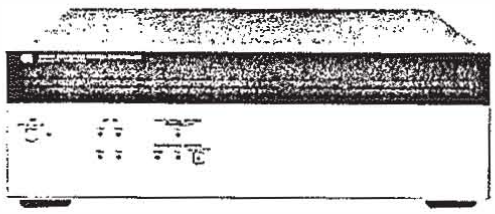
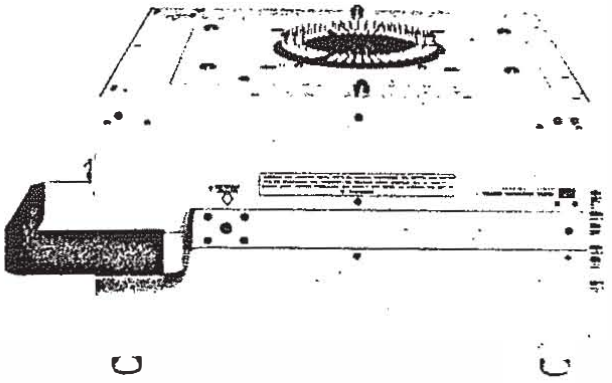
OPERATION MANUAL

4085M
SWITCHING MATRIX





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OPERATION MANUAL

MODEL 4085M
SWITCHING MATRIX for the 4145A

(Including Options 001, 002, 003, 004, 016, and 036)

Manual Part No. 04085-90000
Microfiche Part No. 04085-90050

Printed: JUL. 1984

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SECTION I
GENERAL INFORMATION

1-1. INTRODUCTION

1-2. This manual contains the information required to install, operate and maintain the Hewlett-Packard Model 4085M Switching Matrix. It was written under the assumption that the reader has sufficient knowledge of the HP Model 4145A Semiconductor Parameter Analyzer and the HP Model 9816 or 9836 Desktop Computer. If you're not familiar with the 4145A and at least one of these computers, you should read the manuals furnished with the 4145A and the computer before proceeding any further.

1-3. Section I, General Information, gives a detailed description of the 4085M, and covers specifications, instrument identification, options, furnished and available accessories, and other basic information. Section II, Installation, contains the instructions and procedures for unpacking, installing, and verifying the 4085M. Section III, Operation, provides all the information necessary to operate the 4085M. Included are panel features, basic operating theory, instructions on how to connect test samples, and detailed programming information. Section IV, Diagnostics and Maintenance, contains information about the diagnostics program, DIAG, and outlines maintenance requirements and procedures.

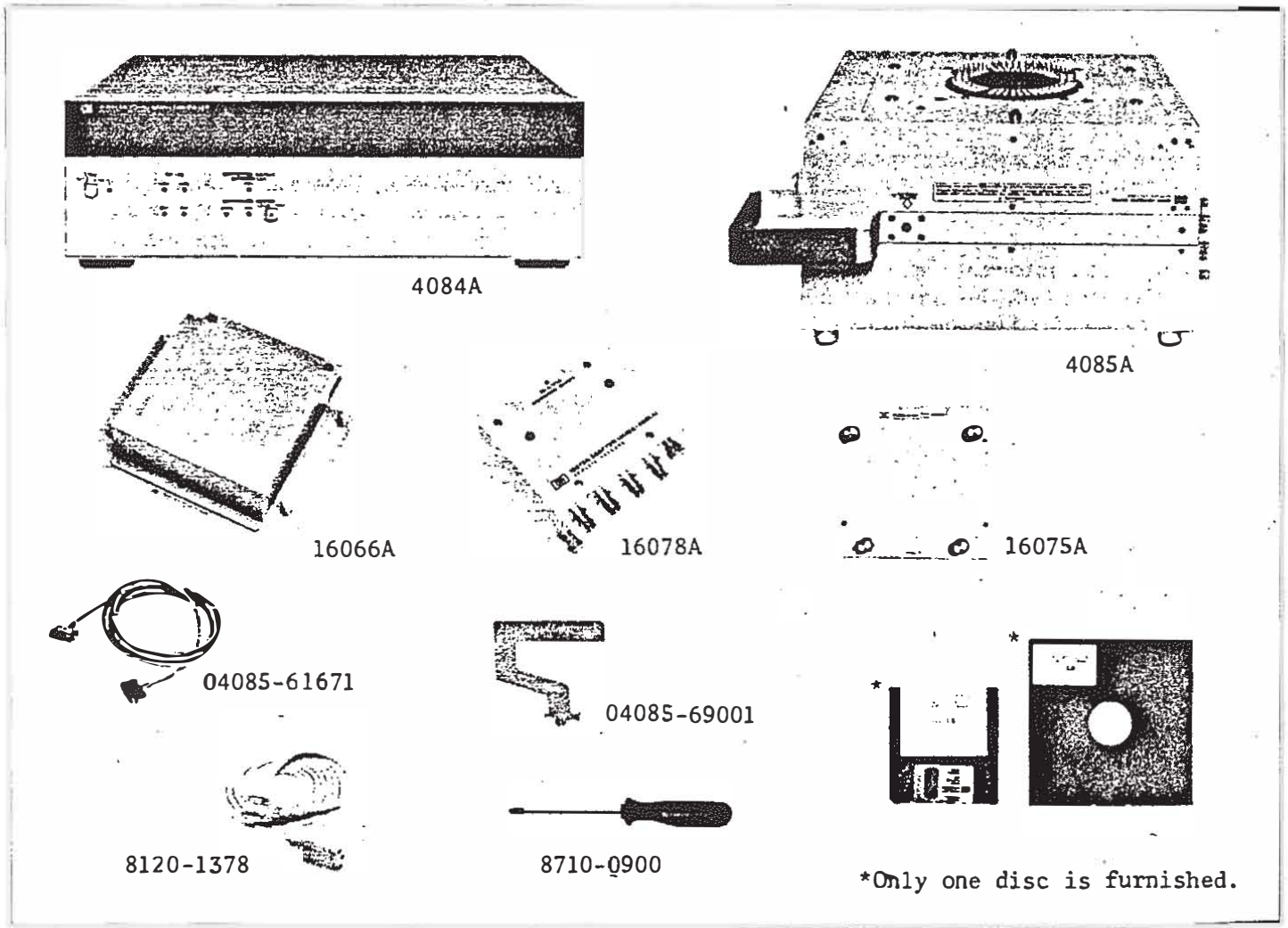


Figure 1-1. Model 4085M and Accessories

1-4. 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 60 photo-duplicates of the manual pages. The microfiche package also includes the latest manual changes supplement as well as all pertinent service notes. To order an additional manual, use the part number listed on the title page of this manual.

1-5. DESCRIPTION

1-6. The HP Model 4085M Switching Matrix, shown in Figure 1-1 along with its furnished accessories, consists of the HP Model 4084A Switching Matrix Controller and the HP Model 4085A Switching Matrix. The 4085M is designed for systemization with the HP Model 4145A Semiconductor Parameter Analyzer and the HP Model 9816 or 9836 Desktop Computer. Figure 1-2 shows the basic configuration of the system. This system can measure and characterize the dc parameters of virtually any low-to-medium power semiconductor device, whether on the wafer or packaged.

1-7. The 4084A Switching Matrix Controller, in response to commands sent from the computer over the HP-IB, controls the connections between the measurement pins of the 4085A and the stimulus/measurement units, voltage sources, and voltage monitors of the 4145A. The 4084A also provides dc power to the 4085A and contains a ROM-based 4085A relay exerciser, which can be initiated manually from the front panel of the 4084A, or under program control from the computer.

1-8. The 4085A Switching Matrix has eight instrument ports for connection of the stimulus/measurement units, voltage monitors, and voltage sources of the 4145A, and can be equipped with twelve to forty-eight measurement pin boards, each having force, sense, and guard terminals, which function as the measurement terminals. Extensive guarding is used on the measurement pin boards and within the 4085A to eliminate the effects of noise and to reduce interterminal leakage current, the prime sources of error in low current measurements.

Switching between the measurement terminals and the instrument ports is done by dry reed relays on the pin boards. Pin boards can be easily removed and installed, making it easy to replace defective relays. Defective relays can be quickly isolated by the relay test function of the 4084A. For wafer measurements, the 4085A can be mounted on any manual or automatic wafer prober that can accommodate a Fairchild Century VII type small test head. For measurement of packaged devices, one of the available test fixtures can be mounted on the 4085A.

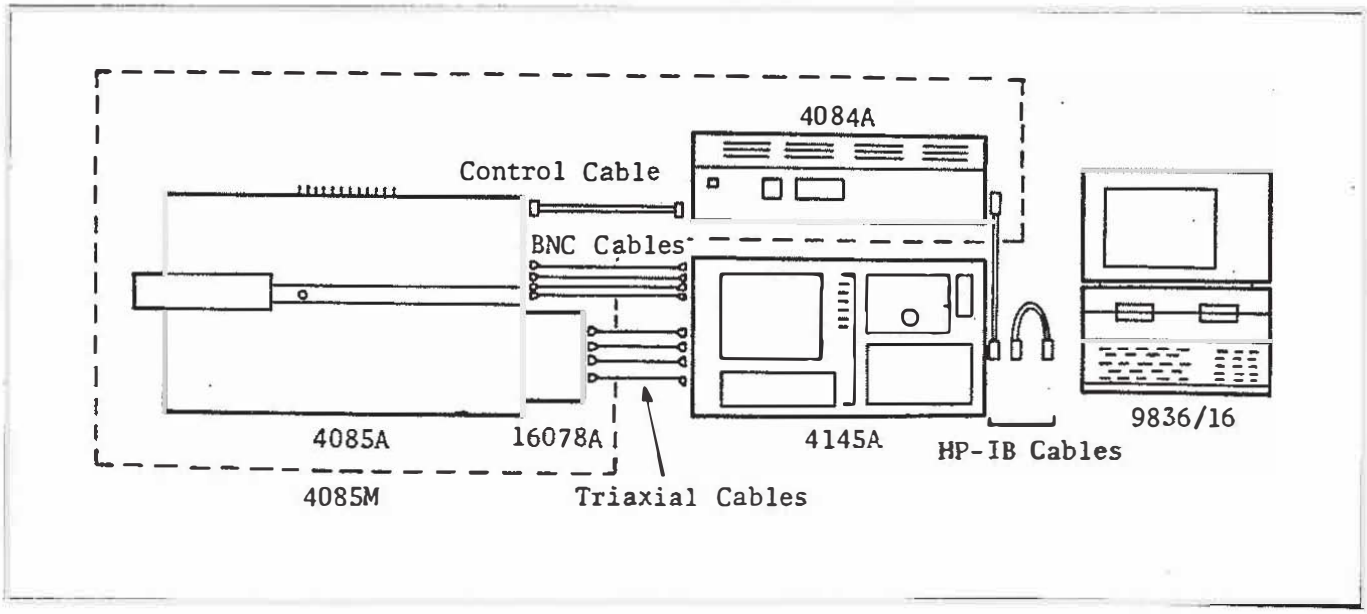


Figure 1-2. System Configuration

1-9. All measurements are made by the 4145A Semiconductor Parameter Analyzer. The 4145A is equipped with four programmable stimulus measurement units (SMUs), two programmable voltage sources (VSs), two voltage monitors (VMs), an interactive graphics display, flexible disc drive, softkeys, full arithmetic keyboard, and HP-IB. More details on the 4145A can be found in its manual.

1-10. The 9816 or 9836 Desktop Computer provides overall control of the 4084A and 4145A via the HP-IB. HP BASIC language programs can be written to implement any system capability. Refer to the BASIC language reference manuals furnished with the 9816 and 9836 for complete details.

1-11. Switching control software and diagnostics software are furnished with the 4085M on either a 5.25 inch or 3.5 inch flexible disc. The switching control software is a library of subprograms that can be linked to and called by a user-written program to control and monitor connections between the instrument ports and measurement pins of the 4085A. The diagnostics software provides quick component-level isolation of failures in the 4085M.

1-12. SPECIFICATIONS

1-13. Complete specifications of the Model 4085M are given in Table 1-1. These specifications are the performance standards or limits against which the system is tested. Table 1-2 lists supplemental performance characteristics. Supplemental performance characteristics are not specifications but are typical characteristics included as additional information for the operator. When the 4085M is shipped from the factory, it meets the specifications listed in Table 1-1.

1-14. SAFETY CONSIDERATIONS

1-15. The Model 4085M Switching Matrix (for 4145A) has been designed to comform to the safety requirements of IEC (International Electromechanical Committee) Safety Class I and was shipped from the factory in a safe condition.

1-16. This manual contains information, cautions, and warnings which must be followed by the user to ensure safe operation and to maintain the 4085M in a safe and serviceable condition.

1-17. SERIAL NUMBERS

1-18. Hewlett-Packard uses two serial numbers to identify each 4085M component. The serial numbers are stamped on a serial number plate and a stick-on label (Figure 1-3) attached to the rear panel of each instrument. The 4085M serial number is used to identify the 4085M. The instrument serial number is used to identify the individual instrument. In any correspondence with Hewlett- Packard, be sure to include both the 4085M serial number and the instruments' serial numbers.

1-19. MANUAL CHANGES

1-20. Hewlett-Packard will publish a yellow Manual Changes supplement to inform owners of the 4085M of any manual changes or manual errors (called Errata). To keep this manual as current and as accurate as possible, Hewlett-Packard recommends that you periodically request the latest Manual Changes supplement. The supplement for this manual is indentified with this manual's print date and part number, both of which appear on the title page. Complimentary copies of the supplement are available from Hewleet-Packard.

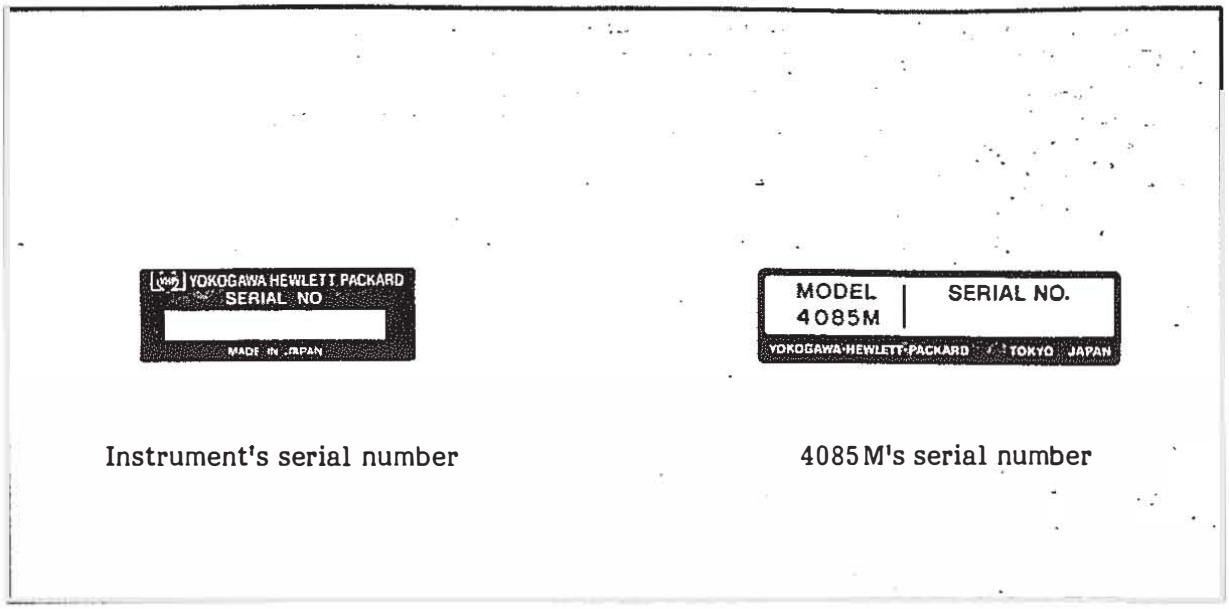


Figure 1-3. Serial Numbers

Table 1-1. Specifications

4084A SWITCHING MATRIX CONTROLLER

Supplies power to the switching matrix and controls relay switching.

Power Requirements: 100V/120V/220V±10%, 240V +5% -10%, 48—66Hz, max. 130VA.

Dimensions: 426mm (W) x 134mm (H) x 432mm (D)

Weight: Approx. 8kg.

4085A SWITCHING MATRIX

DUT PINS: From 12 to 48 pins can be installed.

48 PINS: standard configuration, factory installed
36 PINS: option 003, factory installed
24 PINS: option 002, factory installed
12 PINS: option 001, factory installed
1 PIN: option 004 adds one pin to option 001/002/003, field installed

Instrument Ports: Eight instrument ports are included.

LOW LEAKAGE SMU PORT:	1 ea. (PORT 1)
SMU PORTS:	3 ea. (PORTS 2—4)
VS PORTS:	2 ea. (VS PORTS 1 and 2)
VM PORTS:	2 ea. (VM PORTS 1 and 2)

Residual Resistance:

PORT 1: $\leq 0.5\ \Omega$
PORTS 2—4: $\leq 1.3\ \Omega$
VS/VM PORTS 1 and 2: $\leq 0.6\ \Omega$

Insulation resistance:

PORT 1: $\geq 5 \times 10^{13}\ \Omega$
PORT 2—4: $\geq 10^{10}\ \Omega$

Maximum allowable voltage between instrument ports: ±220V DC

Maximum allowable current through each DUT pin: ±500mA DC

General Specifications:

Operating Temperature and Humidity Range: 10 °C—40 °C, 70% RH at 40 °C

Air Cleanliness: Better than class 100,000

Dimensions: 406mm (W) x 210mm (H) x 380mm (D)

Weight: Approx. 22kg.

Table 1-2. Supplemental Performance Characteristics (Sheet 1 of 3)

REFERENCE DATA

Reference data are typical performance characteristics of the 4145A Semiconductor Parameter Analyzer and the 4085M Switching Matrix combined into a system. Reference data are given for information purposes and should not be considered guaranteed specifications. The following cables, supplied with the 4145A, should be used to interconnect the 4145A and 16078A/4085M.

For each SMU: 1.5m Triaxial Cables (PN 16058-61603)
For each VS/VM: 3m BNC Cables (PN 04145-61630)

Low Leakage SMU PORT (PORT 1):

Accuracy:

Voltage Full Scale Range	Sensitivity	Accuracy* ±(% of rdg + % of range + volt)	Max. Current
±20V	1mV	±(0.1% + 0.05% + 3.8 x Io + 10mV)	100mA
±40V	2mV		50mA
±100V	5mV		20mA

Io = Output Current

Current Full Scale Range	Sensitivity	Accuracy* ±(% of rdg + % of range + Amp)	Max. Voltage
±100mA	100µA	+[0.3% + (0.1 + 0.002 x Vo)%]	20V (>50mA) 40V (>20mA)
±10mA	10µA		100V
±1000µA	1µA		
±100nA	100nA		
±10µA	10nA		
±1000nA	1nA	±[0.5% + (0.1 + 0.002 x Vo)%]	
±100nA	100pA		
±10nA	10pA	±[1% + (0.002 x Vo)% + 15pA]	
±1000pA	1pA	±[1% + (0.002 x Vo)% + 8pA]	

Vo = Output voltage

Table 1-2. Supplemental Performance Characteristics (Sheet 2 of 3)

Residual Resistance (Voltage Source/Current Monitor Mode): 1.5Ω

Input Resistance (Current Source/Voltage Monitor Mode): $\geq 10^{12}\Omega$

Maximum Capacitive Load: 1000pF

SMU PORT (PORT 2 through 4):

Accuracy:

Voltage Full Scale Range	Sensitivity	Accuracy* ±(% of rdg + % of range + offset)	Max. Current
± 20V	1mV	±(0.1% + 0.05% + 4.6 x Io + 10mV)	100mA
± 40V	2mV		50mA
±100V	5mV		20mA

Io = Output Current

Current Full Scale Range	Sensitivity	Accuracy* ±(% of rdg + % of range + offset)	Max. Voltage
±100mA	100µA	±[0.3% + (0.1 + 0.002 x Vo)%]	20V (>50mA) 40V (>20mA)
±10mA	10µA		
±1000µA	1µA		
±100µA	100nA		
±10µA	10nA	±[0.3% + (0.003 x Vo)% + 10nA]	100V
±1000nA	1nA	±[0.5% + (0.003 x Vo)% + 2nA]	
±100nA	100pA	±[0.5% + (0.1 x Vo)% + 1nA]	
±10nA	10pA	Not specified	
±1000pA	1pA		

Vo = Output Voltage

Residual Resistance (Voltage Source/Current Monitor Mode): 2.3Ω

Input Resistance (Current Source/Voltage Monitor Mode): $\geq 10^{10}\Omega$

Maximum Capacitive Load: 1000pF

Table 1-2. Supplemental Performance Characteristics (Sheet 3 of 3)

VS PORT:

Accuracy:

Output Full Scale Range	Voltage Resolution	Accuracy*	Max. Current
±20V	±.001V	±0.5% setting ±10mV	10mA

Residual Resistance: 1.4Ω

Maximum Capacitive Load: 200pF

VM PORT:

Accuracy:

Input Full Scale Range	Voltage Sensitivity	Accuracy*
± 2V	±.0001V	±(0.5% rdg + 10mV)
±20V	±. 001V	±(0.2% rdg + 10mV)

Input Resistance: 1MΩ±1%

Parallel Capacitance: Approx. 900pF

* Accuracy of the SMUs, VSs, and VMs is specified at 23 °C±5 °C after a 40-minute warm up period with AUTO CAL set to ON. SMU 2, 3, or 4 is circuit common reference. Error doubles at 10 °C—40 °C.

1-21. OPTIONS

1-22. The 4085M has the following options.

Option 001: 12 Pin Boards (deletes 36 Pin Boards)

Option 002: 24 Pin Boards (deletes 24 Pin Boards)

Option 003: 36 Pin Boards (deletes 12 Pin Boards)

Option 004: Adds one Pin Board (for maintenance purposes and for augmenting the number of pin boards possible with options 001, 002, and 003)

Option 016: Software supplied on a 3.5-inch flexible disc

Option 036: Software supplied on a 5.25-inch flexible disc

Option 907: Front Handle Kit for 4084A

Option 908: Rack Flange Kit for 4084A

Option 909: Rack Flange and Front Handle Kit for 4084A

Option 920: Extra Manual

1: Order the HP 16320A Pin Board to obtain additional pin boards after system installation.

2: Option 016 or 036 must be ordered.

1-23. ACCESSORIES SUPPLIED

1-24. Accessories furnished with the standard 4085M are listed below:

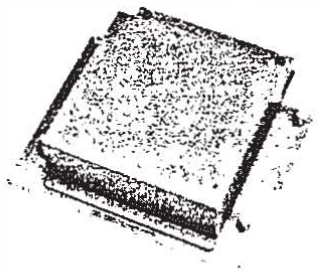
16066A Test Fixture Adapter
16075A Relay Test Adapter
16078A Adapter (4145A-4085A)
Control Cable: PN 04085-61671
Pin Board Extractor: PN 04085-69001
Screw Driver: PN 8710-0900

1-25. ACCESSORIES AVAILABLE

1-26. An assortment of test fixtures that satisfy most measurement requirements is available for use with the 4085M. Table 1-3 lists all available accessories and provides a brief description of each.

1-27. Additional pin boards—for replacement or to augment the number of pin boards possible with options 001, 002, 003, and 004--can be purchased. Order the HP 16320A Pin Board.

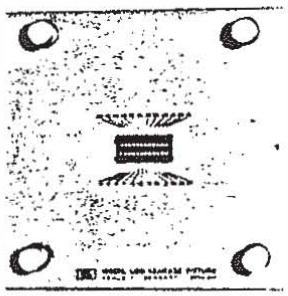
Table 1-3. Accessories Available (Sheet 1 of 2)



16066A Test Fixture Adapter (furnished):

The 16066A Test Fixture Adapter has a light-tight cover that provides electrostatic shielding to ensure stable, accurate measurement of extremely low currents. The 16066A accepts the following test fixtures.

16067A Low Leakage Fixture (24-pin DIP)
16068A Low Leakage Fixture (48-pin DIP)
16069A Universal Low Leakage Fixture
16070A General Purpose DIP Fixture
16071A Universal Fixture



16067A Low Leakage Fixture (24-pin DIP)

The 16077A Low Leakage Fixture (24-pin DIP) is equipped with a 24-pin DIP socket and is designed for extremely low-current measurements on packaged devices.

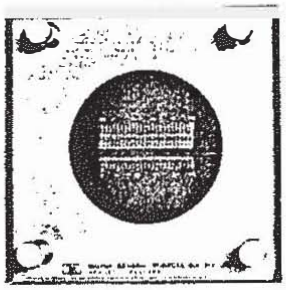
16068A Low Leakage Fixture (48-pin DIP)

The 16068A Low Leakage Fixture (48-pin DIP) is equipped with a 48-pin DIP socket and is designed for extremely low-current measurement on packaged devices.

16069A Universal Low Leakage Fixture

All the measurement terminals on the 16069A Universal Low Leakage Fixture are encased in teflon insulators to effectively eliminate interterminal leakage current. The center of the fixture is covered with a teflon disc to insulate devices under test from the fixture housing. Devices to be tested solder directly to the measurement terminals, making it possible to measure virtually any device, component, or small-scale circuit.

Table 1-3. Accessories Available (Sheet 2 of 2)

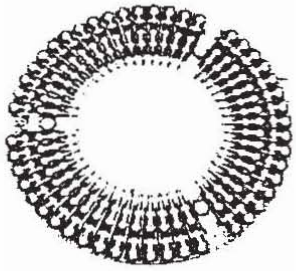


16070A General Purpose DIP Fixture

The 16070A General Purpose DIP Fixture is designed to accept a variety of dual-in-line packaged devices of 48 pins or less. An appropriate IC socket must be installed in the fixture.

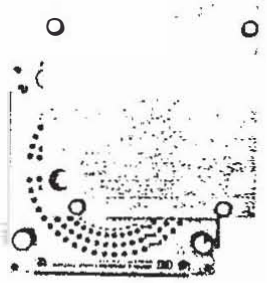
16071A Universal Fixture

The 16071A Universal Fixture is a versatile test fixture that allows connection of virtually any discrete component or packaged device, as well as small-scale circuits. Hole spacing is the standard 2.54mm, ideal for testing ICs.



16072A Personality Board

The 16072A Personality Board functions as a contact interface between the measurement pins of the 4085A and the probe card of an automatic wafer prober.



16077A Extension Cable Fixture

The 16077A Extension Cable Fixture is used when the 4085M is to be used with certain manual wafer probers, or with an environmental chamber.

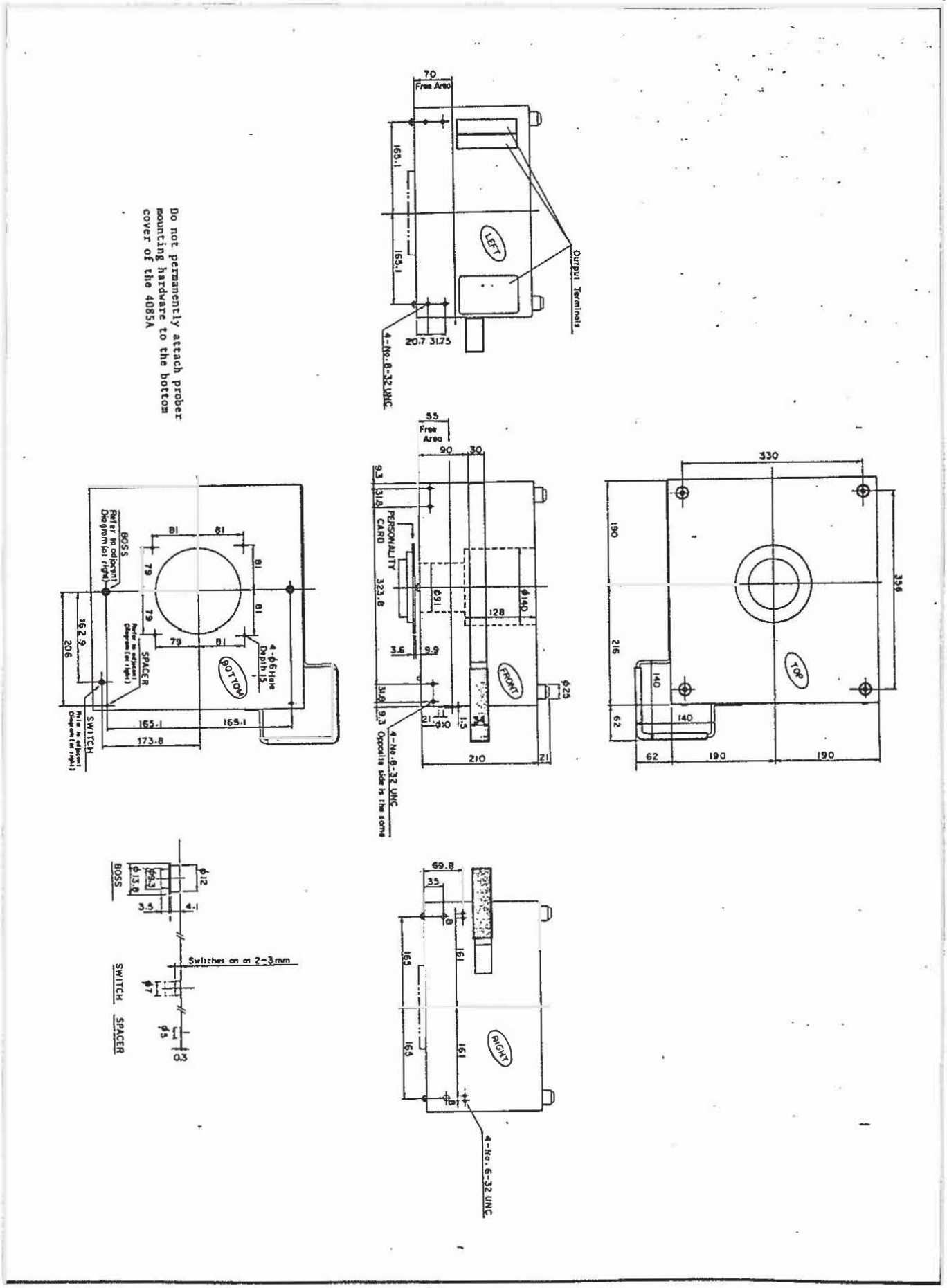


Figure 1-4. Dimensions of 4085A

SECTION II
INSTALLATION

2-1. INTRODUCTION

2-2. This section provides the instructions, procedures, and information necessary to install the Model 4085M Switching Matrix. Figure 2-1 shows, in flow diagram fashion, the steps required to install the 4085M.

2-3. UNPACKING AND INITIAL INSPECTION

WARNING

THE 4085M IS HEAVY, APPROXIMATELY 22kg (48 lb.), AND IS WRAPPED IN VINYL, MAKING IT DIFFICULT TO LIFT AND CARRY. USE CAUTION WHEN HANDLING THE 4085M.

2-4. Remove the 4085M and 4084A from their shipping cartons and check the cables and accessories against the check list enclosed in the cartons. If the shipment is incomplete, if the contents show any signs of mechanical damage or other defects (scratches, dents, broken switches, etc.), or if the 4085M does not pass performance verification as outlined in paragraph 2-18, notify the nearest Hewlett-Packard office (see list at back of this manual). The HP office will arrange for repair or replacement without waiting for claim settlement.

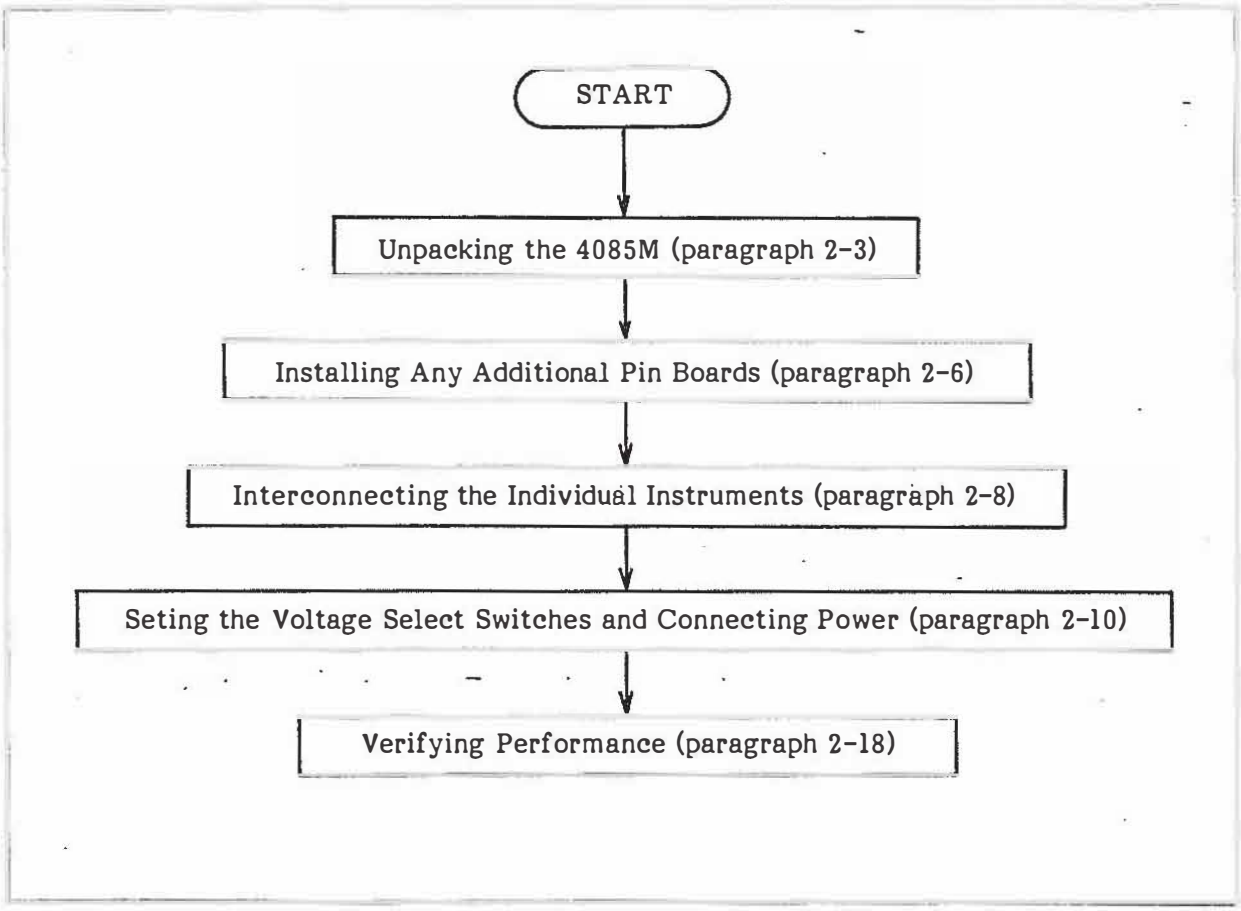


Figure 2-1. Installation Flow Diagram

2-5. When shipped from the factory, the 4085A is wrapped in two separate sheets of vinyl. After removing the 4085A from its carton, remove only the outer sheet of vinyl. Leave the inner sheet in place until the 4085A has been moved to the clean room. If additional pin boards were ordered, they will be enclosed in individual antistatic envelopes. Do not remove the pin boards from the envelopes until you're ready to install them in the 4085A.

CAUTION

DO NOT REMOVE THE 4085A OR ITS ACCESSORIES FROM THEIR PROTECTIVE COVERS OUTSIDE THE CLEAN ROOM. EXPOSURE TO DUST OR OTHER AIRBORNE CONTAMINANTS DEGRADE INSULATION, THEREBY REDUCING MEASUREMENT ACCURACY.

2-6. INSTALLATION OF ADDITIONAL PIN BOARDS

CAUTION

INSTALL ADDITIONAL PIN BOARDS ONLY AFTER THE 4085A HAS BEEN MOVED TO THE CLEAN ROOM. WEAR RUBBER GLOVES AND A LINT FREE CLOTH CAP AND GOWN. OIL, PERSPIRATION, HAIR, FIBROUS DUST AND DIRT DEGRADE BOARD INSULATION, THEREBY REDUCING MEASUREMENT ACCURACY.

2-7. To install additional pin boards, perform as follows:

1. Remove the protective vinyl cover from the 4085A.
2. Remove the protective plate that covers the measurement pins.
3. Using the furnished screwdriver, remove all screws from the bottom panel, and then carefully lift the bottom panel off the 4085A.
4. Remove the board struts and pin board control cables. Refer to Figure 2-2.

CAUTION

WHEN REMOVING A CONTROL CABLE, DISCONNECT EACH CONNECTOR SEPARATELY. DO NOT REMOVE THE CABLE BY DISCONNECTING ONE END AND THEN "PEELING OFF" THE CABLE ALL AT ONCE.

5. Remove the additional 16320A pin boards from their antistatic envelopes.

CAUTION

WEAR RUBBER GLOVES WHEN HANDLING THE PIN BOARDS. IF NO GLOVES ARE AVAILABLE, HOLD THE BOARD ALONG ITS EDGES AS SHOWN IN FIGURE 2-3. IF ANY PART OF THE BOARD BECOMES CONTAMINATED, IT MUST BE THOROUGHLY CLEANED. REFER TO PARAGRAPH 4-25 FOR CLEANING INSTRUCTIONS.

6. Insert each pin board into the desired slot and connect the board's cable assembly to the corresponding position on the measurement pin mounting ring. Refer to Figure 2-4.
7. Reconnect the control cables, reinstall the board struts, and replace the bottom panel.

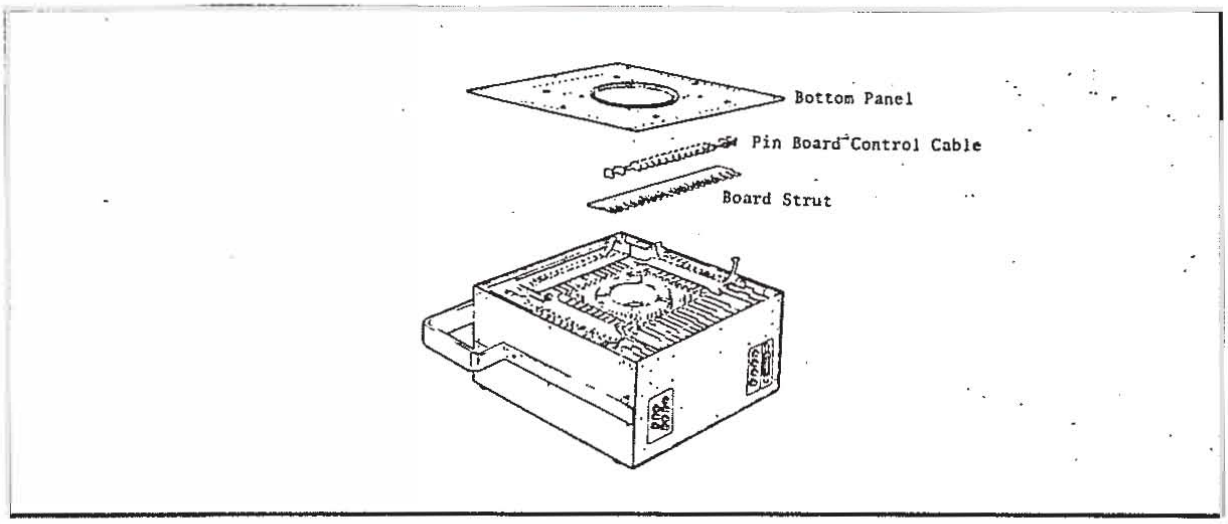


Figure 2-2. Pin Board Installation

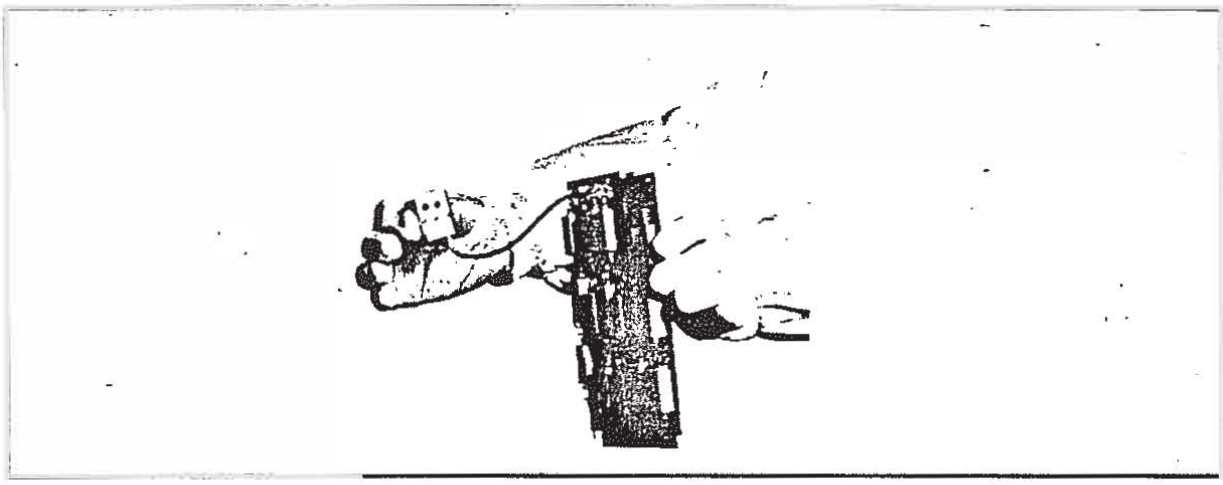


Figure 2-3. Pin Board Handling

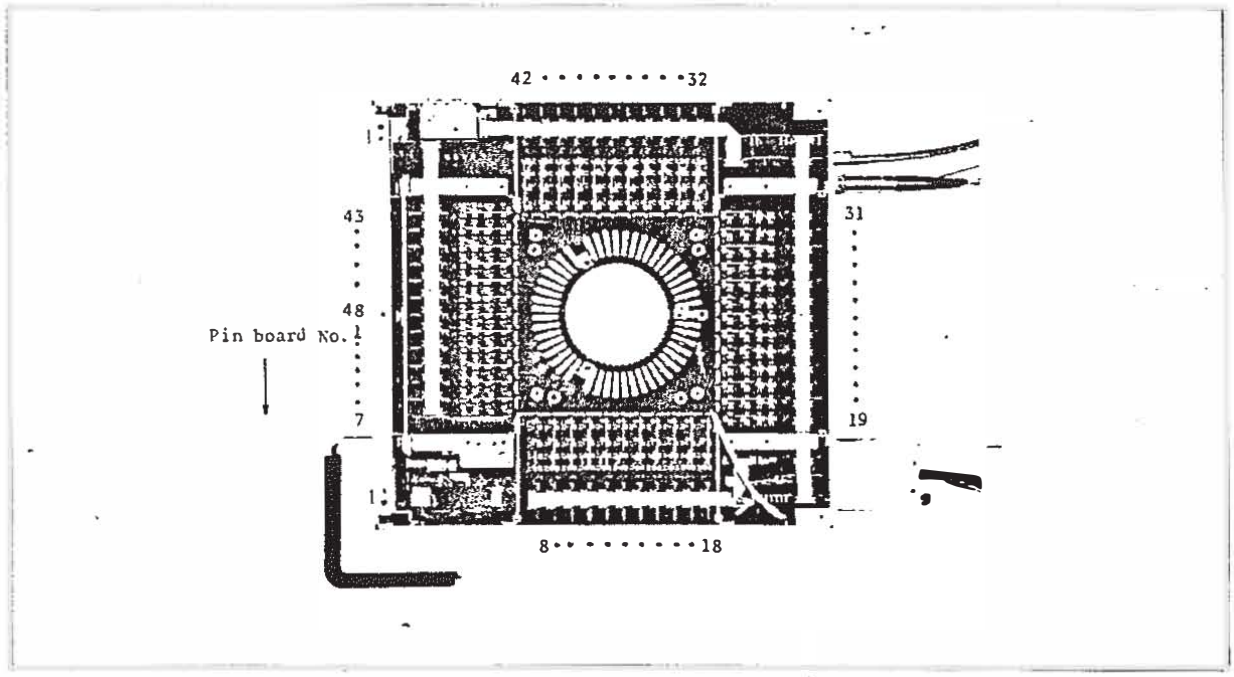


Figure 2-4. Pin Board Locations

2-8. INTERCONNECTIONS

2-9. To construct the system shown in Figure 1-2, interconnect the instruments as shown in Figure 2-5. The required instruments and cables are listed in the figure. The connection procedure is as follows:

1. Interconnect the 4084A ③ and 4085A ① with the furnished control cable ②.
2. Attach the 16078A ⑩ to the 4085A connectors labeled TO 16078A ADAPTER, and then tighten the two thumb screws.
3. Connect each SMU terminal on the rear of the 4145A ⑥ to the corresponding terminal on the 16078A. Use the furnished triaxial cables ⑨.
4. Connect the VM and VS terminals of the 4145A to the VM PORTs and VS PORTs of the 4085A with the furnished BNC cables ⑧.
5. Connect the 24-pin Shorting Connector ⑦ to the System Cable connector of the 4145A.
6. Interconnect the 4084A, 4145A, and computer (internal HP-IB interface) with the furnished HP-IB cables ④.
7. Set the HP-IB Addresses of the 4084A and 4145A as listed below:

   4084A: 22
   4145A: 17

If other HP-IB addresses are used, or if an HP-IB interface card is used instead of the computer's internal HP-IB interface, the furnished software must be modified, as described in paragraph 3-32.

2-10. POWER REQUIREMENTS

2-11. The 4085M requires a power source of 100, 120, 220 Volts ac ±10%, or 240 Volts ac +5%-10%, 48 to 66Hz single phase; power consumption is 130VA maximum.

WARNING

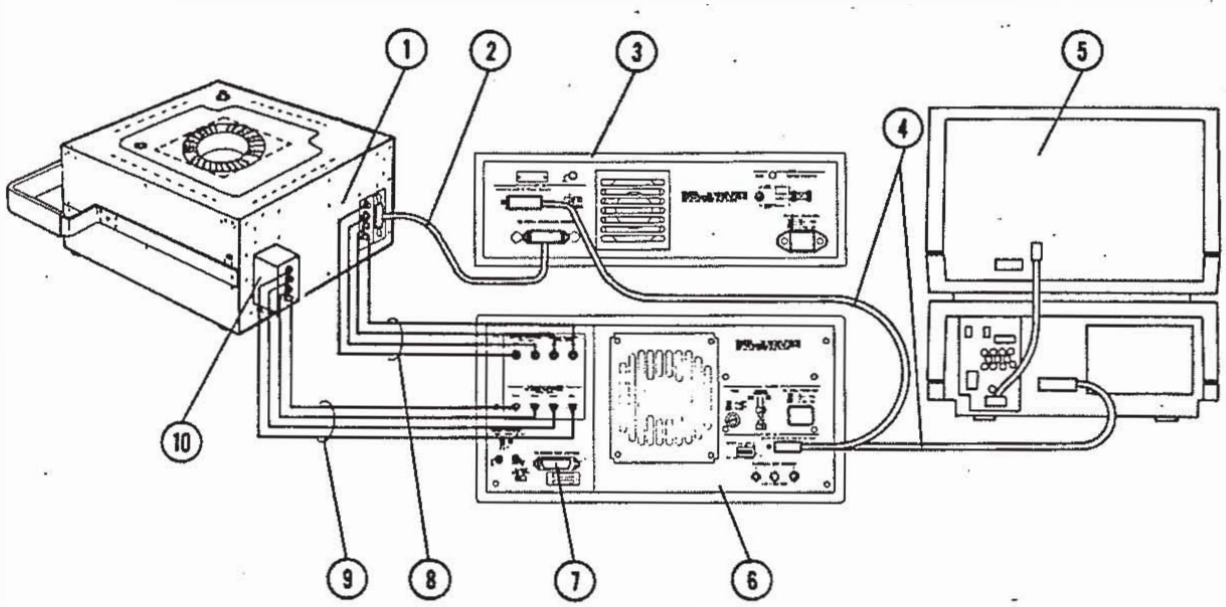
IF THE 4084A IS TO BE ENERGIZED VIA AN EXTERNAL AUTOTRANSFORMER UNIT FOR VOLTAGE REDUCTION, BE SURE THAT THE COMMON TERMINAL IS CONNECTED TO THE NEUTRAL POLE OF THE POWER SUPPLY.

2-12. Line Voltage and Fuse Selection

CAUTION

BEFORE TURNING ON THE 4084A, VERIFY THAT THE VOLTAGE SELECTOR SWITCH ON THE REAR PANEL IS CORRECTLY SET FOR THE LINE VOLTAGE USED.

2-13. Figure 2-6 shows the various settings of the line voltage selector switches and lists the proper fuses for different line voltages. When the 4084A is shipped from the factory, its line voltage selector switch is correctly set and the proper fuse is installed for the line voltage used at the shipment's destination.



(1): 4085A Switching Matrix

(2): Control Cable, PN 04085-61671 (furnished with the 4085M)

(3): 4084A Switching Matrix Controller

(4): 10833A/B/C/D HP-IB Cables 2 ea.

(5): 9836 or 9816 Desktop Computer

(6): 4145A Semiconductor Parameter Analyzer

(7): Shorting Connector, PN 04145-61623 (furnished with the 4145A)

(8): BNC Cables, 4 ea., PN 04145-61630 (furnished with the 4145A)

(9): Triaxial Cables, 1.5m, 4 ea., PN 16058-61603 (furnished with the 4145A)

(10): 16078A Adapter (4085A-4145A) (furnished with the 4085M)

Figure 2-5. Interconnections

CAUTION

USE THE PROPER FUSE FOR THE LINE VOLTAGE SELECTED.

CAUTION

USE ONLY FUSES OF THE REQUIRED CURRENT RATING AND OF THE SPECIFIED TYPE FOR REPLACEMENT. DO NOT USE MENDED FUSES. DO NOT SHORT-CIRCUIT THE FUSE-HOLDER.

2-14. POWER CABLE

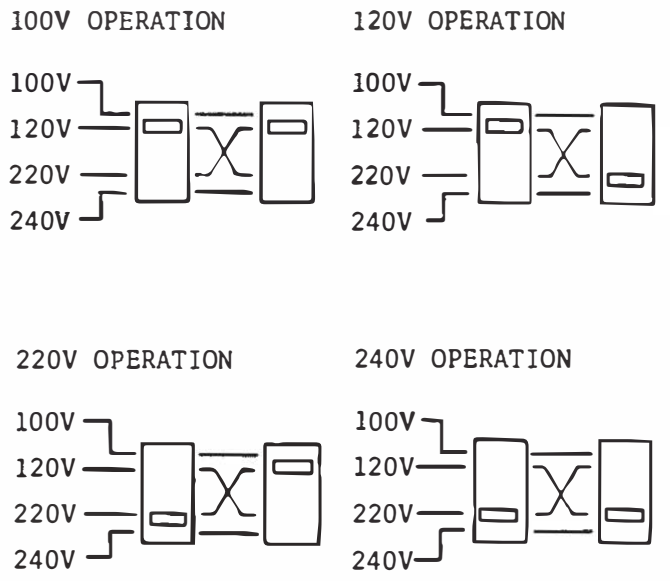
2-15. To protect operating personnel, the National Electrical Manufacturer's Association (NEMA) recommends that the instrument panel and cabinet be grounded. The 4084A is equipped with a three-conductor power cable which, when plugged into an appropriate receptacle, grounds the instrument. The offset pin on the power cable is the ground wire.

2-16. To preserve the protection feature when operating the instrument from a two contact outlet, use a three prong to two prong adapter (PN 1251-8196) and connect the green grounding tab on the adapter to power line ground.

WARNING

THE MAINS PLUG MUST BE INSERTED ONLY 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 PROTECTIVE CONDUCTOR (GROUNDING).

2-17. Figure 2-7 shows the available power cords used in various countries, including the standard power cord furnished with the instrument. HP part number, applicable standards for power plug, power cord color, electrical characteristics and countries using each power cord are listed in the figure. If assistance is needed in selecting the correct power cable, contact the nearest Hewlett-Packard office.

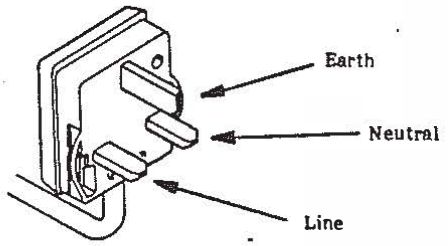


FUSE SELECTION

Line Voltage	Fuse Rating	HP Part No.
100V/120V	1.5AT, 250V Slow Blow	2110-0304
220V/240V	0.75AT, 250V Slow Blow	2110-0360

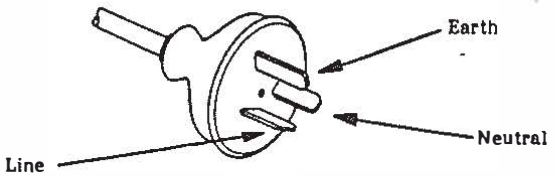
Figure 2-6. Voltage and Fuse Selection

OPTION 900 United Kingdom



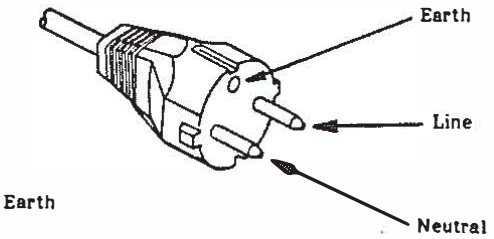
Plug: BS 1363A, 250V
Cable: HP 8120-1351

OPTION 901 Australia/New Zealand



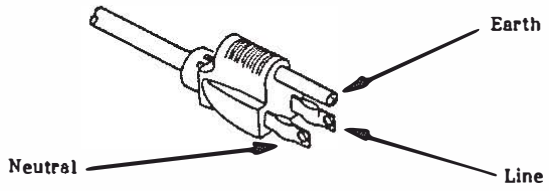
Plug: NZSS 198/AS C112, 250V
Cable: HP 8120-1369

OPTION 902 European Continent



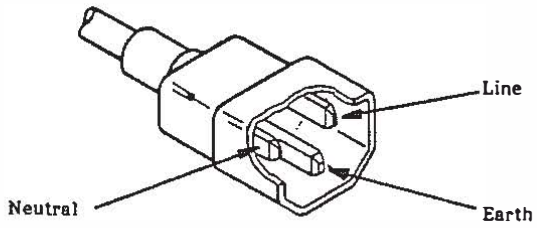
Plug: CEE-VII, 250V
Cable: HP 8120-1689

OPTION 903 U.S./Canada



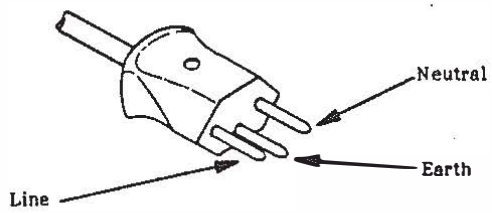
Plug: NEMA 5-15P, 125V, 15A
Cable: HP 8120-1378

OPTION 905* Any country



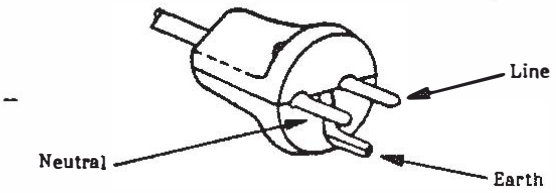
Plug: CEE 22-VI, 250V
Cable: HP 8120-1396

OPTION 906 Switzerland



Plug: SEV 1011.1959-24507 Type 12, 250V
Cable: HP 8120-2104

OPTION 912 Denmark



Plug: DHCR 107, 220V
Cable: HP 8120-2956

* Plug option 905 is frequently used for interconnecting system components and peripherals.

NOTE: Each option number includes a 'family' of cords and connectors of various materials and plug body configurations (straight, 90 ° etc.)

Figure 2-7. Power Cables Supplied

2-18. PERFORMANCE VERIFICATION

2-19. After all interconnections, switch settings, and power line connections have been made, verify performance using the furnished diagnostics software. Complete instructions are given in paragraph 4-3. When shipped from the factory, the 4085M meets all the specifications listed in Table 1-1.

2-20. OPERATING ENVIRONMENT

2-21. Temperature. The 4085M may be operated in environments with ambient temperatures from 0 °C to +40 °C.

2-22. Humidity. The 4085M may be operated in environments with relative humidities to 70% at 40 °C. However, the 4085M must be protected from temperature extremes which cause condensation within the individual instruments.

2-23. Air Cleanliness. The 4085M must be installed in an environment better than class 100,000.

2-24. INSTALLATION OF OPTIONS 907, 908 and 909

2-25. The 4084A Switching Matrix Controller can be rack-mounted. Rack mounting information for the 4084A is given in Figure 2-8.

2-26. STORAGE AND SHIPMENT

2-27. ENVIRONMENT

2-28. The 4085M may be stored or shipped under the following ambient conditions:

Storage:

Temperature (4 °C to 50 °C with discs)	-22 °C to +55 °C
Humidity	8% to 80% (RH)

Shipment:

Temperature (-40 °C to +50 °C with discs)	-40 °C to +62 °C
Humidity	8% to 80% (RH)

The 4085M should be protected from temperature extremes that cause condensation inside the instruments.

2-29. PACKAGING

2-30. Original Packaging. Containers and materials identical to those used in factory packaging are available from Hewlett-Packard.

2-31. Other Packaging. The following general instructions should be used for re-packing with commercially available materials:

a. Before removing the 4085A from the clean room, wrap it in a sheet of clean vinyl to protect it from dust. This is not necessary for the 4084A.

b. Wrap both instruments in heavy paper or vinyl.

c. Use a strong shipping container. A double-walled carton made of 350-pound test material is adequate.

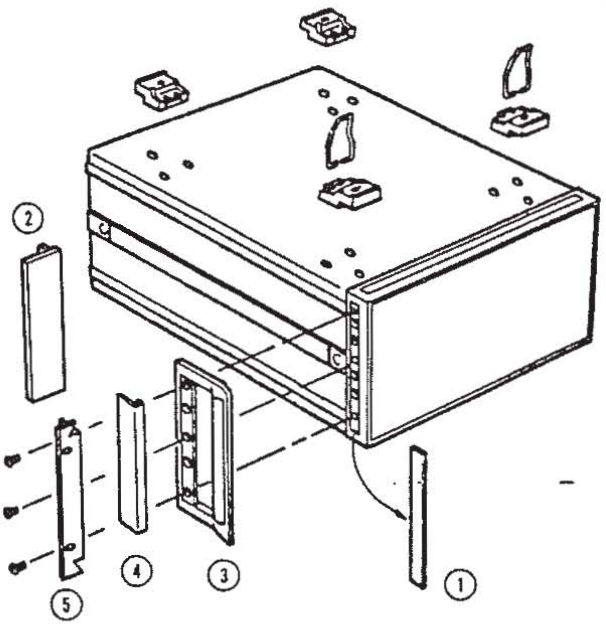
d. Use enough shock absorbing material (3 to 4-inch layer) around all sides of the instrument to provide a firm cushion and to prevent movement inside the container. Protect the front panel of the 4084A with cardboard.

e. Seal the shipping container securely.

f. Mark the shipping container FRAGILE to ensure careful handling.

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

Option	Kit Part Number	Parts Included	Part Number	Q'ty	Remarks
907	Handle Kit 5061-0089	Front Handle	③ 5060-9899	2	
		Trim Strip	④ 5020-8896	2	
		X8-32 x 3/8 Screw	2510-0195	6	9.525mm
908	Rack Flange Kit 5061-0077	Rack Mount Flange	② 5020-8862	2	
		X8-32 x 3/8 Screw	2510-0193	6	9.525mm
909	Rack Flange & Handle Kit 5061-0083	Front handle	③ 5060-9899	2	
		Rack Mount Flange	⑤ 5020-8874	2	
		X8-32 x 3/8 Screw	2510-0194	6	15.875mm



1. Remove the adhesive-backed trim strips ① from the right and left sides of the instrument.

2. HANDLE INSTALLATION: Attach handles ③ to the right and left sides of the instrument with the screws provided and attach the trim ④ to the handles.

3. RACK MOUNTING: Attach rack mount flanges ② to the right and left sides of the instrument with the screws provided.

4. HANDLE AND RACK MOUNTING: Attach handles ③ and rack mount flanges ⑤ together to the right and left side of the instrument with the screws provided.

5. To rack mount (3 and 4 above) the 4084A, remove all four feet (lift bar at inner side of foot, and slide foot toward the bar).

Figure 2-8. Rack Mount Kit

SECTION III
OPERATION

3-1. INTRODUCTION

3-2. This section provides the hardware and software-related information necessary to operate the 4085M. Figure 3-1 shows the organization of the section and provides a brief description of each part. Warnings and cautions are given throughout this section. They must be observed to ensure the safety of the operator and the serviceability of the instruments.

3-3. PANEL FEATURES

3-4. Figures 3-2, 3-3, and 3-4 identify and briefly describe the function of each key, indicator, and connector on the 4084A and 4085A.

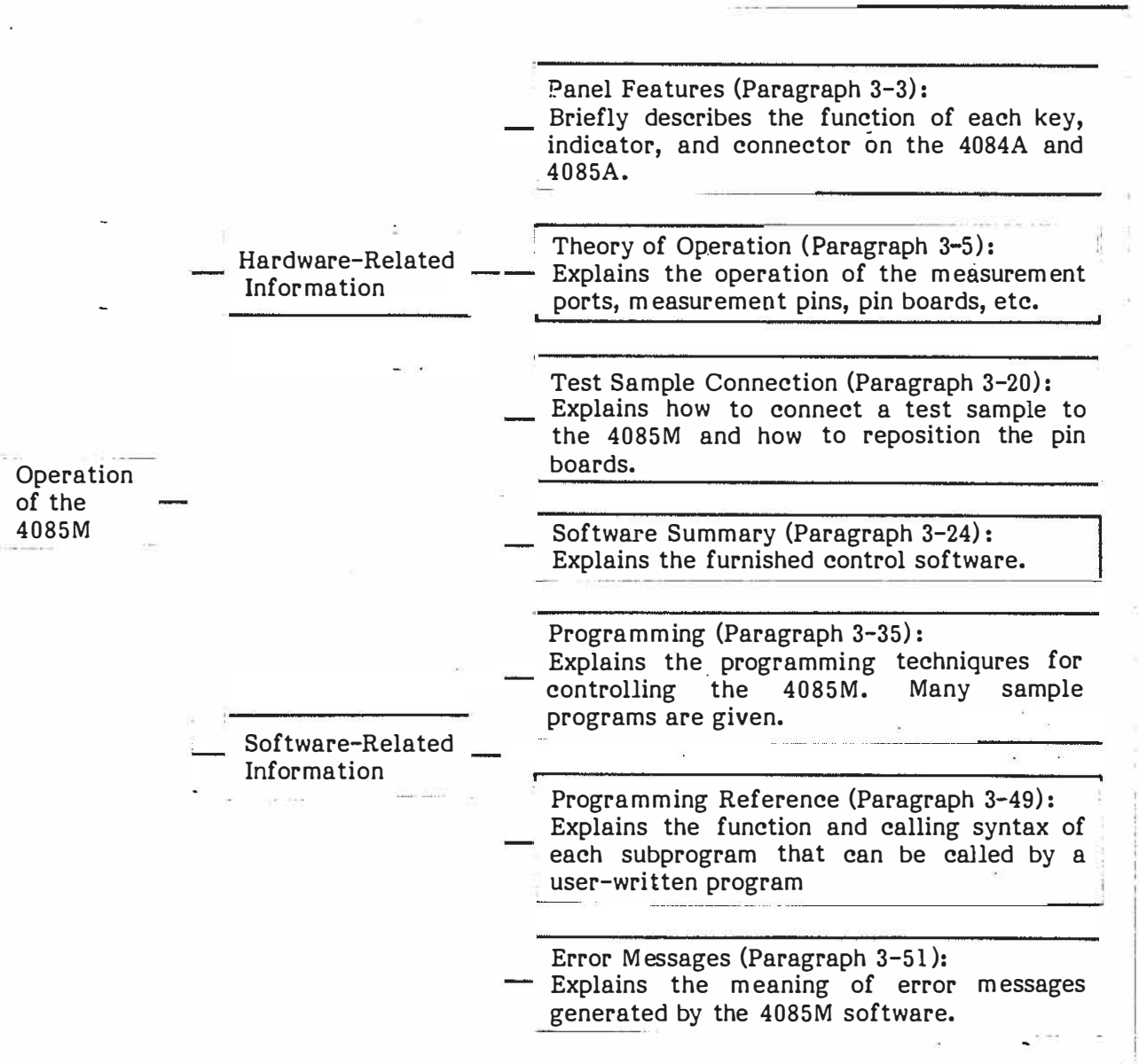
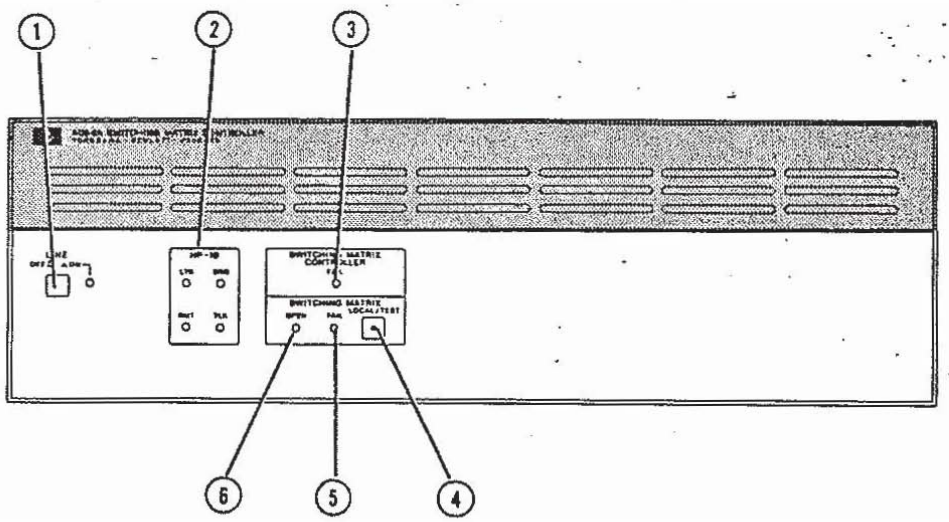


Figure 3-1 Organization of Section III



(1) LINE ON/OFF Switch:
This swicth turns the 4084A on and off. Power for the 4085A is supplied by the 4084A.

(2) HP-1B Status Indicators:
These LED lamps show the HP-IB Status of the 4084A.

(3) SWITCHING MATRIX CONTROLLER FAIL Indicator:
This lamp lights when the 4084A's self test function, which continuously monitors transmissions between the 4084A and 4085A detects an error condition. While this lamp is lit, the 4084A ignores most HP-IB commands. Refer to Section IV for instructions on how to recover from a 4084A FAIL condition.

(4) LOCAL/TEST Key and Indicator:
Pressing this key while the RMT HP-1B indicator lamp is lit (4084A is under remote control) sets the 4084A to local control (RMT lamp goes off). Pressing this key while the 4084A is set to local control starts the RELAY TEST. The indicator lamp at the center of the key lights during the RELAY TEST.

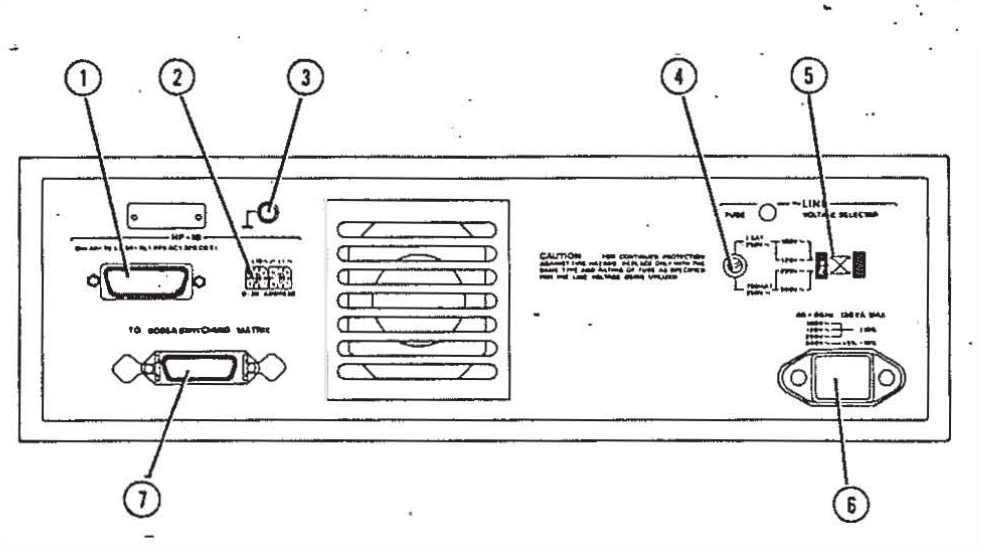
Note

Before executing the RELAY TEST, be sure to attach the 16075A Relay Test Adapter to the 4085A. Test results are indicated by the FAIL lamp adjacent to the LOCAL/TEST Key on the 4084A and by the lamps on the individual pin boards. For further details on the RELAY TEST, refer to Section IV, Maintenance and Diagnostics.

(5) SWITCHING MATRIX FAIL Indicator:
This lamp lights continuously when the 4085A has failed self test, and it flashes off and on when the 4085A has failed the RELAY TEST. If this lamp lights, refer to Section IV for instructions on how to recover from this failure state.

(6) SWITCHING MATRIX OPEN Indicator:
This lamp lights when the 4085A is open (i.e., the measurement pins are exposed). When this lamp is lit, the measurement pins of the 4085A are disconnected from all measurement ports.

Figure 3-2. Front Panel Features of the 4084A



(1) HP-IB Connector:
Twenty-four pin connector that connects the 4084A to the HP-IB.

(2) HP-IB Address Switch:
This switch sets the 4084A's HP-IB address (0-30).

(3) GROUND Terminal:
This terminal is tied to the 4084A's chassis ground.

(4) ∿LINE FUSE Holder:
The instrument's power-line fuse is installed in this holder.

100V/120V operation: 1.5AT, 250V (PN: 2110-0304)
220V/240V operation: 750mAT, 250V (PN: 2110-0360)

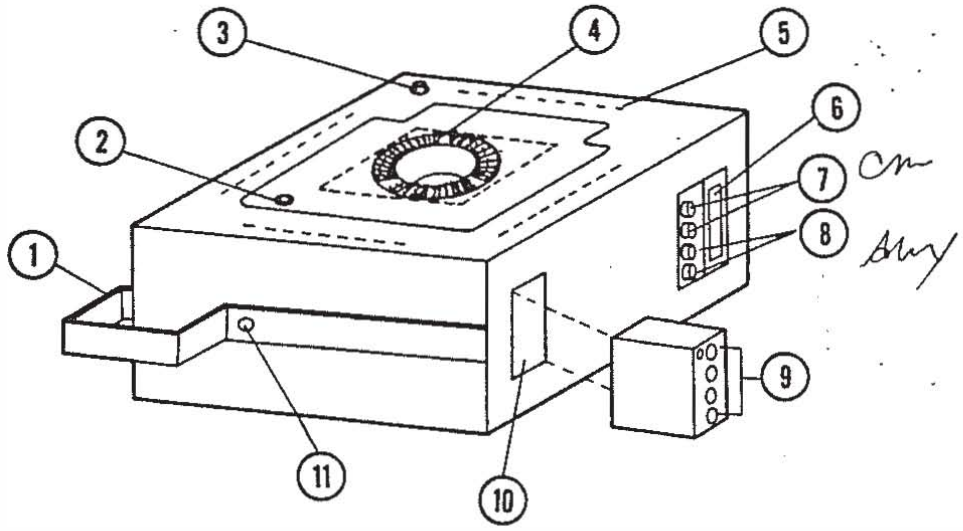
Refer to Paragraph 2-12.

(5) ∿LINE VOLTAGE SELECTOR Switch:
These switches set the 4084A's power supply for the ac line voltage that will be used. Selectable voltages are 100, 120, and 220V ±10%, and 240V +5% -10% (48 to 66Hz). Refer to paragraph 2-12.

(6) ∿LINE Input Receptancle:
AC power cord connects to this receptacle. Refer to pragraph 2-14.

(7) SWITCHING MATRIX Connector:
Thirty-six pin connector for interconnecting the 4084A and 4085A. Switching control signals and dc power for the 4085A are output from this connector.

Figure 3-3 Rear Panel Features of 4084A



① Handle:
Used to lower and raise the 4085A when the 4085A is attached to a wafer prober.

WARNING

THE 4085A IS HEAVY, APPROXIMATELY 22kg (48 lb.). BE SURE TO USE THE HANDLE WHEN RAISING AND LOWERING THE 4085A.

② FIXTURE CLOSED DETECT Switch:
This switch detects whether the lid on the 16066A Test Fixture Adapter is open or closed.

③ WAFER PROBER SENSE Switch:
This switch detects whether the 4085A is positioned atop the wafer prober.

WARNING

WHEN THE FIXTURE CLOSED DETECT SWITCH ② OR THE WAFER PROBER SENSE SWITCH ③ IS ACTUATED, DANGEROUS DC VOLTAGE EXCEEDING ±42V MAY BE PRESENT AT THE MEASUREMENT PINS. SEVERE ELECTRICAL SHOCK WILL RESULT IF THE MEASUREMENT PINS ARE TOUCHED.

Note

The FIXTURE CLOSED DETECT Switch ② and the WAFER PROBER SENSE Switch ③ are connected in parallel so that if either switch is actuated, the 4085A will be enabled. If neither switch is actuated, however, the 4085A will be disabled, disconnecting the system's various measurement ports from the measurement pins. Though disabled, the 4085A can still be controlled. Any changes made while the 4085A is disabled will be automatically set when one of these switches is actuated.

Figure 3-4. Panel Features of the 4085A (Sheet 1 of 2)

④ Measurement Pins:
The measurement pins are spring-loaded and press against the contacts of a test fixture or the contact pads of a personality board attached to a wafer prober.

CAUTION

DO NOT TOUCH THE MEASUREMENT PINS WITH BARE HANDS. OIL, PERSPIRATION, AND DIRT PREVENT GOOD ELECTRICAL CONTACT AND DEGRADE MEASUREMENT ACCURACY.

⑤ Pin Board Fail Indicators:
These indicators light in a sequential pattern during the RELAY TEST. If the test detects a defective pin board, the indicator on the defective board will flash off and on, as will the FAIL lamp on the 4084A.

⑥ SWITCHING MATRIX CONTROLLER Connector:
Thirty-six pin connector for interconnecting the 4084A and 4085A.

⑦ Vm PORTS 1 and 2:
These BNC connectors are the ports for the voltage monitors (Vm1 and Vm2) of the 4145A.

⑧ Vs PORTS 1 and 2:
These BNC connectors are the ports for the voltage sources (Vs1 and Vs2) of the 4145A.

⑨ 16078A Adapter:
The 16078A converts the 4085A's Kelvin-type ports into a configuration that is compatible with the SMUs of the 4145A. SMUs 1 through 4 of the 4145A connect directly to the PORT 1 through PORT 4 connectors. Refer to paragraph 2-8.

⑩ To 16078A ADAPTER Connectors:
The upper four triaxial connectors are the ports for the SMUs of the 4145A. Note, however, that the SMUs cannot be connected directly to these connectors. The 16078A ⑨ must be used. The bottom two connectors—one trixial, one coaxial—are not for 4085M applications.

⑪ OUTPUT ENABLED Indicator:
This LED lamp lights when the FIXTURE CLOSED DETECT switch ② or the WAFER PROBER SENSE switch ③ is actuated. When this lamp is lit, the programmed connections between the specified measurement pins and ports are made.

Figure 3-4. Panel Features of the 4085A (Sheet 2 of 2)

3-5. THEORY OF OPERATION

3-6. The basic operating theory of the 4085M is described in paragraphs 3-7 through 3-18. A thorough understanding of the information presented in these paragraphs is important for effective use of the 4085M.

3-7. The function of the 4085M is to connect the "measurement ports" to the "measurement pins." The 4085A can be thought of as an 8 x 48 matrix, as shown in Figure 3-5. Each crossing point is connected to or disconnected from a port by relays. By properly controlling the relays, virtually any connection between the measurement ports and measurement pins is possible.

3-8. Measurement Ports

3-9. The measurement ports are connected to the SMU, Vm, and Vs terminals of the 4145A. Table 3-1 gives a brief description of each port. Only SMU Port 1 can be used for low current measurements. Generally, SMU1 is connected to this port, but other SMUs can be connected to this port.

3-10. Measurement Pins

3-11. The 4085A can be equipped with up to 48 sets of measurement pins. Each set consists of a SENSE pin, FORCE pin, and GUARD pin, and all are arranged to form three concentric circles at the center of the 4085A, as shown in Figure 3-6. Each pin is spring-loaded to ensure good electrical contact with the contact pads of a test fixture or a personality board, which attaches to the probe card of a wafer prober. Only the FORCE and GUARD pins are used for 4085M applications. The SENSE pin is not used, because it is intended for measurements requiring a Kelvin connection, which is not possible with the 4145A. When connected to PORT 2, 3, or 4, the SENSE and FORCE pins are identical (they're tied to each other inside the 16078A Adapter). When PORT 1 is used, however, the SENSE pin is open.

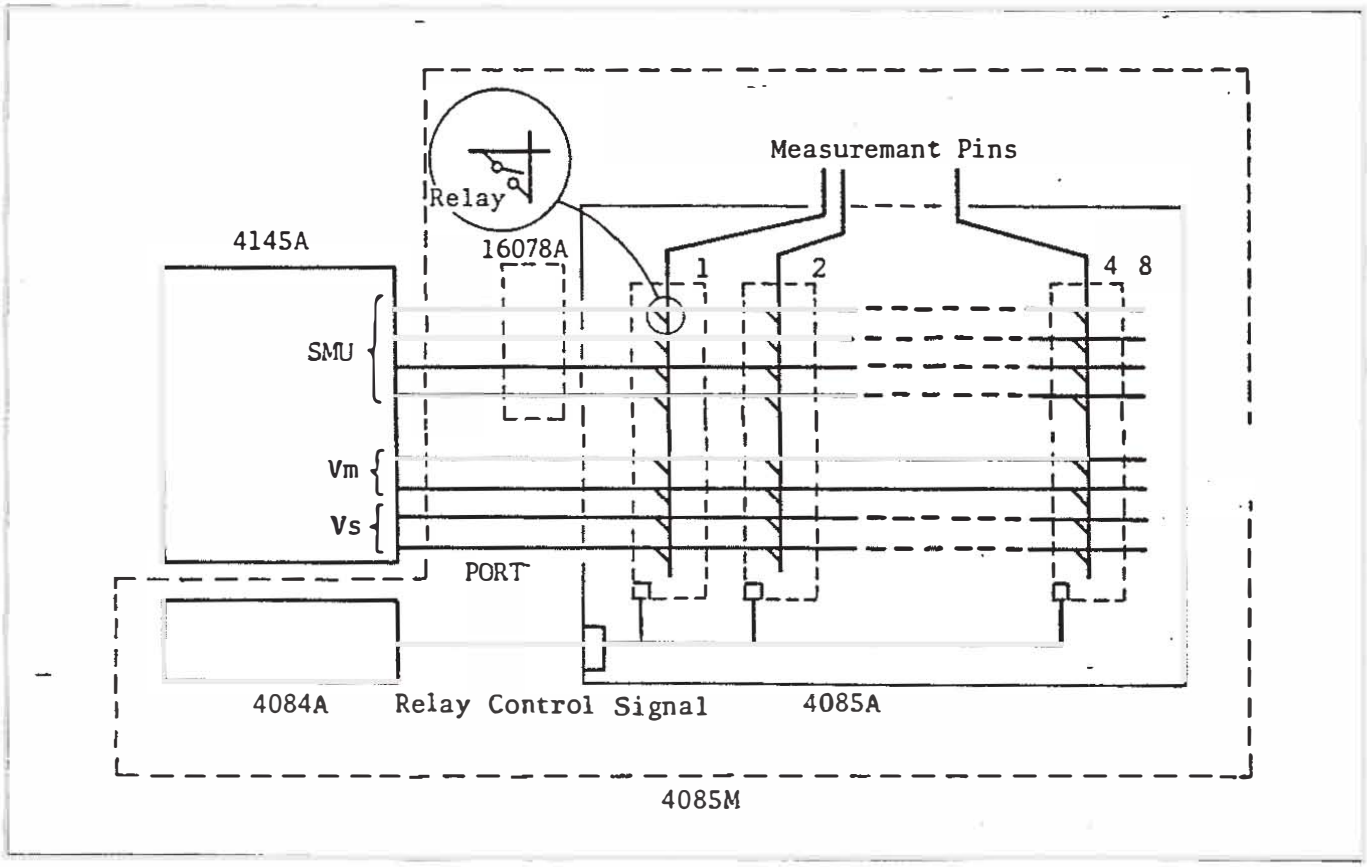
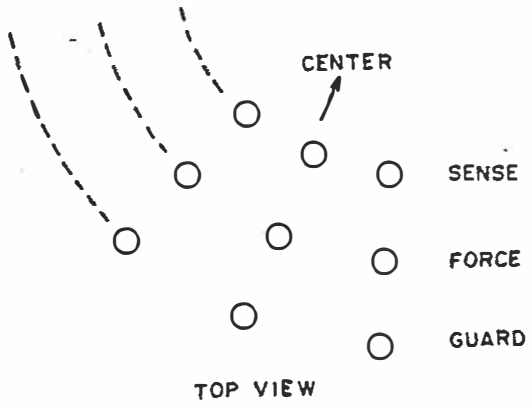


Figure 3-5. Switching Matrix

Table 3-1. Measurement Ports of the 4085M

Port No.*	Port Name	Measurement Unit	Use
1	SMU Port 1	SMU 1,2,3, and 4	Low current measurements
2	SMU Port 2		General dc measurements
3	SMU Port 3		General dc measurements
4	SMU Port 4		General dc measurements
5	VS Port 1	Vs 1	Dc voltage source
6	VS Port 2	Vs 2	Dc voltage source
8	VM Port 1	Vm 1	Dc voltage measurements
9	VM Port 2	Vm 2	Dc voltage measurements
10	GSMU	Guard terminal of SMU Port 1	Guarding for low current measurements

*: Port No. 7 is not available for 4085M applications.



SENSE: This pin functions as the sense terminal for Kelvin connections.

FORCE: Generally, this pin is the measurement pin. When the GSMU (Port 10) is connected to a pin board, however, the board's FORCE pin is a guard terminal.

Note

GSMU is not a true port. It is a pseudo port connected to the guard of PORT 1 (SMU 1). It has no exclusive connectors on the 4085M.

GUARD: This pin functions as the guard terminal.

Figure 3-6. Measurement Pins

3-12. Pin Boards

3-13. The 4085A can be equipped with up to 48 pin boards, each having one set of measurement pins—SENSE, FORCE, and GUARD. Refer to paragraph 3-10 for the function of each pin. Connection between the ports and measurement pins is controlled by the relays on the pin boards, as was shown earlier in Figure 3-5. The pin boards are identical and each has sixteen relays. Figure 3-7 shows the relay circuit configuration. Each relay is assigned a unique number (e.g., K30) for failure isolation with the DIAGNOSTICS program. If a relay failure is detected by the DIAGNOSTICS program, the relay number and the pin board number will appear on the controller's display. See Section IV for a complete discussion on the DIAGNOSTICS program. Figure 3-8 shows two examples of how the relays connect a port to the measurement pins. Table 3-2 lists the ON (make) relays for each port.

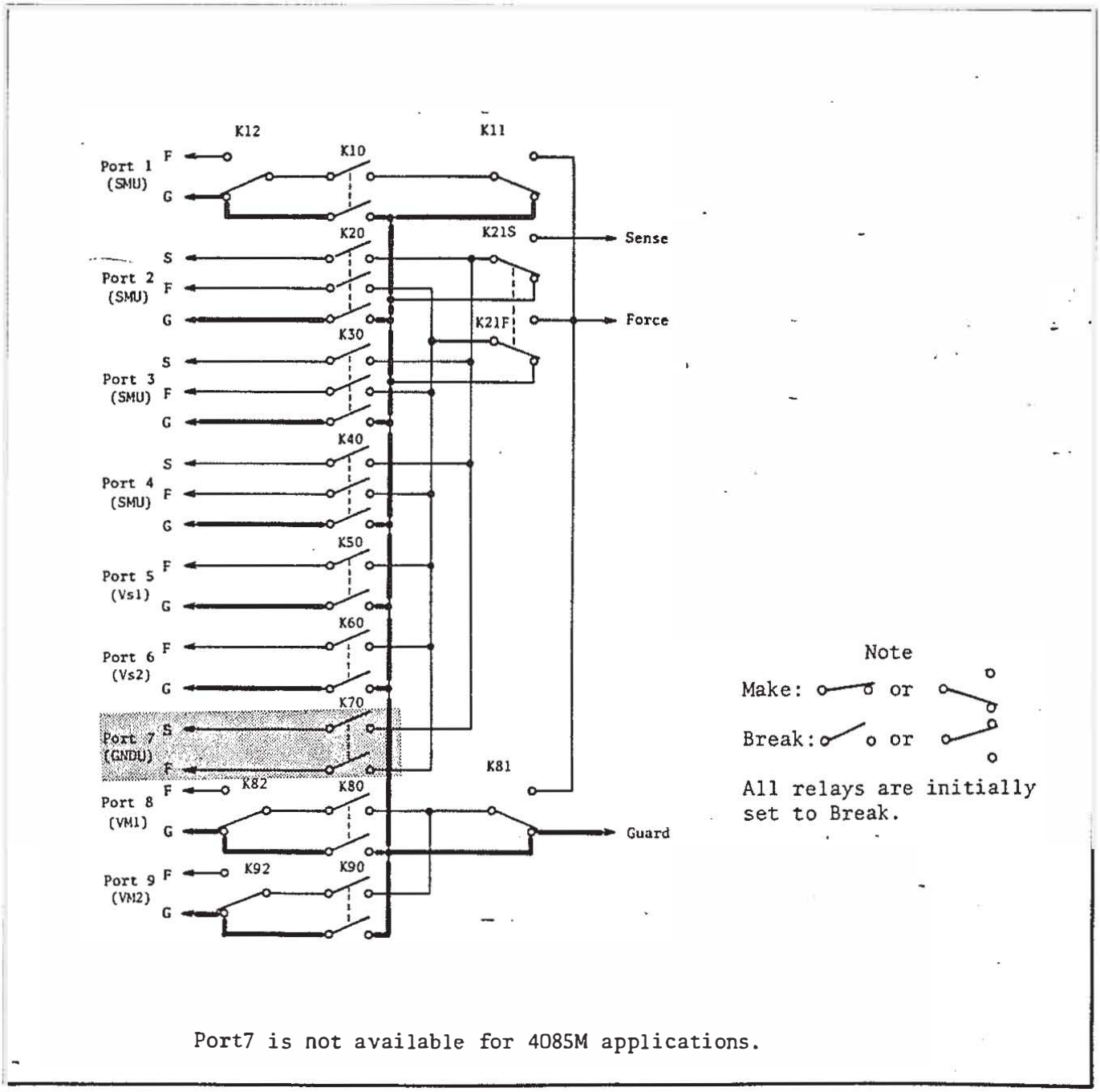
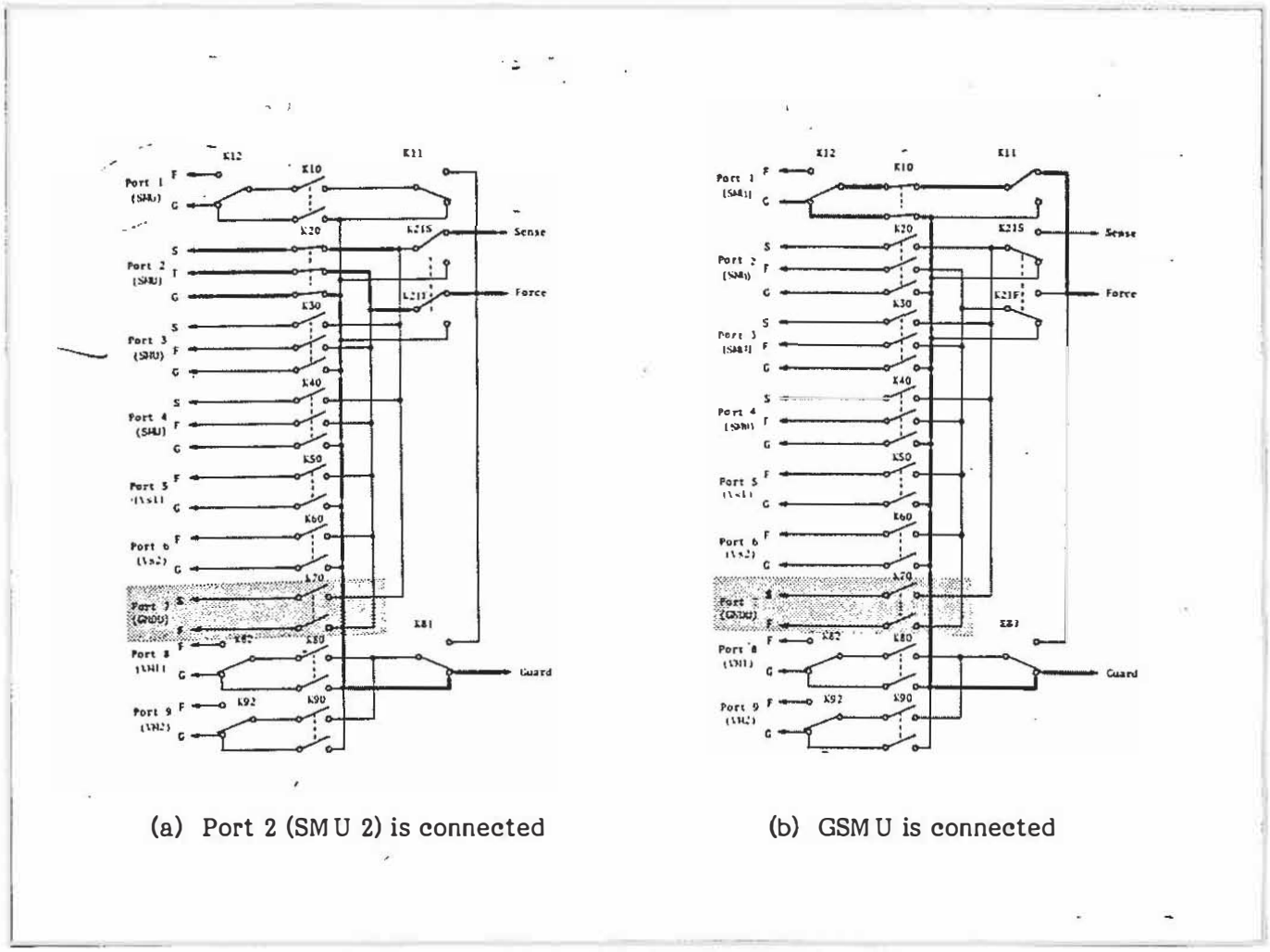


Figure 3-7. Pin Board Relay Circuit Configuration

Table 3-2. Relationship Between Ports and Relays

Port No. (Name)	Relay
Port 1 (SMU1)	K10, K11, K12
2 (SMU2)	K20, K21
3 (SMU3)	K30, K21
4 (SMU4)	K40, K21
5 (VS1)	K50, K21
6 (VS2)	K60, K21
8 (VM1)	K80, K81, K82
9 (VM2)	K90, K81, K92
10 (GSMU)	K10, K11



(a) Port 2 (SMU 2) is connected

(b) GSMU is connected

Figure 3-8. Examples of Pin Board Operation

3-14. 16078A Adapter (4145A-4085A)

3-15. The 4085A was originally designed for use with the 4141A DC Source/Monitor of the 4062A Semiconductor Parametric Test System and therefore cannot be connected directly to the SMUs of the 4145A. The 16078A connects directly to the SMU ports of the 4085A and converts the triaxial configuration of the 4145A's SMUs into a configuration that is 4085A-compatible, as shown in Figure 3-9.

3-16. Switching Matrix Controller

3-17. The 4084A Switching Matrix Controller has two primary functions. The first is to control all switching operations of the 4085A in response to commands sent over the HP-IB from a computer. The second is to supply the necessary dc power to the 4085A and to monitor the ac line in order to detect transitory power losses. If a power loss lasting 500ms or less occurs, the 4084A's microprocessor will be held in a reset state, all front panel indicators will remain lit, and all relays in the 4085A will be set so that the measurement ports are disconnected from the measurement pins. When in this state, the 4084A will not respond to any front panel key operations or to any commands sent from the computer. The only way to recover from this state is to turn the 4084A off, wait at least 1s, and then turn the 4084A back on.

3-18. SAFETY FEATURES

3-19. Because dc voltages up to ±100V can be present at the measurement pins of the 4085A, the 4085M is equipped with several safety features to protect operating personnel against potential shock hazards. Before a measurement can be made, one of two conditions must exist: (1) the 4085A must be firmly mounted atop a wafer prober or (2) the 16066A Test Fixture Adapter, lid closed, must be mounted on the 4085A. Condition (1) is detected by the WAFER PROBER SENSE switch, and condition (2) by the FIXTURE CLOSED DETECT switch. Both these switches are in the 4085A and are monitored by the 4084A. When both switches are open, the 4084A will disable output from the 4085A and the OUTPUT ENABLED lamp on the 4085A will go off. When one of these switches is closed, however, the 4084A enables output from the 4085A and the OUTPUT ENABLED lamp will come on. If this same switch is opened during measurement, output will be disabled immediately. The measurement can be continued after the switch has been closed.

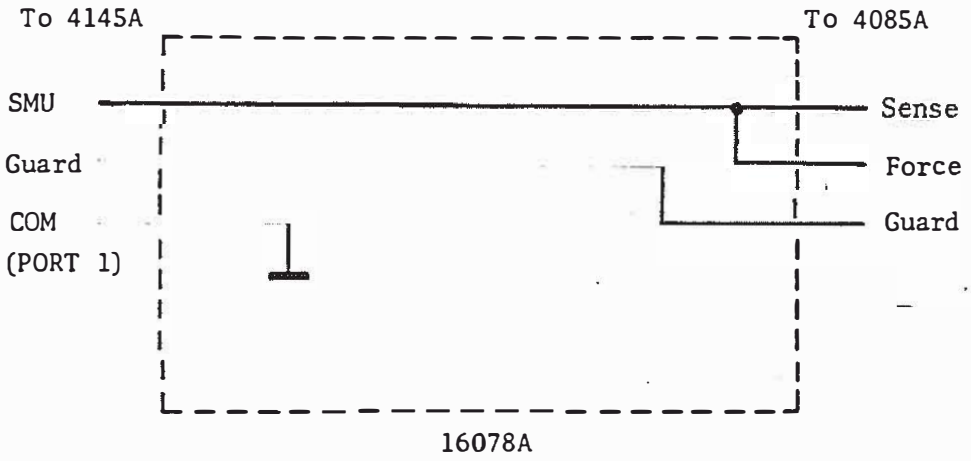


Figure 3-9. Internal Wiring of 16078A

3-20. How To Connect Test Samples

3-21. Measurement is made at the measurement pins of the 4085A, either through the 16072A Personality Board, which attaches to a wafer prober, or through one of the system test fixtures, which mount on the 4085A. Table 1-3 in Section I shows and briefly describes the personality board and the available test fixutures. The method of connecting a sample for measurement depends on the sample type and the measurement objectives and requirements. If you're measuring discrete components, packaged devices, or certain materials, use one of the available test fixtures. If you're using a wafer prober that is too small for the 4085A, or if you're using an environmental control chamber, use the 16077A Extension Cable Fixture. Complete instructions on how to use the available accessories are given in the operating note furnished with each accessory.

Note

When using the 16077A with the 4085M, you need only one coaxial cable for each set of measurement pins, and you can increase cable length up to two meters. Also, the SENSE and FORCE pins of the 16069A and 16077A must be shorted.

3-22. Repositioning Pin Boards

3-23. The standard 4085M has a full complement of 48 pin boards installed in the 4085M. By combining system option 001, 002, or 003 with option 004, however, it is possible to configure a system with fewer pin boards. The minimum number of pin boards is 5. On systems equipped with fewer than 48 pin boards, it is possible to reposition any of the pin boards if necessary. This is possible because the pin boards are identical and because it is the pin board location, not the pin board, that is addressed by the system. Examples of when it might be necessary or desirable to reposition one or more pin boards are (1) when the probe card on the wafer prober has been moved, reconfigured, or altered in some way and (2) when a test fixture has been changed. For instructions on how to reposition a pin board, refer to paragraph 4-21.

3-24. CONTROL SOFTWARE

3-25. Control software for the 4085M is stored on either a 3-1/2 inch or a 5-1/4 inch flexible disc furnished with the 4085M. This software is the only means of controlling the switching operations and self diagnostics function of the 4085M. Since the software is written in BASIC, the BASIC 2.0 Language System must be loaded into the computer. For details on the BASIC 2.0 Language System, refer to the programming manual of the 9816 or 9836 Desktop Computer.

3-26. Copyright And Backup of System Software

3-27. Hewlett-Packard and Yokogawa-Hewlett-Packard software (including software updates), the logical patterns implemented in firmware, and printed documentation are all copyrighted materials, protected under law. Unless HP or YHP specifically grants a customer the right to reproduce copyrighted materials, these may not be copied except for archive purposes, to replace a defective copy, or for program error verification purposes.

The acquisition of any software or software/firmware product grants the customer a license to use the software product originally purchased with one 4085M with no time limit. No title to or ownership of the software is transferred to the customer.

3-28. Although flexible discs are extremely reliable, they do wear out. Since discs can also be damaged due to accidents or careless handling, it is a good idea to make a copy of the furnished software disc and to store the original in a fireproof locker or cabinet. This will provide the system with a working disc and a master disc. The master disc can be used to make additional copies if the working disc is misplaced or accidently erased.

Disc Backup on a 9836 Computer

1. Load the BASIC language system, if it is not already loaded.

2. Insert the source disc into the right-hand disc drive (drive 0). To play it safe, this disc should be write-protected.

3. Insert the destination disc into the left-hand disc drive (drive 1). Be sure that this disc is initialized and write-enabled. Remember that any old files on the destination disc will be lost.

4. Execute this COPY command:

   COPY "INTERNAL" TO "INTERNAL, 4, 1" EXECUTE

If you're using the 9816 computer, the mass storage unit specifier will be different from those shown in step 4 above. Refer to the BASIC programing Techniques Manual or see COPY in the BASIC Language Reference for more details on the COPY command.

3-29. Software Disc

3-30. The software disc furnished with the 4085M contains the following three files.

REVID
SWM
DIAG

REVID: Indicates the version of the software stored on the disc.

SWM: This file contains subprograms that control all 4085M functions, such as establishing the COM block necessary for the subprograms, connecting the measurement ports to user-specified measurement pins, clearing the 4085A, and displaying connection status. To use these subprograms, you simply call them in your main program.

DIAG: This file contains the diagnostics program used to verify normal operation of 4085M. Refer to Section IV for details on DIAG.

3-31. Relay Protection

3-32. The 4085A contains many mechanical relays that are switched to establish various connection configurations between the measurement ports and measurement pins. Because of their mechanical nature, the relays are subject to carbon build up on the contact surfaces, which, if left unchecked, degrades measurement accuracy. To guard against this, the furnished software has two special features. Each is described below.

Dry Switching:

When the relays are switched, output from the 4145A is set temporarily to zero in order to prevent arcing. This is called "dry switching" and it is an integral part of the furnished software.

Contact Cleaning:

When the Relay Test of the diagnostics program is performed, the relays are switched while a low current is forced through the contacts. This is called "wet switching" and it cleans the contacts of the relays. To ensure correct relay performance, perform the relay test every day.

3-33. HP-IB ADDRESS

3-34. Set the HP-IB addresses of the 4084A and 4145A as listed in Table 3-3. If an interface other than the computer's internal interface (select code 2) is used, or if an HP-IB address listed in Table 3-3 cannot be used for the 4084A and 4145A, the furnished software must be modified. The procedure for modifying the software is given below:

1. Clear the computer's memory.

   SCRATCH A [EXECUTE]

2. Load SWM

   LOAD "SWM" [EXECUTE]

3. Enter EDIT mode.

   EDIT [EXECUTE]

4. Change the numerical values on lines 110 and 120 to the desired select code and addresses (select code x 100 + address).

Example: The 4145A is set to address 23 and is connected to an additional HP-IB interface card whose select code is 8.

```
110    Dcs=823
```

Note

Address 21 cannot be used for the instruments, because address 21 is used for the controller.

5. Store the modified program.

RE-STORE "SWM" [EXECUTE]

Note

Use a back-up disc to store the modified program.

Table 3-3. HP-IB Address

Instrument	HP-IB Select Code	HP-IB Address
4084A	7	22
4145A	7	17

3-35. PROGRAMMING

3-36. Starting in this paragraph and continuing through paragraph 3-47 we'll examine various ways to control the 4085M with the SWM subprograms. The calling syntax of each subprogram is given in paragraph 3-48. Error Messages that may occur when the SWM subprograms are used are explained in paragraph 3-50.

3-37. Pre-Run Requirements

3-38. Before running a program that contains SWM subprograms, you must make sure that the following pre-run requirements have been satisfied.

1. Make sure that all the instruments are properly interconnected as shown in Figure 2-5.

2. Make sure that the HP-IB addresses of the 4145A and 4084A are correctly set.

3. Load the BASIC 2.0 Language System into the computer.

Note

If You're going to do any advanced programming, you may have to load BASIC Extensions 2.1. Refer to the computer's manual for details.

4. Run the Start subprogram included in the SWM file. The Start subprogram must be executed (1) after the computer and instruments are first turned on, (2) after the SCRATCH A or SCRATCH C command is executed, and (3) after a program that does not contain any SWM subprograms is executed.

   The Start subprogram, can be executed in one of two ways, as outlined below.

   (1). Load and run SWM.

   LOAD "SWM" [EXECUTE] [RUN]

   (2). Call the Start subprogram at the beginning of your program.

   Note

   If a BASIC ERROR occurs while the Start subprogram is running, the instruments are probably not interconnected correctly. Check the connections and then re-execute the Start subprogram.

5. Link the SWM subprograms. Refer to paragraph 3-43 for instructions.

3-39. SWM Subprograms

3-40. All the subprograms for controlling the 4085M are included in the SWM program file. These subprograms are much like BASIC keywords in that they can be called from a user-written main program, or they can be executed from the keyboard. Explanations of all the SWM subprograms are given below:

Start:

This subprogram initializes the 4085M and establishes the COM blocks used by the other SWM subprograms and the diagnostics program (DIAG). Start must be executed before any other SWM subprogram is executed.

Connect (Port adress, Pin number):

This subprogram connects the specified port to the specified measurement pin. If Port address is 0, the specified measurement pin is disconnected from whatever port it is connected to.

Connect_th (Port address, First pin number, Last pin number):

This subprogram connects the specified port to all measurement pins in the specified range.

Swm_clear:

This subprogram disconnects all measurement ports from the measurement pins.

Swm_status:

This subprogram displays, on the CRT of the computer, the connection status of the port and measurement pin.

Port address functions:

These functions each return the address of the specified port number. They are used as the port address parameter of the Connect and Connect_th subprograms. Table 3-4. lists the port address functions.

Table 3-4. Port Address Functions

Port Name	Port* Number	Port Address Function		
(DISCONNECT)		FNPort(0)		
SMU Port 1	1	FNPort(1)	FNSmu(1)	
SMU Port 2	2	FNPort(2)	FNSmu(2)	
SMU Port 3	3	FNPort(3)	FNSmu(3)	
SMU Port 4	4	FNPort(4)	FNSmu(4)	
Vs Port 1	5	FNPort(5)		FNVs(1)
Vs Port 2	6	FNPort(6)		FNVs(2)
Vm Port 1	8	FNPort(8)		FNVm(1)
Vm Port 2	9	FNPort(9)		FNVm(2)
GUARD for SMU Port 1	10	FNPort(10) or FNPort(-1)	FNSmu(-1)	FNGsmu

*Port number 7 of the 4085A is not used for 4085M applications

3-41. PROGRAMMING EXAMPLES

3-42. Figure 3-10 shows a sample program that (1) establishes the port-to-pin connections necessary for measuring a bipolar transistor, (2) calls a user-written measurement subprogram, and (3) cancels all existing port-to-pin connections after the measurement. The Connect subprogram is used to establish the necessary connections, and the Swm_clear subprogram is used to cancel the connections.

This sample program establishes the connections shown below.

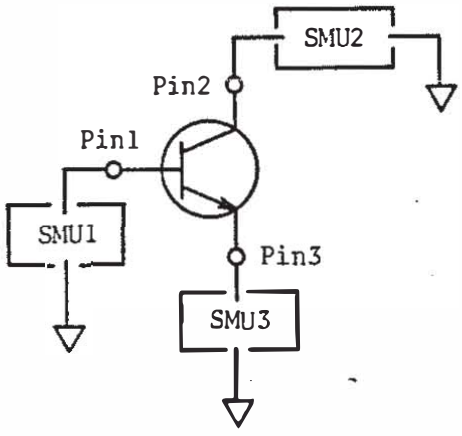


Figure 3-10. Sample Program for Measuring a Bipolar Transistor (Sheet 1 of 2)

```
10    !
20    !  SAMPLE PROGRAM  1
30    !
40    INTEGER Base,Collector,Emitter
50    !
60    Base=1
70    Collector=2
80    Emitter=3
90    !
100   Connect(FNSmu(1),Base)
110   Connect(FNSmu(2),Collector)
120   Connect(FNSmu(3),Emitter)
130   !
140   Measure
150   !
160   Swm_clear
170   END
180   !
190   SUB Measure
200   !
210   SUBEND
220   !
```

Line 40: Declares three integer variables that will be used as parameters in the Connect subprograms.

Lines 60 to 80: Defines the integer variables declared in line 40.

Lines 100 to 120: Connects Port 1, Port 2, and Port 3 to pin 1, pin 2, and pin 3, respectively. The second parameter of the Connect statement (measurement pin number) must be an integer.

Line 140: This line calls a user-written subprogram called Measurement.

Line 160: This statement disconnects all measurement ports from the measurement pins.

Line 200: Insert the actual measurement subprogram here. The subprogram must not end before the measurement is completed. If the subprogram does end prematurely, Swm_clear in line 160 will clear all connections and terminate the measurement. The subprogram should contain some sort of "data ready" check to ensure that control is not returned to the main program before the measurement is completed.

Line 220: The required SWM subprograms, Connect and Swm_clear, must be linked following this line. Refer to paragraph 3-43 for instructions on how to link subprograms.

Figure 3-10. Sample Program for Measureing a Bipolar Transistor (Sheet 2 of 2)

3-43. Figure 3-11 shows a sample program that controls the measurement of a device having multiple MOSFETS. In this program, the Connect subprogram is used not only to connect a measurement port to a measurement pin but also to disconnect an existing connection. When used to disconnect a port from a pin, the Connect subprogram differs from the Swm_clear subprogram in that it disconnects only one connection, whereas Swm_clear disconnects all existing port-to-pin connections.

This sample program establishes the connections shown below and measures the three transistors one at a time, first Q1, then Q2, and finally Q3.

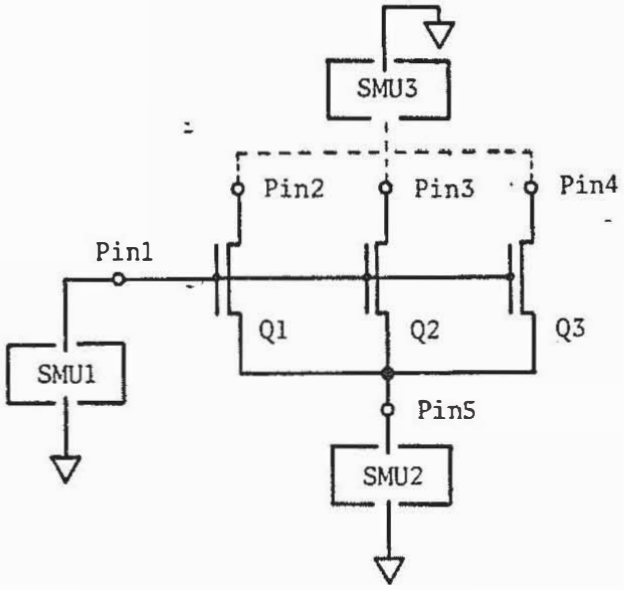


Figure 3-11. Sample Program for Measuring a Multiple MOSFET Device (Sheet 1 of 2)

```
10    !
20    !  SAMPLE PROGRAM  2
30    !
40    INTEGER Gate_com,Source_com,Drain_1,Drain_2,Drain_3
50    !
60    Gate_com=1
70    Source_com=5
80    Drain_1=2
90    Drain_2=3
100   Drain_3=4
110   !
120   Start
130   !
140   Connect(FNSmu(1),Gate_com)
150   Connect(FNSmu(2),Source_com)
160   Connect(FNSmu(3),Drain_1)
170   Measure
180   !
190   Connect(FNPort(0),Drain_1)
200   Connect(FNSmu(3),Drain_2)
210   Measure
220   !
230   Connect(FNPort(0),Drain_2)
240   Connect(FNSmu(3),Drain_3)
250   Measure
260   !
270   Swm_clear
280   END
290   !
300   SUB Measure
310   !
320   SUBEND
330   !
```

Line 40: Declares the integer variables necessary for the Connect subprograms.

Lines 60 to 100: Defines the integer variables declared in line 40 with values that represent pin numbers.

Line 120: Executes the Start subprogram.

Lines 140 to 160: Connects Ports 1, 2, and 3 to pins 1, 5, and 2, respectively.

Line 170: Calls the measurement subprogram.

Line 190: Disconnects Port 3 from measurement pin 2.

Line 200: Connects Port 3 to measurement pin 3.

Line 210: Call the measurement subprogram.

Lines 230 to 250: Disconnects Port 3 from measurement pin 3 and connects it to measurement pin 4, then calls the measurement subprogram.

Lines 270 to 330: Same as lines 160 to 220 of the sample program given in Figure 3-10.

Figure 3-11. Sample Program for Measuring a Multiple MOSFET Device (Sheet 2 of 2)

3-44. How To Link SWM Subprograms

To use any of the SWM subprograms, you must link them to the end of your program. There are three ways to accomplish this.

(1) LOADSUB Sub_name From "SWM"

This command links a single subprogram (Sub_name) from the SWM program library to the last line of the program presently in memory.

(2) LOADSUB ALL FROM "SWM"

This command links all the subprograms contained in the SWM program library to the last line of the program presently in memory.

(3) LOADSUB FROM "SWM"

This command is similar to the LOADSUB ALL FROM "..." command described above except that it links only those subprograms actually called in the main program.

Which form of the LOADSUB command should you use? The choice depends on a number of considerations; for example, the number of subprograms to be linked, the size of the main program, and the size of your computer's user memory. If you have to link only one subprogram, form (1) is the best choice since it links only the specified subprogram. Form (1) of the LOADSUB command can also be used programmatically. This allows you to link a subprogram only when the main program requires it; when the subprogram is no longer necessary, it can be "unlinked" by the DELSUB command, and another subprogram can then be linked. Only one subprogram will be linked to the main program at any given time. This is an important consideration if you have severe memory constraints; for example, the main program is very large or user memory is small. If you have to link many subprograms and you are "memory rich," form (2) of the LOADSUB command can be used. Like form (1), form (2) can be used programmatically, but it is uneconomical because it links all subprograms, including unnecessary ones. Form (3) of LOADSUB offers you a happy medium between forms (1) and (2) since it scans the main program at prerun to find out which subprograms are required, and then links only those subprograms. This from, however, requires BASIC Extensions 2.1, and it cannot be used programmatically. Complete details on the various forms of the LOADSUB command can be found in the computer's reference manuals.

One last word on linking subprograms. If you've written several measurement subprograms that you use often, you should consider storing them in the SWM program library. This will simplify subprogram handling.

3-45. Connection Status

3-46. Often it is necessary to monitor the status of port-to-pin connections during program execution. This is possible by calling the Swm_status subprogram at the appropriate points in the program. When executed, the Swm_status subprogram displays, on the CRT of the computer, a matrix-type table showing the connection status of each port/pin combination. Figure 3-12 shows the table, and Figure 3-13 shows a sample program that illustrates the use of the Swm_status subprogram.

3-47. COM Block

3-48. You can use the SWM COM block in your own programs and subprograms simply by inserting the necessary COM block declaration, as shown below.

```
COM /Syscom/ INTEGER Dcs,Swm,Pin_port(1:48)
```

Figure 3-13 lists a sample program that illustrates the use of the SWM COM block in a user-written subprogram. Each variable declared in the SWM COM block is described below.

Dcs: Integer variable for the HP-IB select code and address of the 4145A. This variable is defined as 717, but it can be changed as described in paragraph 3-32.

Swm: Integer variable for the HP-IB select code and address of the 4084A. This variable is defined as 722, but it can be changed as described in paragraph 3-32.

Pin_port (1:48): Integer variable array that stores the connection status of the measurement pins. Array subscripts correspond to pin numbers. Each array element can take on any valid integer value, but only those listed below have significance.

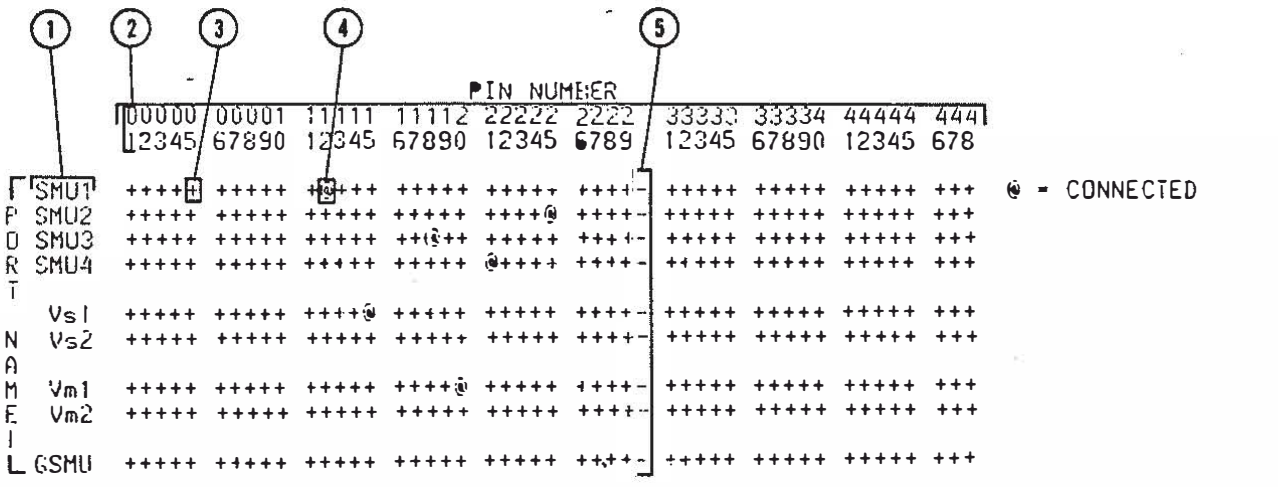
0: The measurement pin is not connected to a measurement port.

1 through 6 and 8 through 10: The measurement pin is connected to the measurement port that corresponds to the stored number. Refer to Table 3-3 for a listing of the port numbers.

-32768: The measurement pin board is not installed.

Note

When used in a user-written subprogram, these variables can be referenced, but they cannot be redefined.



(1) : Port names

(2) : Pin numbers (each pin number is written vertically).

(3) : The "+" symbol indicates that the corresponding port (row) and pin (column) are not connected.

(4) : The "@" symbol indicates that the corresponding port (row) and pin (column) are connected.

(5) : The "-" symbol indicates that the pin board is not installed in the 4085A.

Figure 3-12. Connection Status Display

This sample program allows the user to manually connect or disconnect ports and measurement pins using the softkeys. Connection status is displayed on the CRT of the computer. The print and plot functions of the 4145A are also featured in this program.

```
10    !
20    !  SAMPLE PROGRAM 3
30    !
40    Start
50    !
60    ON KEY 0 LABEL "   CONNECT    " CALL Connect_port
70    ON KEY 1 LABEL "  DISCONNECT  " CALL Disconnect
80    ON KEY 2 LABEL "  Swm_clear   " CALL Clear_swm
90    ON KEY 4 LABEL "PLOT and PRINT" CALL Plot_print
100   !
110   Swm_status
120   LOOP
130     DISP "SELECT with Softkey"
140   END LOOP
150   END
160   !
170   SUB Connect_port
180     INTEGER Pin_number,Port_number
190     INPUT "INPUT PORT Number: ",Port_number
200     INPUT "INPUT PIN Number: ",Pin_number
210     Connect(Port_number,Pin_number)
220     Swm_status
230   SUBEND
240   !
250   SUB Disconnect
260     INTEGER Pin_number
270     INPUT "INPUT PIN Number: ",Pin_number
280     Connect(0,Pin_number)
290     Swm_status
300   SUBEND
310   !
320   SUB Clear_swm
330     Swm_clear
340     Swm_status
350   SUBEND
360   !
370   SUB Plot_print
380     COM /Syscom/ INTEGER Dcs,Swm,Pin_port(1:48)
390     DIM Command$[25]
400     INTEGER Selector,Hp_ib,A_device,Status_byte
410     Hp_ib=Dcs DIV 100
420     INPUT "PLOT [1] or PRINT [2] ?",Selector
430     IF Selector=1 THEN
440       A_device=5
450       Command$="PL 100,100,5000,3000"
460     ELSE
470       A_device=1
480       Command$="PR"
490     END IF
500     !
```

Figure 3-13. Manual Operation of 4085M (Sheet 1 of 2)

```
510     ON INTR Hp_ib,2 GOSUB Service
520     ENABLE INTR Hp_ib;2
530     OUTPUT Dcs;Command$
540     SEND Hp_ib;UNT UNL TALK (Dcs MOD 100) LISTEN A_device DATA
550     !
560     Status_byte=0
570     LOOP
580     EXIT IF BIT(Status_byte,2)=1
590     END LOOP
600     SUBEXIT
610     !
620 Service:   !
630     Status_byte=SPOLL(Dcs)
640     RETURN
650   SUBEND
660     !
```

Line 40: The Start subprogram is executed.

Lines 60 to 90: These program lines define the softkeys. When a softkey is pressed, the specified subprogram is called.

line 110: Displays the connection status of the ports and measurement pins. See Figure 3-12.

Lines 120 to 140: Initiates a loop that continues until a softkey is pressed.

Lines 170 to 230: When KEY 0 (CONNECT) is pressed, this subprogram is called. This subprogram requests the user to input a port number and measurement pin number. It then connects them and redisplays the connection status screen.

Lines 250 to 300: When KEY 1 (DISCONNECT) is pressed, this subprogram is called. This subprogram requests the user to input a pin number. It then disconnects the specified pin from the port and redisplays the connection status screen.

Lines 320 to 350: When KEY 3 (Swm_clear) is pressed, this subprogram is called. This subprogram disconnects all measurement ports from the measurement pins, and redisplays the connection status screen.

Lines 370 to 650: When KEY 4 (PLOT and PRINT) is pressed, this subprogram is called. This subprogram enables the PLOT and PRINT capabilities of the 4145A. Refer to Section III of the 4145A Operation Manual for details.

Line 380: Enables the subprogram to use the COM block variables. Refer to paragraph 3-46.

Line 410: Calculates the HP-IB select code. This is necessary for interrupt handling at lines 510 and 540.

Lines 420 to 490: Selects the 4145A's PLOT or PRINT function, and determines the proper HP-IB address of the peripheral device.

Line 510: Sets a higher priority for HP-IB interrupts than for softkey interrupts.

Line 660 to end: Link the required subprograms from this line. Swm_status, Connect and Swm_clear subprograms are required in this sample program.

Figure 3-13. Manual Operation of 4085M (Sheet 2 of 2)

3-49. PROGRAMMING REFERENCE

3-50. This pargraph contains an alphabetical listing of the subprograms contained in the 4085M's software that can be called by user-written programs. Each entry defines the subprogram name, shows the syntax of the calling context, gives several examples, and explains relevant semantic detailes, as shown below.

(1)

Connect

This subprogram connects the specified port to the specified measurement pin.

(2)

(3)

Item	Description	Range Restrictions
port address	integer expression	0, port address functions
pin number	integer expression	1 through 48

(1) : Subprogram name

(2) : Syntax diagram

(3) : Explanation of parameters

Syntax Diagrams Explained

Subprogram calling context is represented pictorially. All characters enclosed by a rounded envelope must be entered exactly as shown. Words enclosed by a rectangular box are names of items used in the calling context. A description of each item is given either in the table following the drawing or in another drawing. Calling context elements are connected by lines. Each line can be followed in only one direction, as indicated by the arrow at the end of the line. Except for the three cases described later, any calling context that can be generated by following the lines in the proper direction is syntactically correct.

The omission of CALL when invoking a subprogram is left to the discretion of the programmer. However, the following three instances require the CALL statement when invoking a subprogram.

1) If the subprogram is called from the keyboard

2) If the subprogram is called after the THEN keyword in an IF statement

3) In an ON [event] CALL statement

Connect

This subprogram connects the specified port to the specified of measurement pins.

Item	Description	Range Restrictions
port address	integer expression	0, port address functions
pin number	integer expression	1 through 48

Example Statements

```
Connect (FNSmu (1), 12)
Connect (0, 8)
```

Semantics

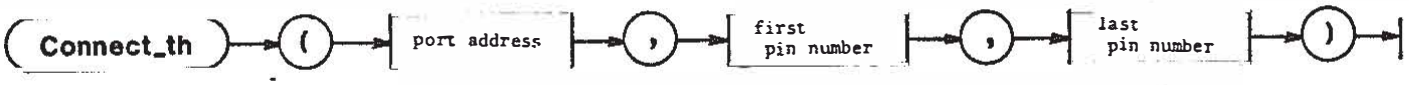
No more than one port can be connected to a single measurement pin. Thus, if the same pin number apears in two or more Connect statements that specify different ports, only the port specified in the most recent connect statement will be connected to the measurement pin. A single port can be connected to multiple measurement pins with additional Connect stetements. If the port address is 0, the measurement pin specified in the statement is disconnected. When this subprogram is executed, the 4145A will be set to one of the states listed in Table 3-5.

Table 3-5. 4145A Status After Connect Statement Execution

4145A Control Mode	Status After Connect Subprogram
LOCAL	MEASUREMENT: STOP AUTO SEQ: STOP
REMOTE and System Mode	HP-IB STATUS: LOCAL
REMOTE and User Mode	SMU 1 to 4: Voltage source, 20V range, 0V Output, 10μA Compliance. Vs 1 and 2: 0V Output HP-IB STATUS: LOCAL

Connect_th

This subprogram connects the specified port to a range of measurement pins.



Item	Description	Range Restrictions
port address	integer expression	0, port address functions
first pin number	integer expression	1 through 48, must be lower than the last pin number
last pin number	integer expression	1 through 48, must be higher than the first pin number

Example Statements

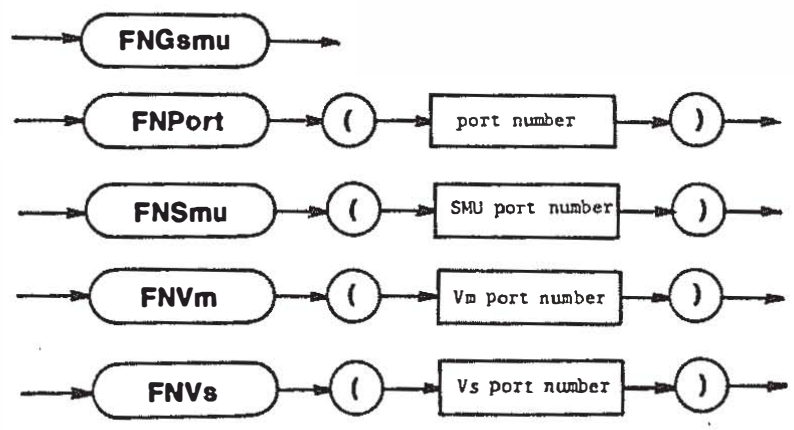
```
Connect_th(FNSmu (2), 4, 8)
Connect_th(FNSmu (3), From_pin, to_pin)
```

Semantics

The Connect_th subprogram is functionally idential to the Connect subprogram. Refer to the Semantics of the Connect subprogram for further details.

FNGsmu
FNport
FNSmu
FNVm
FNVs

These functions return the port address of the specified port.



Item	Description	Range Restriction
port number	integer expression	0, 1 through 6, 8, 9, 10, -1
SMU port number	integer expression	1 through 4
Vm port number	integer expression	1, 2
Vs port number	integer expression	1, 2

Example Statements

```
Port_number = FNSmu (2)
Connect (FNVm (1), 12)
```

Semantics

These functions are used as parameters in the Connect and connect_th subprograms. Table 3-4 explains the relationship between each function and each port.

Start

This subprogram establishes the COM block necessary for the other subprograms and initializes the system.

Semantics

This subprogram must be executed each time the sytem is turned on and each time SCRATCH A or SCRATCH C is executed. Start sets the HP-IB addresses of the 4145A and 4084A, determines the available pin boards, and then assigns this information to the appropriate COM block variable. This subprogram also disconnects all port-to-pin connections. The HP-IB address settings in this subprogram can be changed by the user. Refer to paragraph 3-32. Also, the COM block variables can be used in user-written subprograms. Refer to paragraph 3-46.

Swm_clear

This subprogram disconnects all measurement-ports from the measurement pins.

Semantics

When this subprogram is executed, the 4145A is set to one of the states listed in Table 3-5.

Swm_status

This subprogram displays the connection status of the measurement ports and measurement pins on the CRT of the computer.

Semantics

Connection status is displayed as shown in the figure below. The meaning of each symbol on the connection status display is explained in Figure 3-12. When this subprogram is executed, the CRT is selected as the system printer.

```
                                PIN NUMBER
          ┌00000 00001 11111 11112 22222 22223 33333 33334 44444 4441
           12345 67890 12345 67890 12345 67890 12345 67890 12345 678

 ┌ SMU1   +++++ +++++ +@+++ +++++ +++++ +++++ +++++ +++++ +++++ +++   @ = CONNECTED
 P SMU2   +++++ +++++ ++++@ +++++ +++++ +++++ +++++ +++++ +++++ +++
 O SMU3   +++++ +++++ +++++ ++@++ +++++ +++++ +++++ +++++ +++++ +++
 R SMU4   +++++ +++++ +++++ +++++ +++++ +++++ +++++ +++++ +++++ +++
 T
    Vs1   +++++ +++++ +++@+ +++++ +++++ +++++ +++++ +++++ +++++ +++
 N  Vs2   +++++ +++++ +++++ +++++ +++++ +++++ +++++ +++++ +++++ +++
 A
 M  Vm1   +++++ +++++ +++++ +++++ +++++ +++++ +++++ +++++ +++++ +++
 E  Vm2   +++++ +++++ +++++ +++++ +++++ +++++ +++++ +++++ +++++ +++
 └ GSMU   +++++ +++++ +++++ +++++ +++++ +++++ +++++ +++++ +++++ +++
```

3-51. ERROR MESSAGES

3-52. The following is a listing of all SWM-related error messages. A brief explanation of each error message is given, along with instructions on how to recover from the error. For the meanings of BASIC-related errors, refer to the computer manual.

4085M ERROR 1 Improper port assigned.

The port number specified in the calling context of the Connect subprogram is out of range. Check the port number parameter of each calling context of the Connect subprogram.

4085M ERROR 2 Improper pin assigned.

The pin number specified in the calling context of the Connect statement is out of range. Check the pin number parameter of each calling context of the Connect subprogram.

4085M ERROR 3 This pin board not present.

The measurement pin specified in the calling context of the Connect subprogram cannot be used. Check whether the specified pin board is installed or not. If the pin board is installed, it is probably faulty. Refer to Section IV.

4085M ERROR 4 Improper port assigned.

The port number specified in the calling context of the connect_th subprogram is out of range. Check the port number parameter of each calling context of the Connect_th subprogram.

4085M ERROR 5 Improper pin assigned.

The pin number specified in the calling context of the Connect_th subprogram is out of range. Check the pin number parameter of each calling context of the Connect_th subprogram.

SECTION IV
DIAGNOSTICS and MAINTENANCE

4-1. INTRODUCTION

4-2. This section provides complete information on the failure diagnostics program included in the 4085M software. Included are instructions on how and when to run the program, descriptions of the tests performed by the program, and discussions on what to do if the program detects a system failure. Also covered in this section is general maintenance information for the operator, specifically instructions on how to remove pin boards and on how to clean contact surfaces and measurement pins.

4-3. DIAGNOSTICS PROGRAM

4-4. The diagnostics program is stored on the furnished software disc (file name DIAG). DIAG is fully interactive and can be executed by the operator at any time to verify correct operation of the 4085M, to isolate the cause of any failures that may occur, or to exercise and clean the relays on the pin boards.

4-5. To ensure the integrity of measurement results, you should include DIAG in the 4085M's daily start-up routine. DIAG should also be executed after repairs and following the installation of additional pin boards.

4-6. PREPARATIONS FOR DIAGNOSTICS

4-7. There are several hardware and software requirements that you must satisfy before you can run the diagnostics program. First, make sure that at least five pin boards are installed in the 4085A and that the 4084A, 4085A, 4145A, and computer are interconnected as shown in Figure 2-5. Pay special attention to the interconnections of the 4085A's measurement ports and the 4145A's SMUs. SMU 1 must be connected to PORT 1, SMU 2 to PORT 2, and so on. Having satisfied these hardware-related requirements, you must load the BASIC 2.0 Language System into the computer, and then load and run the Start subprogram as described in paragraph 3-36.

4-8. Required equipment consists of the 16075A Relay Test Adapter for the Relay Test, and the 16066A Test Fixture Adapter for the DC Leakage Test. The 16075A and 16066A are furnished accessories.

4-9. HOW TO RUN DIAGNOSTICS

4-10. To run DIAG, perform as follows.

(1) Load and run the Start subprogram. Refer to paragraph 3-36 for instructions.

(2) Load and run DIAG.

LOAD "DIAG" [EXECUTE] [RUN]

(3) Follow the instructions displayed on the CRT of the computer. Refer to Figure 4-1.

The function of each labeled softkey appearing on the Diagnostics Menu is described below.

[K5] (RELAY): Starts the Relay Test. Refer to paragraph 4-11.

[K6] (DC LEAK): Starts the DC Leakage Test. Refer to paragraph 4-13.

[K7] (INSTRUCTION): Displays a detailed explanation of the DIAG program.

[K8] (EXIT): Exits the program.

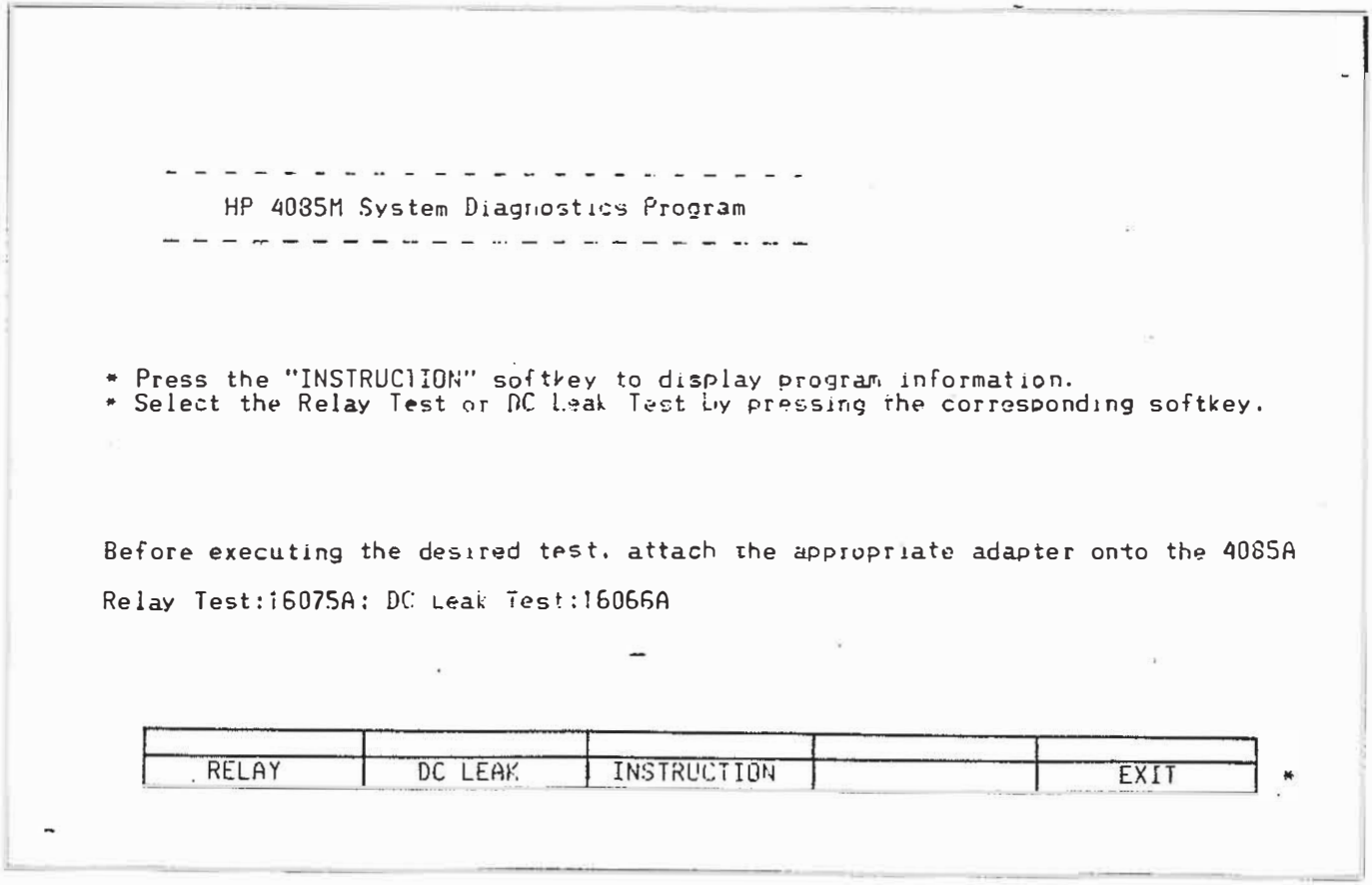


Figure 4-1. Diagnostics Menu

4-11. RELAY TEST

4-12. The Relay Test checks all relays on all the pin boards installed in the 4085A for normal MAKE/BREAK operation. The check is performed by applying a dc voltage to the 16075A Relay Test Adapter and measuring the voltage obtained when a specified relay is set to MAKE. If a faulty relay is detected, the pin board number and relay number will be displayed and the test will stop. The test procedure is given below.

(1) Be sure the contacts of the 16075A are clean. Then mount the 16075A securely atop the 4085A as shown in Figure 4-2. If the 16075A is loose, or if the contacts are dirty, poor contact with the measurement pins will result. The system may fail the test.

(2) Press softkey [K5] (RELAY). The Relay Test will begin immediately. the computer's screen will be as shown in Figure 4-3. If no errors are detected, all relays are operating correctly. The test takes about 1.5 minutes.

(3) If a faulty relay is detected, an error message, along with the pin board number, relay number, and a brief description of the fault, will appear on the computer's screen, as shown in Figure 4-4. the Relay Test will stop when a faulty relay is detected.

Note

Once the Relay Test detects a faulty relay, it stops and cannot be continued. Additional faulty relays may exist, however. After repairing the indicated faulty relay (as described in paragraphs 4-19 and 4-21), be sure to rerun the Relay Test to check for additional faulty relays.

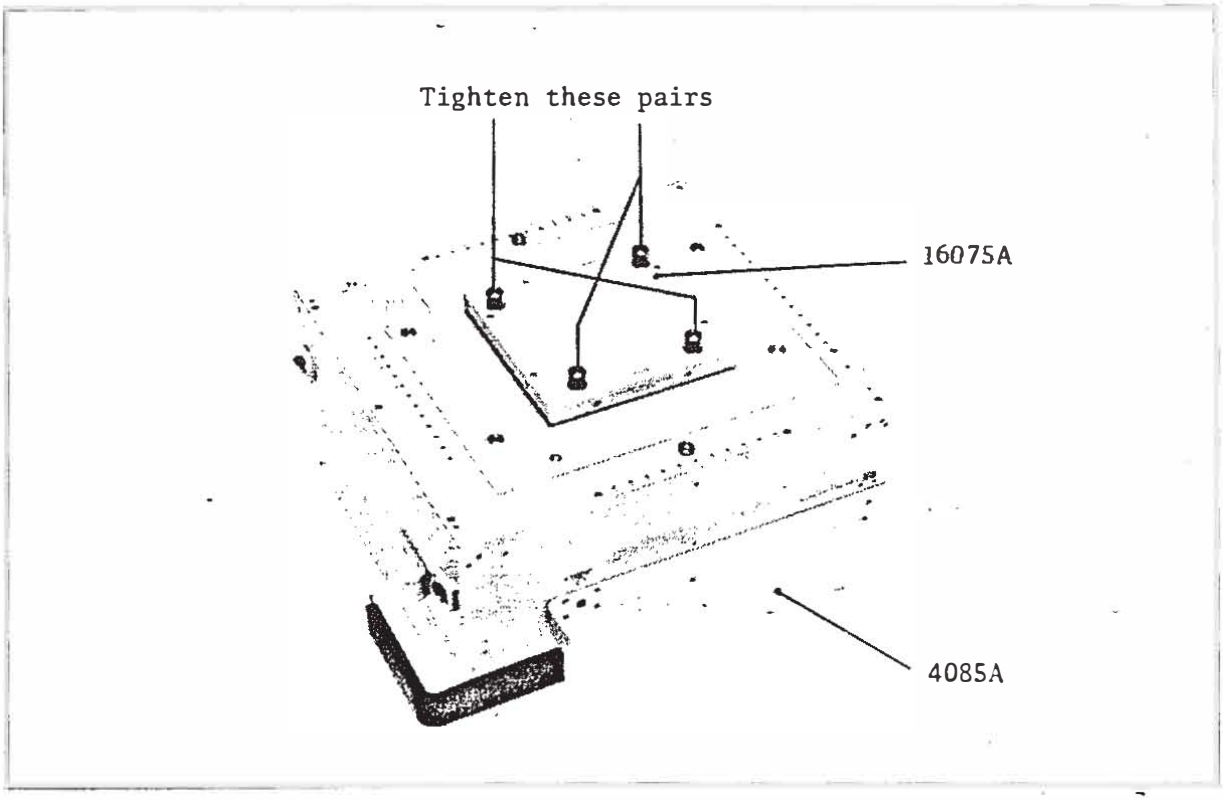


Figure 4-2. Relay Test Adapter Mounting

Note

The relay Test checks the relays of all pin boards installed in the 4085A. At least five pin boards, arranged in any configuration, must be installed in the 4085A.

(4) The test result, OK or ERROR, will appear in the test result table displayed on the CRT of the computer.

(5) To execute the Relay Test again, press softkey [K5] (RETRY). To exit the Relay Test and return to the diagnostics menu, press softkey [K9] (EXIT).

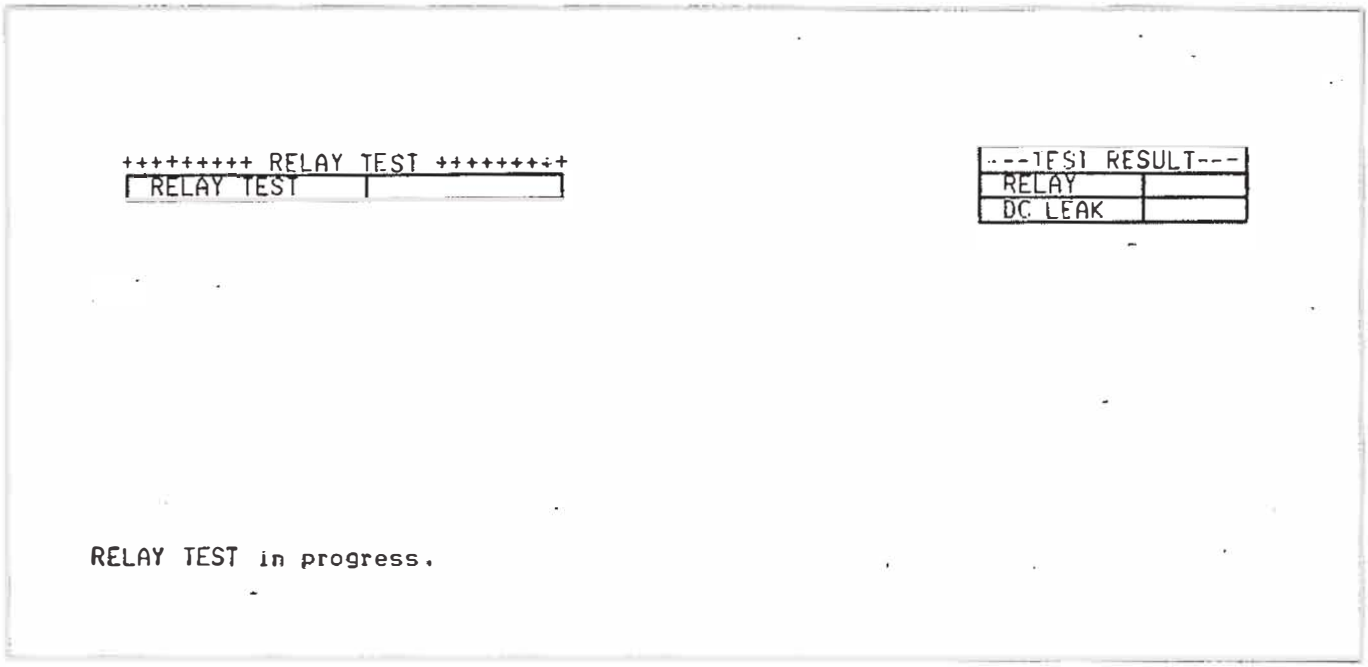


Figure 4-3. Relay Test Display

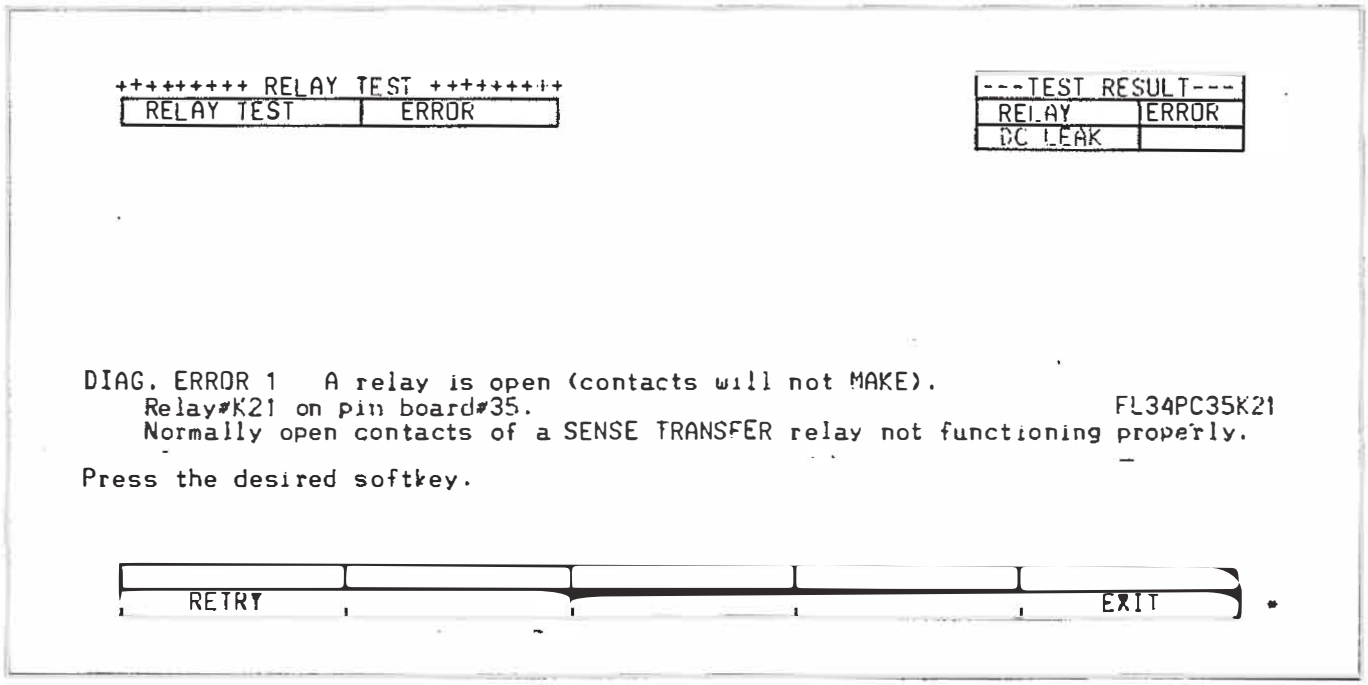


Figure 4-4. Relay Test Failure

4-13. DC LEAKAGE TEST

4-14. The DC Leakage Test checks for excessive leakage current in the 4085A. Two tests—OPEN TEST and SHORT TEST—are performed.

(1) OPEN TEST:

Sets all relays on all pin boards to BREAK and measures leakage current.

(2) SHORT TEST:

Checks the level of current measured by an SMU connected to all the measurement pins.

The test procedure is given below.

Note

Execute the Relay Test and the 4145A's self test before the DC Leakage Test.

Note

Before executing the DC Leakage Test, make sure that the SMU terminals of the 4145A are connected to the corresponding SMU ports of the 4085A, and make sure the shorting connecter is connected to the To 16058A TEST FIXTURE connecter of the 4145A.

(1) Mount the 16066A Test Fixture Adapter atop the 4085A. Do not install a test fixture in the 16066A. Close the lid.

(2) Press softkey [K6] (DC LEAK). The Leakage Test will begin immediately. If no errors are indicated, the 4085A is functioning properly. The test takes about 30 seconds.

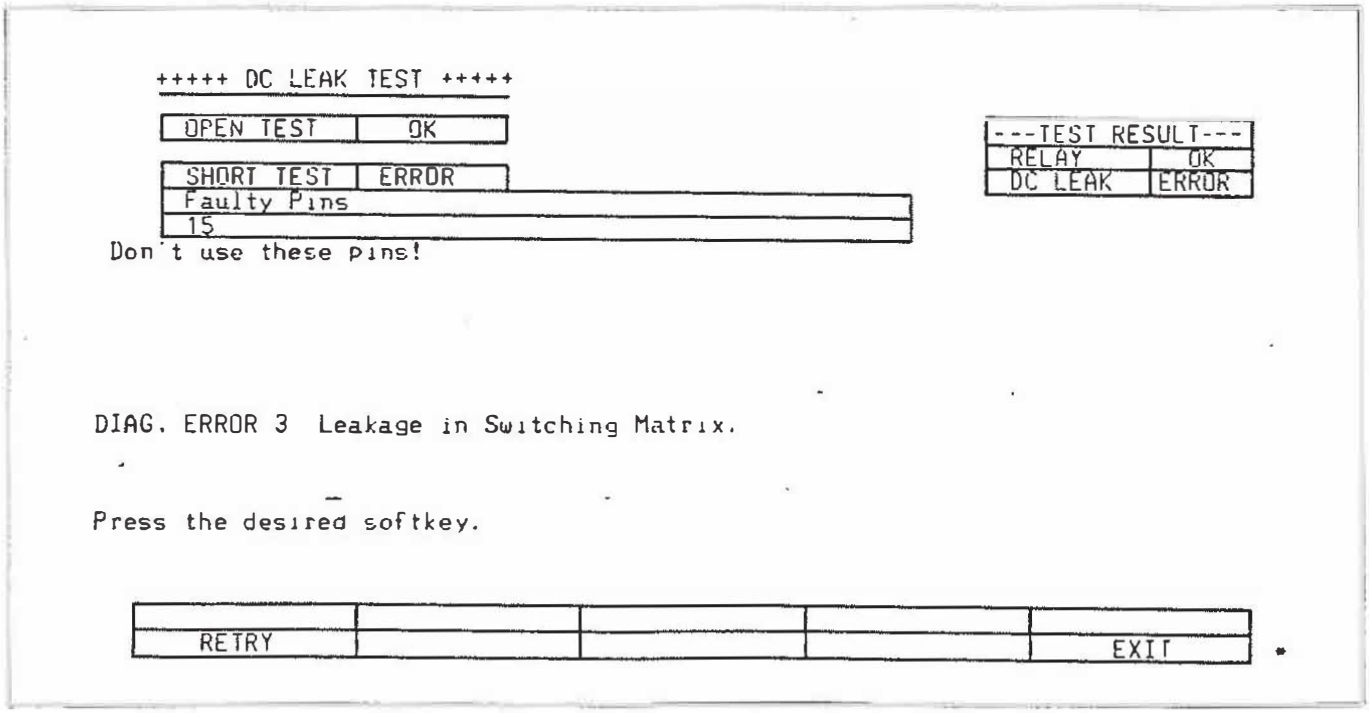


Figure 4-5. DC Leak Test Display

(3) If the 4085A fails the Leakage Test, an error message, along with the number of the defective port or measurement pin, will appear on the computer's screen as shown in Figure 4-5. Refer to paragraph 4-17 for error handling instructions.

(4) To execute the Leakage Test again, press softkey [K5] (RETRY). To exit the Leakage Test, press softkey [K0] (EXIT). The diagnostics menu will be redisplayed.

4-15. INTERPRETING TEST RESULTS

4-16. If no errors are reported by the diagnostics program, the 4085M is functioning properly. If an error occurs, if the program stops, or if the system exhibits any anomalies during the program, check for the following possible causes. Then run DIAG again.

—Is the 16075A, or 16066A firmly mounted atop the 4085A?

—Are the contacts on the 16075A clean?

—Is the 4145A fully warmed up? Recommended warm-up time is 40 minutes.

—Are all instruments turned on?

—Are all instruments interconnected properly? Refer to Section II for correct connections.

—Has the start program been executed?.

If the same error occurs when DIAG is run a second time, contact the nearest Hewlett-Packard service office. Describe the failure symptoms and include any error messages or codes displayed on the computer's screen. Refer to paragraph 4-17 for the meanings of diagnostics error messages.

Note

Certain failures can be remedied by replacing a faulty pin board. Refer to paragraphs 4-21.

4-17. ERROR MESSAGES

4-18. If a failure is detected, or if an illegal operation is attempted during the DIAG program, an error message will appear on the computer's screen. An example is shown below.

```
DIAG. ERROR 1  No Relay Test Adapter.
```

In this error message, DIAG indicates that the error was detected by the DIAG program, ERROR 1 is the error code, and the message briefly explains the cause of the error. A listing of diagnostics error messages is given in Table 4-1. For other error messages, refer to paragraph 3-51 or to the computer's manual.

Table 4-1. DIAGNOSTICS Error Messages

DIAG.ERROR 1

A relay failure has been detected in the switching matrix. The location of the failure will be displayed in the error message. Make sure that the 16075A Relay Test Adapter is securely fastened to the 4085A, then press softkey [K5] (RETRY). If the same error at the same location is displayed, contact the nearest HP Service Office. If emergency repair is necessary, replace the defective pin board. See paragraph 4-19 for details on pin board replacement. If DIAG.ERROR 1 followed by the message—A relay is stuck....—is displayed, it may be possible to repair the relay itself. Refer to paragraph 4-21 for details. To ensure that multiple pin board failures have not occurred, when a failure has been detected, remove the defective pin board and rerun the relay test.

DIAG.ERROR 2

Excessive leakage current has been detected in the 4085A, or in the cabling to the 4085A. Contact the nearest HP Service Office.

DIAG.ERROR 3

Excessive leakage current has been detected on a pin board. If a test fixture is mounted in the 16066A, remove the fixture and press softkey [K5] (RETRY). If the same error message is displayed, contact the nearest HP Service Office.

4-19. PIN BOARD REPLACEMENT

4-20. If an error message indicating a faulty pin board or relay is displayed as shown below, the system can be repaired by replacing the pin board.

```
DIAG. ERROR 1  A relay is open (contacts will not MAKE).
```

There are two ways to replace a faulty pin board.

(1) Replacement with a spare pin board or a new 16320A pin board.

(2) Replacement with a pin board from another slot. Install a pin board from another slot, one not frequently used, into the faulty pin board's slot.

Contact the nearest Hewlett-Packard sales office to order new pin boards and to have faulty pin boards repaired. The procedure for removing and installing pin boards is as follows:

1. Turn all the instruments off.

2. Using the funished screwdriver, remove the bottom panel from the 4085A. Then remove the necessary board struts and control bus cables. Refer to Figure 4-6.

CAUTION

WHEN REMOVING A CONTROL BUS CABLE, DISCONNECT EACH CONNECTOR SEPARATELY. DO NOT REMOVE THE CABLE BY DISCONNECTING ONE END AND THEN "PEELING OFF" THE CABLE ALL AT ONCE.

3. Remove the pin boards that are to be repositioned. Use the pin board extractor. Refer to Figure 4-7. The pin board locations are shown in Figure 4-8.

CAUTION

DO NOT TOUCH THE EDGE CONNECTOR, SOLDERED SURFACES, OR PINS OF THE PIN BOARD WITH BARE HANDS. WHEN HANDLING A PIN BOARD, HOLD IT ALONG ITS EDGES AS SHOWN IN FIGURE 4-9. IF ANY PART OF THE BOARD BECOMES CONTAMINATED, IT MUST BE THOROUGHLY CLEANED. REFER TO PARAGRAPH 4-23 FOR CLEANING INSTRUCTIONS.

4. Insert the pin boards into the desired slots and connect the board's cable assembly to the corresponding position on the measurement pin mounting ring.

5. Reconnect the control cables, reinstall the board struts, and replace the bottom panel.

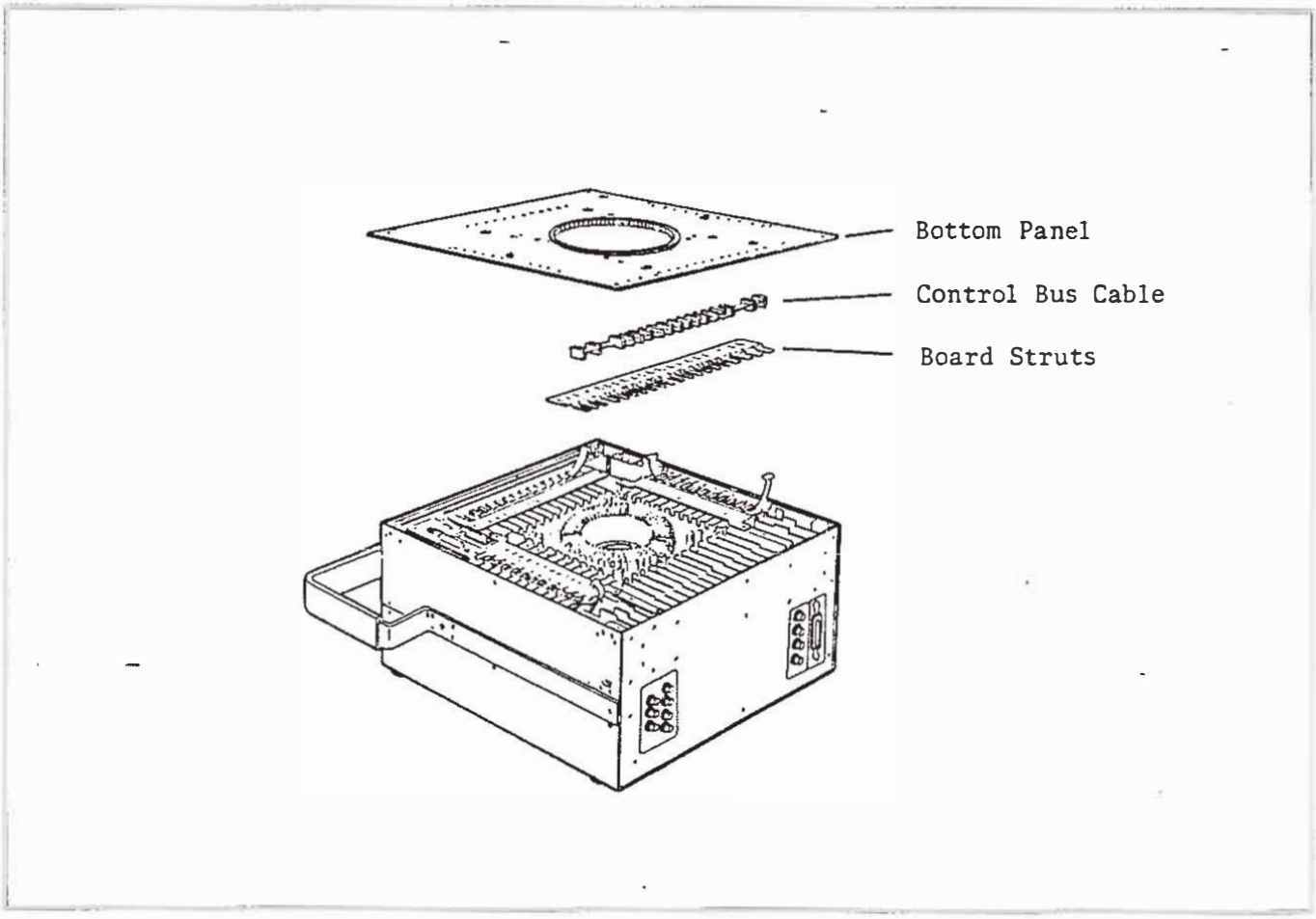


Figure 4-6. Pin Board Access

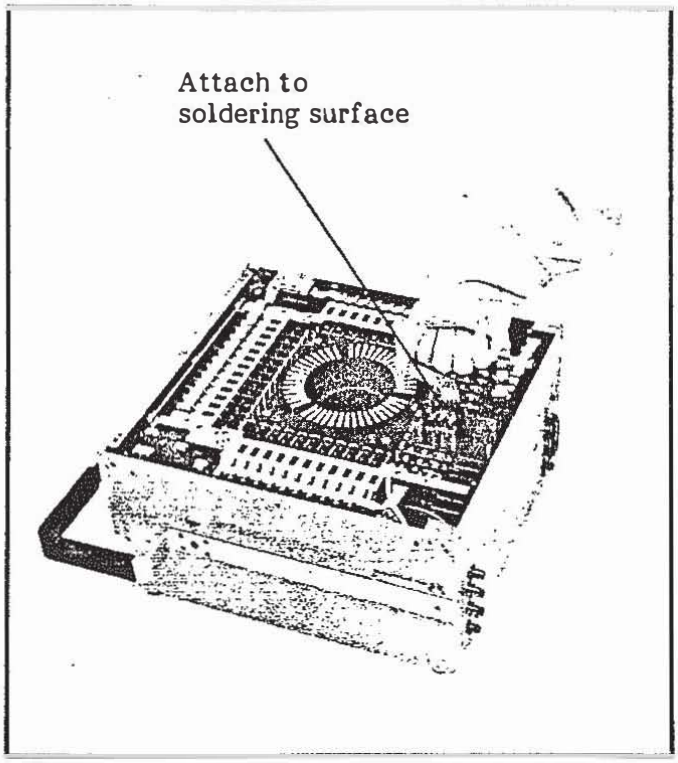


Figure 4-7. Pin Board Removal

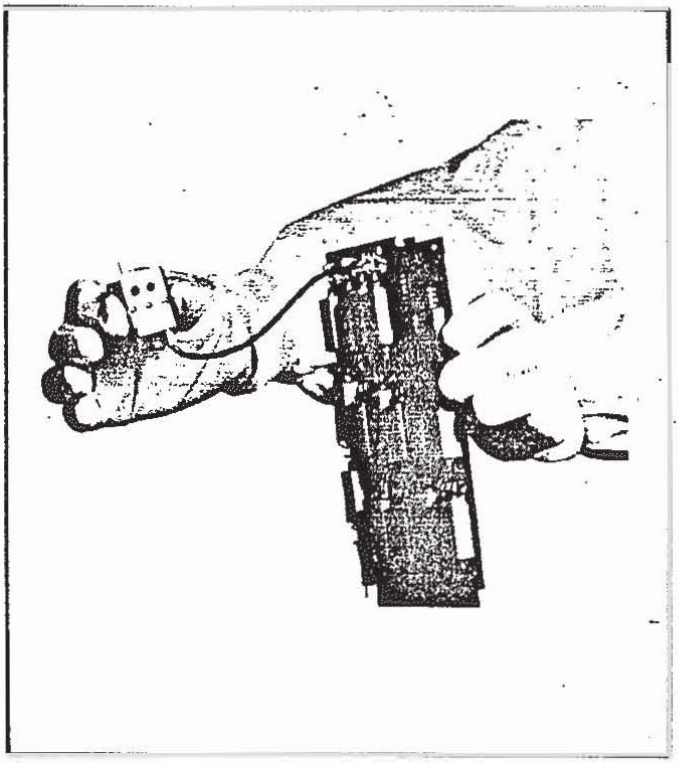


Figure. 4-9. Pin Board Handling

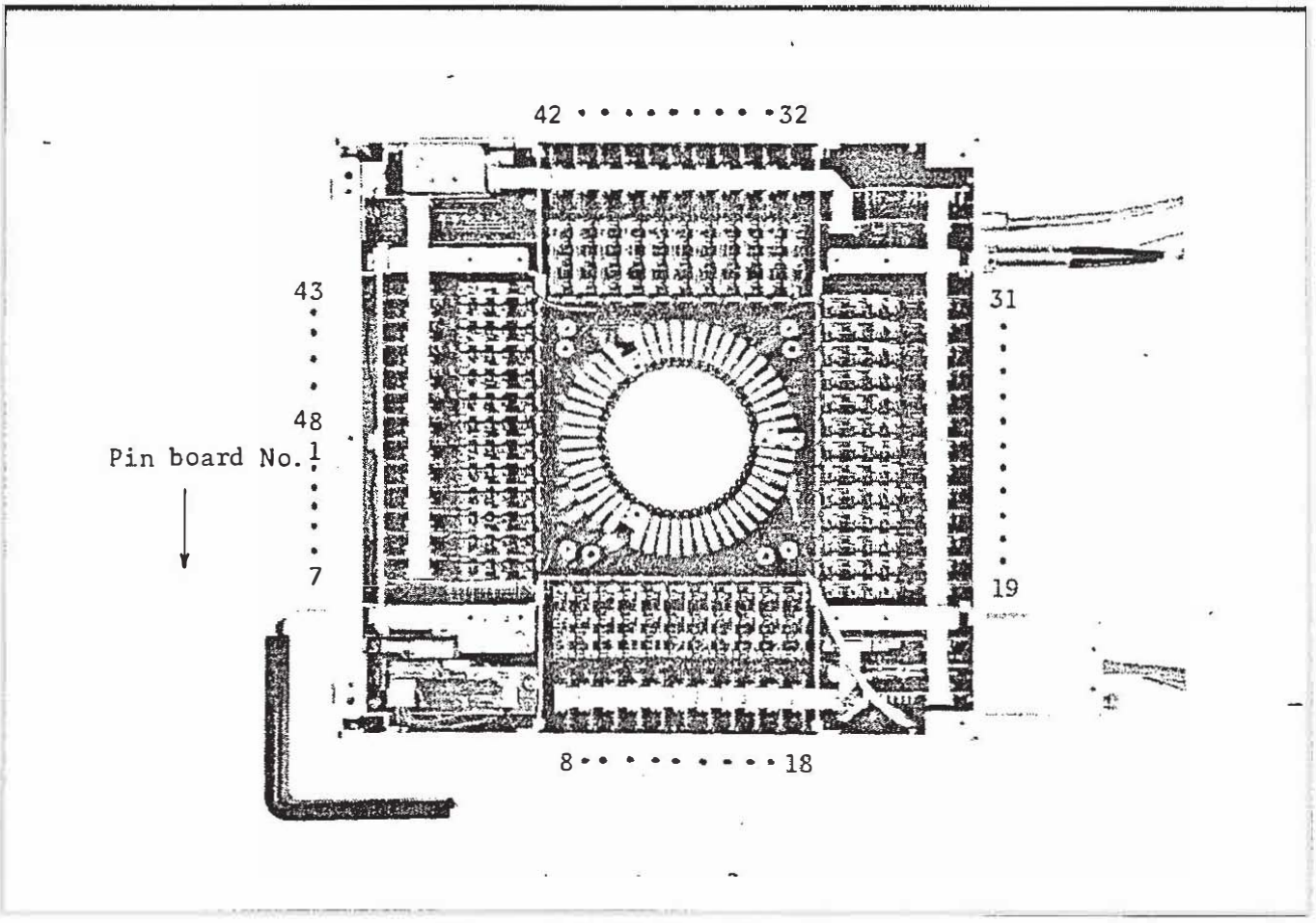


Figure. 4-8. Pin Board Locations

4-21. STUCK RELAY RECOVERY

4-22. If the error message shown below appears on the computer's screen during the Relay Test, the indicated relay on the indicated pin board is stuck. That is, its contacts remain in the MAKE position even though a BREAK command was sent.

```
DIAG. ERROR !  A relay is stuck (contacts will not BREAK).
```

If a relay is stuck, perform the following procedure:

(1) Note the pin board number and relay number given in the error message.

(2) Remove the pin board. Refer to paragraph 4-19. Figure 4-8 shows the pin board locations.

CAUTION

Do not touch the pin board with bare hands.

(3) Lightly tap the stuck relay with your finger two or three times. See Figure 4-10 for relay locations on the pin board.

(4) Mark the stuck relay with a ball-point pen to indicate its failure history. If the stuck relay fails more than twice, the pin board should be replaced. Refer to paragraph 4-19 for instructions on pin board replacement.

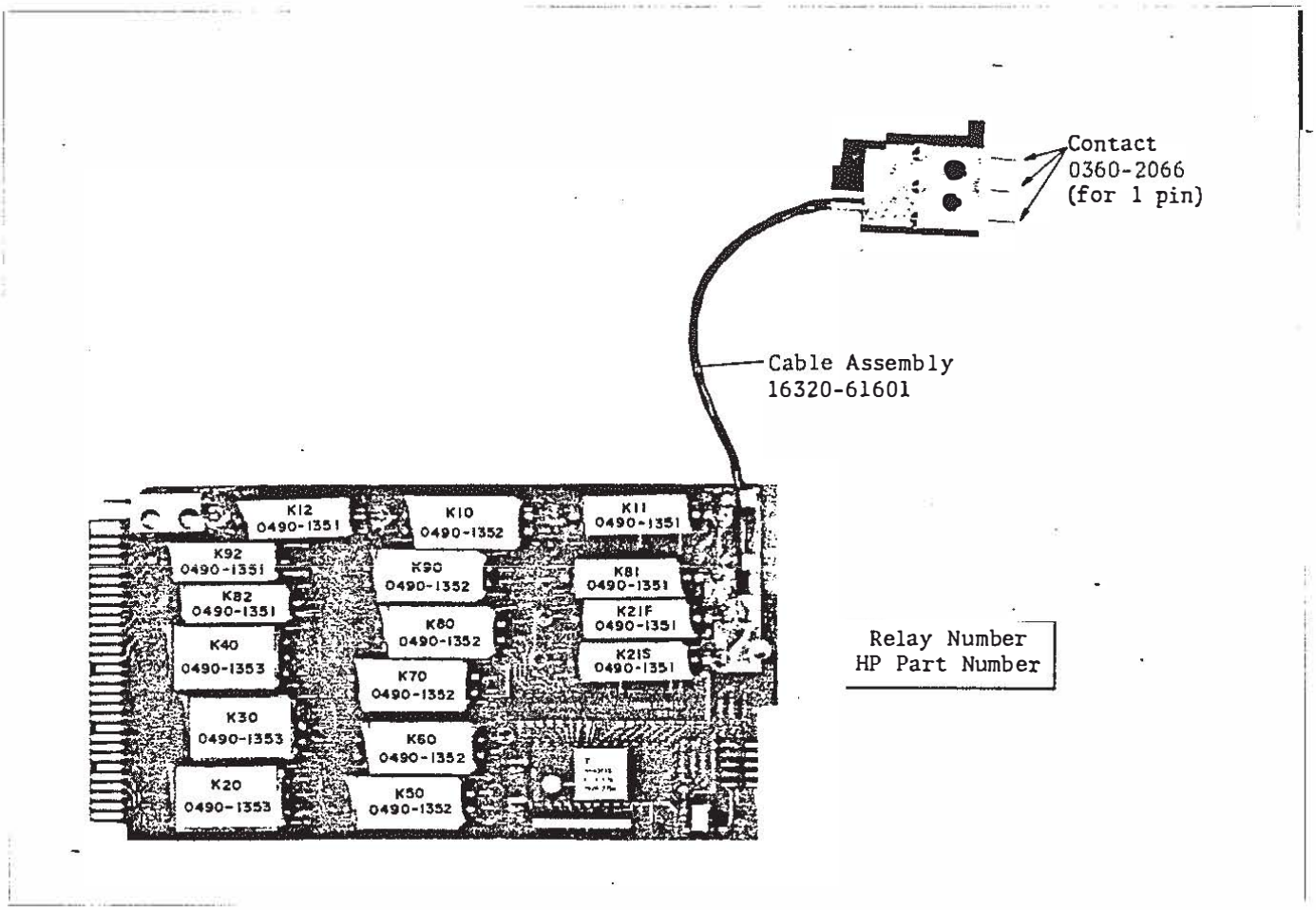


Figure 4-10. Relay Locations

4-23. CLEANING

4-24. To maintain the system's low current measurement capability, the pin boards, measurement pins, test fixtures, and exposed signal lines must be kept extremely clean. If the system is operating in a clean room, where air purity is high and where personnel take the necessary precautions against contamination, only periodic cleaning is required. In any other environment, however, cleaning must be done as often as possible. When cleaning is necessary, apply generous amounts of alcohol and lightly scrub the area with a soft brush. Rinse the area with clean alcohol, and allow whatever alcohol that remains on the area to evaporate. Do not dry the area with a cloth. When cleaning the measurement pins of a pin board, be sure to first remove the board from the 4085A as described in paragraph 4-19. Do not allow alcohol to splash into the 4085A.

MANUAL CHANGES

4085M

SWITCHING MATRIX

MANUAL IDENTIFICATION

Model Number: 4085M
Date Printed: MAR. 1985
Part Number: 04085-90000

This supplement contains important information for correcting manual errors and for adapting the manual to instruments containing improvements made after the printing of the manual.

To use this supplement:
Make all ERRATA corrections.
Make all appropriate serial number related changes indicated in the tables below.

SERIAL PREFIX OR NUMBER	MAKE MANUAL CHANGES
2429**00127 and above	1
ALL	2

SERIAL PREFIX OR NUMBER	MAKE MANUAL CHANGES

► NEW ITEM

CHANGE 1

Page 2-9, Figure 2-8:
Change the kit part numbers as follows:

Option 907 : 5061-9689
Option 908 : 5061-9677
Option 909 : 5061-9683

NOTE

Manual change supplements are revised as often as necessary to keep manuals as current and accurate as possible. Hewlett-Packard recommends that you periodically request the latest edition of this supplement. Free copies are available from all HP offices. When requesting copies quote the manual identification information from your supplement, or the model number and print date from the title page of the manual.

HEWLETT PACKARD

CHANGE 2

Page 1-2, Figure 1-2:
Change "9836/16" to "computer"

Page 1-9, paragraph 1-22:
Add option 030 and change option 016 and 036 as follows:

Option 016: Software supplied on a 3.5-inch flexible disc (for HP9000 Series 200 Model 216)
Option 030: Software supplied on a 3.5-inch flexible disc (for HP9000 Series 300 Model 310)
Option 036: Software supplied on a 5.25-inch flexible disc for HP9000 Series 200 Model 236)

Page 1-9, paragraph 1-22:
Change note 2 to read:

2: option 016, 030 and 036 must be ordered.

Page 3-12, paragraph 3-28, line 15:
Change "If you're using the 9816 computer, ..." to read:

If you're using the HP9000 Series 200 Model 216 or Series 300 Model 310 computer, ...

All pages:
Change the expressions on the left to read as shown on the right:

HP Model 9816 or 9836	HP9000 Series 200 or 300
9816 or 9836	HP9000 Series 200 or 300
BASIC 3.0	BASIC 3.0 or BASIC 4.0
EXECUTE	EXECUTE or Return
RUN	RUN or softkey (RUN)
Softkey Kx (XXXXXX)	Softkey (XXXXXX)