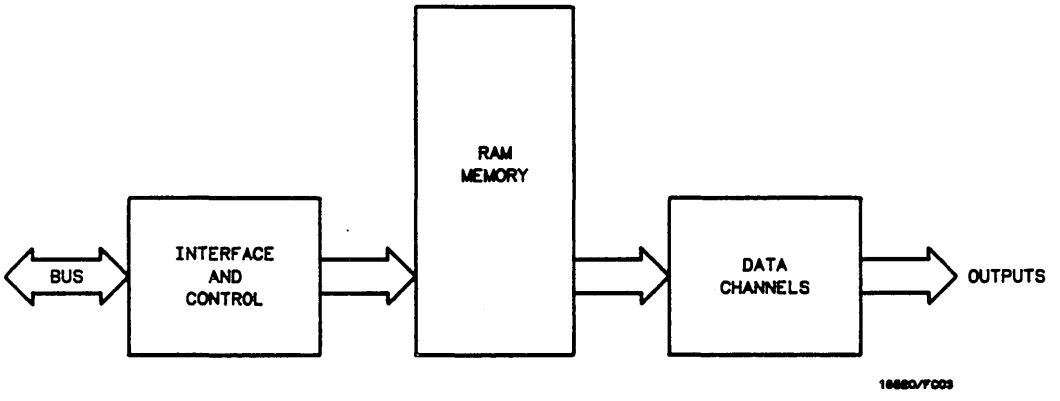



*Figure 6-3. Pattern Generator Expansion Block Diagram*



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# 6-5. PATTERN GENERATOR THEORY OF OPERATION

## Interface And Control

The microprocessor interface circuitry enables the pattern generator module to communicate via the mother board to other modules in the mainframe. User selectable pattern generator parameters and programs (stimulus output) are loaded into the pattern generator from the CPU. Pattern generator status is communicated to the CPU from the module.

The intermodule bus circuitry (IMB) enables the pattern generator module to trigger/arm other modules or be triggered/armed by the state of another module in the mainframe.

The clock circuitry is responsible for the generation of the user selectable clock rates. These user selectable clock rates come in three formats. The system master clock, minor clock, and the pre-master clock. The system master clock is fanned out to run the pattern generator and is the primary clock source in the pattern generator module. The minor clock is used to generate strobe channel timing and is typically a higher frequency than the system master. The pre-master clock is a slightly advanced version of the master clock and is used whenever setup time is necessary in the pattern generator module.

The program counter is 12-bits wide. With the 4k deep memory, 12-bits permits access to the complete address space. The counter can be parallel loaded and asynchronously reset.

## Ram Memory

Three 4k x 4 RAMs are used to store the 12 data channel programs. Four 4k x 4 RAMs are used to store the three strobe channel parameters, the pattern generator instruction field and the instruction parameter field. This memory arrangement provides a 28-bit microword which controls the operation of the program counter and generates data and strobe vectors for the user.



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### Data And Strobe Outputs

The RAM data latch contains flip-flops that latch memory output data. After the memory data is latched, it sends ECL data out to be series terminated before becoming available to the user at a connector. The same ECL data, from the data latch, is translated to TTL and sent to be series terminated before becoming available to the user in the same manner. Output data voltage levels (TTL/ECL) are accessed by physically locating the data output cable in the appropriate connector.

There are three strobe channels that can be used to output user defined pulses. Within a single pattern generator program step, the strobe channel pulse can be controlled in increments of 1/10th or 1/5th of a program step. The user can define polarity, delay, and pulse width.

### Instruction Latch And Decode

Just as the memory data is latched, the instruction data must also be latched. This circuit takes two of the five instruction opcode bits and decodes them. Three other opcode bits have dedicated hardware functions. The remaining eight instruction bits are for a parameter field. The parameter field bits are used by the REPEAT and WAIT EXT instructions.

The external input circuit enables the user to input three bits of external qualification information and an external clock. This external clock may be used in place of the internally generated clock. The external qualification information may stop the program counter with the WAIT EXT instruction until the input qualification conditions are met. Inputs can be TTL, ECL or user defined between +9.9 and -9.9 volts.

The repeat instruction counter is eight bits wide. The user may repeat a strobe/data pattern up to 256 times.

## 6-6. EXPANSION CARD THEORY OF OPERATION

### Interface And Control

The interface and control circuitry enables the expansion card to receive pattern generation parameters and program data from the CPU and clock and control signals from the pattern generator master card.

The program counter is made of three 4-bit wide counters, making it 12-bits wide. With 4096 X 4 bit memory, 12-bits permits access to the complete address space. The counter can be parallel loaded and asynchronously reset. The expansion card program counter steps are based on the control signals from the master card.

### RAM Memory

There are twelve 4096 X 4 bit, RAM chips on the 16521A card. Each RAM stores four channels of data, making the total number of outputs at 48.

### Data Outputs

The RAM data latch contains flip-flops that latch memory output data. After the memory data is latched, it sends ECL data out to be series terminated before becoming available to the user at a connector. The same ECL data, from the data latch, is translated to TTL and sent to be series terminated before becoming available to the user in the same manner. Output data voltage levels (TTL/ECL) are accessed by physically locating the data output cable in the appropriate connector.



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## 6-7. SELF TESTS

The self tests for the HP 16520/21A Pattern Generator 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 pattern generator modules, they 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 chart in paragraph 6-8 may require the installation of the extender board to isolate a specific card or cable.

**CAUTION**

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

**SELF TEST ACCESS PROCEDURE:**

a. Disconnect all inputs and turn power switch on.

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

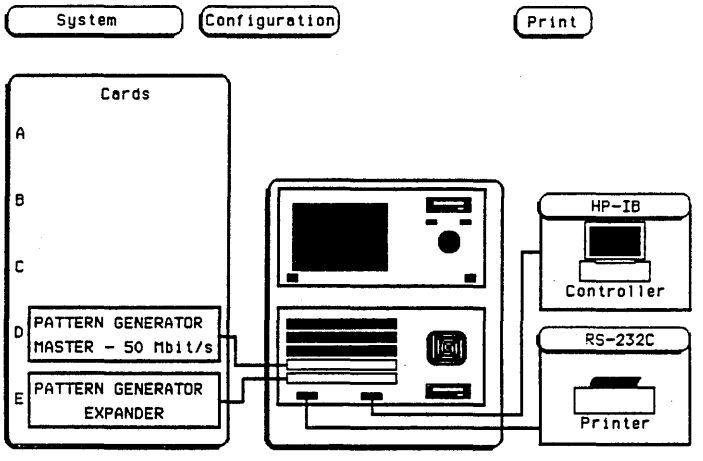



*Figure 6-4. Startup Screen*



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

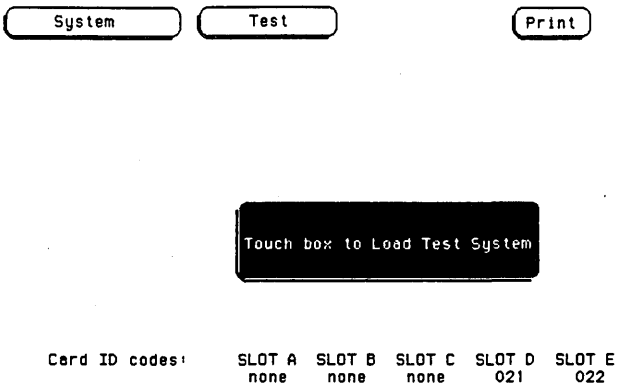



*Figure 6-5. Load Test System*

d. From test screen in figure 6-6, touch **Test System**, then touch **Pattern Gen.** (If multiple pattern generator modules, select the one to be tested)

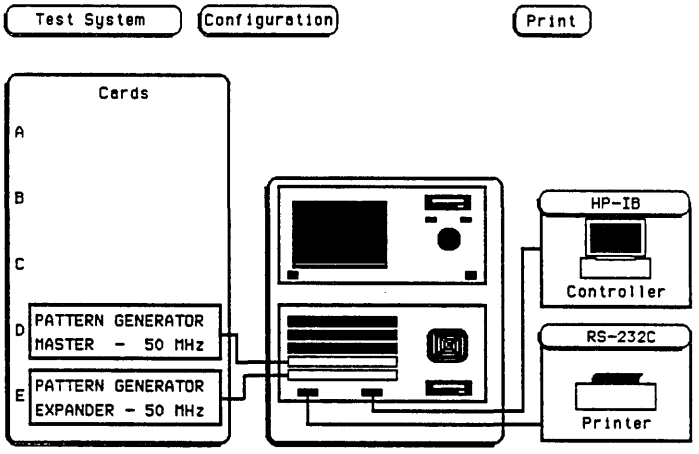



*Figure 6-6. Test System Screen*



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

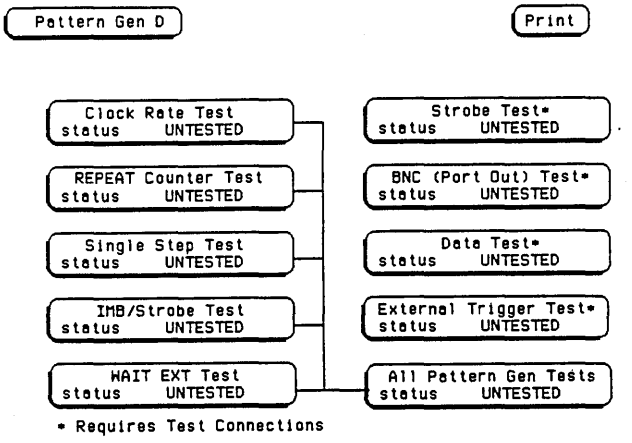



*Figure 6-7. Main Test Menu*

f. Touch **Clock Rate Test.**

g. 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 the number of test failures.

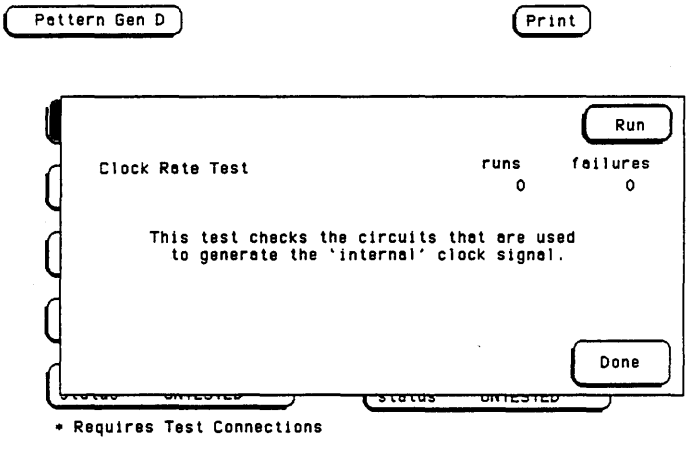



*Figure 6-8. Clock Rate Test Run Screen*

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

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



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

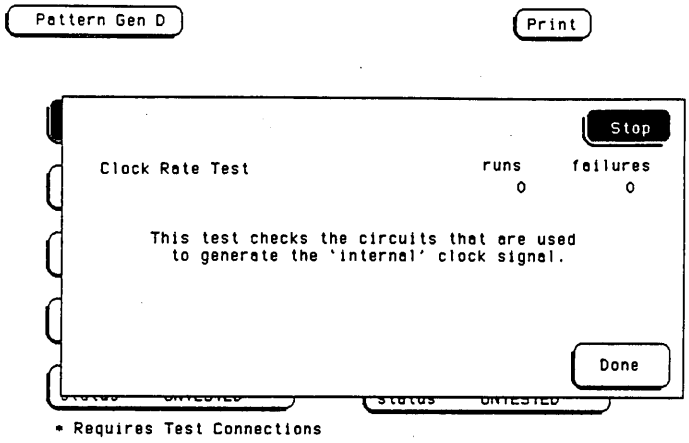



*Figure 6-9. Stop Field*

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

1. **Pattern Gen**
2. **Test System**
3. **Configuration**
4. **Exit Test**

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

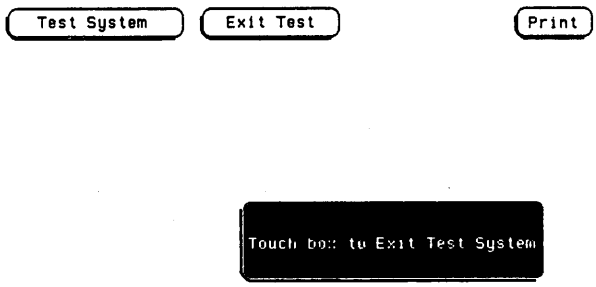



*Figure 6-10. Exit Test System*



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**TEST DESCRIPTIONS:**

**Clock Rate Test**

This test checks for clock occurrence and clock accuracy on the pattern generator master card.

**Repeat Counter Test**

This test checks the repeat counter on the pattern generator master card.

**Single Step Test**

This test verifies that a microprocessor "BREAK" instruction can be set and cleared by the pattern generator master card.

**IMB/Strobe Test**

This test checks the ability of the trigger circuits on the pattern generator master card to see and react to the IMB trigger/arm signals.

**Wait External Test**

This test checks the ability of the pattern generator master card to use the three external trigger lines.

**Strobe Loopback Test**

This test checks the strobe outputs of the pattern generator master card. An external connection is required.

**BNC Loopback Test**

This test verifies the ability of the pattern generator master card to both trigger and receive a signal from the BNC PORT IN and BNC PORT OUT on the microprocessor board.

**Data Loopback Test**

This test checks the data path of a single data pod for signal continuity and proper function of the buffers and other assorted circuitry. An external connection is required.

**External Trigger Loopback Test**

This test verifies the ability of the pattern generator master card to use the three external trigger lines during real data combination verification.

## 6-8. TROUBLESHOOTING

If self tests indicate a failure, begin at the **Start** of the troubleshooting flow chart shown in figure 6-11. When a specific test fails, you will be instructed to replace a faulty card or you will be referred to other flow charts for the isolation of the faulty card or cable.



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## Troubleshooting Sheet 1

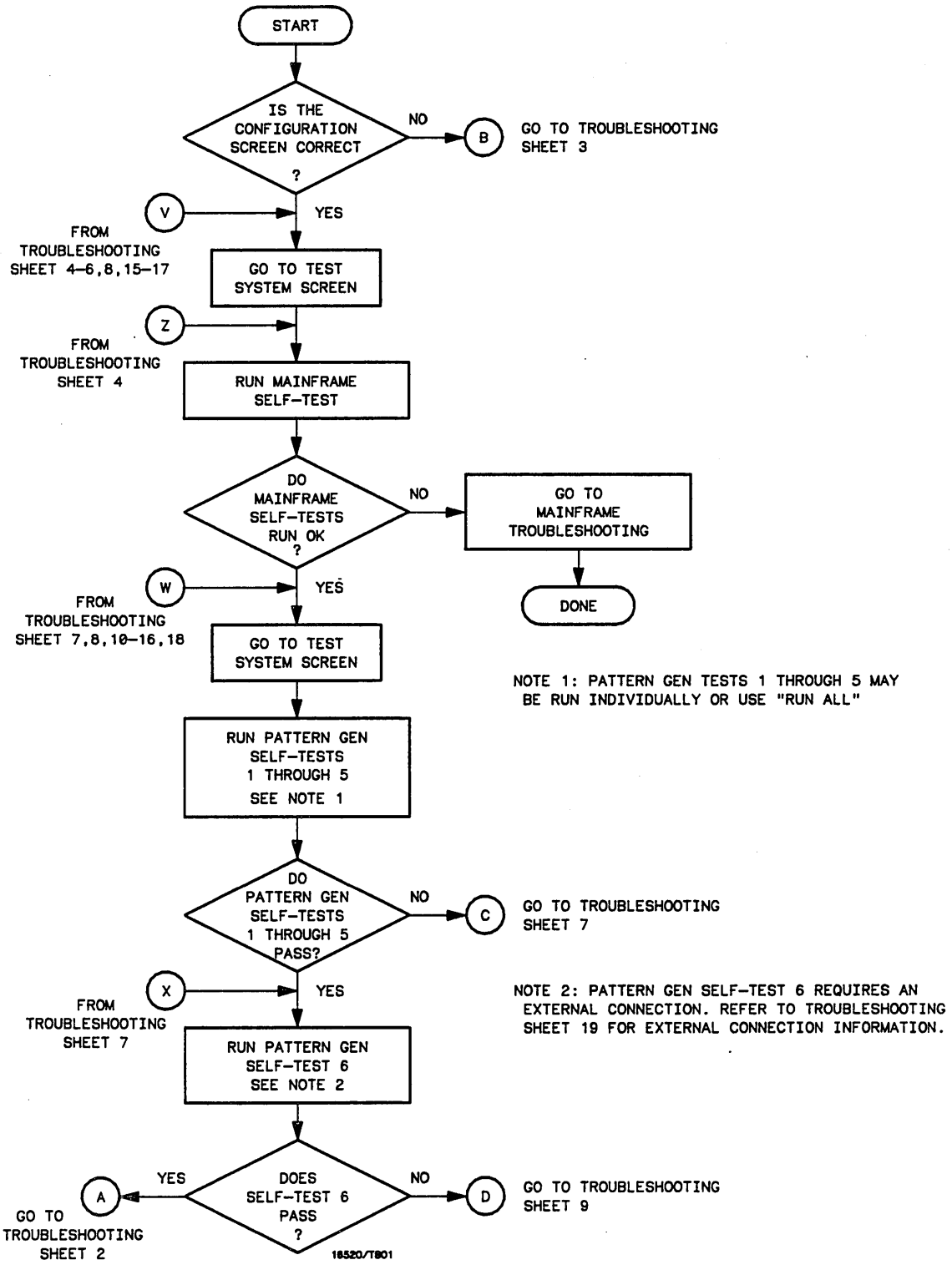



*Figure 6-11. Troubleshooting Flow Chart*



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## Troubleshooting Sheet 2

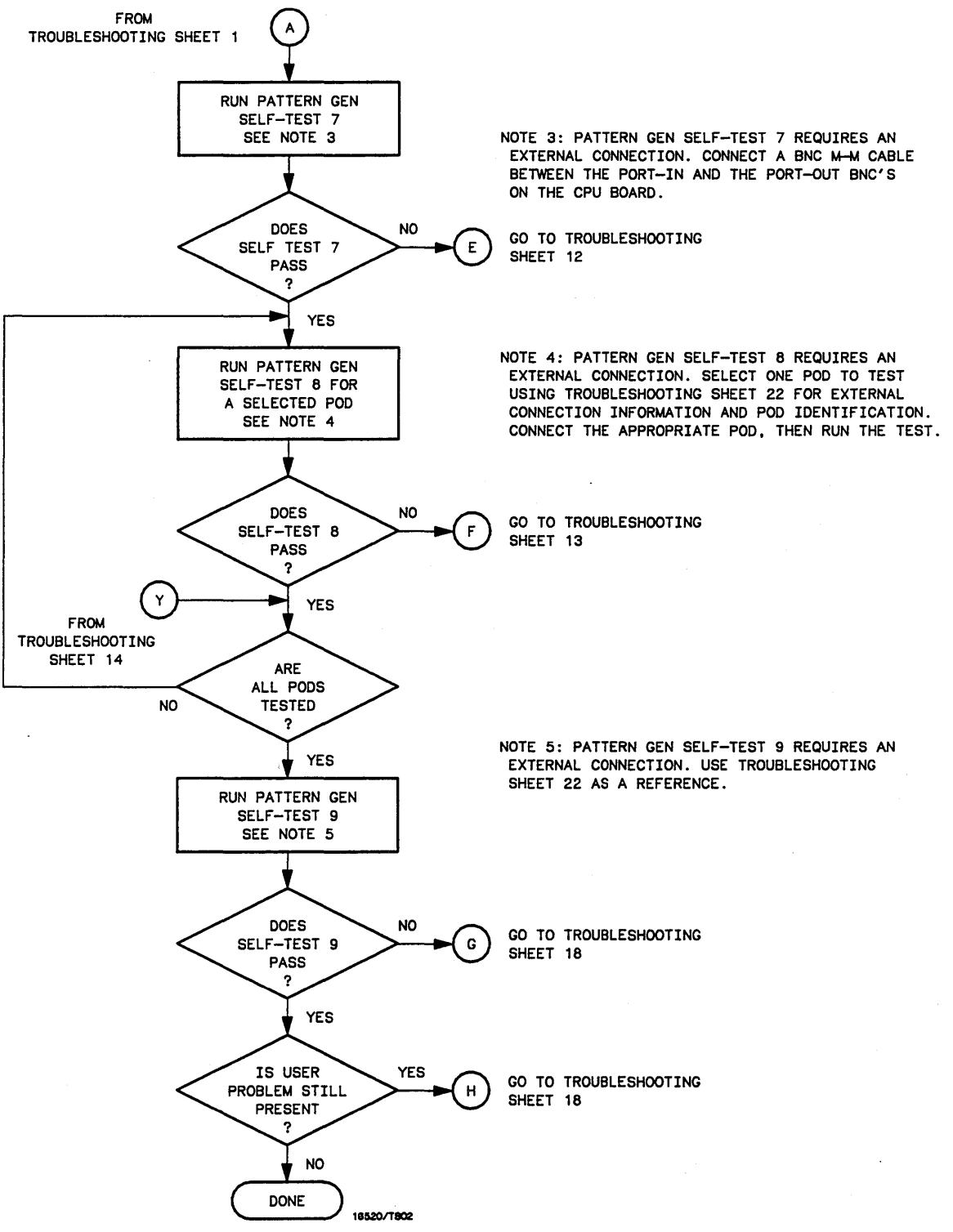





*Figure 6-11. Troubleshooting Flow Chart (cont.)*



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## Troubleshooting Sheet 3



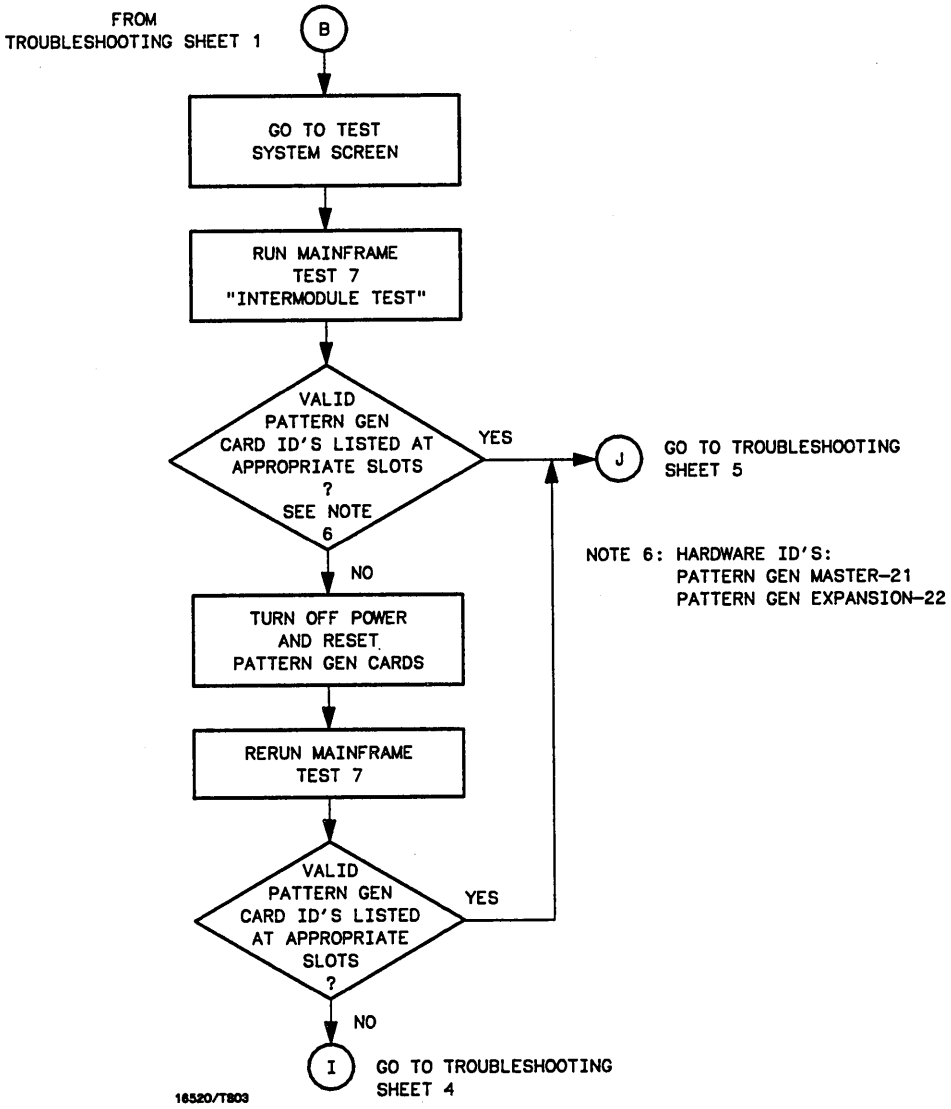



*Figure 6-11. Troubleshooting Flow Chart (cont.)*



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## Troubleshooting Sheet 4

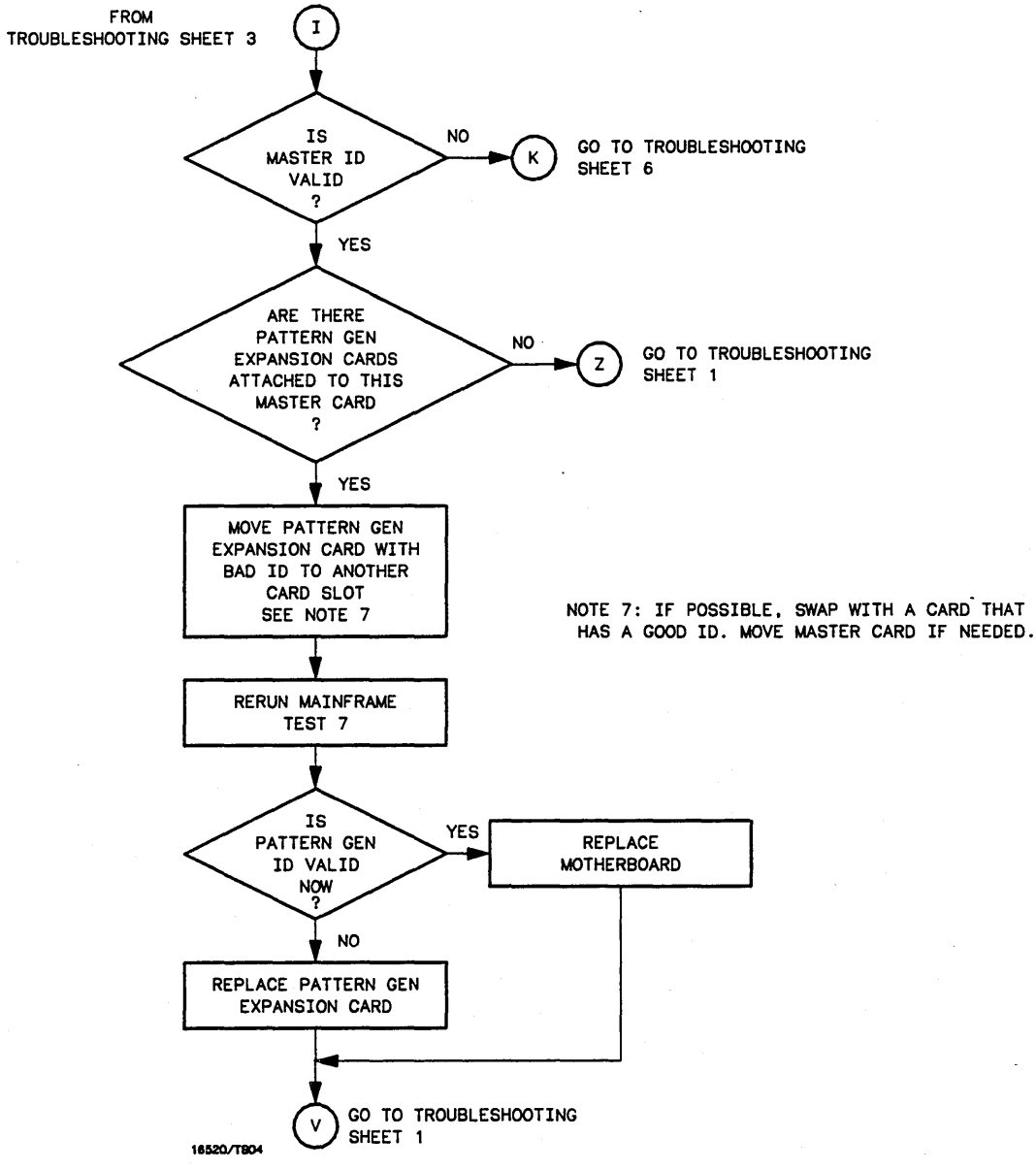



*Figure 6-11. Troubleshooting Flow Chart (cont.)*





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## Troubleshooting Sheet 5



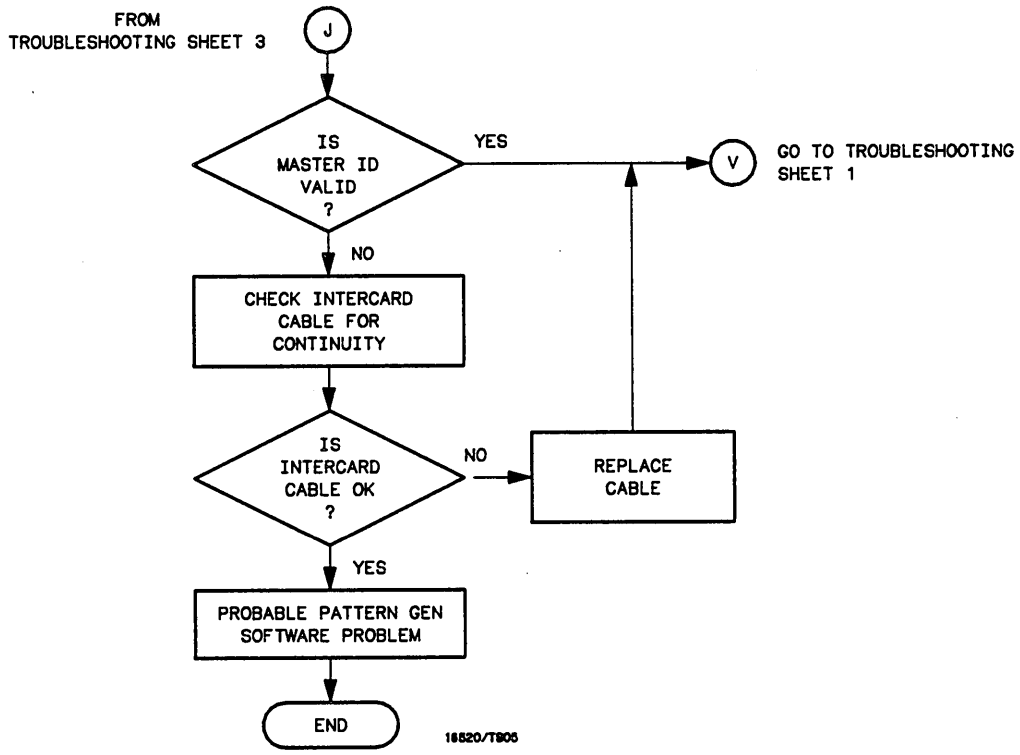



*Figure 6-11. Troubleshooting Flow Chart (cont.)*



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## Troubleshooting Sheet 6

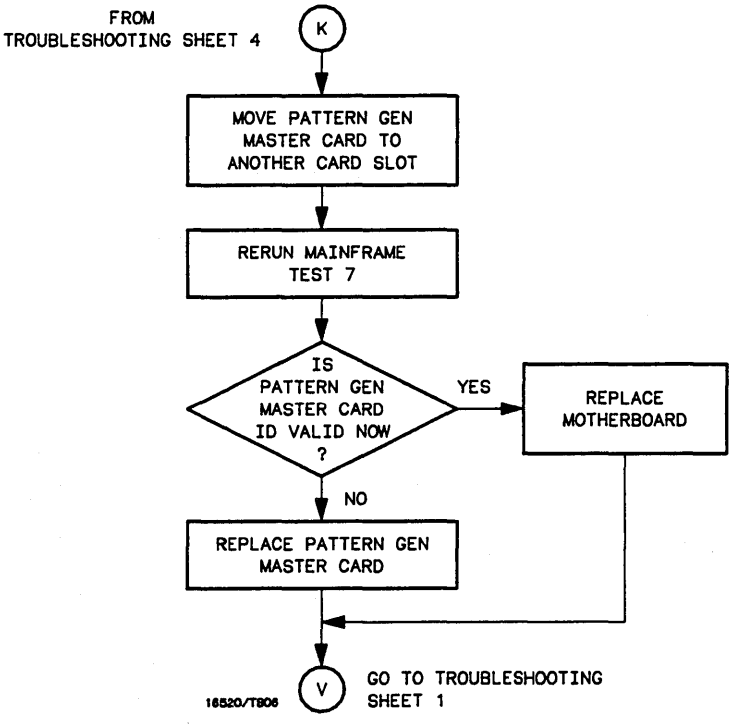



*Figure 6-11. Troubleshooting Flow Chart (cont.)*





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## Troubleshooting Sheet 7



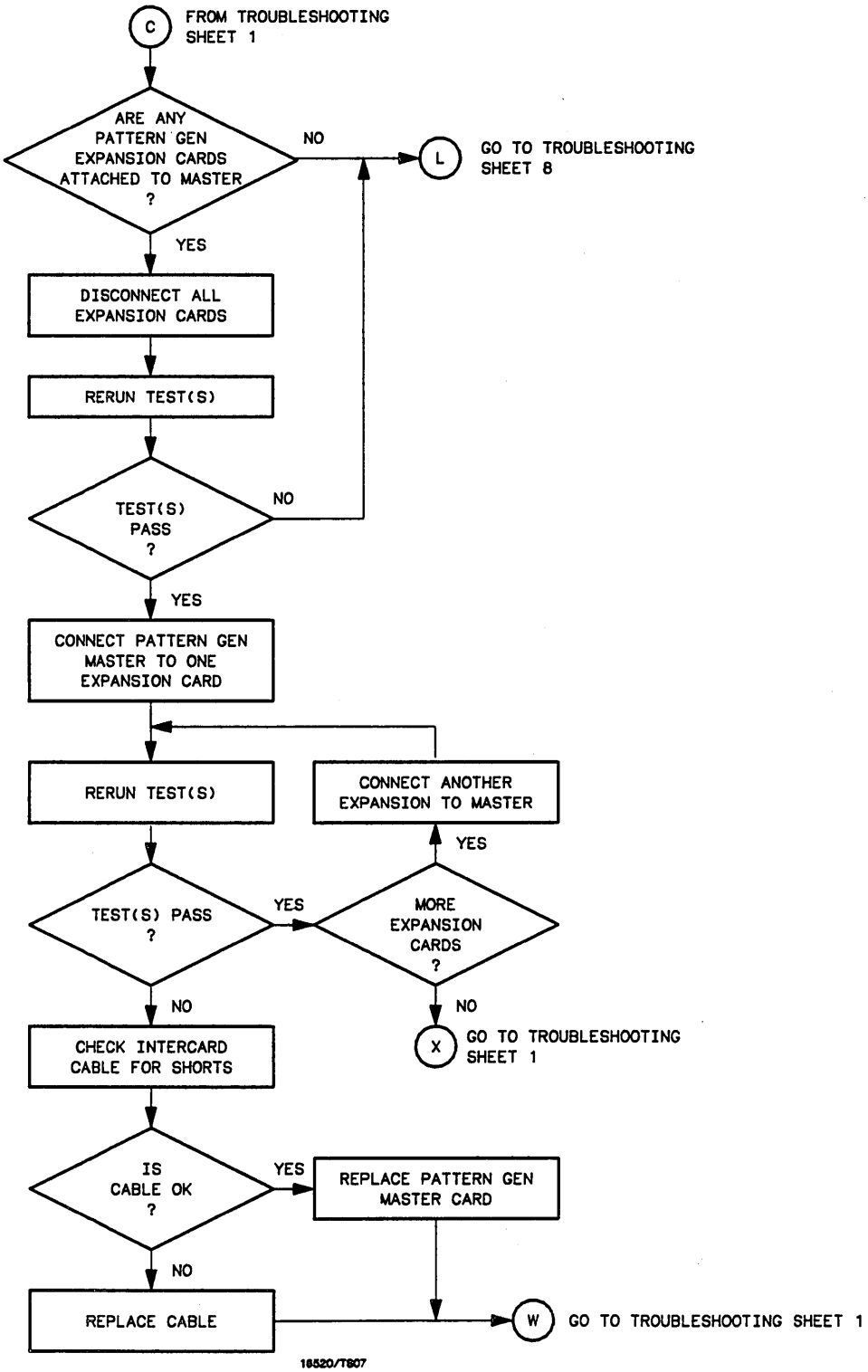



*Figure 6-11. Troubleshooting Flow Chart (cont.)*



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## Troubleshooting Sheet 8

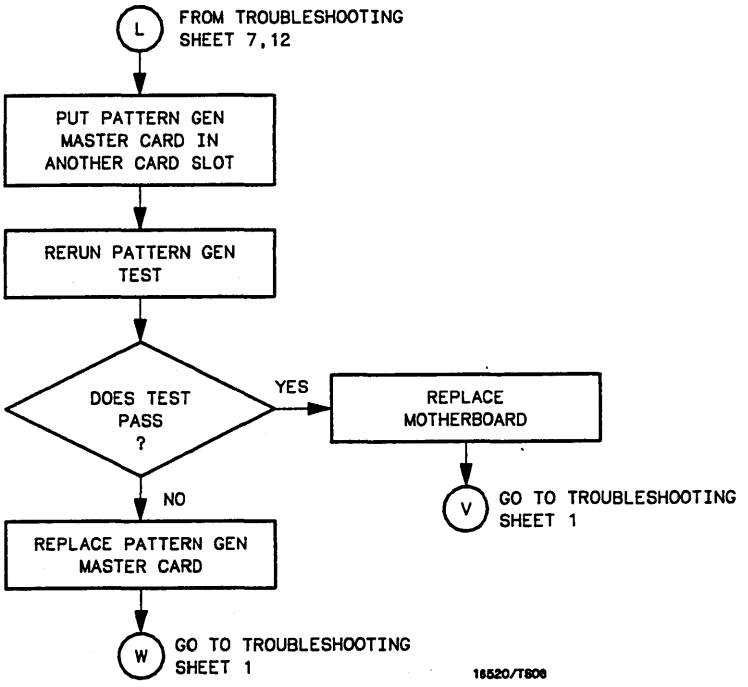



*Figure 6-11. Troubleshooting Flow Chart (cont.)*





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## Troubleshooting Sheet 9

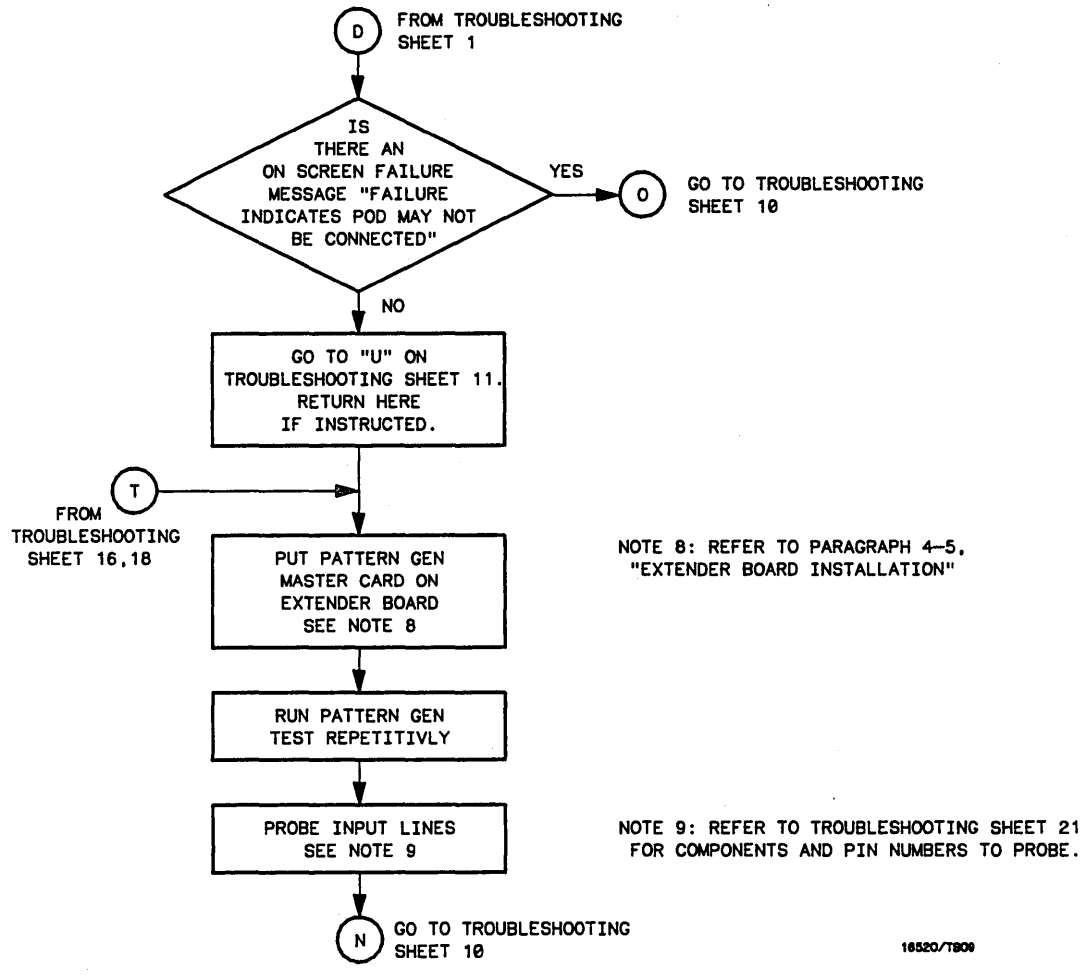
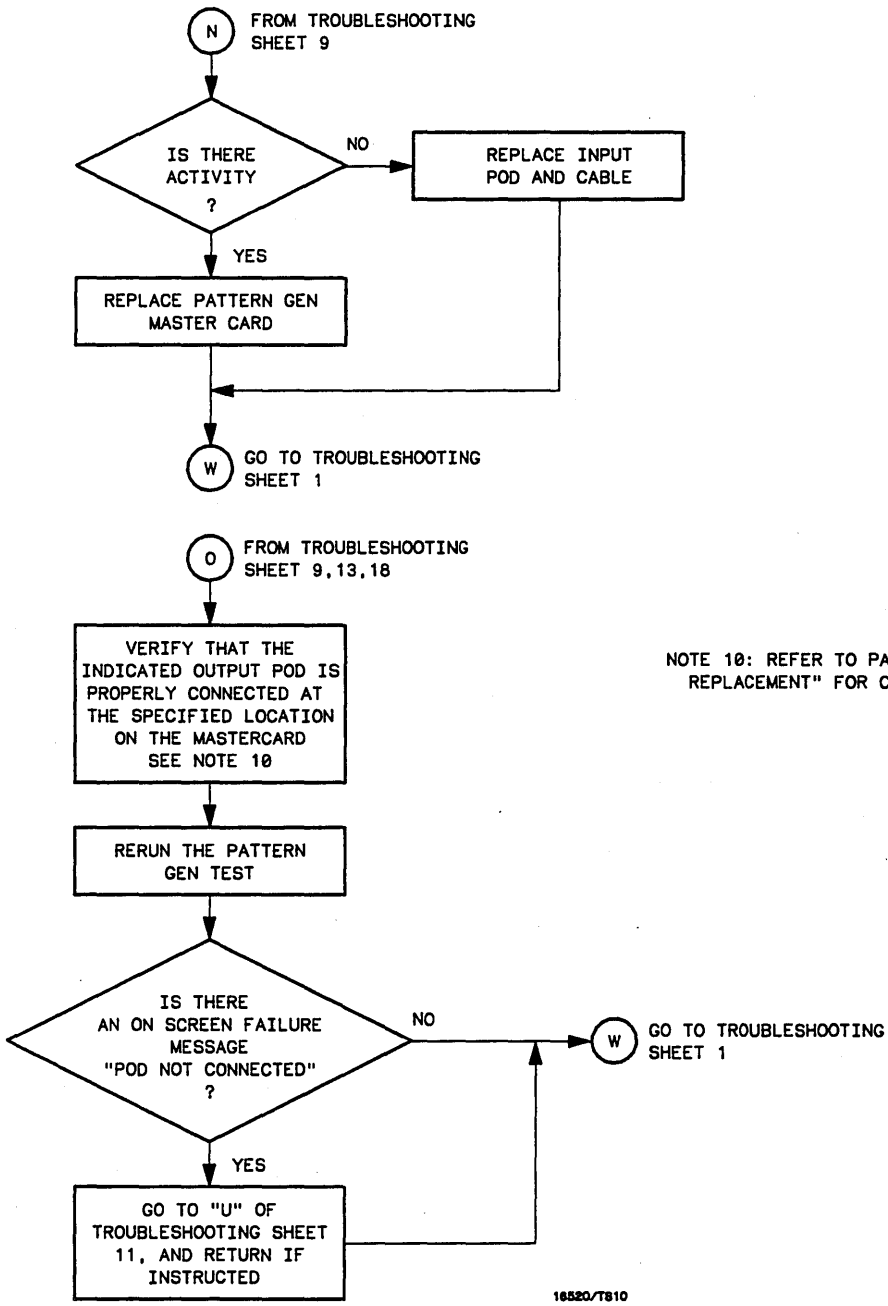



*Figure 6-11. Troubleshooting Flow Chart (cont.)*



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## Troubleshooting Sheet 10




NOTE 10: REFER TO PARAGRAPH 6–10, "PROBE CABLE REPLACEMENT" FOR CABLE CONNECTION PROCEDURE.

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





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## Troubleshooting Sheet 11



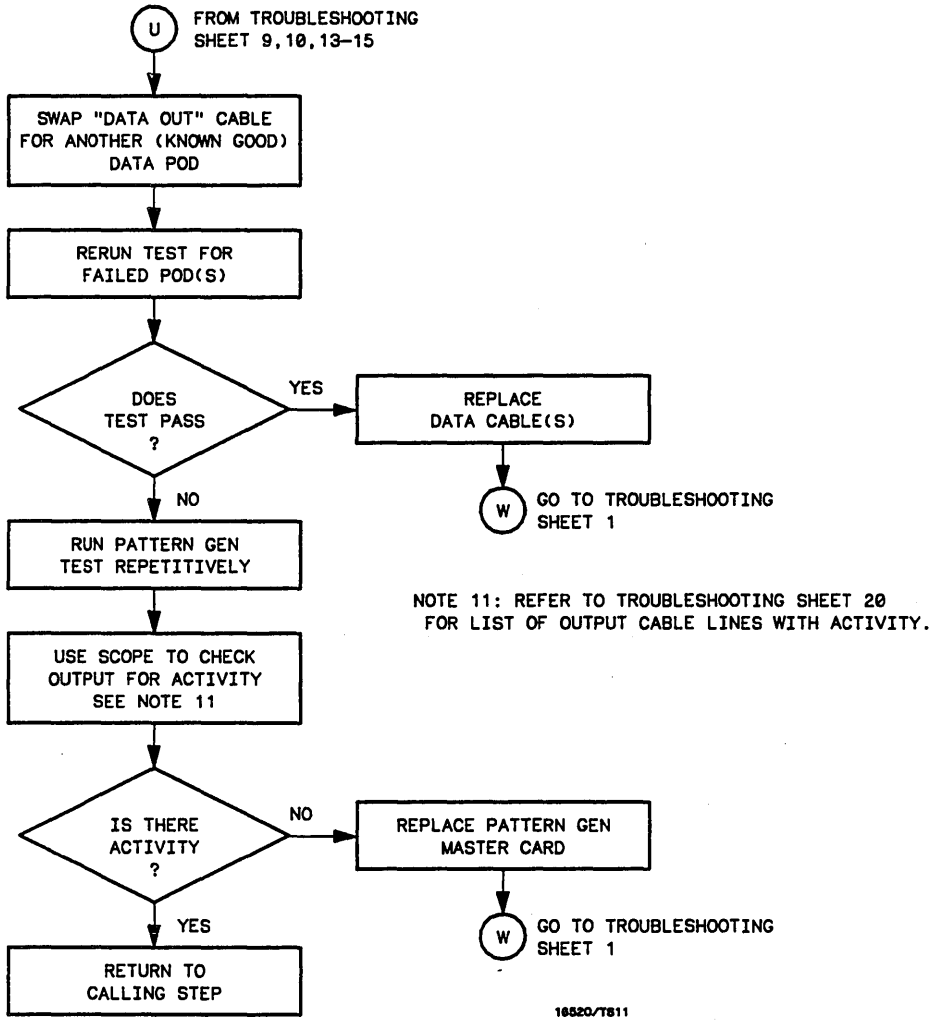



*Figure 6-11. Troubleshooting Flow Chart (cont.)*



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## Troubleshooting Sheet 12

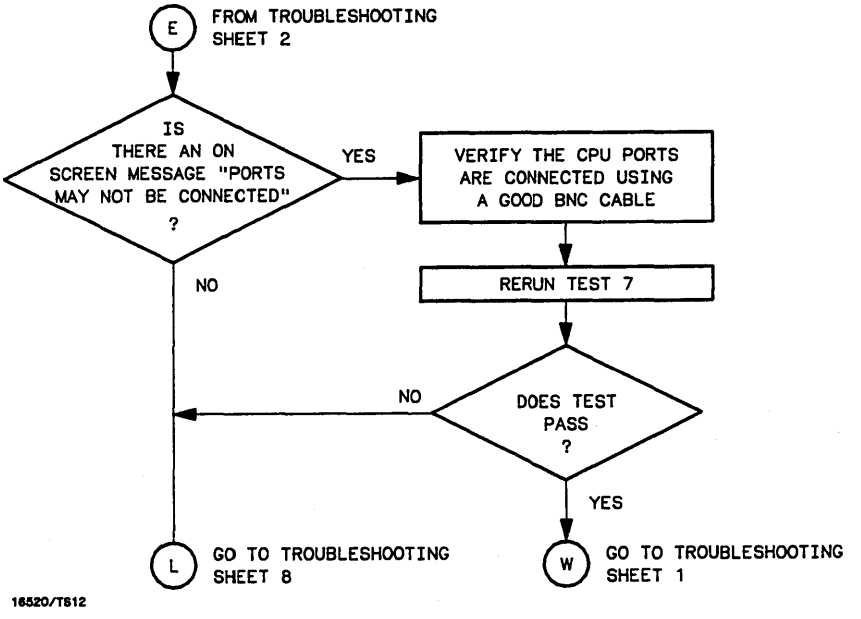



*Figure 6-11. Troubleshooting Flow Chart (cont.)*





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## Troubleshooting Sheet 13

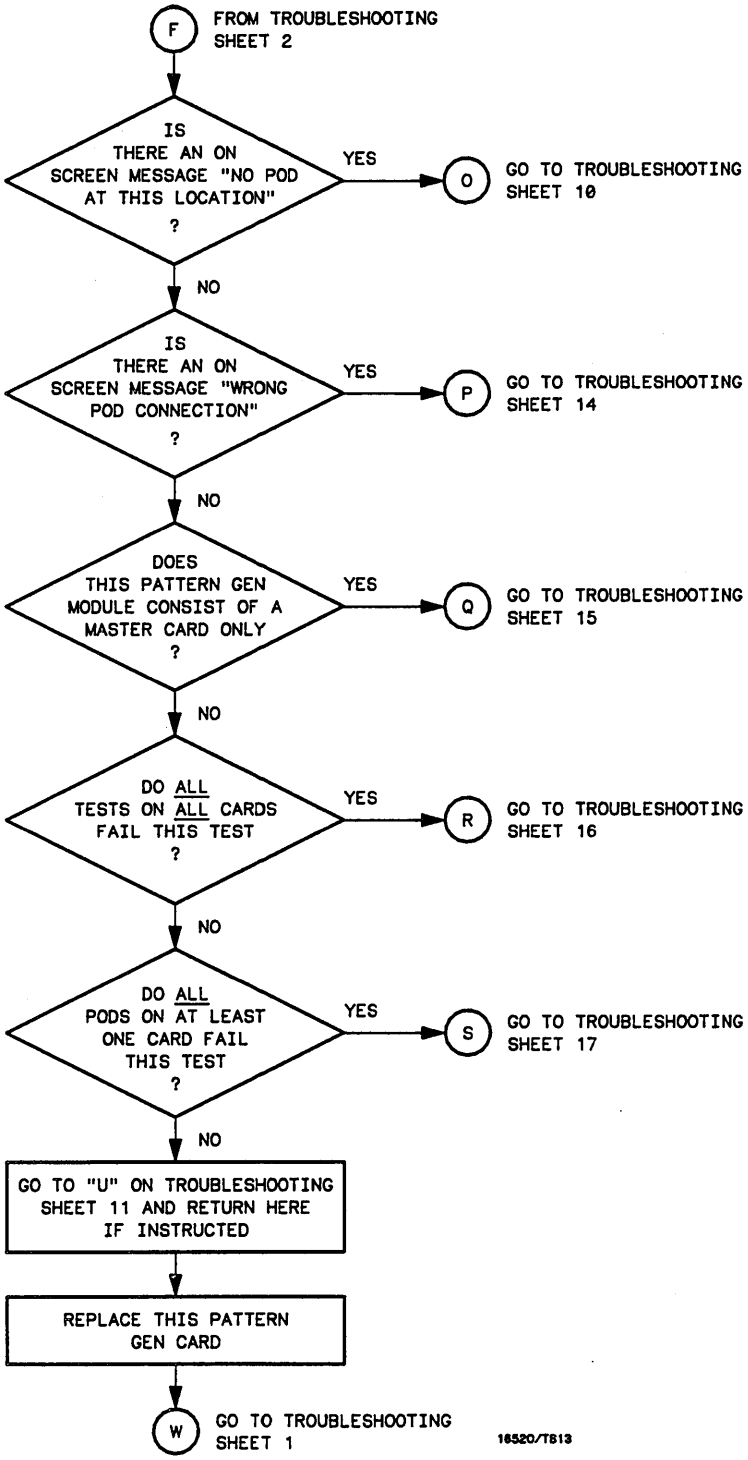



*Figure 6-11. Troubleshooting Flow Chart (cont.)*



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## Troubleshooting Sheet 14

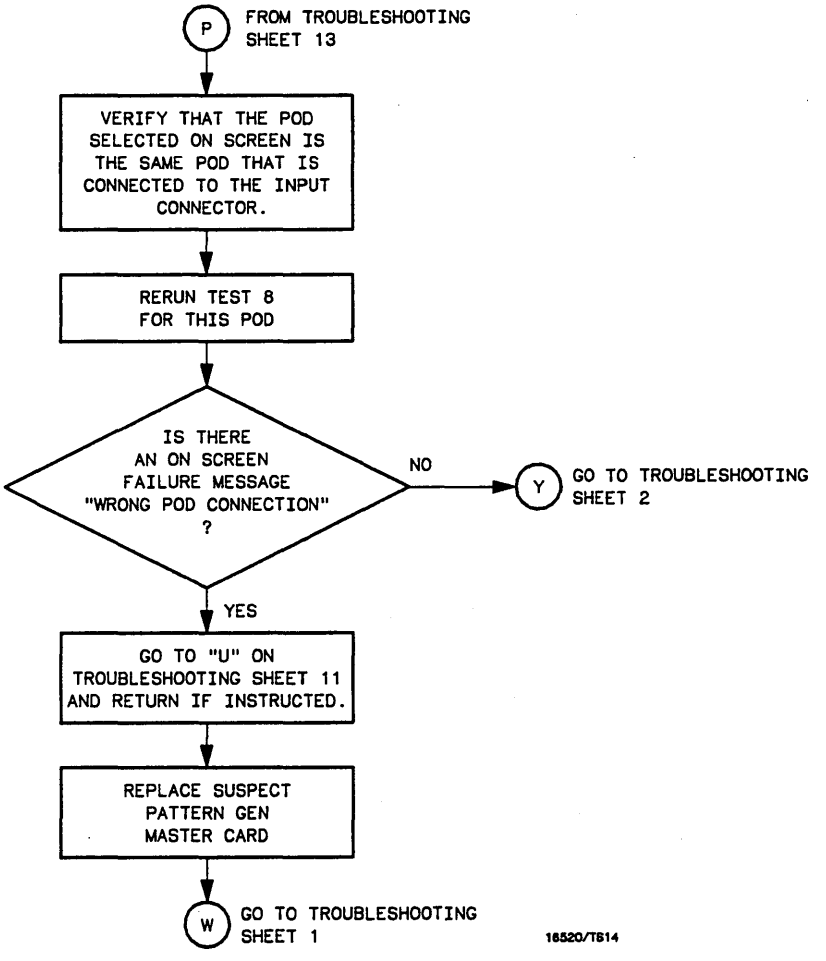



*Figure 6-11. Troubleshooting Flow Chart (cont.)*





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## Troubleshooting Sheet 15

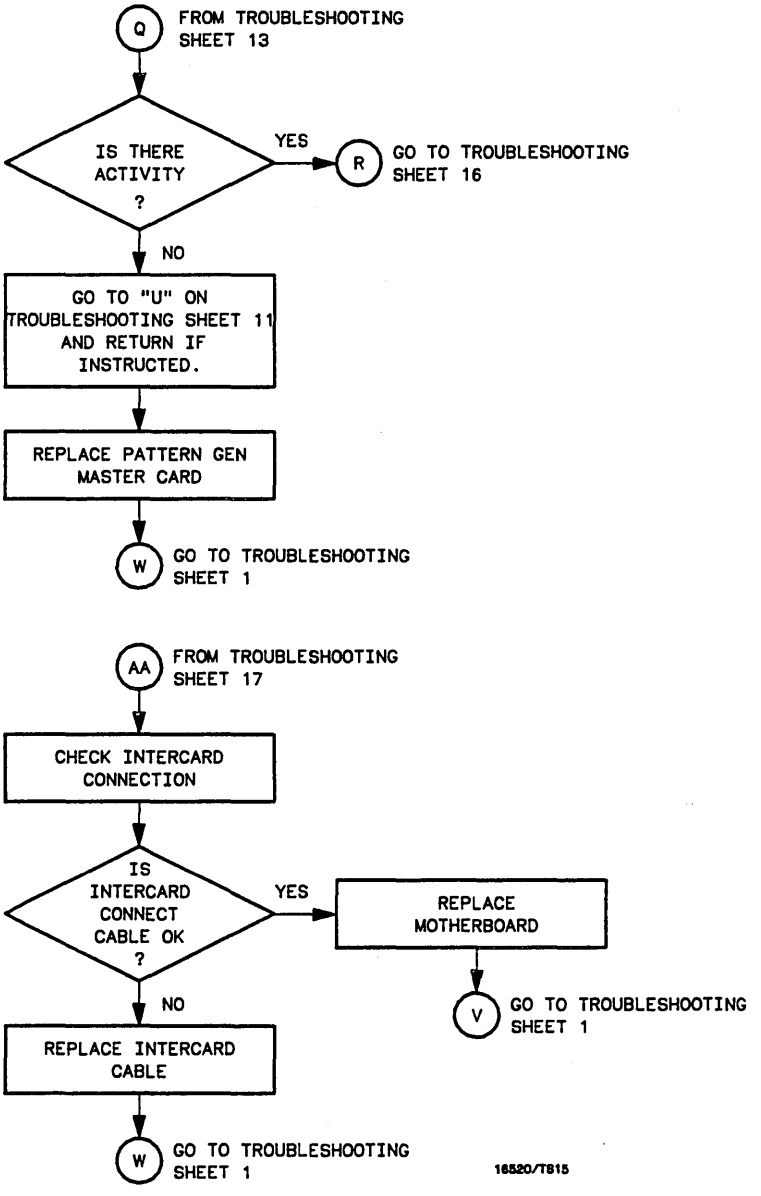



*Figure 6-11. Troubleshooting Flow Chart (cont.)*



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## Troubleshooting Sheet 16

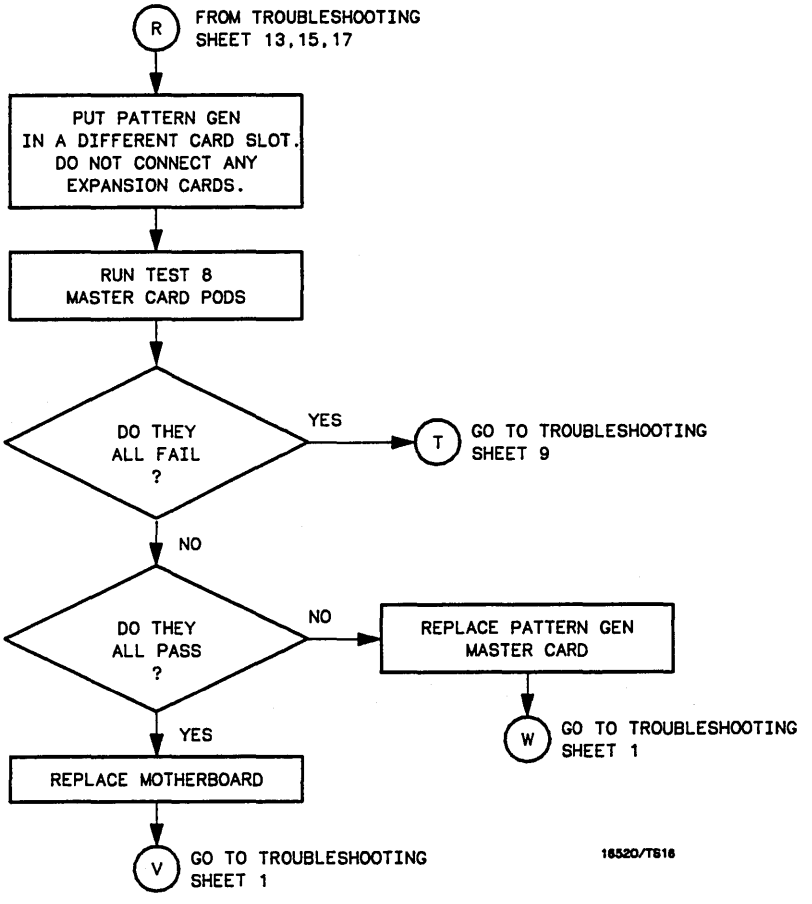



*Figure 6-11. Troubleshooting Flow Chart (cont.)*





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## Troubleshooting Sheet 17



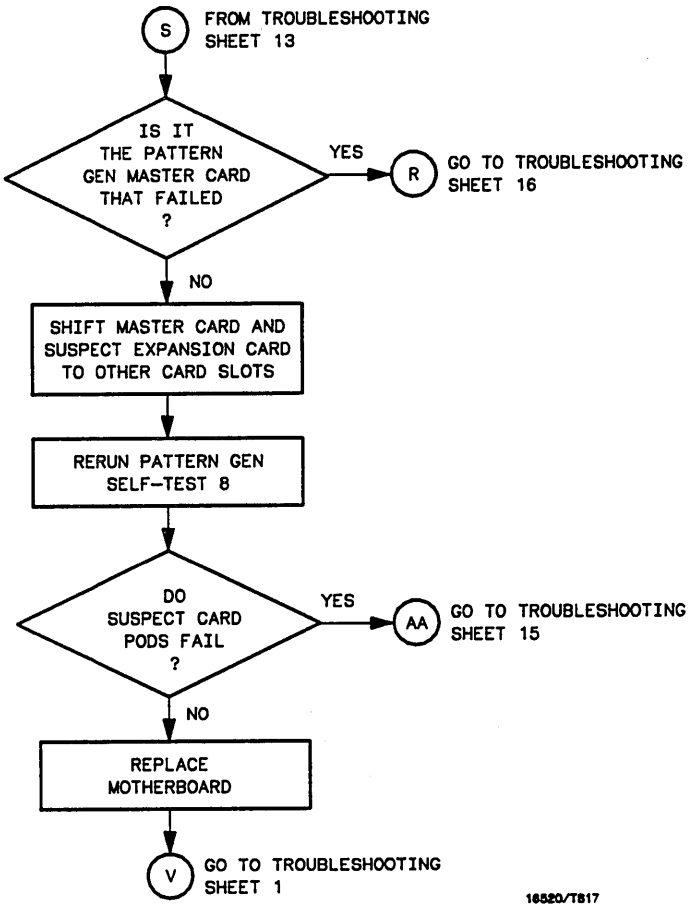



*Figure 6-11. Troubleshooting Flow Chart (cont.)*



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## Troubleshooting Sheet 18

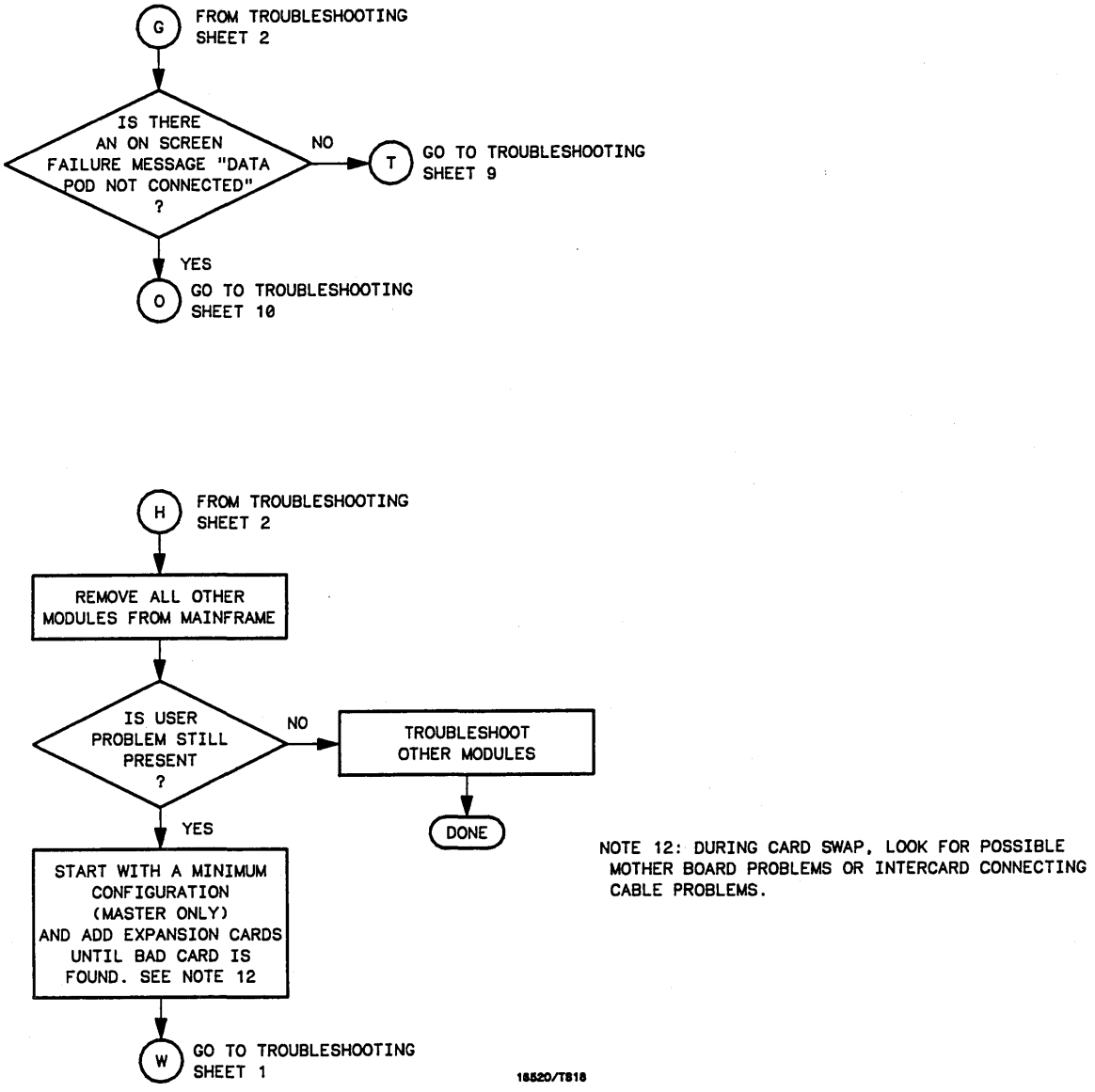



*Figure 6-11. Troubleshooting Flow Chart (cont.)*



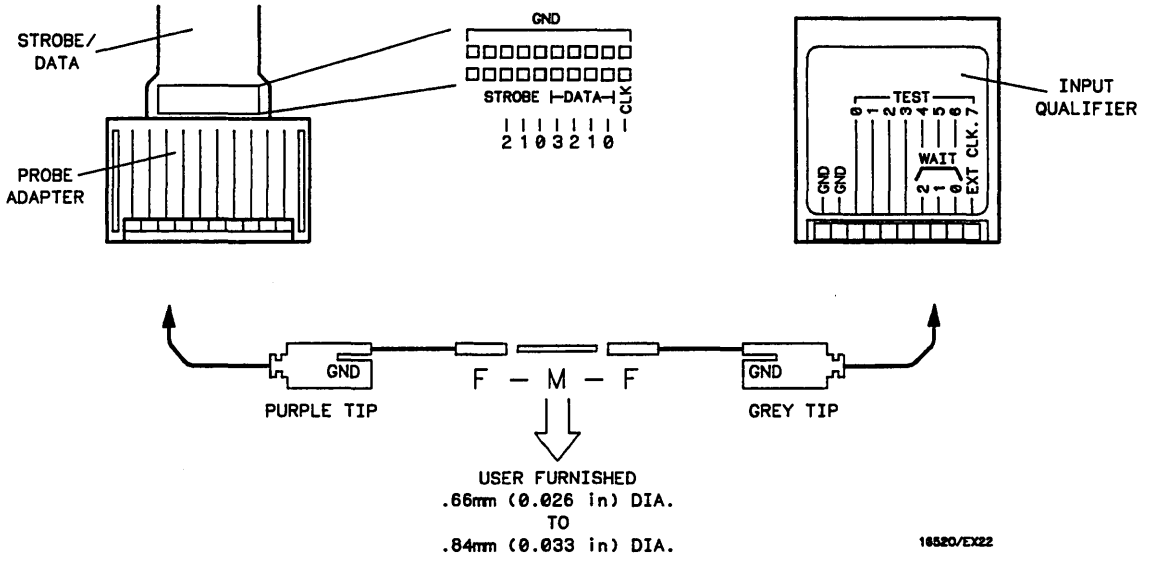


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# Troubleshooting Sheet 19



**NOTE 2: From Troubleshooting Sheet 1**




## External Connection For Test 6

Use the figure above as a guide for the external connection required in test 6.

| STROBE/DATA POD | CONNECTS TO | INPUT QUALIFIER POD |
|---|---|---|
| GND | TO | GND |
| STROBE 2 | TO | TEST 4 |
| STROBE 1 | TO | TEST 5 |
| STROBE 0 | TO | TEST 6 |



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# Troubleshooting Sheet 20

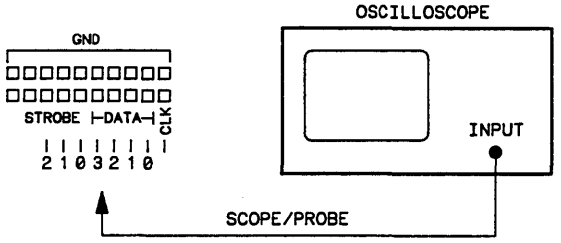
**NOTE 12: From troubleshooting Sheet 11**

## Activity For Test 6

You should see activity at ECL or TTL levels on:

**Strobe/Data Pod**

CLK
Strobe 0
Strobe 1
Strobe 2




**ECL:** L= ≤ -1.75V
H= ≥ -0.9V

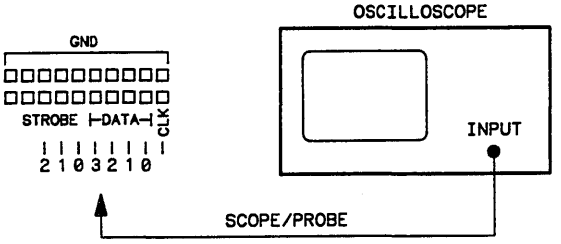
**TTL:** L= ≤ +0.8V
H= ≥ +2.0V

## Activity For Test 8 and 9

You should see activity at ECL or TTL levels on:

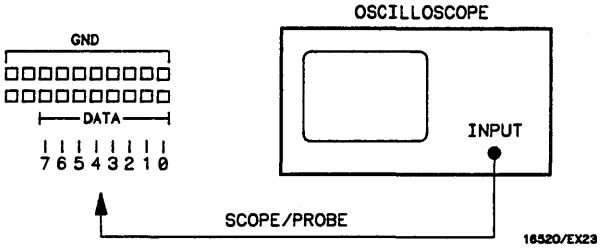
**Strobe/Data Pod**

CLK
Data 0
Data 1
Data 2
Data 3




**Data Pod**

Data 0
Data 1
Data 2
Data 3
Data 4
Data 5
Data 6
Data 7





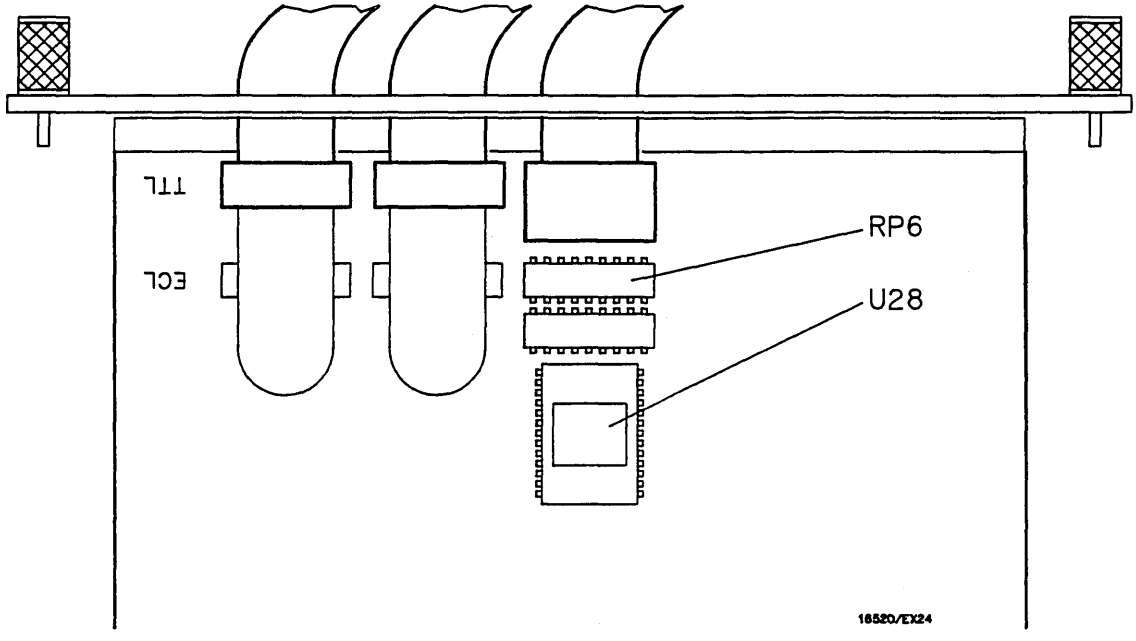



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## Troubleshooting Sheet 21



**NOTE 9: From Troubleshooting Sheet 9**




### Probe Points For Test 6

**First** probe **U28.** Activity at ECL levels should be present on pins:

**U28**

Pin 26
Pin 13
Pin 4

**If no activity** on U28, probe **RP6 next.** RP6 is an alternative point. Activity may be checked at either RP6 or U28.

**RP6**

Pin 7
Pin 6
Pin 5

**ECL:** L= ≤ -1.75V
H= ≥ -0.9V

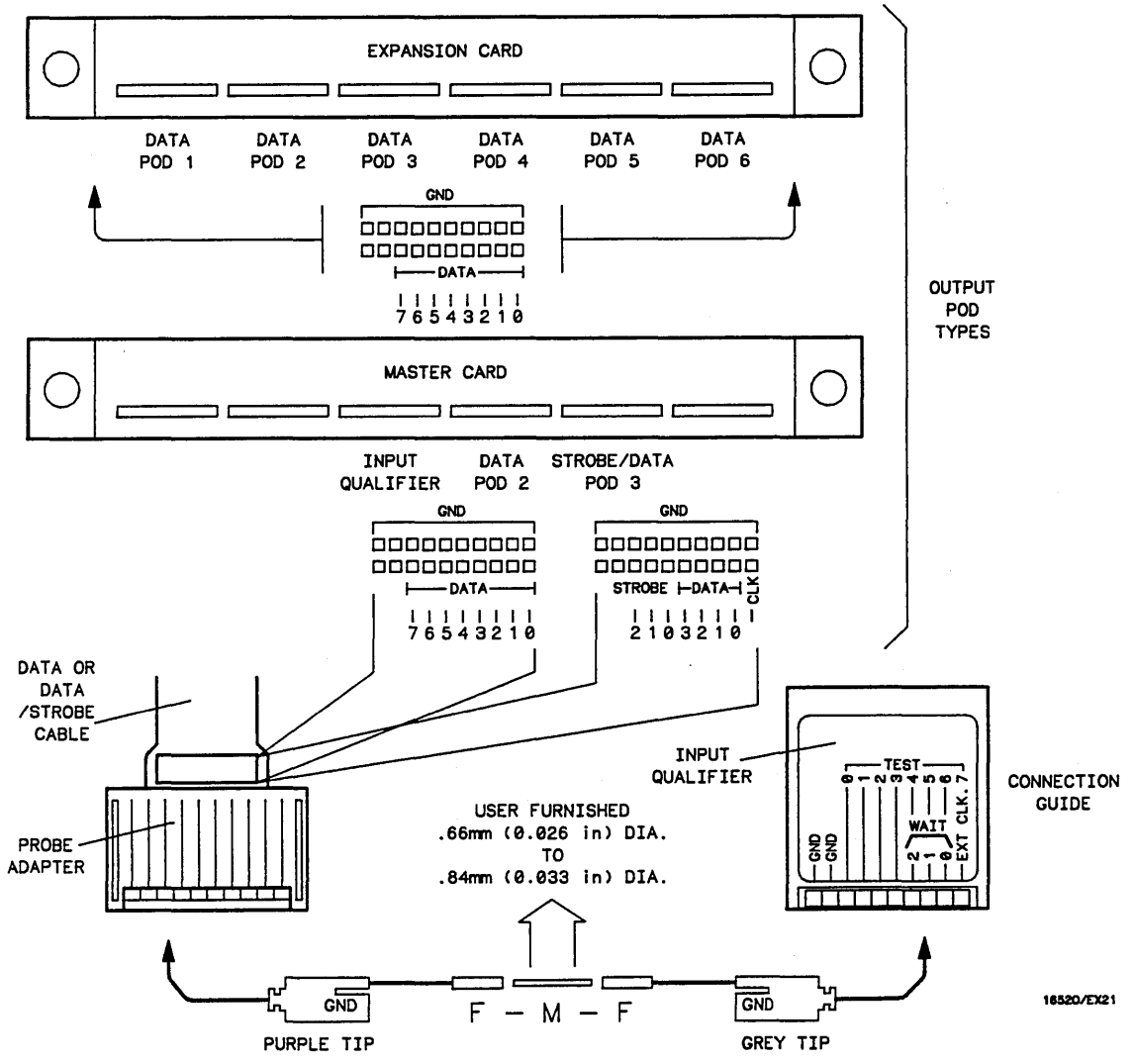
**TTL:** L= ≤ +0.8V
H= ≥ +2.0V



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## Troubleshooting Sheet 22

**NOTE 4: From Troubleshooting Sheet 2**




### Pod Identification and External Connections For Test 8 and 9

Depending on output pod type being connected, follow the appropriate connection scheme.

| STROBE/DATA | OR | DATA POD | CONNECTS TO | INPUT QUALIFIER POD |
|---|---|---|---|---|
| GND | OR | GND | TO | GND |
| DATA 0 | OR | DATA 0 | TO | TEST 0 |
| DATA 1 | OR | DATA 1 | TO | TEST 1 |
| DATA 2 | OR | DATA 2 | TO | TEST 2 |
| DATA 3 | OR | DATA 3 | TO | TEST 3 |
| | | DATA 4 | TO | TEST 4 |
| | | DATA 5 | TO | TEST 5 |
| | | DATA 6 | TO | TEST 6 |
| | | DATA 7 | TO | TEST 7 |





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## 6-9. CARD 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:**

- Cards or filler panels below the empty slots intended for the module installation do not have to be removed.
- You will need only one intercard connecting cable for any installation configuration.
- If previously installed modules prevent proper installation, they must be repositioned in the card cage.
- To maintain the channel-to-channel skew and adequate intercard signal quality, the shortest intercard connecting cable should be used and the expansion cards should be no more than two slots away from the master card.

**PROCEDURE:**

a. Turn instrument power switch off, unplug power cord and disconnect any input or output connections.

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

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

**CAUTION**

*All multi-card modules will be cabled together. Care should be taken to pull these cards out together.*

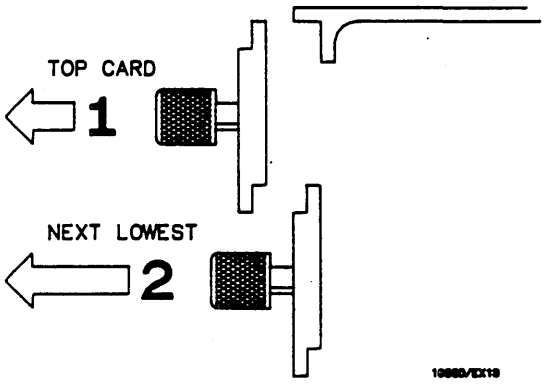



*Figure 6-12. Endplate Overlap*



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d. Pull all cards in pattern generator module completely out.

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

f. Disconnect the cable from all cards in the Pattern Generator Module.

g. Replace faulty card in module.

**Note**

*If the configuration is changed or help is needed in configuration of the module, refer to step d of paragraph 2-8, "MODULE INSTALLATION". to Plan your configuration.*

h. Insert correct end of appropriate cable into connector on bottom card of configuration. See figure 6-13.

i. Lay cable flat and pointing out to the rear of card. See figure 6-14.

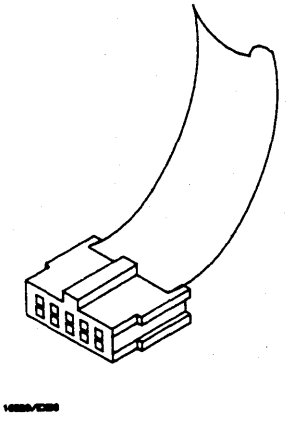


*Figure 6-13. Cable End*

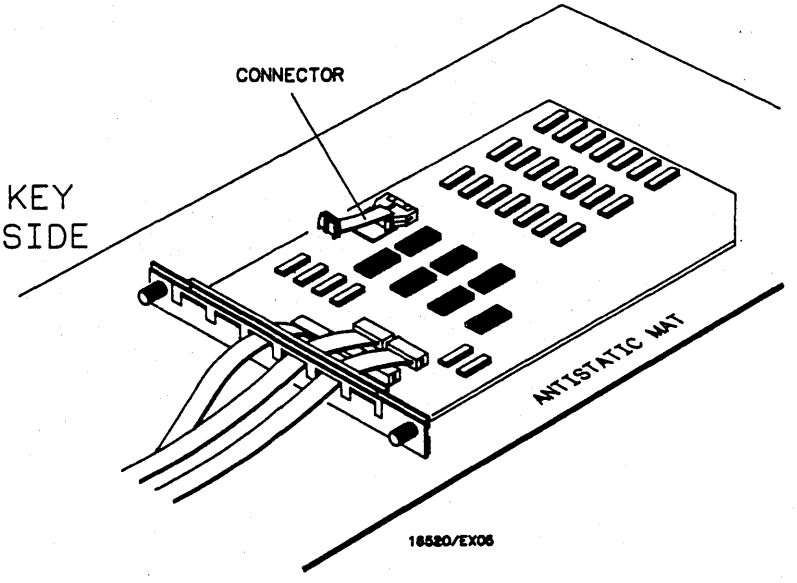



*Figure 6-14. Cable Position*

j. Slide card approximately half way into lowest of slots that you are using.

k. Slide next card half way into next highest slot feeding cable up through the hole.

l. Insert appropriate cable end into card.

m. If there are more cards to install, repeat steps k and l, until all cards are in place.



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

o. Repeat for all cards and filler panels in a **bottom to top** order. See figure 6-15.

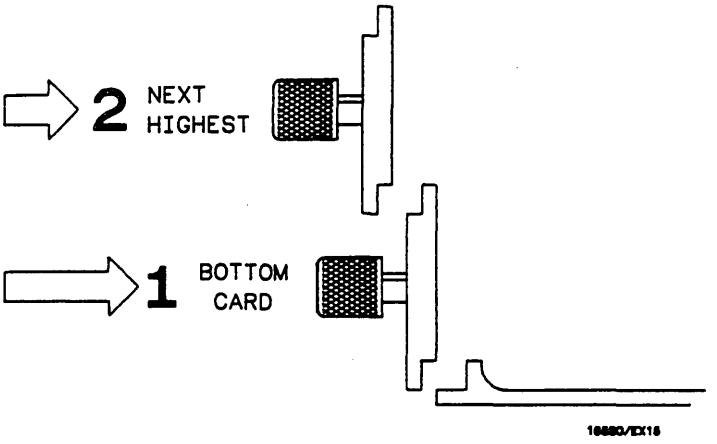



*Figure 6-15. Endplate Overlap*

p. 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.



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## 6-10. PROBE CABLE 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.*

**PROCEDURE:**

a. Turn the instrument power switch off, unplug power cord and disconnect any input or output connections.

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

c. Starting **from the top**, begin pulling all filler panel(s) and card(s) out **half way**. See figure 6-16.

**CAUTION**

*All multi-card modules will be cabled together. Care should be taken to pull these cards out together.*

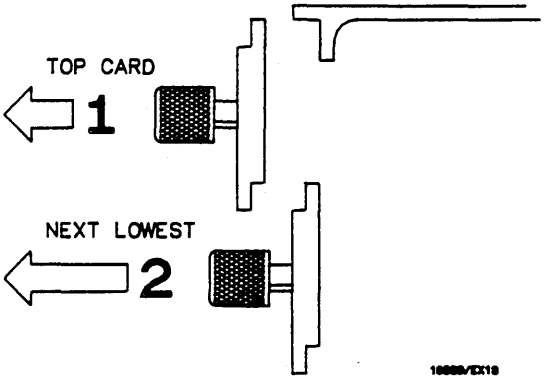



*Figure 6-16. Endplate Overhang*

d. Pull HP 16520/21A Module to be serviced completely out.



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e. Lay card on antistatic mat with cable(s) flat and pointing out to rear of card. See figure 6-17.

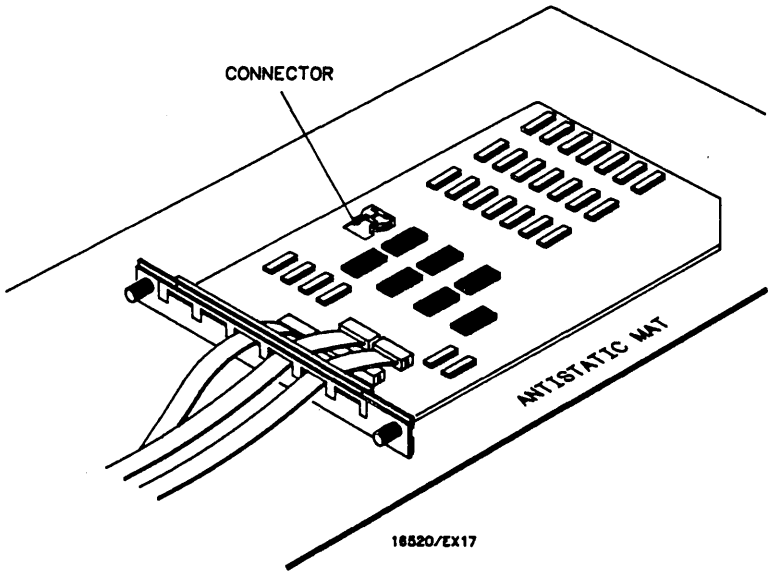



*Figure 6-17. Card On Antistatic Mat*

f. Using a No. 10 torx ® driver, remove four screws that hold cable retainer onto card. See figure 6-18.

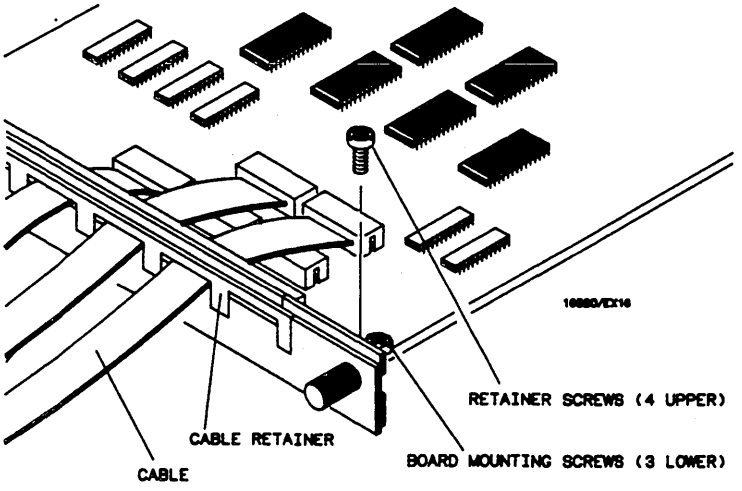



*Figure 6-18. Retainer And Screws*



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g. Remove cable(s) from card connector(s) and install new cable(s). See figure 6-19.

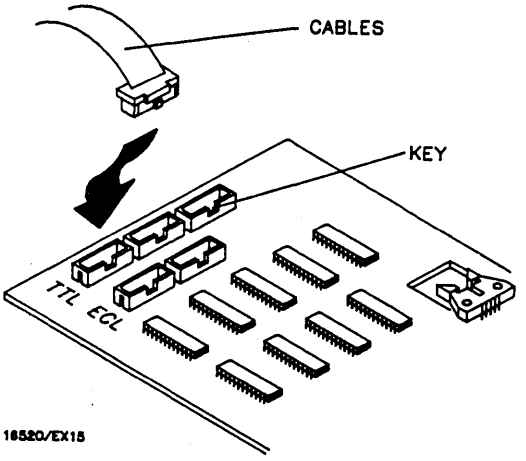



*Figure 6-19. Card Connectors*

h. Install cable retainer.

i. At this point go to step d of paragraph 2-8, "MODULE INSTALLATION", and continue installation of cards.



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