

HP 16087A Module Selector
Operation Manual



**HEWLETT
PACKARD**

HP Part No. 16087-90000
Printed in Japan June 1992

Edition 3
E0692

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About This Manual

This manual describes:

- Functions of the HP 16087A
- How to install the HP 16087A
- How to connect the test device to the HP 16087A
- How to clean the HP 16087A
- Specifications and reference data of the HP 16087A
- How to perform the safety tests of the HP 16087A
- How to service the HP 16087A

For information on controlling the HP 16087A, see the manual for the source/monitor that controls your HP 16087A.

Contents

1. Introduction	
HP 16087A	1-1
Furnished Accessories	1-4
2. Setup	
Installing the HP 16087A	2-1
Connecting the HP 16087A	2-4
Removing the Top Cover	2-5
Connecting the HP 16087A to the Test Device	2-6
Installing the Top Cover	2-8
3. Cleaning	
4. Specifications and Supplemental Performance Characteristics	
HP 16087A Specifications	4-1
Channels	4-1
Specification Conditions	4-1
Maximum Voltage and Current	4-1
Operating Environment	4-1
Physical Characteristics	4-1
Supplemental Performance Characteristics (Reference Data)	4-2
SMU Channel	4-2
HCU Channel	4-2
HVV Channel	4-2
Operating Environment	4-2
5. Performing Floating Measurements	
6. Performing the Safety Tests	
Performing the Safety Tests with an HP 4142B	6-1
Performing the INTLK Circuit Test	6-1
Performing the OUTPUT ON/OFF STATUS Circuit Test	6-1
Performing the Safety Tests without an HP 4142B	6-2
Performing the INTLK Circuit Test	6-2
Performing the OUTPUT ON/OFF STATUS Circuit Test	6-2
7. Performing the Relay Switching Tests	
Performing the Relay Switching Tests by using a Power Supply	7-2
Performing the Relay Switching Tests by using an HP 4142B	7-6
8. Servicing the Module Selector	
Replaceable Parts	8-2

Figures

1-1. HP 16087A and Accessories	1-1
1-2. HP 16087A Operation Diagram	1-2
1-3. HP 16087A Circuit Diagram	1-3
1-4. HP 16087A Output Terminals	1-4
2-1. HP 16087A Screw Holes for Installation	2-2
2-2. Connector Assignment and Connector Plate Dimensions	2-3
2-3. HP 16087A Connection Overview	2-4
2-4. Connections between the HP 16087A and Test Device	2-7
2-5. HP 16087A Internal Connections	2-8
5-1. Wire that connects Chassis Ground to CIRCUIT COMMON	5-1
7-1. Circuit for Relay Testing by using a Power Supply	7-2
7-2. Locations of Connectors and Relay Contact Terminals	7-4
7-3. Component Locations on Relay Board Assembly	7-5
7-4. Configuration for Relay Testing by using the HP 4142B	7-6
7-5. Circuit on the Relay Board of the IIP 16087A	7-8
8-1. View of Cable Connections in the Module Selector	8-2
8-2. How to Install Triaxial and BNC Connectors	8-4
8-3. Exploded View of the Warning Indicator	8-5

Tables

2-1. Parts List for Connections between the IIP 16087A and Test Device	2-8
7-1. Relay Testing with the Power Supply Turned OFF	7-3
7-2. Relay Testing with the Power Supply Turned ON	7-3
7-3. Part Numbers for Replaceable Relays	7-5
7-4. Relay Testing by using ERC Commands	7-7
8-1. Parts List of Cable Connections in the Module Selector	8-3
8-2. Parts List for Triaxial and BNC Connectors	8-4
8-3. Parts List of Warning Indicator	8-5

Introduction

HP 16087A

The HP 16087A Module Selector selects one output from among the modules of the HP 4142B Modular DC Source/Monitor. The selectable modules are as follows:

- HP 41420A Source/Monitor Unit (High Power SMU, 200 V / 1 A maximum) or HP 41421B Source/Monitor Unit (Medium Power SMU, 100 V / 100 mA maximum)
- HP 41422A High Current Source/Monitor Unit (HCU, 10 V / 10 A maximum)
- HP 41423A High Voltage Source/Monitor Unit (HVV, 1000 V / 10 mA maximum)

You can also select the “no selection” condition. The HP 16087A is controlled by sending HP-IB commands from a controller to the HP 4142B. You can automate wide-range measurements from low voltage/current to high voltage/current for power devices.

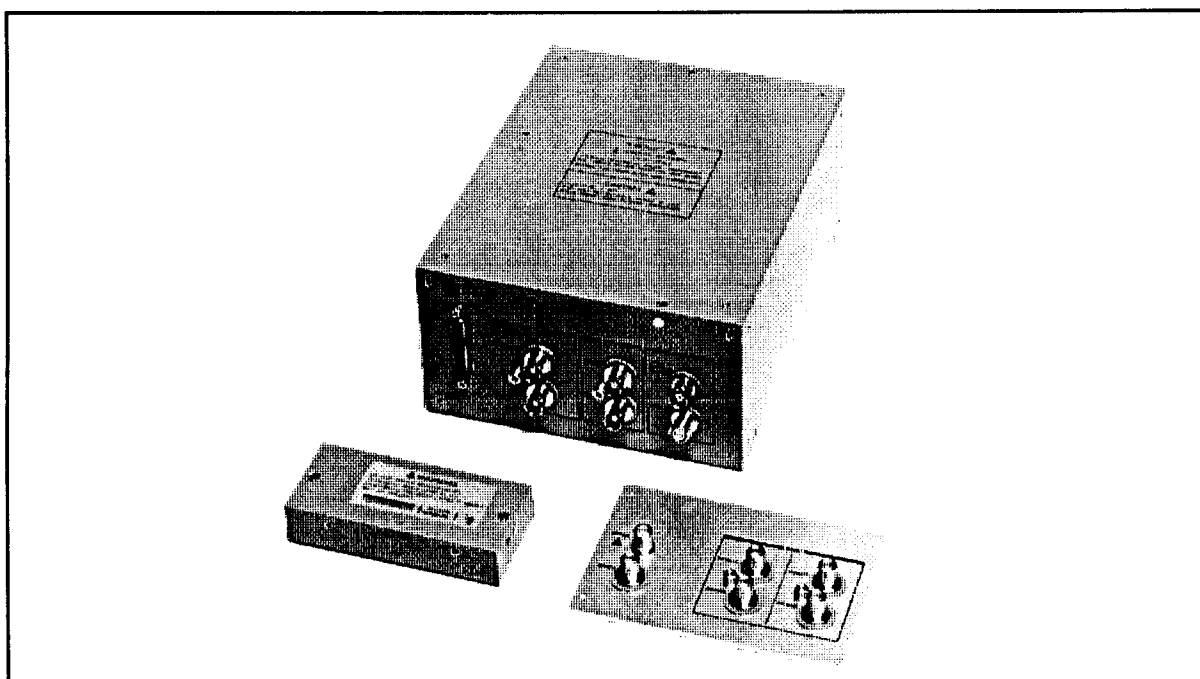


Figure 1-1. HP 16087A and Accessories

The following figures show the operation diagram, circuit diagram, and overview of the output terminals.

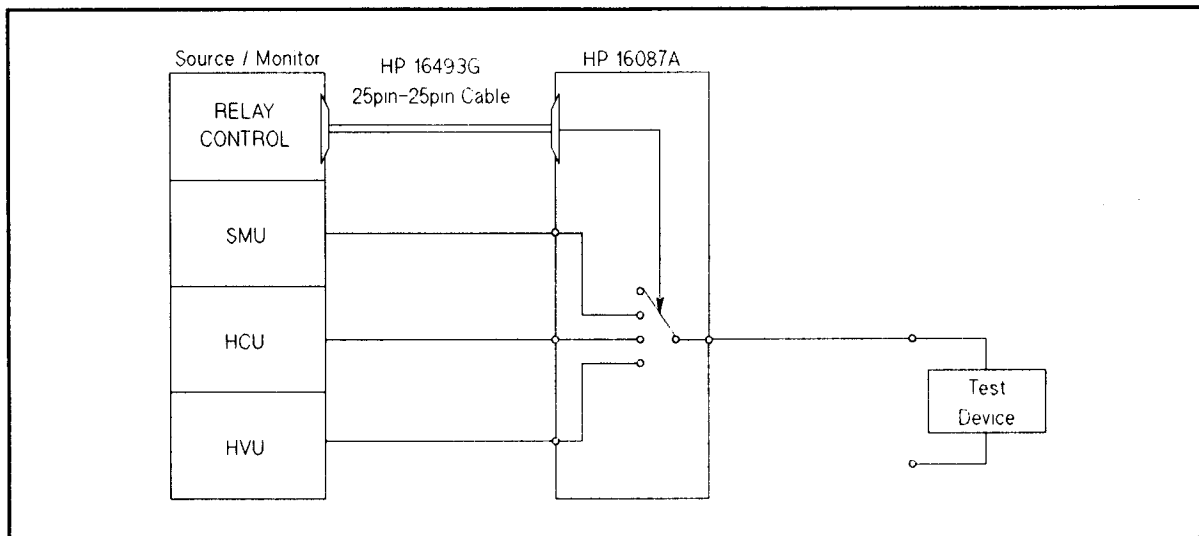


Figure 1-2. HP 16087A Operation Diagram

Warning



Even if you set the HP 16087A selection to HCU or No selection, the GUARD output of the HP 16087A is still equal to SMU output (200V maximum).

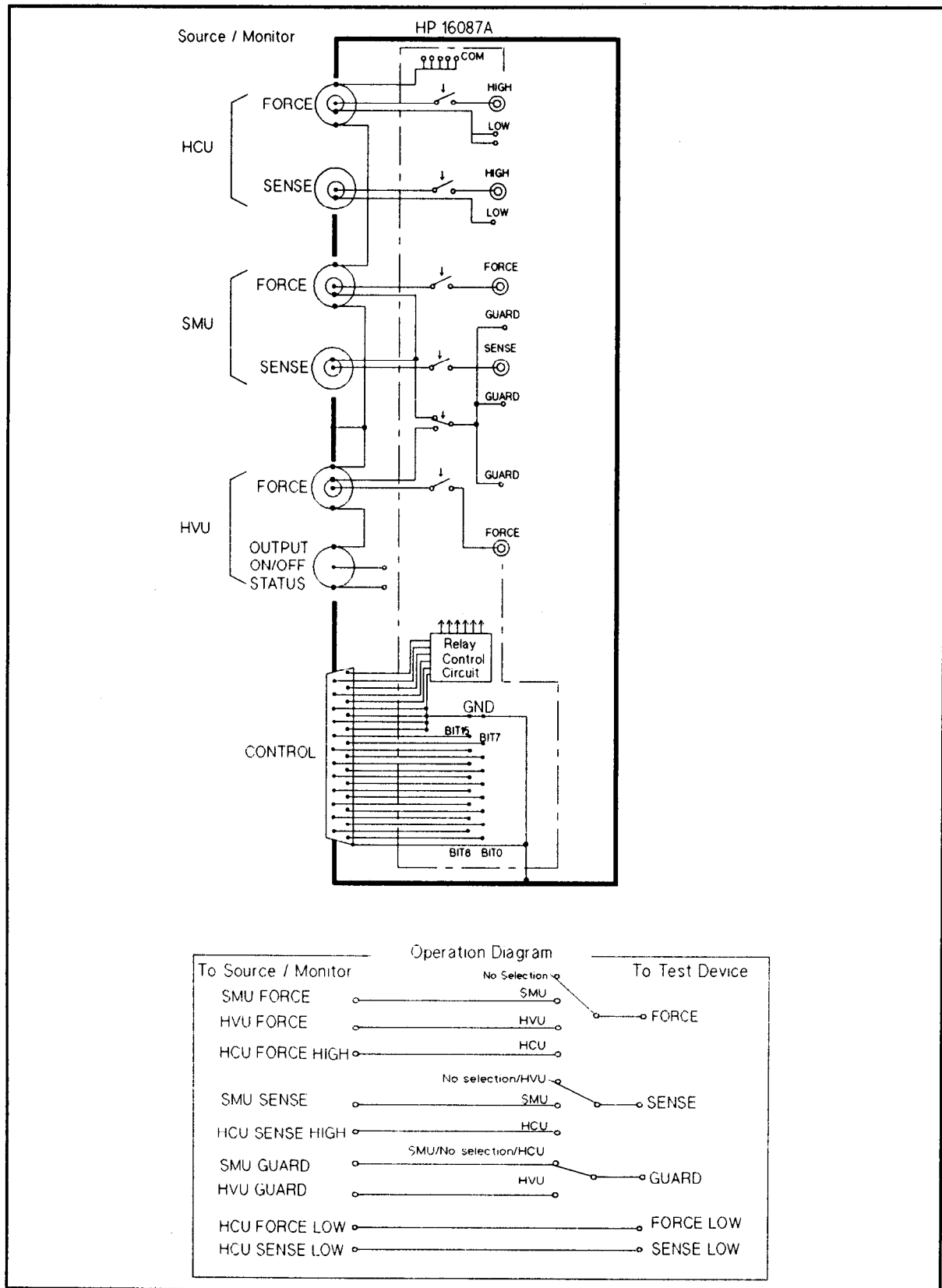


Figure 1-3. HP 16087A Circuit Diagram

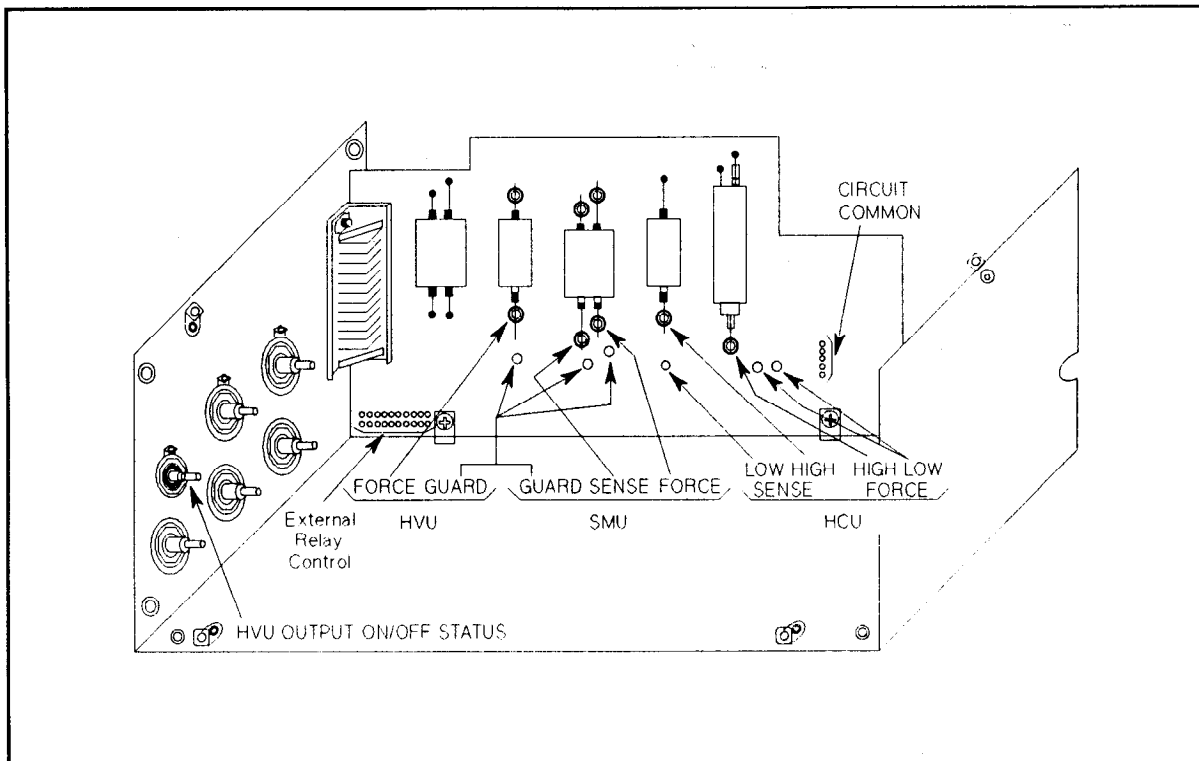


Figure 1-4. HP 16087A Output Terminals

Furnished Accessories

The HP 16087A comes with the following accessories:

■ Warning Indicator

Part number for English Version: 16087-60013
 Part number for Japanese Version: 16087-60014
 Part number for German Version: 16087-60015
 Dimensions: 114.4W × 52.1H × 25.4D mm

■ Connector Plate for 2 SMUs, GNDU, and INTLK

Part number: 16087-60002
 Dimensions: 136W × 94.8H × 28D mm

Setup

Warning

Dangerous voltages of up to 1000 V may be present on the 16087A and the connection cables. To ensure your safety, be sure to observe all WARNINGS.

Installing the HP 16087A

Caution

Place the HP 16087A within $\pm 20^\circ$ of horizontal during operation.

If the angle exceeds $\pm 20^\circ$, the HP 16087A does not operate correctly (a relay that is set to off could be inadvertently set to on, and the resistance of the relay can increase).

To attach the HP 16087A to the shielding box, use the four screw holes (size: M3×0.5) on the front, left side, right side, top, or bottom panel shown in Figure 2-1.

Figure 2-2 shows the connector assignment and the dimensions of the connector plate and holes in the plate.

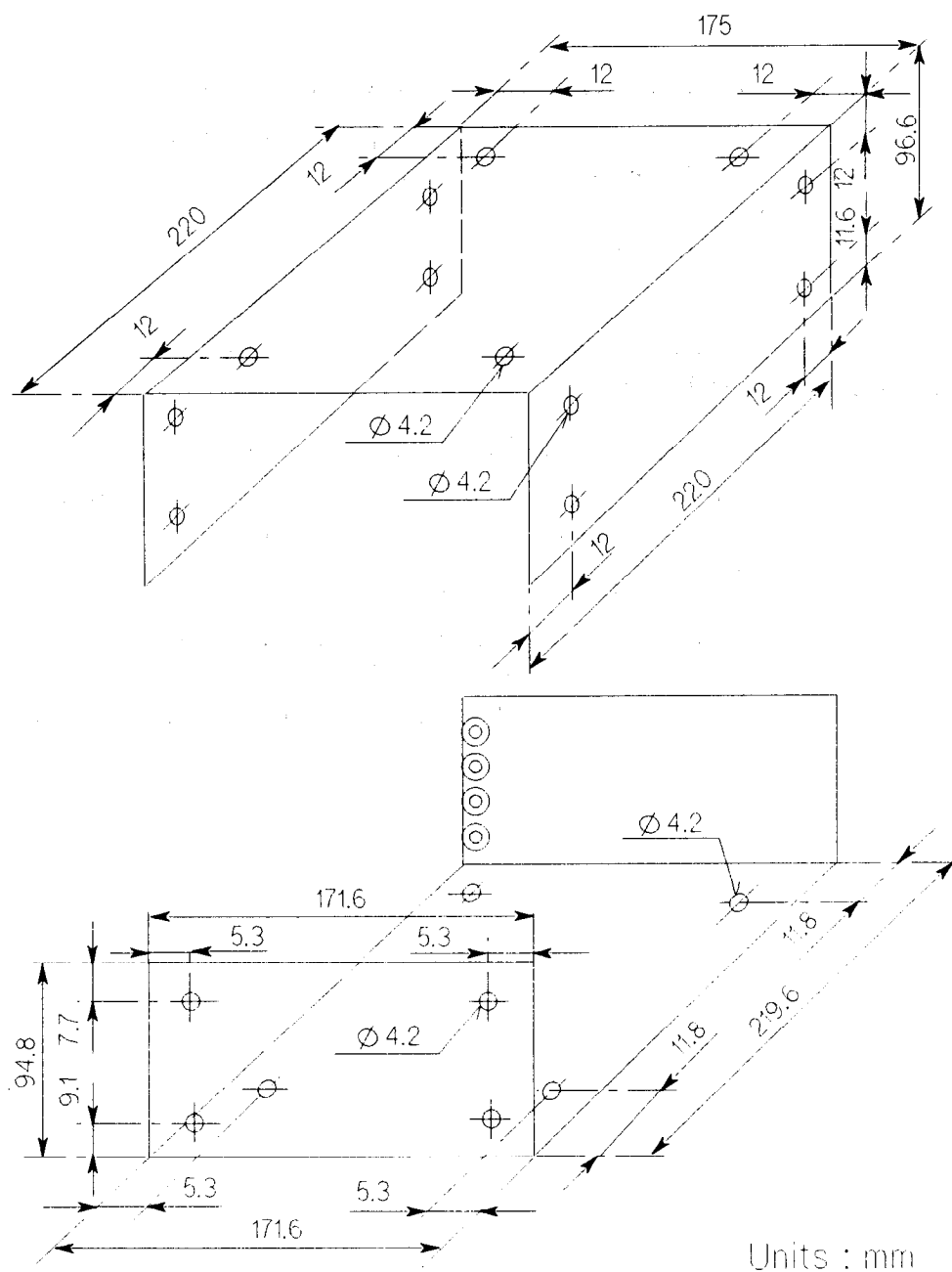


Figure 2-1. HP 16087A Screw Holes for Installation

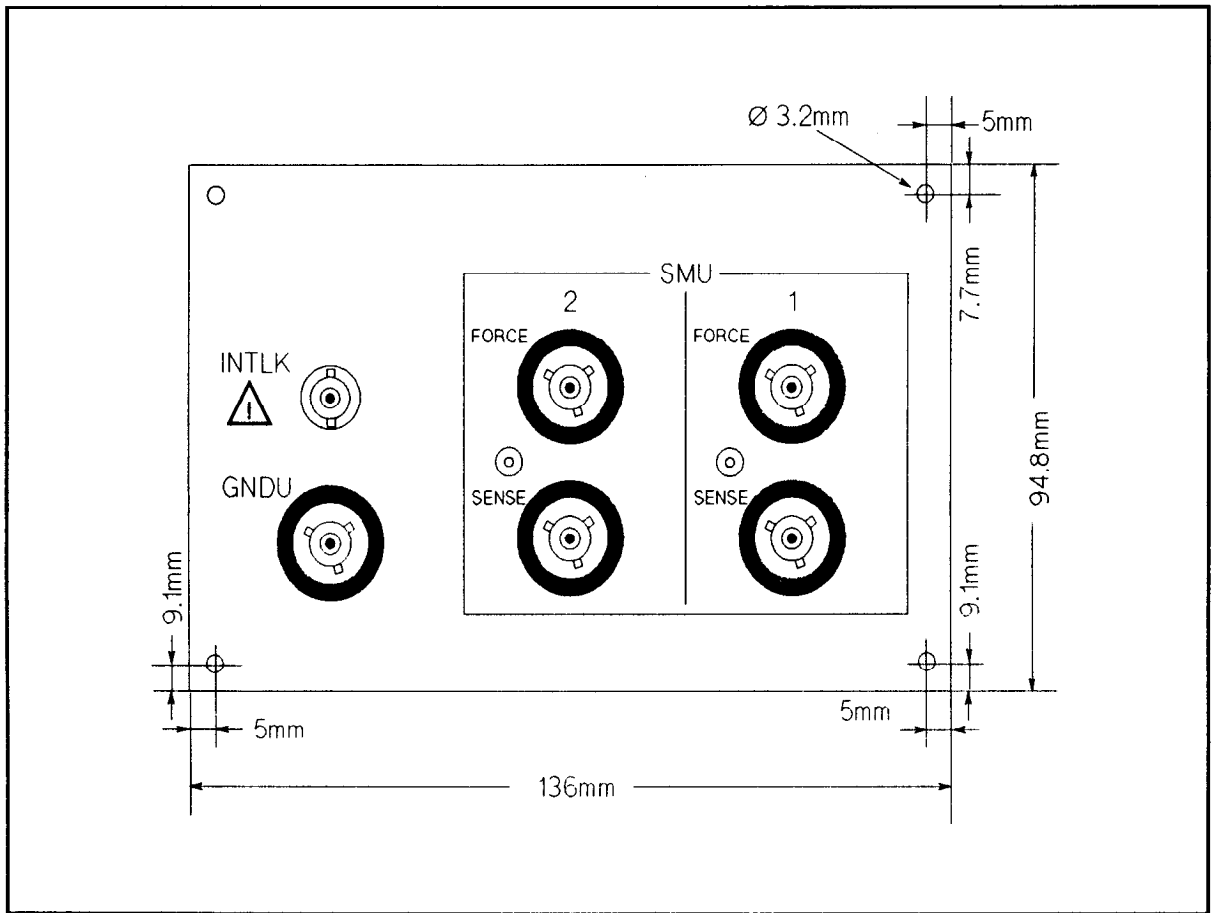


Figure 2-2. Connector Assignment and Connector Plate Dimensions

Connecting the HP 16087A

Figure 2-3 shows an overview of the HP 16087A connections.

Warning



To prevent an electric shock, perform the following items:

- Connect the Interlock (INTLK) terminal to a switch that turns off when the shielding box access door is opened.
 - For HVU, connect the OUTPUT ON/OFF STATUS terminal to a warning indicator.
 - Ground the chassis of the source/monitor using a three-conductor ac power cable.
-

For more information about the INTLK, warning indicator, and source/monitor connections, see the Source/Monitor manual. The HP 16087A chassis is connected to the chassis ground of the source/monitor with the CONTROL connector.

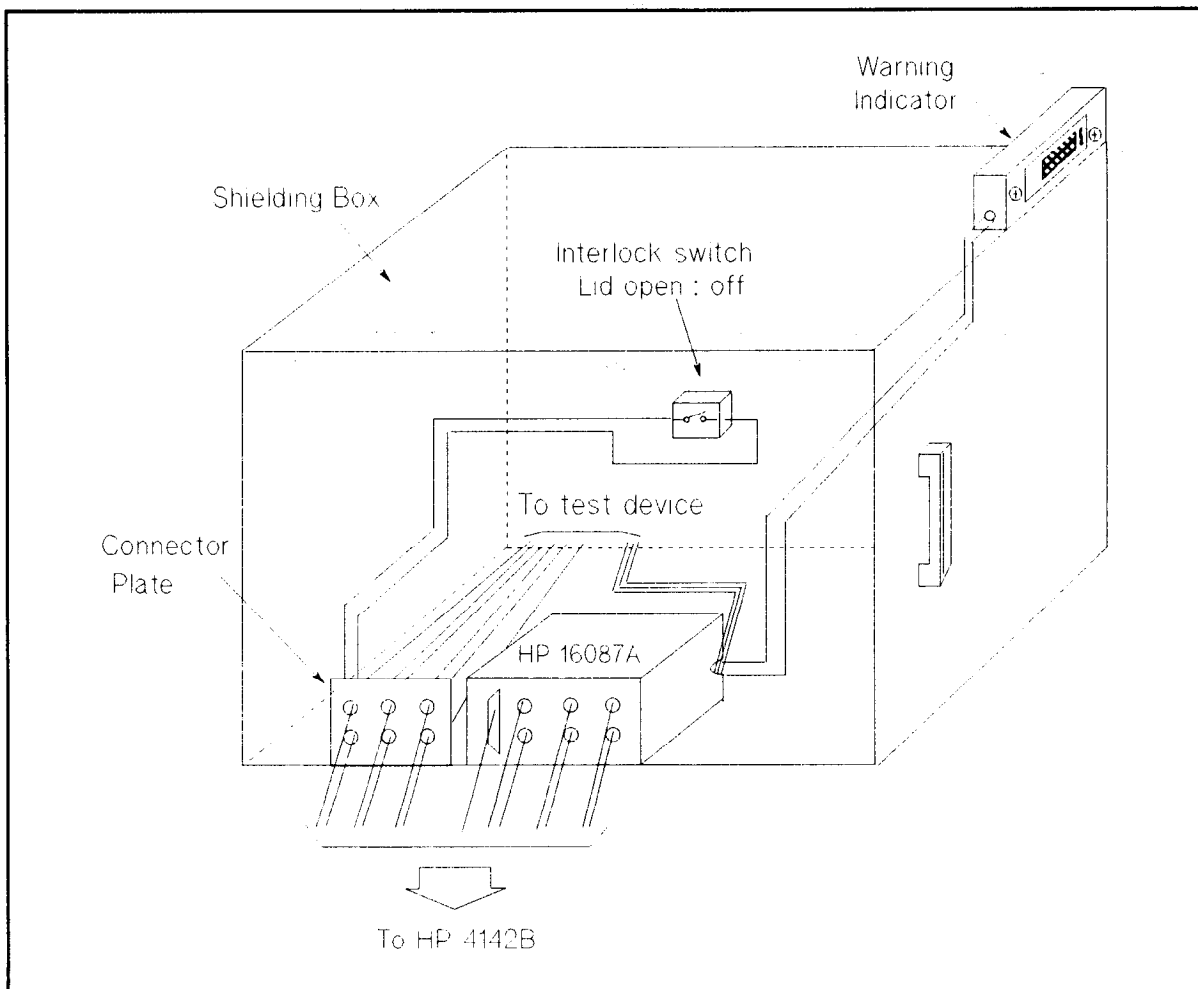


Figure 2-3. HP 16087A Connection Overview

Removing the Top Cover

To connect the HP 16087A to the test device, you must remove the top cover of the HP 16087A. Remove the following six screws using a Phillips driver, then lift off the top cover.

- Two screws on the top panel
- Two screws on the left side panel
- Two screws on the right side panel

Caution



Do not touch the terminals and board in the current path with your bare hands. Oil, perspiration, and dirt prevent good electric contact and degrade measurement accuracy.

Connecting the HP 16087A to the Test Device

Caution



When wiring the HP 16087A, use low hydrochloric acid solder (part number 8090-0433) to minimize leakage current (to prevent the flux in the solder from spreading unnecessarily).

Warning



For the FORCE (HIGH), SENSE (HIGH), and GUARD connections, use a cable with a withstand voltage of greater than or equal to 1000 V (cable test voltage: 3000 Vrms/minute).

Connect the HP 16087A and test device as shown in the following figure. The main points are below:

- Use a high withstand voltage (greater than or equal to 1000 V), low capacitance, and low resistance coaxial cable (or triaxial cable) for the FORCE (HIGH) and SENSE (HIGH) lines.
- Use a low resistance cable (AWG 16) for FORCE LOW line.
- Connect the FORCES of the SMU, HCU, and HVU on the HP 16087A internal board and connect the FORCE to the test device with one cable. Do not use three cables to connect each FORCE to the test device because this will increase cable capacitance. The goal is to minimize cable capacitance.
- Use two wires for the FORCE LOW line and twist the FORCE HIGH and FORCE LOW cables to minimize cable inductance.
- Twist the SENSE HIGH and SENSE LOW cables to minimize cable inductance.
- Surround the FORCE and SENSE lines with a GUARD as far as possible to minimize leakage current.
- Make the FORCE and SENSE cables as short as possible to minimize cable capacitance and inductance. Note that the lengths in the figure are for the following conditions. For any other case, see the Source/Monitor manual.
 - SMU: HP 41420A or HP 41421B
 - HCU: HP 41422A
 - HVU: HP 41423A
 - HP 41420A/41421B – HP 16087A: 1.5 m Quad coaxial Cable (HP 16493D Opt. 001)
 - HP 41422A – HP 16087A: 1.5 m Dual-coaxial Cable (HP 16493E Opt. 001)
 - HP 41423A – HP 16087A: 1.5 m Triaxial/BNC Cable Pair (HP 16493F Opt. 001)

You can use part number 8150-5053 or 8150-5063 instead of 8150-0447; however, part number 8150-0447 must not be used in place of 8150-5053 or 8150-5063.

Warning



Before connecting the HP 16087A to the test device, make sure that voltage or current is not present on the source/monitor and test device.

To prevent electric shock, do not expose the FORCE (FORCE HIGH), SENSE (SENSE HIGH), and GUARD lines.

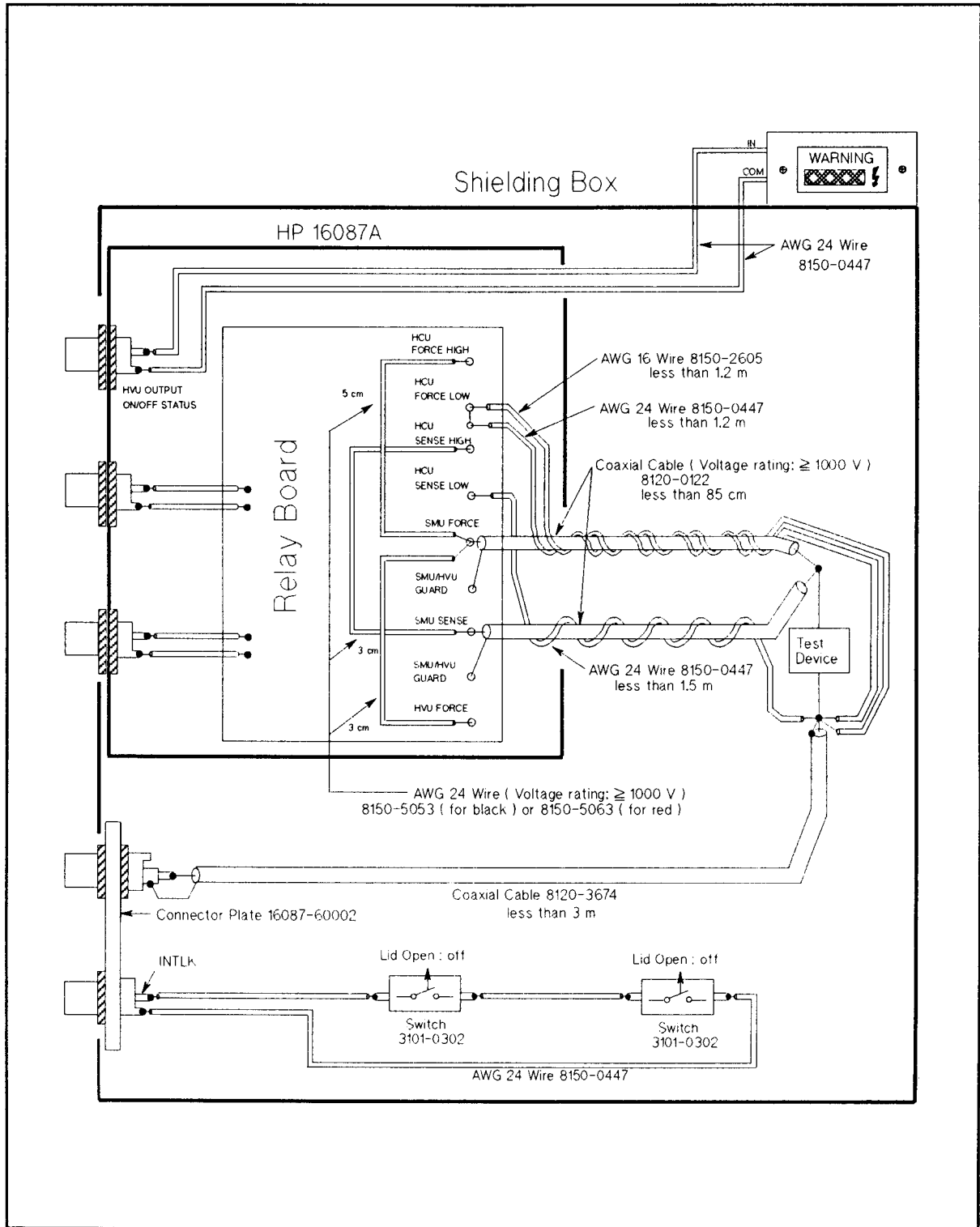


Figure 2-4. Connections between the HP 16087A and Test Device

Table 2-1.
Parts List for Connections between the HP 16087A and Test Device

HP Part Number	Description
8150-0447	AWG 24 Wire, Voltage rating:300V, Resistance:89mΩ/m (Units:in.)
8150-2605	AWG 16 Wire, Voltage rating:600V, Resistance:14mΩ/m (Units:in.)
8150-5053	AWG 24 Wire, Voltage rating:1000V, Resistance:84.4mΩ/m (Units:cm)
8150-5063	AWG 24 Wire, Voltage rating:1000V, Resistance:84.4mΩ/m (Units:cm)
8120-0122	Coaxial Cable, Voltage rating:1900V, Resistance:40mΩ/m, Capacitance:100pF/m(Units:in.)
8120-3674	Coaxial Cable, Resistance:133mΩ/m, Capacitance:77pF/m (Units:cm)

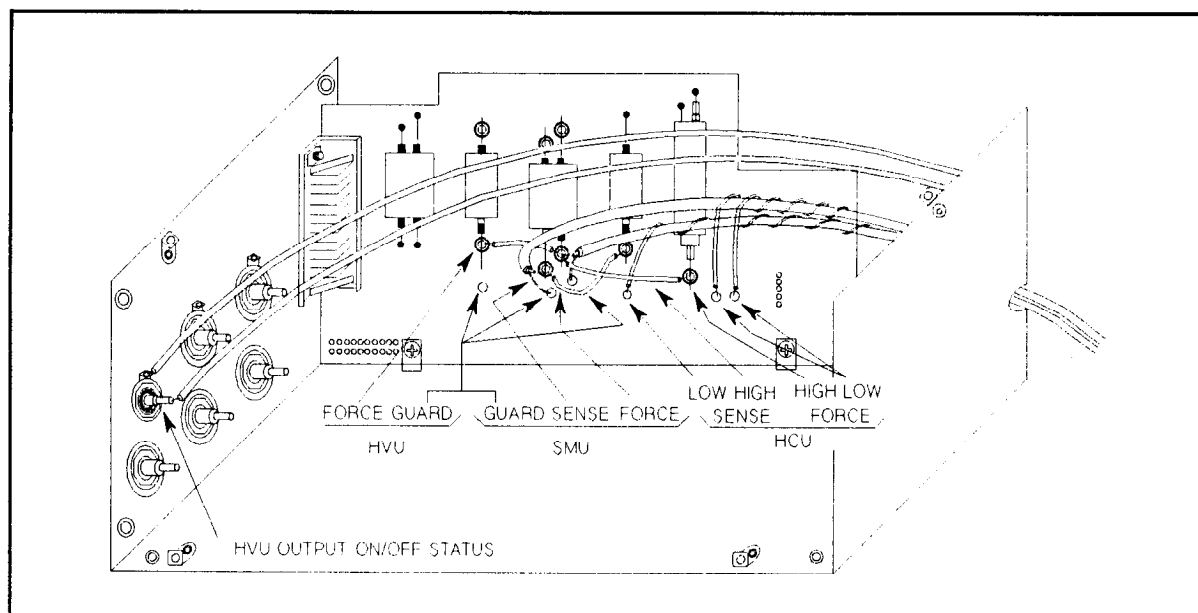


Figure 2-5. HP 16087A Internal Connections

Installing the Top Cover

After making the wire connections, install the top cover.

Warning



Before you touch the **FORCE**, **SENSE**, and **GUARD** lines of an HP 16087A that is setup, make sure that voltage or current is not present on these lines.

Cleaning

To maintain high performance, keep the HP 16087A clean. Oil, perspiration, hair, fibrous dust, and dirt in the circuit path degrade insulation. This increases leakage current and decreases measurement accuracy.

Clean the chassis, lid, inner board, connection cables of the HP 16087A using the following procedure:

1. Make sure that voltage or current is not present on the connection cables of the HP 16087A.
2. Disconnect the HP 16087A from the measurement circuit.
3. Using lint-free paper that is dipped into alcohol, gently wipe the terminals, the contact metal on the connection cables, inner board, chassis, and lid.

Specifications and Supplemental Performance Characteristics

HP 16087A Specifications

Channels

SMU: 1 ch (Kelvin)
HCU: 1 ch (Kelvin)
HVU: 1 ch

Specification Conditions

Temperature: $23 \pm 5^{\circ}\text{C}$
Humidity: 50% RH no condensation

Maximum Voltage and Current

Channel	Max. Voltage	Max. Current
SMU	200 V	1 A
HCU	10 V	10 A
HVU	1000 V	10 mA

Operating Environment

Operating Temperature range: 5 to 40°C
Operating Humidity range: 5 to 80% RH no condensation
Storage Temperature range: -40 to 70°C
Storage Humidity range: $\leq 90\%$ RH at 65°C no condensation

Physical Characteristics

Dimension: Approximately 175W $\times$ 97H $\times$ 220D mm
Weight: Approximately 850 g

Supplemental Performance Characteristics (Reference Data)

The following reference data is specified at $23 \pm 5^\circ\text{C}$ and 50% relative humidity.

SMU Channel

Leakage Current (force or sense – common):	15 pA at 200 V
Stray Capacitance (force or sense – common):	15 pF
Stray Capacitance (force or sense – other SMU):	3 pF
Residual Resistance (force):	200 m Ω
Residual Resistance (sense):	400 m Ω
Guard Capacitance (force or sense – guard):	60 pF
Channel Off Resistance:	100 G Ω

HCU Channel

Leakage Current (high-force – low-force):	1 nA maximum at 10 V
Leakage Current (high-sense – low-sense):	1 nA maximum at 10 V
Stray Capacitance (high-force – low-force):	400 pF
Stray Capacitance (high-sense – low-sense):	200 pF
Residual Resistance (high-force):	60 m Ω
Residual Resistance (low-force):	35 m Ω
Residual Resistance (high-sense):	160 m Ω
Residual Resistance (low-sense):	60 m Ω
Channel Off Resistance:	100 G Ω

HVU Channel

Leakage Current (force – common):	15 pA at 200 V
Stray Capacitance (force – common):	15 pF
Stray Capacitance (force – other SMU):	3 pF
Residual Resistance (force):	400 m Ω
Guard Capacitance (force – guard):	30 pF
Channel Off Resistance:	100 G Ω

Operating Environment

Maximum Tilt Angle: 20°

Performing Floating Measurements

The CIRCUIT COMMON and Chassis Ground of the source/monitor is connected in the HP 16087A. If you disconnect them to perform floating measurements, cut both ends of the green wire that is shown in the following figure, and remove the green wire.

Warning



A potential shock hazard exists at the CIRCUIT COMMON lines and terminals if you remove the green wire of the HP 16087A and disconnect the Chassis Ground and CIRCUIT COMMON of the source/monitor.

Note



Chassis Ground of the source/monitor is connected to the HP 16087A with the outer conductor of the CONTROL connector. The CIRCUIT COMMON of the source/monitor is connected to the HP 16087A with the outer conductors of the SMU, HCU, and HVU. The HP 16087A chassis is tied to Chassis Ground of the source/monitor with the outer conductor of the CONTROL connector even if you remove the green wire.

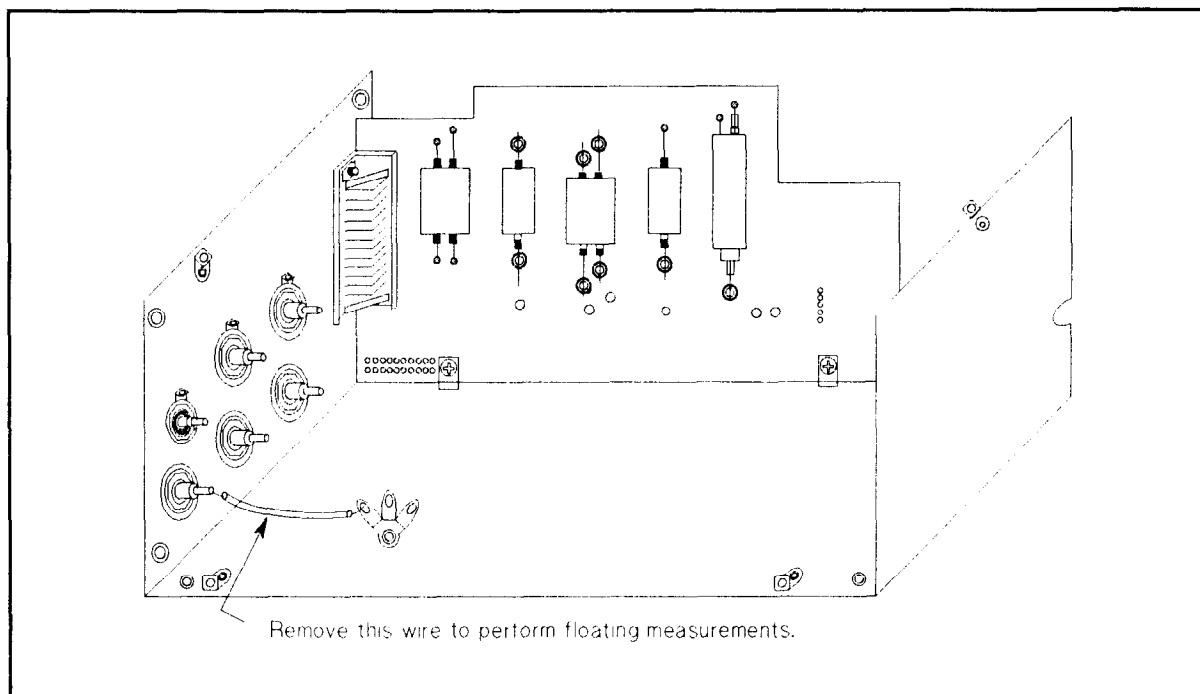


Figure 5-1. Wire that connects Chassis Ground to CIRCUIT COMMON

Performing the Safety Tests

Warning



Dangerous voltages of up to 1000 V are forced to the HP 16087A. To prevent electric shock, confirm that the following circuit operation tests of the Interlock (INTLK) terminal and the OUTPUT ON/OFF STATUS terminal pass before using the Module Selector.

- If you use this Module Selector with an IIP 4142B equipped with HVUs, perform the tests as described in “Performing the Safety Tests with an HP 4142B” in this section.
 - If you use this Module Selector with another high voltage source monitor unit, perform the tests as described in “Performing the Safety Tests without an HP 4142B” in this section.
-

Performing the Safety Tests with an HP 4142B

Performing the INTLK Circuit Test

1. Open the shielding box lid.
2. Press the **LOCAL/SELF TEST** key on the front panel of the HP 4142B to perform Self-Test.
3. Confirm that “U” is displayed in the ERROR/FAILURE display after Self-Test finishes.
4. Close the shielding box lid (short the INTLK terminal).
5. Press the **LOCAL/SELF TEST** key to perform Self-test.
6. Confirm that “0” is displayed in the ERROR/FAILURE display after Self-Test finishes.

If step 3 and step 6 pass, the INTLK circuit works correctly. If step 3 or step 6 does not pass, repair the INTLK circuit.

Performing the OUTPUT ON/OFF STATUS Circuit Test

1. Press the **LOCAL/SELF TEST** key to perform Self-Test.
2. During Self-Test, confirm that the warning indicator connected to the OUTPUT ON/OFF STATUS terminal is lit for about 5 seconds for each HVU installed.
3. Confirm that the warning indicator is not lit after the Self-Test finishes.

If step 2 and step 3 pass, the OUTPUT ON/OFF STATUS circuit works correctly. If step 2 or step 3 does not pass, notify the nearest Hewlett-Packard office.

Performing the Safety Tests without an HP 4142B

Performing the INTLK Circuit Test

1. Open the shielding box lid.
2. With a hand held multimeter, measure the resistance between the center and outer conductors of the INTLK terminal on the rear panel.
3. Confirm that the resistance is greater than 100 k Ω (interlock switch: off).
4. Close the shielding box lid.
5. Perform step 2.
6. Confirm that the resistance is less than 2 Ω (interlock switch: on).

If step 3 and step 6 pass, the INTLK circuit works correctly. If step 3 or step 6 does not pass, repair the INTLK circuit.

Performing the OUTPUT ON/OFF STATUS Circuit Test

1. Force 4 Vdc (± 1 Vdc) between the center and outer conductors of the HVU OUTPUT ON/OFF STATUS terminal on the rear panel (center conductor: +, outer conductor: -).
2. Confirm that the warning indicator is lit.

If step 2 passes, the OUTPUT ON/OFF STATUS circuit works correctly. If step 2 does not pass, notify the nearest Hewlett-Packard office.

Performing the Relay Switching Tests

This chapter describes how to perform the relay switching tests to check the function of relays, which are on the relay board in the HP 16087A.

Perform the tests after repairing the HP 16087A to verify operation of relays and inside wiring of the Module Selector.

Caution Place the HP 16087A within $\pm 20^\circ$ of horizontal during relay switching tests.



If the angle exceeds $\pm 20^\circ$, the HP 16087A does not operate correctly (a relay that is set to off could be inadvertently set to on, and the resistance of the relay can increase).

You can easily perform the relay switching tests with an HP 4142B by sending IIP-IB commands from a controller. Or you can perform the relay switching tests with a power supply when you don't have an HP 4142B and a controller.

Performing the Relay Switching Tests by using a Power Supply

This section describes how to perform the relay switching tests by using a power supply. Figure 7-1 shows the circuit for the relay switching tests that use a power supply.

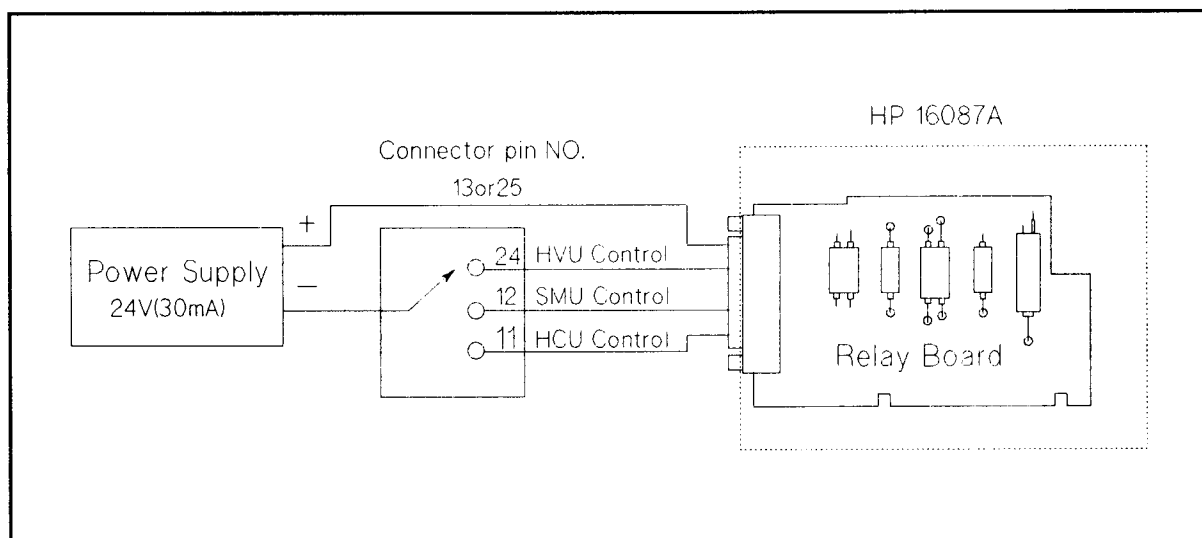


Figure 7-1. Circuit for Relay Testing by using a Power Supply

To test the relay switching, measure the resistance between connectors on the rear panel and relay terminals according to Table 7-1 and Table 7-2.

Figure 7-2 shows the locations of connectors on the rear panel and relay contact terminals.

Table 7-1. Relay Testing with the Power Supply Turned OFF

Measurement Terminals		Relay Tested	Measured Resistance
Connectors on the Rear Panel	Relay Contact Terminals		
SMU GUARD	HVU GUARD	K4	<10 Ω
HVU GUARD	HVU GUARD	K4	>100k Ω
HVU FORCE	HVU FORCE	K3	>100k Ω
SMU FORCE	SMU FORCE	K2	>100k Ω
SMU SENSE	SMU SENSE	K2	>100k Ω
HCU FORCE HIGH	HCU FORCE HIGH	K1	>100k Ω
HCU SENSE HIGH	HCU SENSE HIGH	K5	>100k Ω

Table 7-2. Relay Testing with the Power Supply Turned ON

Power Supply	Measurement Terminals		Relay Tested	Measured Resistance
	Connectors on the Rear Panel	Relay Contact Terminals		
J1 24 HVU Control	SMU GUARD	HVU GUARD	K4	>100k Ω
J1 24 HVU Control	HVU GUARD	HVU GUARD	K4	<10 Ω
J1 24 HVU Control	HVU FORCE	HVU FORCE	K3	<10 Ω
J1 12 SMU Control	SMU FORCE	SMU FORCE	K2	<10 Ω
J1 12 SMU Control	SMU SENSE	SMU SENSE	K2	<10 Ω
J1 11 HCU Control	HCU FORCE HIGH	HCU FORCE HIGH	K1	<10 Ω
J1 11 HCU Control	HCU SENSE HIGH	HCU SENSE HIGH	K5	<10 Ω

If the measured resistances do not correspond to Table 7-1 and Table 7-2, check the inside wiring of the HP 16087A. If there are any wiring mistakes, correct them.
(For inside wiring of the HP 16087A, see Figure 8-1, "Replaceable Parts".)

If the wiring is correct and measured resistances do not correspond to Table 7-1 and Table 7-2, replace the relays with new relays.

Figure 7-5 shows the circuit on the Relay Board of the HP 16087A.

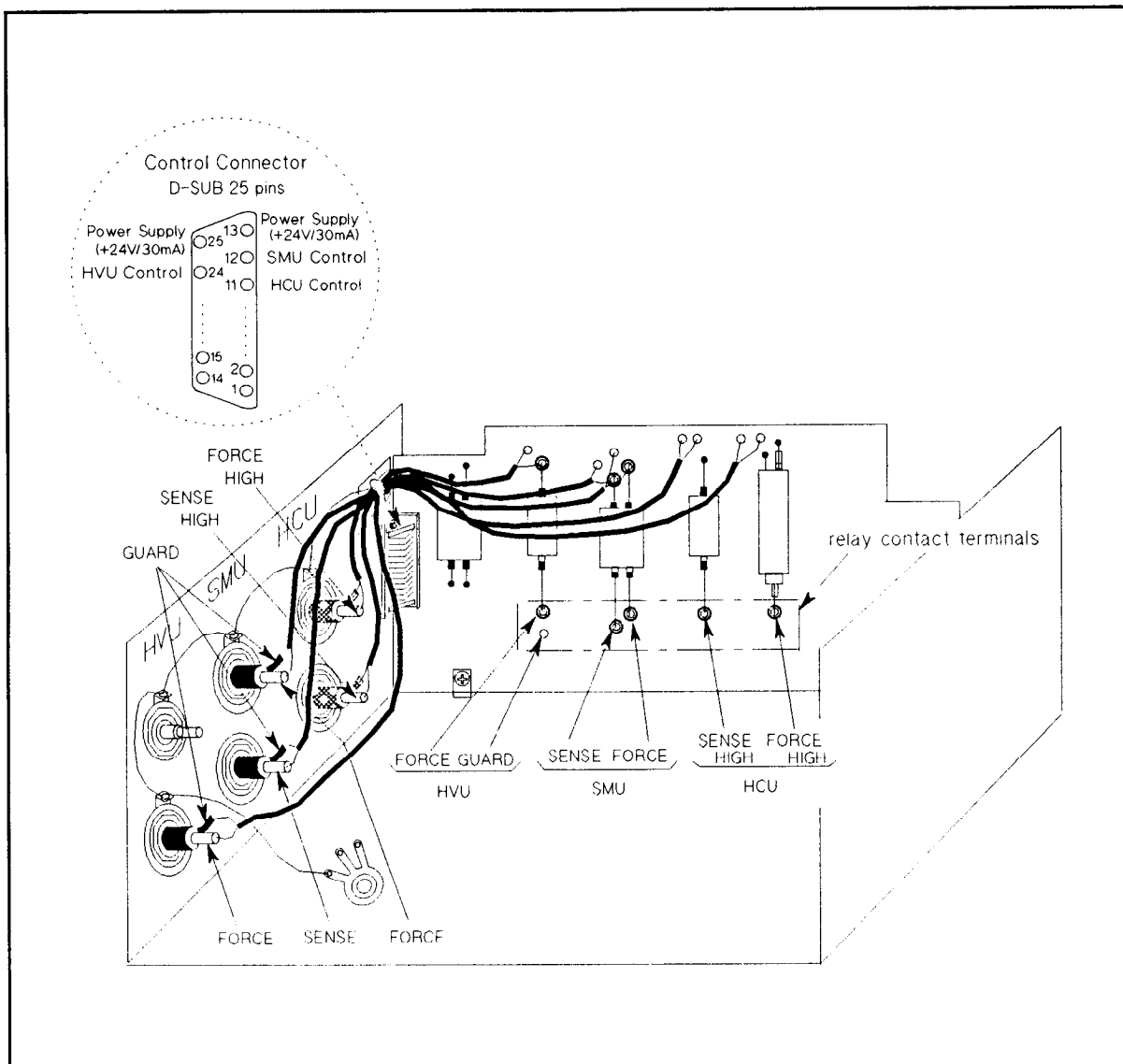


Figure 7-2. Locations of Connectors and Relay Contact Terminals

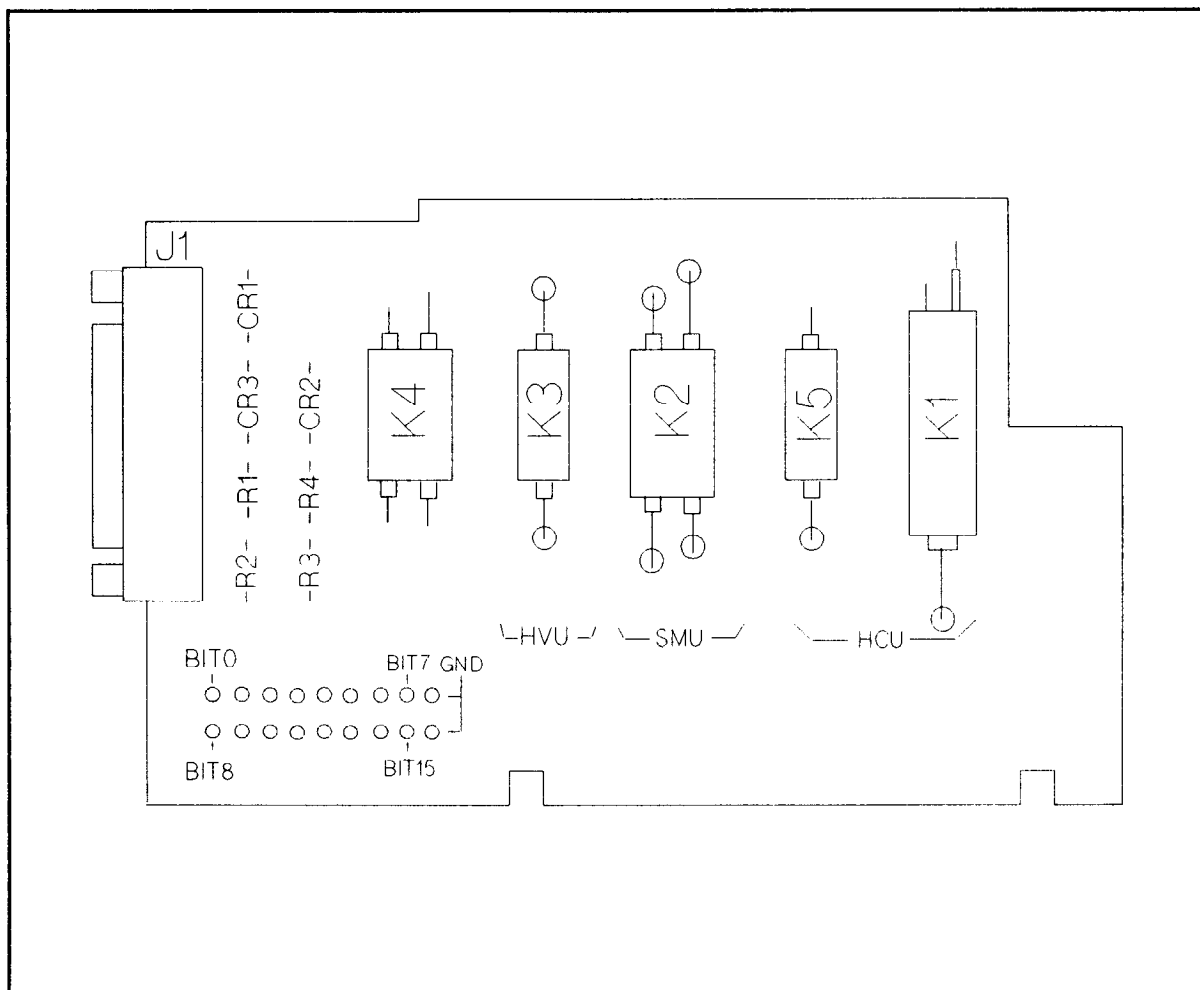


Figure 7-3. Component Locations on Relay Board Assembly

Table 7-3. Part Numbers for Replaceable Relays

Relay Number	HP Part Number
K1	0490-1763
K2	0490-1613
K3	0490-1698
K4	0490-1694
K5	0490-1698

Performing the Relay Switching Tests by using an HP 4142B

This section describes how to perform the relay switching tests by using the Control Unit of an HP 4142B and a controller. Figure 7-4 shows the configuration for the relay switching tests that use the HP 4142B.

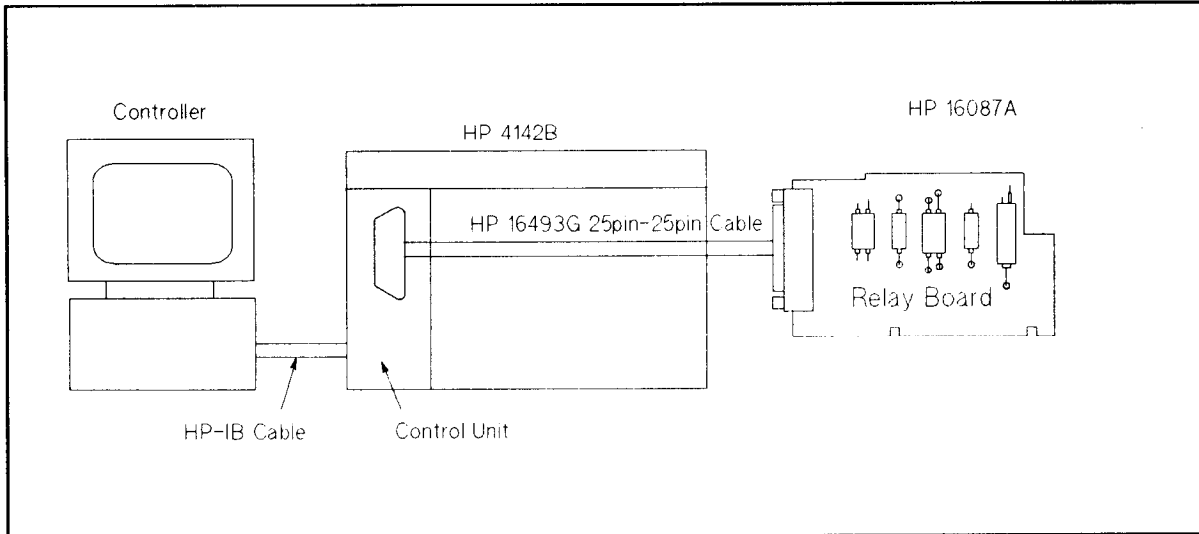


Figure 7-4. Configuration for Relay Testing by using the HP 4142B

By sending the ERC command as follows from the controller, you can set each control situation.

- For HVU Control: OUTPUT 717;"ERC";1,2
- For SMU Control: OUTPUT 717;"ERC";1,1
- For HCU Control: OUTPUT 717;"ERC";1,3
- For Open Condition: OUTPUT 717;"ERC";1,0

To test the relay switching, measure the resistance between connectors on the rear panel and the relay contact terminals according to Table 7-4.

Figure 7-2 shows the locations of connectors on the rear panel and relay contact terminals.

Table 7-4. Relay Testing by using ERC Commands

ERC Command	Measurement Terminals		Relay Tested	Measured Resistance
	Connectors on the Rear Panel	Relay Contact Terminals		
"ERC";1,2	SMU GUARD	HVU GUARD	K4	>100k Ω
"ERC";1,2	HVU GUARD	HVU GUARD	K4	<10 Ω
"ERC";1,2	HVU FORCE	HVU FORCE	K3	<10 Ω
"ERC";1,1	SMU FORCE	SMU FORCE	K2	<10 Ω
"ERC";1,1	SMU SENSE	SMU SENSE	K2	<10 Ω
"ERC";1,3	HCU FORCE HIGH	HCU FORCE HIGH	K1	<10 Ω
"ERC";1,3	HCU SENSE HIGH	HCU SENSE HIGH	K5	<10 Ω
"ERC";1,0	SMU GUARD	HVU GUARD	K4	<10 Ω
"ERC";1,0	HVU GUARD	HVU GUARD	K4	>100k Ω
"ERC";1,0	HVU FORCE	HVU FORCE	K3	>100k Ω
"ERC";1,0	SMU FORCE	SMU FORCE	K2	>100k Ω
"ERC";1,0	SMU SENSE	SMU SENSE	K2	>100k Ω
"ERC";1,0	HCU FORCE HIGH	HCU FORCE HIGH	K1	>100k Ω
"ERC";1,0	HCU SENSE HIGH	HCU SENSE HIGH	K5	>100k Ω

If the measured resistances do not correspond to Table 7-4, check the inside wiring of the HP 16087A. If there are any wiring mistakes, correct them.

(For inside wiring of the HP 16087A, see Figure 8-1, "Replaceable Parts".)

If the wiring is correct and the measured resistances do not correspond to Table 7-4, replace the relays with new relays. (For the locations and the part numbers of relays, see Figure 7-3 and Table 7-3.)

Figure 7-5 shows the circuit on the Relay Board of the HP 16087A.

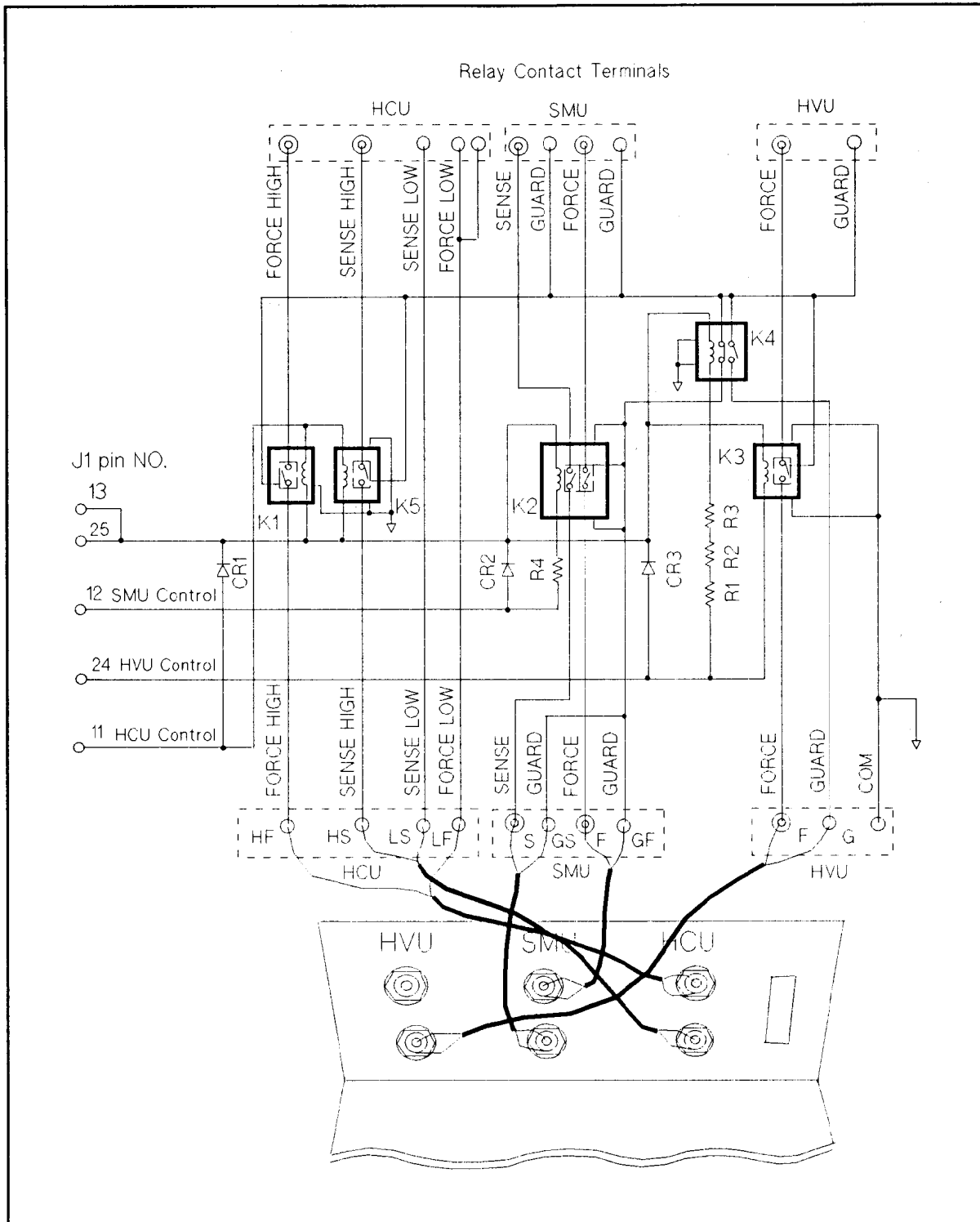


Figure 7-5. Circuit on the Relay Board of the HP 16087A

Servicing the Module Selector

This chapter provides information for trained service personnel to repair the Module Selector.

“Replaceable Parts” provides the HP part numbers of replaceable parts. When a part needs to be replaced, order the parts from the nearest HP Sales and Service Office.

Warning

Dangerous voltage of up to 1000V may be present in the Module Selector when voltage or current is added to the Module Selector. Dangerous voltage may be generated on wires or parts and the danger of electric shock exists.

Make sure that ports are not connected to the instruments before you repair the Module Selector.

When wiring the Module Selector, use low hydrochloric acid solder (HP part number: 8090-0433) to prevent the flux in the solder from spreading unnecessarily. When soldering, make sure the terminals do not make contact with each other. After soldering, make sure that there are no lint bridges so that leakage current is minimal.

Replaceable Parts

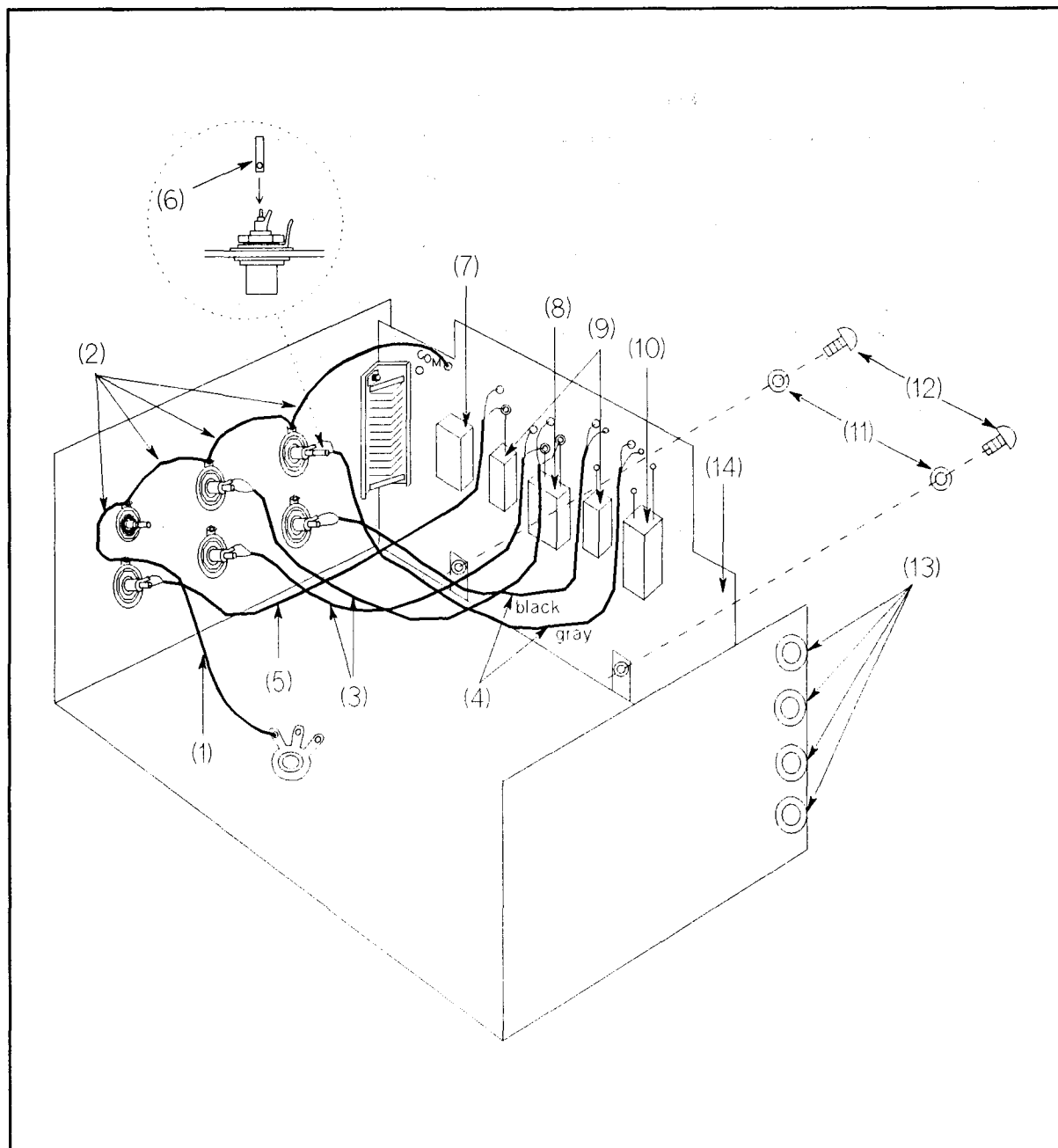


Figure 8-1. View of Cable Connections in the Module Selector

Table 8-1.
Parts List of Cable Connections in the Module Selector

Reference Designation	HP Part Number	Quantity	Description
(1)	8150-0452	15cm×1	Wire 24 Green
(2)	8150-0447	7cm×2, 5cm×2	Wire 24 Black
(3)	8120-0102	22cm×2	Coaxial Cable 50 Ω
(4)	8120-5297	25cm	A Pair of Coaxial Cable ¹
(5)	8120-4856	22cm×1	Coaxial Cable 50 Ω
(6)	41422-24099	1	Pipe
(7)	0490-1694	1	Reed Relay
(8)	0490-1613	1	Reed Relay
(9)	0490-1698	1	Reed Relay
(10)	0490-1763	1	Reed Relay
(11)	2190-0644	2	Lock Washer
(12)	0515-1550	2	Screw M3-L 8 P-H
(13)	0400-0011	4	Bushing
(14)	16087-66501	1	Relay Board

- ¹ This cable includes two coaxial cables—gray and black cables—wrapped a tube. The gray cable is connected to the force terminal and the black cable is connected to sense terminal for the HCU port.

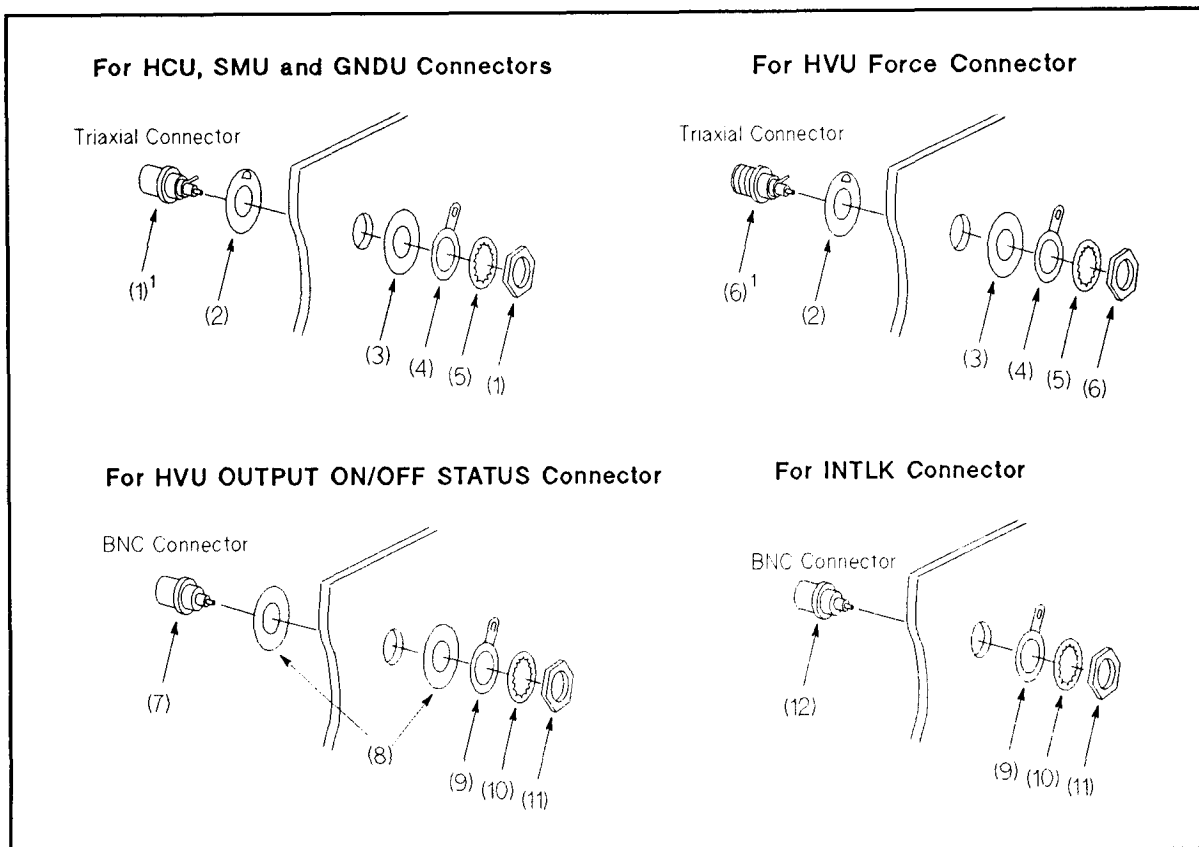


Figure 8-2. How to Install Triaxial and BNC Connectors

- ¹ Junk the lock washers attached to the triaxial connectors and use lock washers (5) shown in figure 7-2.

Table 8-2. Parts List for Triaxial and BNC Connectors

Reference Designation	HP Part Number	Quantity	Description
(1)	1250-1906	9	Triaxial Connector
(2)	16146-40002	9	Insulator
(3)	16146-40001	9	Insulator
(4)	5000-4218	9	Terminal-Solder Lug
(5)	2190-0104	9	Lock Washer
(6)	1250-2228	1	Triaxial Connector
(7)	1250-0118	1	BNC Connector
(8)	5040-0345	2	Insulator
(9)	0360-1190	1	Terminal-Solder Lug
(10)	2190-0016	1	Lock Washer
(11)	2950-0001	1	Nut
(12)	1250-0083	1	BNC Connector

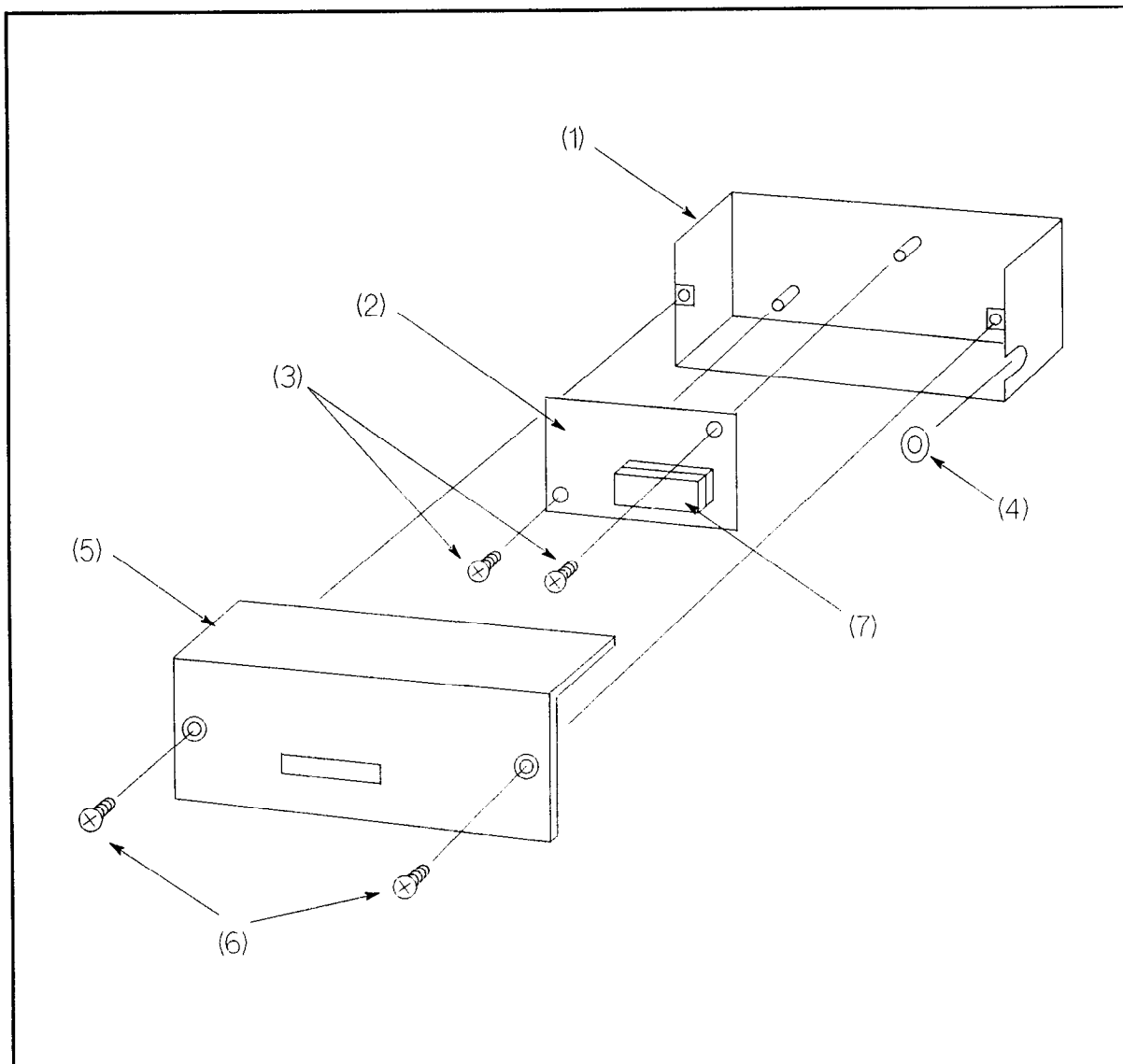


Figure 8-3. Exploded View of the Warning Indicator

Table 8-3. Parts List of Warning Indicator

Reference Designation	HP Part Number	Quantity	Description
(1)	16087-04006	1	Cover
(2)	16088-66502	1	LED Board
(3)	0515-1550	2	Screw M3-L 8 P-II
(4)	0400-0002	1	Insulator
(5)	16087-04005	1	Cover
(6)	0515-0914	2	Screw M3×0.5
(7)	1990-1219	1	LED



Reorder No. or
Manual Part No.
16087-90000

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Printed in Japan 6/92

**Manufacturing
Part No.
16087-90003**



16087-90003