Operating and Service Guide

for the

HP 70611A Attenuator/Switch Driver
HP 70612A Interface Module
HP 70612C Interface Module
HP 70613A Interface Module
HP 70613C Interface Module

HP Part No. 70611-90011
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1400 Fountaingrove Parkway, Santa Rosa, CA 95403-1799, USA

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

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

For any assistance, contact your nearest Hewlett-Packard Sales and Service Office.

Safety Symbols

The following safety symbols are used throughout this manual. Familiarize yourself with each of the symbols and its meaning before operating this instrument.

CAUTION	The *CAUTION* sign denotes a hazard. It calls attention to a procedure which, if not correctly performed or adhered to, could result in damage to or destruction of the product or the user's work. Do not proceed beyond a *CAUTION* sign until the indicated conditions are fully understood and met.
WARNING	**The *WARNING* sign denotes a hazard. It calls attention to a procedure which, if not correctly performed or adhered to, could result in injury to the user. Do not proceed beyond a *WARNING* sign until the indicated conditions are fully understood and met.**
DANGER	**The *DANGER* sign denotes an imminent hazard to people. It warns the reader of a procedure which, if not correctly performed or adhered to, could result in injury or loss of life. Do not proceed beyond a *DANGER* sign until the indicated conditions are fully understood and met.**

General Safety Considerations

WARNING

- **The instructions in this document are for use by qualified personnel only. To avoid electrical shock, do not perform any servicing unless you are qualified to do so.**
- **The opening of covers or removal of parts is likely to expose dangerous voltages. Disconnect the instrument from all voltage sources while it is being opened.**
- **The power cord is connected to internal capacitors that may remain live for five seconds after disconnecting the plug from its power supply.**
- **This is a Safety Class 1 Product (provided with a protective earthing ground incorporated in the power cord). The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. Any interruption of the protective conductor inside or outside of the instrument is likely to make the instrument dangerous. Intentional interruption is prohibited.**
- **For continued protection against fire hazard, replace fuse only with same type and ratings, (type nA/nV). The use of other fuses or materials is prohibited.**

WARNING

- **Before this instrument is switched on, make sure it has been properly grounded through the protective conductor of the ac power cable to a socket outlet provided with protective earth contact.**

  Any interruption of the protective (grounding) conductor, inside or outside the instrument, or disconnection of the protective earth terminal can result in personal injury.
- **Before this instrument is switched on, make sure its primary power circuitry has been adapted to the voltage of the ac power source.**

  Failure to set the ac power input to the correct voltage could cause damage to the instrument when the ac power cable is plugged in.

Declarations

HERSTELLERBESCHEINIGUNG

Hiermit wird bescheinigt, dass dieses Gerat/System in Ubereinstimmung mit den Bestimmungen von Postverfugung 1046/84 funkenstort ist.

Der Deutschen Bundespost wurde das Inverkehrbringen dieses Gerates/System angezeigt und die Berechtigung zur Uberprufung der Serie auf Einhaltung der Bestimmungen eingeraumt.

Zusatzinformation fur Mess- und Testgerate:

Werden Mess-und Testgerate mit ungeschirmten Kabeln und/oder in offenen Messaufbauten verwendet so ist vom betreiber sicherzustellen dass die Funk-Entstorbestimmungen unter Betriebsbedingungen an seiner Grundstucksgrenze eingehalten werden.

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Note If test and measurement equipment is operated with unshielded cables! used for measurements on open setups, the user must ensure that under these operating conditions, the radio frequency interference limits are met at the border of his premises

In This Book

This book provides installation, troubleshooting, operation, and programming details for the following list of instruments designed as components in a modular measurement system. For system-level configuration information, refer to the *HP 70000 Modular Measurement System Manual.*

- HP 70611A attenuator/switch driver
- HP 70612A interface module
- HP 70612C interface module
- HP 70613A interface module
- HP 70613C interface module

Each MMS module has its own service guide. For further information related to the servicing of additional and alternate modules that can be used in this system, refer to that module's service guide.

- Part 1, "Installation," describes how to set up and troubleshoot the HP 70611A, 70612A,C and 70613A,C switch driver and interface modules.

  Chapter 1, "General Information," describes switch driver and interface modules features, options and accessories.

  Chapter 2, "Installation," provides steps for configuring and installing the switch driver and interface modules in an HP 70000 Modular Measurement System Mainframe.

- Part 2, "Specifications and Verification," describes how to verify the operation of the switch driver or interface module.

  Chapter 3, "Specifications," lists specifications for the switch driver and interface modules.

  Chapter 4, "Verification," provides software-supported tests that verify switch driver and interface module section specifications.

- Part 3, "Operation and Programming," descibes how to operate and program a switch driver or interface module.

  Chapter 5, "Local Operation," contains the details for local operation.

  Chapter 6, "Remote Operation," contains the details for remote operation. Basic programming techniques and special programming considerations that must be understood before programming a switch driver or interface module for remote programming are discussed. A language reference describing the programming commands is also included.

- Part 4, "Troubleshooting," descibes how to troubleshoot the switch driver or interface module.

  Chapter 7, "Replaceable Parts," contains information on ordering parts.

  Chapter 8, "Troubleshooting," describes status indicators, error codes generated by the switch driver and interface modules, and a procedure that aids problem isolation.

Notation Conventions in this Manual

The display presents seven softkeys on the right side of the display. A softkey executes a function defined by the switch driver or interface module section firmware. The name of the function appears on the display next to the activating key.

This manual uses the following conventions:

(KEY)	A key-name that looks like this represents a key physically located on the instrument. These are commonly referred to as hardkeys. The (MENU) display hardkey causes softkey labels to appear on the right side of the display.
`softkey`	Text that looks like this (with all lowercase letters) represents a softkey that accesses a subset menu of softkeys.
`SOFTKEY`	Text that looks like this (with all uppercase letters) represents a softkey that executes its function.
`CRT Text`	Text that looks like this represents messages that appear on a CRT.

Contents

Figures

Tables

1

General Information

Module Descriptions

HP 70611A

The HP 70611A switch driver is an HP-IB/MSIB compatible device designed as a component to the HP 70000 Modular Measurement System (MMS). An HP-HIL keyboard can be used to speed manual interface operations. The standard HP 70611A switch driver, when externally connected to a maximum of eight HP 84940A driver boards, can control and sense switching states for up to 248 switches.

Options—HP 70611A only

Option 001 Adds an internal driver board that can control and sense switching states for up to 31 switches.

HP 70612A,C and HP 70613A,C

The HP 70612A,C and HP 70613A,C are self-contained switching interfaces for the HP 70000 Modular Measurement System. The standard units have a controller board, a switch driver board and five built-in, SPDT, terminated switches. See Figure 1-1. The controller board provides the MSIB link and protocol management. It also provides SCPI command translation, storage for configuration information and translating and relaying QUERY results. The controller board communicates with the HP 84940A driver board over a TTL level parallel data bus. The connection between the controller board and the driver board provides the power necessary to bias the driver board and the power required to drive the switches.

The HP 84940A driver board translates the commands from the controller board and either provides signals to the switches or checks the status of the switches. The board is designed for use with switches by sinking the control pins to ground.

Both the HP 70612A,C and HP 70613A,C come standard with five SPDT switches. The HP 70612A,C are configured to provide a single input and six outputs. The HP 70613A,C provide routing for two inputs to five outputs.

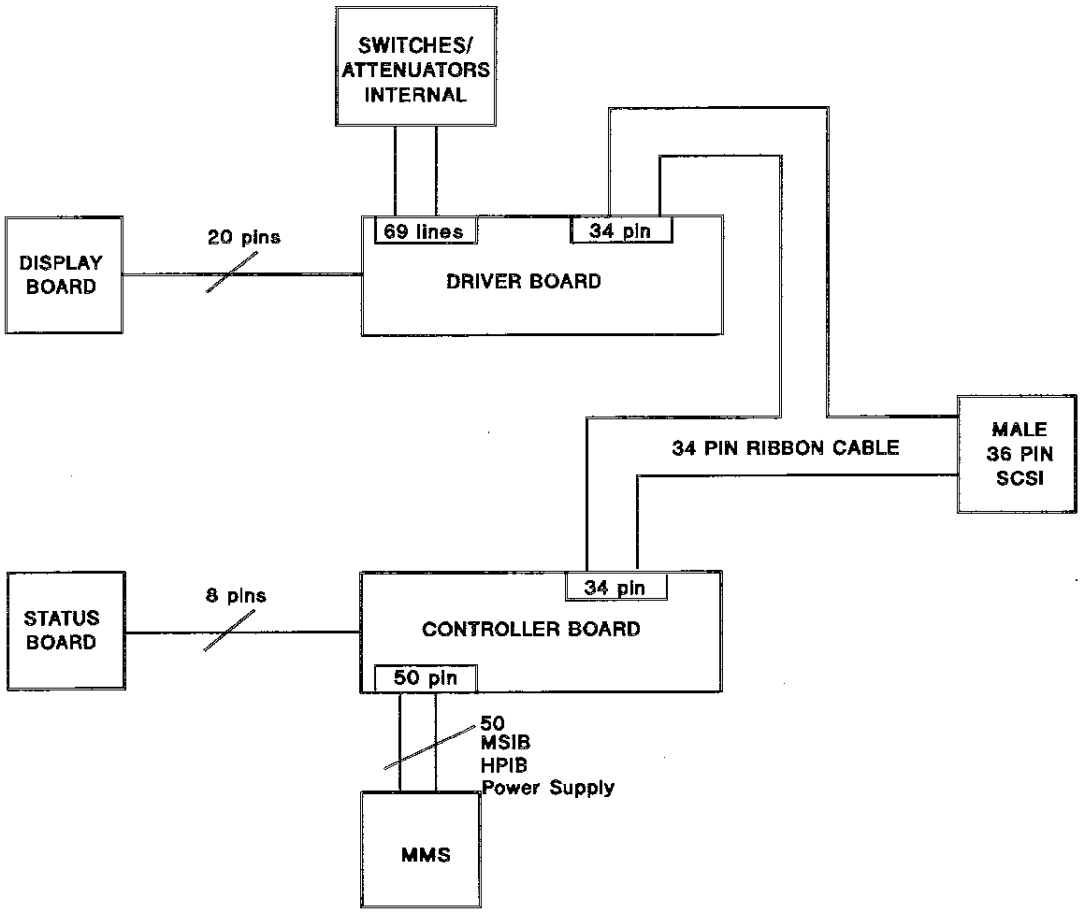

Figure 1-1. HP 70612A,C and HP 70613A,C Block Diagram

Options—HP 70612A,C and HP 70613A,C only

Option 002	Replaces the terminated switches with unterminated switches.
Option 003	Adds an 11 dB step attenuator (1 dB/step).
Option 004	HP 70612A, 70613A — Adds 110 dB step attenuator (10 dB/step).
	HP 70612C, 70613C — Adds 90 dB step attenuator (10 dB/step).
Option 005	Moves the RF input connectors from the front panel to the rear panel.
Option 006	Moves the RF input connectors from the front panel to the rear panel and deletes the controller board. (Requires an HP 70611A in the system.)
Option 007	HP 70612A, 70613A — Adds 11 dB and 110 dB step attenuators.
	HP 70612C, 70613C — Adds 11 dB and 90 dB step attenuators.
Option 008	Adds a data I/O cable.
Option 011	Deletes the controller card (requires HP 70611A).

Drive Pulse and Sensing Delay

The HP 70611A, 70612A,C and 70613A,C are designed to work in conjunction with at least one and up to eight HP 84940A driver boards. The HP 84940A contains Darlington arrays which can deliver 200 mA, 24 Vdc current pulses to 62 individual switch loads. These low impedance pulses can be adjusted for pulse width in order to optimize switching speed.

The switch driver and interface modules can verify switching operation when used with switches that can sense switch position (such as the HP 33311C switches). This kind of switch requires additional time to be added to allow the sense lines to settle. Although the recommended delay is 20 ms for HP 33311C switches, yours may be different. The sensing delay can be adjusted to conform to the switch characteristics.

Pulse width and sensing delay can be set from 0.005 to 1.275 seconds per switching operation in 0.005 second increments. The pulse width default setting is 30 ms. The sensing delay default setting is 20 ms. The MMS power supply allows the switch driver four switching operations (200 mA per throw) at the same time. This means that at the default setting, seven groups of four switches and one group of three switches will *each* take 50 ms to switch and verify. This results in a default switching speed of 0.4 seconds for 31 relays with sensing enabled. See the "Speed Calculation Example" at the end of section 6, "Remote Operation".

Compatible Switches and Attenuators

The HP 70611A, 70612A,C and 70613A,C were made to drive the following Hewlett-Packard switches and attenuators. If you are using switches or attenuators made by another company check their switching characteristic against those specified in section 3, "Specifications".

Table 1-1. Compatible Hewlett-Packard Switches

Switches		Switches	
Model No.	**Description**	**Model No.**	**Description**
HP 33314A,B,C,D (Opt 024)	Unterminated SPDT	HP 8765A,B,C,D,F (Opt 024)	Unterminated SPDT
HP 33311A,B,C	Terminated SPDT	HP 8762A,B,C,F	Terminated SPDT
HP 33312A,B,C	Terminated Transfer	HP 8763A,B,C,F	Terminated Transfer
HP 33313A,B,C	5 Port Switch	HP 8764A,B,C,F	5 Port Switch
HP 33363K	SP3T	HP 8766K	SP3T
HP 33364K	SP4T	HP 8767K	SP4T
HP 33365K	SP5T	HP 8768K	SP5T
HP 33366K	SP6T	HP 8769K	SP6T

Table 1-2. Compatible Hewlett-Packard Attenuators

Attenuators		Attenuators	
Model No.	**Description**	**Model No.**	**Description**
HP 33320G,H	11 dB, 1 dB Steps	HP 8494G,H	11 dB, 1 dB Steps
HP 33321G,H,K	70 dB, 10 dB Steps	HP 8495G,H,K	70 dB, 10 dB Steps
HP 33322G,H	110 dB, 10 dB Steps	HP 8496G,H	110 dB, 10 dB Steps
HP 33323K	90 dB, 10 dB Steps	HP 8497K	90 dB, 10 dB Steps
HP 33324K,L,M	11 dB, 1 dB Steps	HP 84904K,L,M	11 dB, 1 dB Steps
HP 33326K,L,M	90 dB, 10 dB Steps	HP 84906K,L,M	90 dB, 10 dB Steps
HP 33327K,L,M	70 dB, 10 dB Steps	HP 84907K,L,M	70 dB, 10 dB Steps

Connecting Accessories

Included with each HP 70612A,C and HP 70613A,C module are seven (7) connector savers, HP part number 1250-2320. These connector savers are designed to be used where frequent connect/disconnects are made. It is more economical to sacrifice a low priced adapter than to have an expensive repair to replace the front or rear panel connecctors on the Interface Module. The connector savers are relatively inexpensive male to female adapters that are connected to the instrument's input and output connectors. System connections are then made to the adapters, rather than to the front or rear panel connectors. The connector saver's only drawback is the additional insertion loss or SWR introduced by the device. This additional loss is generally small, and can be calibrated out of a system measurement. Note that published specifications reflect the inclusion of connector savers in the measurement path.

Note Published specifications include connector savers in the measurement path.

Accessories for connecting the switch driver and interface modules to switches are described in section 2, "Installation" and section 7, "Replaceable Parts".

Test Accessories

An accessory for testing the switch driver is described in section 4, "Verification" and section 8, "Troubleshooting".

Front Panel Features

Front Panel LEDs

The front panel LEDs indicate the status of the HP 70611A switch driver, 70612A,C and 70613A,C interface modules. The front panel LEDs should turn on and off while the switch driver is performing the self test (for example, at turn-on).

If the ERR (error) LED lights at any time other than during self test, an error condition exists in the switch matrix. The switch driver ERR light indicates it is ready to report one or more error codes. The error code(s) may be viewed in either of two ways:

- Use the display interface keys. Press (DISPLAY) or (DSP), then press REPORT ERRORS. See ":ERRor?" in Section 6, "Remote Reference" for a description of the error codes.
- Use the controller. See ":ERRor?" in Section 6, "Remote Reference".

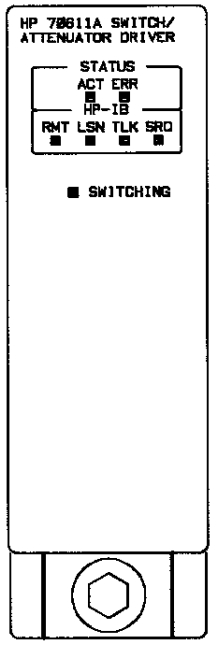

Figure 1-2. HP 70611A, 70612A,C and 70613A,C Front-Panel Features

The SRQ (service request) state can be remotely set by the user to take place under certain conditions, (for example: completion of an operation or if an error condition occurs). The SRQ LED will only be lit during self test, when it is turned on and off to test the LED.

The other LEDs, ACT (active), RMT (remote), LSN (listen), TLK (talk), and SWITCHING indicate the normal functioning of the switch driver and do not indicate an error condition.

Module Latch

An eight-mm hex-ball driver is used to turn the module hex-nut latch for installation of the module in the HP 70000 MMS mainframe. Chapter 2 contains switch driver module specific installation and removal instructions.

HP 70611A

The HP 70611A switch driver (standard) has a high density, 36-pin (Male) SCSI II(Small Computer System Interface) type connector which can be connected in parallel to a maximum of eight external driver cards.

Option 001

The HP 70611A switch driver (Option 001) can drive 31 individual switches through a high density, 68-pin (Female) SCSI II type connector.

HP 70612A,C and HP 70613A,C

The HP 70612A,C and HP 70613A,C Interface Modules have high density, 36-pin (Male) SCSI II type connector, which can be connected to a maximum of seven external driver cards (HP 84940A).

Initial Inspection

Inspect the shipping container for damage. If the shipping container or cushioning material is damaged, it should be kept until the contents of the shipment have been checked for completeness and the instrument has been checked mechanically and electrically. The contents of the shipment should be as shown in Table 1-3. Procedures for checking electrical performance are given in chapter 4.

Table 1-3. HP 70611A, 70612A,C and 70613A,C Package Contents

Description	HP 70611A Quantity	HP 70612A,C 70613A,C Quantity	Part Number
Switch Driver	1		HP 70611A
Interface Module		1	HP 70612A,C or 70613A,C
Beginner's Guide	1	1	H2325-90001
Operating and Service Manual	1	1	70611-90011
Cable, 68-pin to 68-pin SCSI II (Option 001 only)	1		70611-60004
Adapter, SMA (m) to SMA (f)		7	1250-2320
Cable, 36-pin to 36-pin SCSI II (Options 006, 008 and 011 only)		1	70611-60010

If the instrument is damaged or defective contact the nearest Hewlett-Packard office. Hewlett-Packard will arrange for repair or replacement of the damaged or defective equipment without waiting for a claim settlement. Keep the shipping materials for the carrier's inspection.

Storage and Shipment

Environment

The instrument should be stored in a clean, dry environment. The following environmental limitations apply to both storage and shipment:

Temperature ..... −40°C to +70°C

Humidity ..... <95% relative

Altitude ..... <15 300 meters (50 000 feet)

Calling Hewlett-Packard

Before calling Hewlett-Packard or returning your MMS module for service, please read your warranty information. Warranty information is printed at the front of this service guide.

In any correspondence or telephone conversations, refer to the MMS module by its full model number and full serial number. With this information, the Hewlett-Packard representative can determine whether your unit is still within its warranty period.

Determining Your MMS Module's Serial Number

When a module is manufactured by Hewlett-Packard, it is given a unique serial number. This serial number is attached to a label on the front frame or front panel of the module. A serial number label is in two parts. (Refer to Figure 1-3.) The first part makes up the serial number prefix and consists of four digits and a letter. The second part makes up the serial number suffix and consists of the last five digits on the serial number label. The serial number prefix is the same for all identical modules; it only changes when a change in the electrical or physical functionality is made. The serial number suffix, however, changes sequentially and is different for each module.

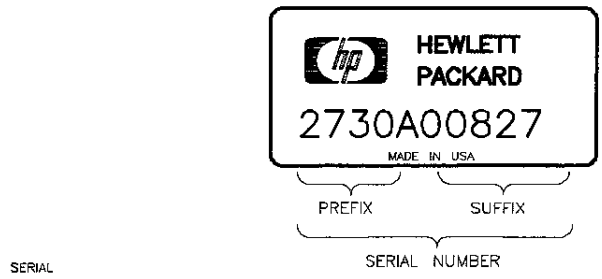

Figure 1-3. Typical Serial Number Label

Table 1-4. Hewlett-Packard Sales and Service Offices

US FIELD OPERATIONS HEADQUARTERS
Hewlett-Packard Company
19320 Pruneridge Avenue
Cupertino, CA 95014, USA
(800) 752-0900

California
Hewlett-Packard Co.
1421 South Manhattan Ave.
Fullerton, CA 92631
(714) 999-6700

Hewlett-Packard Co.
301 E. Evelyn
Mountain View, CA 94041
(415) 694-2000

Colorado
Hewlett-Packard Co.
24 Inverness Place, East
Englewood, CO 80112
(303) 649-5000

Georgia
Hewlett-Packard Co.
2000 South Park Place
Atlanta, GA 30339
(404) 955-1500

Illinois
Hewlett-Packard Co.
5201 Tollview Drive
Rolling Meadows, IL 60008
(708) 342-2000

New Jersey
Hewlett-Packard Co.
150 Green Pond Road
Rockaway, NJ 07866
(201) 586-5400

Texas
Hewlett-Packard Co.
930 E. Campbell Rd.
Richardson, TX 75081
(214) 231-6101

EUROPEAN OPERATIONS HEADQUARTERS
Hewlett-Packard S.A.
150, Route du Nant-d'Avril
1217 Meyrin 2/Geneva
Switzerland
(41 22) 780.8111

France
Hewlett-Packard France
1 Avenue Du Canada
Zone D'Activite De Courtaboeuf
F-91947 Les Ulis Cedex
France
(33 1) 69 82 60 60

Germany
Hewlett-Packard GmbH
Hewlett-Packard-Strasse
61352 Bad Homburg
Germany
(+49 6172) 16-0

Great Britain
Hewlett-Packard Ltd.
Eskdale Road, Winnersh Triangle
Wokingham, Berkshire RG11 5DZ
England
(44 734) 696622

INTERCON OPERATIONS HEADQUARTERS
Hewlett-Packard Company
3495 Deer Creek Rd.
Palo Alto, California 94304-1316
(415) 857-5027

Australia
Hewlett-Packard Australia Ltd.
31-41 Joseph Street (P.O. Box 221)
Blackburn, Victoria 3130
(61 3) 895-2895

Canada
Hewlett-Packard (Canada) Ltd.
17500 South Service Road
Trans-Canada Highway
Kirkland, Quebec H9J 2X8
Canada
(514) 697-4232

Japan
Yokogawa-Hewlett-Packard Ltd.
1-27-15 Yabe, Sagamihara
Kanagawa 229, Japan
(81 427) 59-1311

China
China Hewlett-Packard, Co.
38 Bei San Huan X1 Road
Shuang Yu Shu
Hai Dian District
Beijing, China
(86 1) 256-6888

Singapore
Hewlett-Packard Singapore
Pte. Ltd.
Alexandra P.O. Box 87
Singapore 9115
(65) 271-9444

Taiwan
Hewlett-Packard Taiwan
8th Floor, H-P Building
337 Fu Hsing North Road
Taipei, Taiwan
(886 2) 712-0404

Returning Your MMS Module for Service

Hewlett-Packard has sales and service offices around the world to provide complete support for your MMS module. To obtain servicing information or to order replacement parts, contact the nearest Hewlett-Packard sales and service office listed in Table 1-4.

Use the following procedure to return your MMS module to Hewlett-Packard for service:

1. Fill out a service tag (available at the end of this service guide) and attach it to the instrument. Please be as specific as possible about the nature of the problem. Send a copy of any or all of the following information:
   - any error messages that appeared on the HP 70000 Series display
   - a completed Performance Test record
   - any other specific data on the performance of the MMS module

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CAUTION Damage can result if the original packaging materials are not used. Packaging materials should be anti-static and should cushion the MMS module on all sides.

Never use styrene pellets in any shape as packaging materials. They do not adequately cushion the instrument or prevent it from moving in the shipping container. Styrene pellets can also cause equipment damage by generating static electricity or by lodging in fan motors.

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2. Place the MMS module in its original packaging materials.

   If the original packaging materials are not available, you can contact a Hewlett-Packard sales and service office to obtain information on packaging materials or you may use an alternative packing material referred to as "bubble-pack". One of the companies that makes bubble-pack is Sealed Air Corporation of Hayward, California, 94545.

3. Surround the MMS module with at least 3 to 4 inches of its original packing material or bubble-pack to prevent the MMS module from moving in its shipping container.

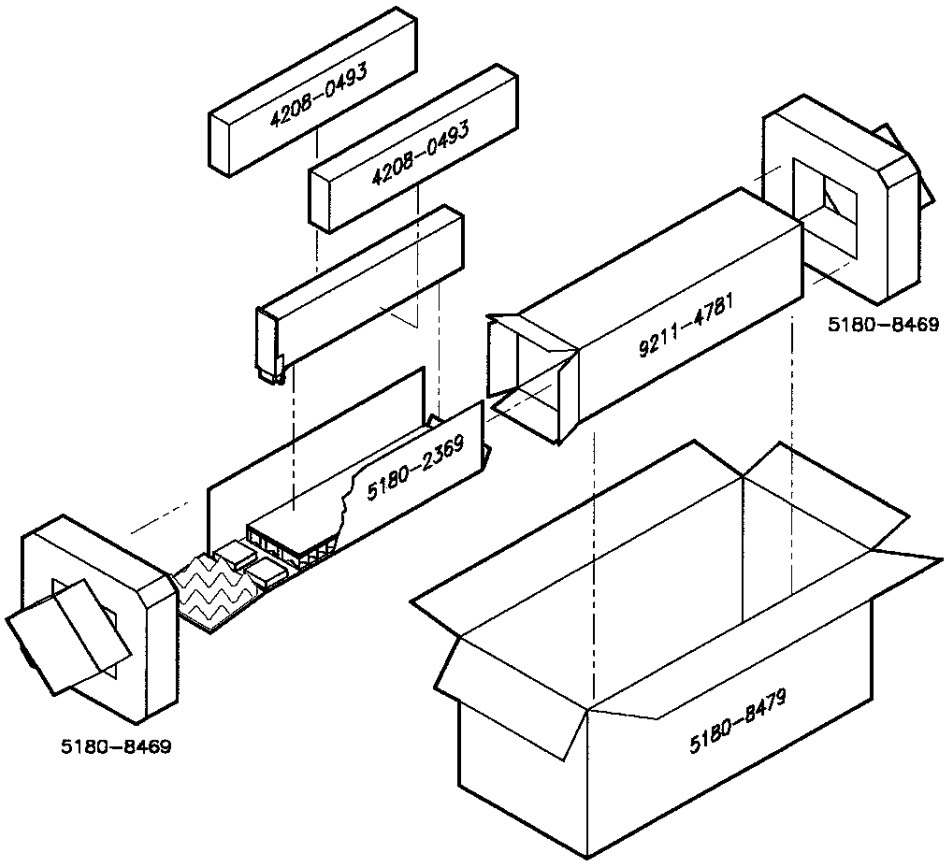
4. Place the MMS module, after wrapping it with packing material, in its original shipping container or a strong shipping container that is made of double-walled corrugated cardboard with 159 kg (350 lb) bursting strength.

   The shipping container must be both large enough and strong enough to accommodate your MMS module and allow at least 3 to 4 inches on all sides for packing material.

5. Seal the shipping container securely with strong nylon adhesive tape.

6. Mark the shipping container "FRAGILE, HANDLE WITH CARE" to help ensure careful handling.

7. Retain copies of all shipping papers.



packing1

Table 1-5. Packaging for a 1/8 Module

Item	Description	HP Part Number	Qty
1	Carton-outer	5180-8479	1
2	Carton-inner	9211-4781	1
3	Carton-sliders	5180-2369	1
4	Foam inserts	4208-0493	2
5	Foam pads	5180-8469	2

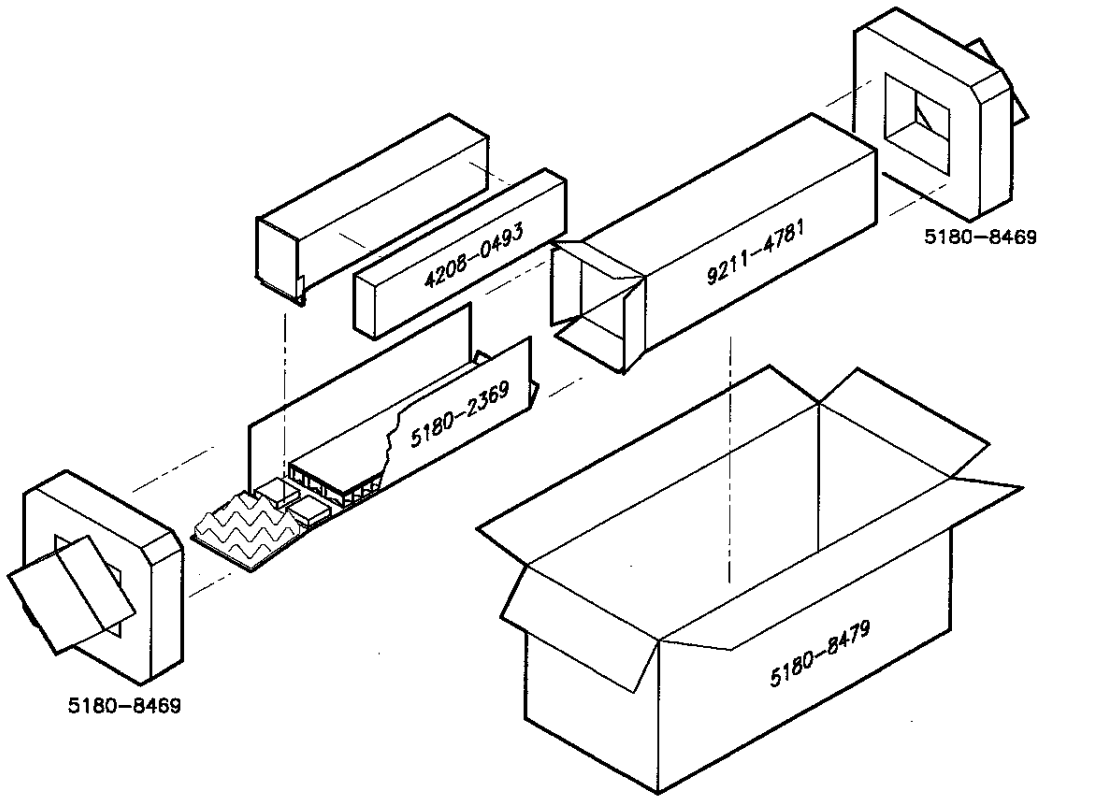


Table 1-6. Packaging for a 2/8 Module

Item	Description	HP Part Number	Qty
1	Carton-outer	5180-8479	1
2	Carton-inner	9211-4781	1
3	Carton-sliders	5180-2369	1
4	Foam inserts	4208-0493	1
5	Foam pads	5180-8469	2

2

Installation

This chapter describes installation of the switch driver or interface modules in an HP 70000 Modular Measurement System mainframe: how to install it, address it, connect it to the switches or switch matrix, and verify its basic functionality.

Note

1. The address switches on the back of the system graphics display (HP 70205A, 70206A, or 70004A) are for the display instrument only. They do *not* set the address of the modules in the system.
2. When the system is first turned on, the HP 70611A, 70612A,C or 70613A,C softkeys may not be visible on the CRT. This is usually caused by the display window's not being assigned to the HP 70611A, 70612A,C or 70613A,C. Assign the display window to an instrument, with a row address of 0, by pressing (DISPLAY), then NEXT INSTR or SELECT INSTR. This assigns the display to the instrument with the lowest column address. Press the (▲) key to assign the display to the instrument with the next-highest column address. Repeat until the label at the bottom of the screen indicates the HP 70611A, 70612A,C or 70613A,C has been selected, then press the (MENU) key.

Module Installation and Removal

It is impossible to predict which configuration of the MMS you have. Here are some general guide lines to follow when installing or removing the HP 70611A, 70612A,C or 70613A,C.

1. *Always* set the MMS LINE switch to OFF before removing or installing any MMS module.
2. Make sure the switch driver is in good condition. Do not install the switch driver if you can see *any* damage to the connectors. Refer to "Initial Inspection" in section 1.
3. Swing the mainframe front door down. On some MMS mainframe models the door will not open unless the LINE switch is OFF.
4. When installing the switch driver, check the module HPIB/HP-MSIB address switches for the correct address. The default address is set to 9. See Figure 2-2.
5. Slide the module into the mainframe.
6. Tighten the module latch using an 8 mm hex-ball driver.

HP-MSIB/HP-IB Addressing

This section describes how to change the HP-IB or HP-MSIB address from the default setting. If the default setting is sufficient, and you want to start using the switch driver, go to section 5, "Local Operation".

HP 70000 Modular Measurement Systems are made up of separate parts called elements. All elements communicate over the HP-MSIB. To communicate and function properly, all elements must have appropriate HP-MSIB addresses.

HP-MSIB addressing is not the same as HP-IB addressing. Given below are definitions of essential terms, and explanations of the three main subjects you must understand to set the HP-MSIB and HP-IB addresses of an element:

- Modular Measurement System Terms
- Address Matrix
- Address Protocol
- Address Switches

Modular Measurement System Terms

Understanding the following terms is essential to understanding HP-MSIB addressing and the structural relationship of modular measurement system devices.

Functional Terms

Functional terms refer to the types of function, or work, that a given device may perform in a system and to the interrelationships that occur among the devices in a system.

Element	Any device (for example, the HP 70611A switch driver) that communicates over the HP-MSIB. In contrast, the MMS mainframe provides a path for all HP-MSIB communication, but does not communicate over the HP-MSIB and therefore is not an element.
Master	An element that controls other elements.
Sub-master	An element that simultaneously controls other elements and is controlled by another element.
Slave	An element that is controlled by another element.
Independent Element	An independent element is not a master and not a slave. A display is an example of an independent element.
Instrument	An independent element and an element that performs an independent function.

Structural Terms

Structural terms refer to the hardware type of the device.

Mainframe	A device designed for modules to plug into. The mainframe supplies power, and HP-IB and HP-MSIB interconnections for the modules.
Module	A plug-in designed to work in a modular measurement system mainframe.
Stand-Alone Instrument	An element that can function without being plugged into a mainframe (for example, the HP 70206A system graphics display).

Address Matrix

The address matrix (see Figure 2-1) is a graphic representation of the addresses on the HP-MSIB and the relationships among elements . The placement of an element on the address matrix is one of the factors that determines whether the element will have HP-IB access and can respond to display queries. (Illustrations of the physical switches used to set these addresses are given in Figure 2-2.)

To allow the elements to communicate and function properly, each element must have a binary eight-bit HP-MSIB address that is appropriately positioned on the address matrix. Every element in a system must have a unique address. The three most significant bits (MSB) of the HP-MSIB address determine the row address; the five least significant bits (LSB) determine the column address (see Figure 2-1). The decimal equivalents of the binary row and column addresses are used throughout this documentation. For example:

	Row	Column
Binary	(MSB) 010	11000 (LSB)
Decimal	2	24

There are eight possible row addresses and 32 possible column addresses. Address 0, 31 (row, column) is an illegal address, leaving 255 HP-MSIB addresses available.

HP-IB Access Area

The HP-IB access area on the address matrix is row 0 (except address 0, 31). Elements that have been designed for HP-IB access will be able to communicate on HP-IB only if they are addressed at row address 0 in the HP-IB access area. Note that IEEE 488.1 limits are 16 addresses on the bus at row 0.

Display-Response Area

When there is a display on the HP-MSIB, a display-response area exists at row address 0 of the address matrix. Only elements that have been designed to interface with the display and report errors (for example, HP 70611A switch driver) should be addressed at row address 0.

Note If an element that does not have these capabilities is addressed at row address 0, the system will cease to communicate. Although there are 32 possible addresses available on the HP-MSIB bus at row 0, Limiting your HP-IB bus to 15 instruments, including the display, is recommended. Ensure the HP-IB Enable switch is ON for a maximum of 15 instruments. See Figure 2-1

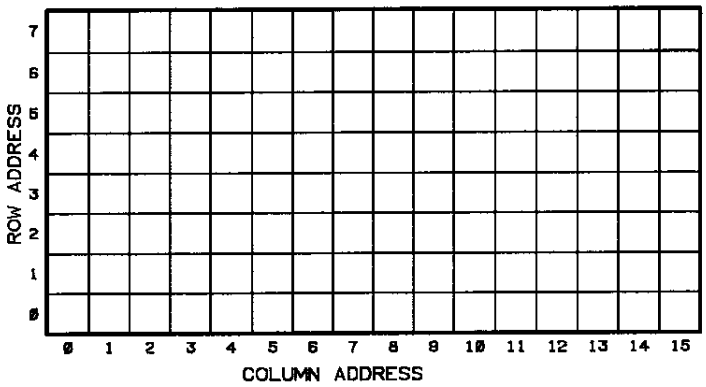


Figure 2-1. Address Matrix

Display Communication Capabilities

Before an element can communicate with the display it must have a display window or keyboard assigned. This assignment provides a communications link between the display and the element.

A display can be assigned to any element at a legal address. The element must have the capability to interface with the display and report errors.

An element that is addressed at row address 0, and has a display assigned to it, can use both the automatic error-reporting routine and the REPORT ERRORS softkey to report errors to the display. To assign a display to an element at row address 0:

1. Press (DISPLAY).
2. Press NEXT INSTR or SELECT INSTR.

This automatically assigns the display to the element with the lowest HP-MSIB column address. Use the (▲) key to select an element with a higher HP-MSIB column address.

A display can be assigned to an element that is at an address other than row address 0; however, the element will not be able to use the REPORT ERRORS softkey to report errors to the display. See your display manual for details.

Address Switches

The address switches set the HP-MSIB address of an element; the column switches also set the HP-IB address for elements and independent elements. Some elements and displays can also have their HP-IB address set through the use of softkeys (that is, soft-set address). The instructions for entering a soft-set HP-IB address are given after the descriptions of the (hard) address switches.

Descriptions of the address switches are given below.

HP 70611A, 70612A,C and 70613A,C HP-IB, HP-MSIB Address Switches

The HP 70611A, 70612A,C and 70613A,C HP-IB binary weighted address switches are located on the top of the module. The default value of 9 is shown. The address switches are shown in Figure 2-2.

COLUMN Address Switches 1–5. These set the HP-MSIB column address, which is also the HP-IB address. The switch labeled with a one is the least significant bit.

ROW Address Switches 1–3. These set the HP-MSIB row address. The switch labeled with a one is the least significant bit.

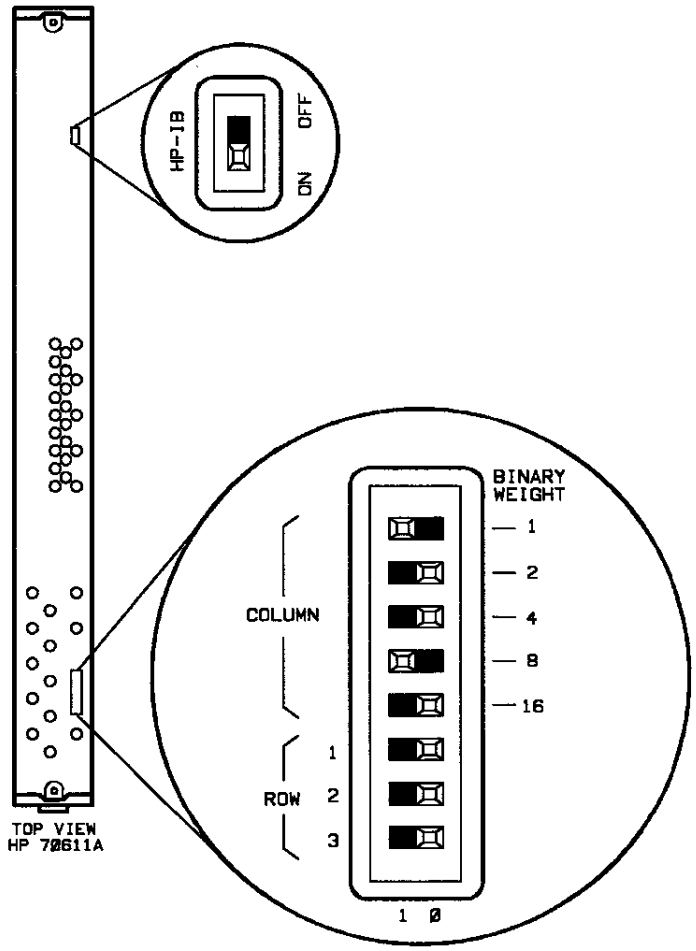


Figure 2-2. HP-IB / MSIB ON/OFF and Address Switch (Default 9 shown)

Soft-Set HP-IB Addresses

The HP-IB address of the switch driver can be set from the front panel of a display. When initially switched on, the soft-set address will override the address switch settings. The soft-set address remains only until the next power cycle or HP-MSIB reset.

Use the following procedure to enter a soft-set HP-IB address:

1. Press [DISPLAY] on the display front panel.
2. When the menu appears, press `address map`.
3. When the next menu appears, select the switch driver, using the display front panel knob or [▲] and [▼] keys.
4. Press `SET HP-IB`.
5. Enter the new HP-IB address, using the numeric keys on the display front panel.

6. Press (ENTER).

Connecting Switch Drivers to Switches and Attenuators

When installing the switch driver, it is imperative to know which wires will cause an OPEN or CLOSED condition on each switch.

CAUTION Miswiring the +24 V wire will cause catastrophic driver board failure. On the standard switch driver, the recommended repair of this kind of failure is replacing the HP 84940A driver board assembly. The recommended repair procedure for an HP 70611A Option 001 is to return the HP 70611A switch driver to Hewlett-Packard for repair.

Standard Switch Driver

Connecting Switches

A standard switch driver can control up to eight HP 84940A driver cards. Each driver card has 31 4-pin black output connectors numbered J1 to J31 (silkscreened on the circuit side of the PCA). On card 1, your first HP 84940A driver card, J1 to J31 correspond to channels 100 to 130 on your switch driver channel menu. Card 2 would correspond to channels 200 to 230; card 3, 300 to 330, and so forth. A typical operating setup showing one driver card is shown in Figure 2-3.

Note The HP 70611A Option 001 already has the driver card installed. It cannot control additional cards.

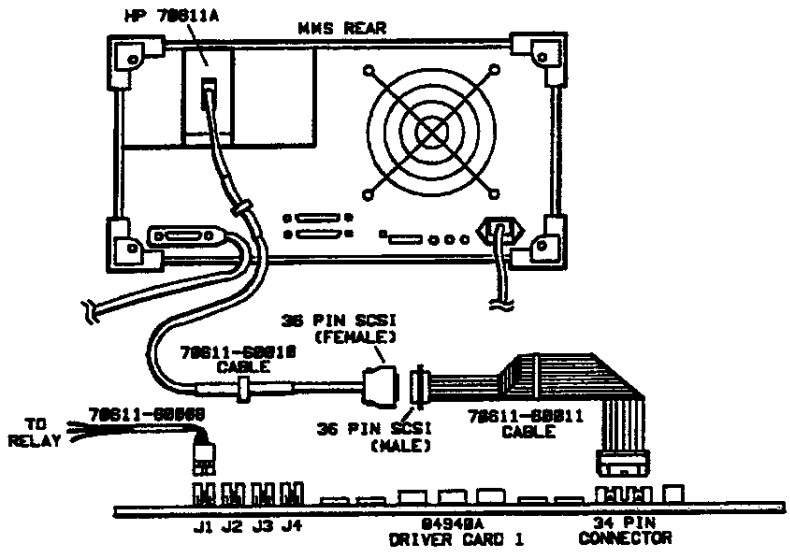


Figure 2-3. HP 70611A Typical Operating Setup

CAUTION Make sure your MMS mainframe is **OFF** before adding or removing relays or miswiring the +24 V can occur. Miswiring the +24 V red wire will cause catastrophic driver board failure. On the standard switch driver, the recommended repair for this kind of failure is replacing the HP 84940A driver board assembly to which the switch was attached. The recommended repair procedure for an HP 70611A Option 001 is to return the HP 70611A switch driver to Hewlett-Packard for repair.

Figure 2-4 shows a single typical switch channel connector.

- An OPEN condition is defined as: the black wire from J1 pin 1 is active-to-common (+24 V dc red wire).
- A CLOSED condition is defined as: the white wire from J1 pin 3 is active-to-common (+24 V dc red wire).

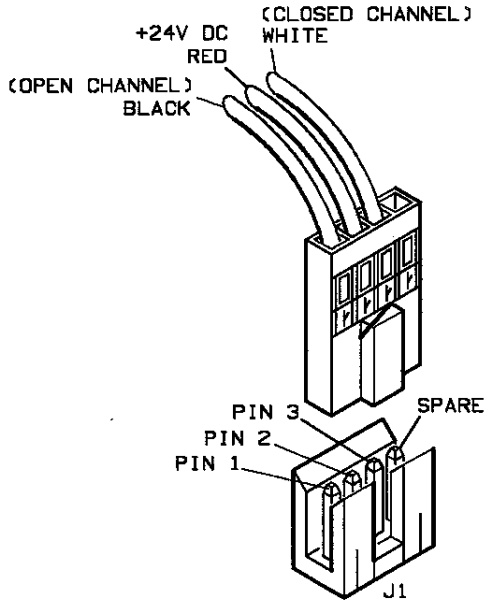


Figure 2-4. Single Typical Switch Channel Connector

Connecting Attenuators

Figure 2-5 shows the typical connection of four section attenuators using a Viking connector and a ten pin connector. When connecting attenuators, a CLOSE position should add attenuation. An OPEN position should remove attenuation.

CAUTION Make sure your MMS mainframe is **OFF** before adding or removing relays or miswiring the +24 V can occur. Miswiring the +24 V red wire will cause catastrophic driver board failure.

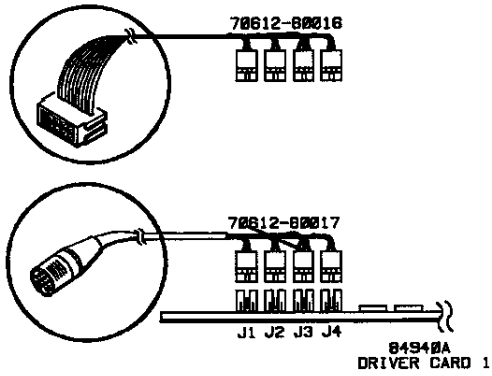


Figure 2-5. Typical Attenuator Connectors to HP 84940A

Connecting for Speed

This section describes how to connect your HP 84940A driver board to relays in order to increase switching speed.

CAUTION Make sure your MMS mainframe is **OFF** before adding or removing relays or miswiring the +24 V can occur. Miswiring the +24 V red wire will cause catastrophic driver board failure.

Note Switching speed is a function of pulse widths, sensing delays, the state of the chosen channels, and the sequence of relays driven. Pulse widths, sensing delays and which channels are opened or closed are determined by the user, and cannot be predicted here.

Explanation

The MMS power supply limits the switch driver to a total of 800 mA to drive relays at any one time. This means that four throws of 200 mA each is the limit for one switching operation.

If it is your objective to increase the speed at which your switch matrix operates, you need to determine which four relays, when connected, will be on the same drive lines. Table 2-1 shows which connectors (J1 to J31) are on the same drive lines. Refer to Figure 2-4 to wire your relay into the arbitrary positions of OPEN and CLOSE.

Table 2-1. Relay Drive Sequence

Drive Line	Connector Locator	Channel List
1	J1, J2, J3, J4	00, 01, 02, 03
2	J5, J6, J7, J8	04, 05, 06, 07
3	J9, J10, J11, J12	08, 09, 10, 11
4	J13, J14, J15, J16	12, 13, 14, 15
5	J17, J18, J19, J20	16, 17, 18, 19
6	J21, J22, J23, J24	20, 21, 22, 23
7	J25, J26, J27, J28	24, 25, 26, 27
8	J29, J30, J31	28, 29, 30

Note The channel number must be preceded by the driver card number. Channels connected to driver card 1 would be numbered 100 to 130; card 2, 200 to 230; card 3, 300 to 330, and so forth.

See the "Example Speed Calculation" at the end of Section 6, "Remote Operation" for an explanation on calculating and minimizing overall switching time.

Connecting Multiple Driver Cards

CAUTION Make sure your MMS mainframe is **OFF** before adding or removing driver cards, or miswiring the +24 V can occur. Miswiring the +24 V red wire will cause catastrophic driver board failure.

Figure 2-6 shows the typical daisy chain of driver cards. Connectors (HP part number 1251-7090) are placed on ribbon cable (HP part number 8120-1727). To reliably install the 34-pin connector to the ribbon cable use the following 3M™ tools: The central order number for 3M™ is 1-800-225-5373.

Platen	3M™ part number: 3442-1A
Locator plate	3M™ part number: 3443-94
Hand press	3M™ part number: 3540

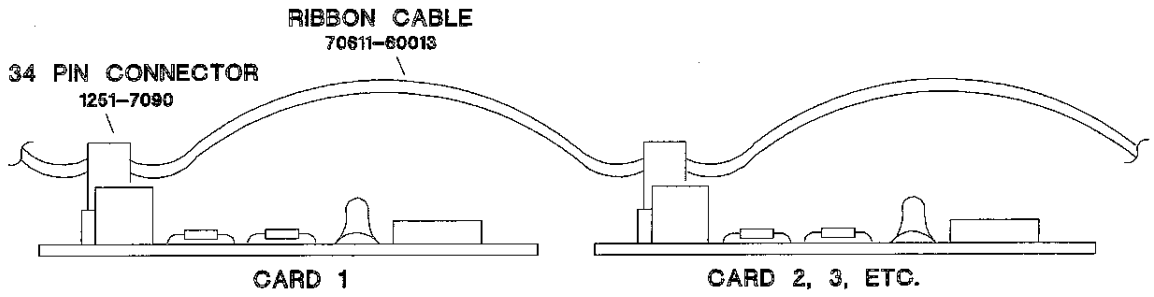
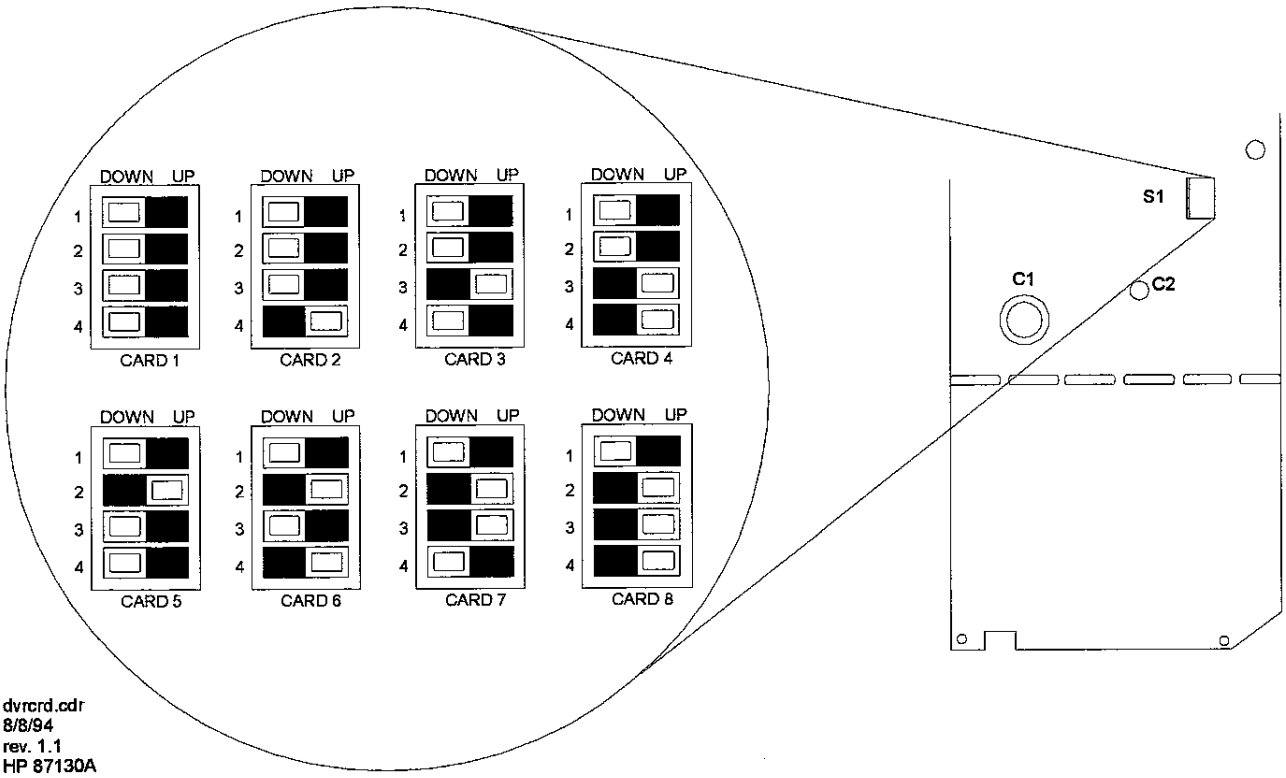


Figure 2-6. Daisy Chain of Driver Cards

Each driver card must have a unique address setting. Find the 4-bit DIP switch on the HP 84940A driver assembly card and set each address according to Figure 2-7.



dvrcrd.cdr
8/8/94
rev. 1.1
HP 87130A

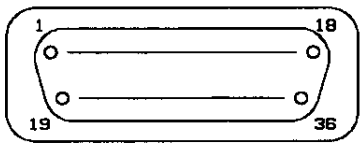
Figure 2-7. Eight Driver Card Addresses

It is impossible to predict the exact configuration of your particular switch matrix. It is assumed that each HP 84940A driver assembly will be in a separate, grounded switch matrix box. The total length of ribbon cable should not exceed 1.8 metres (6 feet) for all eight possible driver cards in order to meet specifications. The total length of wire from the driver card to each switch should not exceed 1.3 metres (4.4 feet).

The rear connector on the standard switch driver is a high density, 36-pin SCSI II type connector. The pin functions are depicted in Figure 2-8.

The standard I/O data cable for the HP 70611A, HP 70612A,C and HP 70613A,C is a five-foot cable with two female, 36-pin SCSI II type connectors.

Note The standard output cable for the HP 70611A is a five-foot cable with two female, high density, 36-pin SCSI II type connectors (HP 70612A,C and 70613A,C Option 008).



Pin	Function	Pin	Function
1	Return	19	D6,Data Line
2	Return	20	D7,Data Line
3	NC	21	D8,Data Line
4	NC	22	D9,Data Line
5	NC	23	D10,Data Line
6	NC	24	D11,Data Line
7	+5 V dc	25	D12,Data Line
8	+5 V dc	26	D13,Data Line
9	+24 V dc	27	D14,Data Line
10	+24 V dc	28	NC
11	Return	29	NC
12	Return	30	Register CLR
13	D0,Data Line	31	Store
14	D1,Data Line	32	I/O
15	D2,Data Line	33	Return
16	D3,Data Line	34	Return
17	D4,Data Line	35	NC
18	D5,Data Line	36	NC

Figure 2-8. Standard 36-Pin (Male) SCSI II Type Connector

HP 70611A Option 001

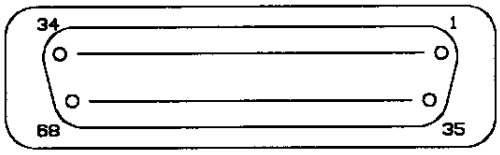
The rear connector for the HP 70611A Option 001 switch driver is a high density, 68-pin SCSI II type connector. A list of accessories for Option 001 switch drivers is located in "Replaceable Parts", chapter 7.

When you wire your Option 001 switch driver to your switches, use Figure 2-9 to define an OPEN or CLOSE position.

Standard output cable for HP 70611A Option 001, 70612A,C and 70613A,C is a six-foot cable with two male, 68-pin SCSI II type connectors.

HP 70612A,C 70613A,C Option 006 and Option 011

The rear connector for the HP 70612A,C and HP 70613A,C Option 006 and Option 011 have two high density, 36-pin SCSI II type connectors.



Pin	Function	Pin	Function
1	Return	35	Return
2	Channel 0,Open	36	Channel 0,Close
3	Channel 1,Open	37	Channel 1,Close
4	Channel 2,Open	38	Channel 2,Close
5	Channel 3,Open	39	Channel 3,Close
6	Channel 4,Open	40	Channel 4,Close
7	Channel 5,Open	41	Channel 5,Close
8	Channel 6,Open	42	Channel 6,Close
9	Channel 7,Open	43	Channel 7,Close
10	Channel 8,Open	44	Channel 8,Close
11	Channel 9,Open	45	Channel 9,Close
12	Channel 10,Open	46	Channel 10,Close
13	Channel 11,Open	47	Channel 11,Close
14	Channel 12,Open	48	Channel 12,Close
15	Channel 13,Open	49	Channel 13,Close
16	Channel 14,Open	50	Channel 14,Close
17	Channel 15,Open	51	Channel 15,Close
18	Channel 16,Open	52	Channel 16,Close
19	Channel 17,Open	53	Channel 17,Close
20	Channel 18,Open	54	Channel 18,Close
21	Channel 19,Open	55	Channel 19,Close
22	Channel 20,Open	56	Channel 20,Close
23	Channel 21,Open	57	Channel 21,Close
24	Channel 22,Open	58	Channel 22,Close
25	Channel 23,Open	59	Channel 23,Close
26	Channel 24,Open	60	Channel 24,Close
27	Channel 25,Open	61	Channel 25,Close
28	Channel 26,Open	62	Channel 26,Close
29	Channel 27,Open	63	Channel 27,Close
30	Channel 28,Open	64	Channel 28,Close
31	Channel 29,Open	65	Channel 29,Close
32	Channel 30,Open	66	Channel 30,Close
33	+24 V dc	67	+24 V dc
34	Return	68	Return

Figure 2-9. 68-Pin (Female) SCSI II Type Connector

3

Specifications

This chapter contains the module specifications for the HP 70611A, 70612A,C and 70613A,C switch driver and interface modules. The specifications are organized into two categories; characteristics and measurement related specifications. Tables in this chapter list **specifications** and **characteristics** together, in the same format. The italic words identify characteristics. The user should understand the distinction between the terms.

Specifications describe warranted performance over the temperature range of 0° C to +55° C after one hour of continuous operation, unless otherwise noted.

Characteristics provide useful but non-warranted functional and performance information.

The performance specifications that follow are the performance standards or limits against which the HP 70611A can be tested. To verify the performance of your HP 70611A, 70612A,C or 70613A,C see chapter 4, "Performance Tests".

Table 3-1. HP 70611A, 70612A,C and 70613A,C Specifications

ELECTRICAL SPECIFICATIONS	
Drive Capacity	
HP 70611A	248 relays, when mated with eight HP 84940A daisy chained driver cards. *Each HP 84940A can drive up to 31 relays.*
HP 70611A Option 001	31 relays. *The equivalent of one HP 84940A driver card is installed within the module.*
HP 70612A,C and HP 70613A,C	217 relays, when mated with seven HP 84940A daisy chained driver cards. *Each HP 84940A can drive up to 31 relays.*
Voltage	+24 ±3.0 Vdc
Current Pulses	800 mA maximum per four relay group. 200 mA per relay. *Pulse width is adjustable for 5 ms to 1275 ms ± 5 ms, in 5 ms steps.*
Load Inductance	*Typically <500 mH.*
Load Capacitance	*Typically <0.01 μF.*
Switching Speed	Sensing delay is adjustable, per relay, from 5 to 1275 ms ± 5 ms. Pulse width is also adjustable, per relay, from 5 to 1275 ms ± 5 ms. *See chapter 6, "Example Speed Calculation". The final switching speed is a function of pulse widths, sensing delays, the sequence of relays driven, and the state of the chosen channels.*
Remote Programming	All functions are HP-IB or HP-MSIB programmable except the line switch and bus address. All functions are programmable to conform with IEEE 488.2-1987 Standard Commands for Programmable Instruments (SCPI). The HP 70611A, 70612A,C and 70613A,C can output over the interface almost all settings, error/malfunction codes and operational status codes.
Interface to controller	16-bit bidirectional (custom) TTL
Interface to external drivers	36-pin SCSI
Interface to relays	
HP 70611A Option 001	68-pin SCSI
HP 70612A,C and HP 70613A,C	68-pin SCSI

Table 3-1.
HP 70611A, 70612A,C and 70613A,C Specifications (continued)

GENERAL SPECIFICATIONS	
Environmental Specifications	
Temperature	
Operating	−5°C to +60°C
Survival	−40°C to +70°C
Humidity	95% relative humidity at 40°C max
Altitude	
Operating	4 600 meters (15 000 feet)
Operating (Functional)	15 300 meters (50 000 feet)
Vibration	
Operating	0.21 g (rms)
Survival	2.1 g (rms)
Swept Sine	0.5 g (pk)
Shock	
End Use	350 g (pk) for 3 ms duration
Transportation	100 g (pk) for 30 ms duration
Electromagnetic Compatibility	
Military Specification	Conducted and radiated interference is in compliance with CISPR, Publication 11 (1985), and Messempfaenger-Postverfuegung 526/527/79 (Kennzeichnung Mit F-Nummer/Funkschutzzeichen). Meets the requirements of MIL-STD-461B.
Maximum Power Dissipation	180 watts
Weight	
HP 70611A	3.2 kg (7 lb)
HP70612A,C and 70613A,C	3.9 kg (8.5 lb)
Dimensions	
HP 70611A	Standard 1/8-width module
HP 70612A,C and HP 70613A,C	Standard 2/8-width module

Table 3-2. HP 70612A,C and HP 70613A,C RF Path Specifications

Specification	HP 70612A, 70613A	HP 70612C, 70613C
Frequency Range	DC to 6.0 GHz	DC to 18.0 GHz *18 to 26.5 GHz typical*
Isolation *(f = frequency in GHz)* (between adjacent ports) Option 002	 >120 – 4.2f dB >100 dB	 >110 – 2.8f dB >60 dB
Insertion Loss *(f = frequency in GHz)* (any path) Option 003, 004 (any path) Option 005, 006 (any path) Option 007 (any path)	 <0.8 + 0.2f dB <1 + 0.25f dB <1 + 0.25f dB <1 + 0.4f dB	 <1.5 + 0.22f dB (18 GHz) *6.5 dB (18 to 26.5 GHz) typical* <1.5 + 0.28f dB (18 GHz) *8.0 dB (18 to 26.5 GHz) typical* <1.5 + 0.28f dB (18 GHz) *8.0 dB (18 to 26.5 GHz) typical* <2.0 + 0.35f dB (18 GHz) *10.0 dB (18 to 26.5 GHz) typical*
Switching Speed Option 002	<30 ms <20 ms	<30 ms <20 ms
SWR (any port)	<1.4:1	<1.7:1 (18 GHz) *2.7:1 (18 to 26.5 GHz) typical*
Maximum Power Average Peak	 >1 W >100 W	 >1 W >100 W
Repeatability	<0.1 dB	<0.1 dB
Lifetime Option 002	>1 × 10^6 cycles >5 × 10^6 cycles	>1 × 10^6 cycles >5 × 10^6 cycles
Electrical Interface Option 006 and 011 CPU Output Driver Card Input	 36 pin SCSI II (male) 36 pin SCSI II (male)	 36 pin SCSI II (male) 36 pin SCSI II (male)

4

Verification

Introduction

The procedures in this section test the electrical performance of the HP 70611A, 70612A,C and 70613A,C. The specifications in chapter 3, Specifications, are used as the performance standards.

Note If the performance tests are to be considered valid, the following conditions must be met:

- The HP 70611A, 70612A,C or 70613A,C must have one-half hour warm-up for all specifications.
- The module must be a component in an MMS mainframe.
- The ambient temperature must be 0° to 55° C.
- The HP 70611A, 70612A,C or 70613A,C must pass all self tests.

Performance Tests

The performance tests given in this section are suitable for incoming inspection, troubleshooting, or preventive maintenance. During any performance test, all shields and connecting hardware must be in place. The tests are designed to verify published instrument specifications.

Test Procedures

It is assumed that the person performing the following tests understands how to operate the specified test equipment. Equipment settings, other than those for the HP 70611A, 70612A,C or 70613A,C are stated in general terms. It is also assumed that the technician will select the proper cables, adapters, and probes required for the test setups illustrated in this section.

Equipment Required

The equipment and accessories required for the performance tests are listed below in Table 4-1. Other equipment may be substituted if it meets or exceeds the critical specifications listed.

Table 4-1. Recommended Test Equipment for HP 70611A

Instrument	Critical Specifications	Recommended Model	Use[1]
External Driver HP 70611A Standard	No substitute.	HP 84940A	O,P,T
Modular Measurement System	No substitute.	HP 70000 (with display)	O,P,T
Oscilloscope	Bandwidth: dc - 100 MHz Vertical Sensitivity: 4 V/div Vertical Input: 50Ω impedance dc coupled Timebase: 5 ms/div	HP 54100A,D or HP 54110D or HP 54111A,D	P,T
Test Accessory	No substitute. Made specifically for HP MMS switch drivers.	HP 70611-60014	P,T
Cable	No substitute. Made specifically for HP MMS switch drivers.	HP 70611-60010	P,T
[1]P = Performance Tests, T = Troubleshooting, O = Operator's Checks			

Table 4-2.
Recommended Test Equipment for HP 70612A,C and HP 70613A,C

Instrument	Critical Specifications	Recommended Model	Use[1]
External Driver HP 70612A,C and HP 70613A,C Except Options 006 and 011	No substitute	HP 84940A	O,P,T
External CPU HP 70612A,C and HP 70613A,C Option 006 and 011 only	No substitute	HP 70611A, 70612A,C, or 70613A,C	O,P,T
Oscilloscope	Bandwidth: dc - 100 MHz Vertical Sensitivity: 4 V/div Vertical Input: 50Ω impedance dc coupled Timebase: 5 ms/div	HP 54100A,D or HP 54110D or HP 54111A,D	P,T
Test Accessory	No substitute. Made specifically for HP MMS switch drivers.	HP 70611-60014	P,T
Cable	No substitute. Made specifically for HP MMS switch drivers.	HP 70611-60010	P,T
Network Analyzer HP 70612A, 70613A HP 70612C, 70613C	 DC - 6.5 GHz DC - 26.5 GHz	 HP 8510B HP 8510B	 O,P,T O,P,T
Synthesized Sweeper	DC - 26.5 GHz	HP 83651A	O,P,T
Spectrum Analyzer HP 70612A, 70613A HP 70612C, 70613C	 DC - 6.5 GHz DC - 26.5 GHz	 HP 71209A HP 71209A	 O,P,T O,P,T
[1]P = Performance Tests, T = Troubleshooting, O = Operator's Checks			

To Install the Module

1. Set the Modular Measurement System's LINE switch to OFF.
2. Ensure that the switch driver's HP-MSIB switch is set to 9.

Note Each module in the Modular Measurement System mainframe has a unique HP-MSIB address.

---

3. Open the Modular Measurement System's door and slide the HP 70611A, 70612A,C or 70613A,C into any available slot.
4. Using a hex-ball driver, tighten the hex-ball nut at the bottom of the HP 70611A, 70612A,C or 70613A,C until it is firmly seated in the Modular Measurement System.
5. Close the Modular Measurement System's door.
6. Set the Modular Measurement System's LINE switch to ON.

To Display Readings

1. Press the (DISPLAY) key on the graphics display.
2. Press the SELECT INSTR or NEXT INSTR key.
3. Press (▲) or (▼) until the following message appears at the bottom of the display:

   `Row 0 Column 9: 70611A, Sw Driver` (Or 70612A,C or 70613A,C as appropriate.)
4. Press the (MENU) key on the graphics display to display the module's menu.

Pulse Parameters Test

Specification

Electrical Characteristics	Performance Limits	Conditions
Switching Speed:	0.050 ±0.005 s	(User set). Pulse width + delay.
Pulse width:		
Maximum:	1.275 ±0.005 s	
Minimum:	0.005 ±0.005 s	
Default:	0.030 ±0.005 s	
Sensing Delay:		
Maximum:	1.275 ±0.005 s	
Minimum:	0.005 ±0.005 s	
Default:	0.020 ±0.005 s	
Power:		
Voltage	+24±3.0 Vdc	
Current	800 mA maximum	200 mA per relay

Description

Sensing Disabled

The HP 70611A, 70612A,C or 70613A,C is designed to drive electro-mechanical switches (see Table 1-1 and 1-2). Each switch coil is internally connected between the +24 V bias supply and a power transistor. The transistor provides the ground return. A DC switch for the controller assembly provides the base current to actuate the transistor. This control current is nominally set to provide a pulse width of 20 ms. At the default setting, the switch driver provides a 30 ms pulse for actuating the electro-mechanical switch.

Sensing Enabled

The switch should be driven an additional 20 ms after the initial 30 ms closure pulse to allow sense lines to settle. At this time an error and a programmed position check are performed. The combined time for the switch driver to close a switch and verify its position is 50 ms.

Hardware Limits

The +24 volt supply in the switch driver can supply sufficient current to drive up to four HP 33311/8762 Series relays at one time.

Each open collector driver IC can drive only one channel (a maximum of four switches) at a time to avoid exceeding package dissipation limits.

Performance Test

The following procedure verifies the drive pulse parameters as delivered to the switches from the rear panel (as is the case with the HP 70611A Opt 001) and from an external HP 84940A (as is the case with the HP 70611A, 70612A,C and 70613A,C).

One channel (capable of driving four switches) is tested for switching speed at 30 ms (sensing disabled) and 50 ms (sensing enabled), voltage at +24 Vdc, and current at 200 mA for each switch (800 mA for all four switches).

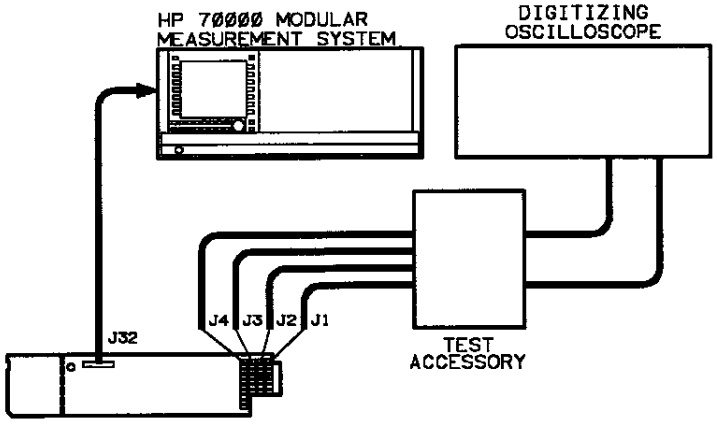


Figure 4-1. Pulse Parameters Test Setup

Equipment

Modular Measurement System ..... HP 70000 Series
Oscilloscope ..... HP 54100A,D
Load 70611-60014
Driver Board (HP 70611A, 70612A,C and 70613A,C) ..... HP 84940A
Cable (HP 70611A, Opt 001) 70611-60004

Procedure

In this example the HP-MSIB address is set to 9.

1. Set your MMS mainframe system's LINE switch to OFF.

CAUTION Do not connect or disconnect relays while the MMS mainframe LINE switch is ON, or an unintentional short to +24 V could occur. This will cause a catastrophic driver board failure.

---

2. Connect the equipment as shown in Figure 4-1. Connect to J1, J2, J3, J4 if using an external driver card. Connect to cable (HP part number 70611-60004) if using an HP 70611A, Option 001, 70612A,C or 70613A,C.
3. Set the oscilloscope as follows:

   Volts/Div ..... 5 V
   Pulse Width ..... 10 ms per division
   Trigger ..... INTERNAL

4. Set the System's LINE switch to ON.
5. If necessary, bring the interface module's display onto the screen.

6. Toggle channels 100, 101, 102, and 103 by pressing [Channel] and [TOGGLE].

or

If you are using an HP Series 200/300 controller, use the following program:

```
10 OUTPUT 709:"*RST"
20 OUTPUT 709;"ROUT:DRIV:ON (@100:103);"
30 OUTPUT 709;"ROUT:DRIV:OFF (@104:130);"
40 !
50 ! OUTPUT 709;"ROUT:VER:ON (@100:103);"
60 !
70 ! For the Sensing (:VERify) Disabled test, comment out line 50
80 ! and leave line 100 in the program, as shown here.
90 !
100 OUTPUT 709;"ROUT:VER:OFF (@100:103);"
110 !
120 ! For the Sensing (:VERify) Enabled test, comment out line 100 and
130 ! leave line 50 in the program.
140 !
150 OUTPUT 709;"ROUT:WIDT .03,(@100:103);"
160 !
170 ! This sets the pulse (:WIDTh) to the default 30 ms.
180 !
190 OUTPUT 709;"ROUT:DEL .02,(@100:103);"
200 !
210 ! This sets the sensing (:DELay) to the default 20 ms.
220 ! When sensing (:VERify) is OFF (line 100), (:DEL) does not apply.
230 ! Switching speed is then the 30 ms pulse (:WIDTh).
240 !
250 OUTPUT 709;"ROUT:CLOS (@100:103);"
260 PAUSE
270 OUTPUT 709;"ROUT:OPEN (@100:103);"
280 END
```

Voltage

1. Set the oscilloscope to: 5 V/div
2. Read the oscilloscope.
3. Record this reading:

+21 V< _____ <27 V

Current

1. Divide voltage by **120 Ω** to get the value of the current.

200 mA< _____

Switching Speed (sensing disabled)

1. Set the switch driver to: 30 ms Pulse Width
2. Set the oscilloscope to: 5 ms/div
3. Read the oscilloscope.
4. Record this reading:

25 ms< _____ <35 ms

Switching Speed (sensing enabled)

1. Set the switch driver to: 20 ms Delay
2. Set the oscilloscope to: 10 ms/div
3. Read the oscilloscope.
4. Record this reading:

45 ms< _____ <55 ms

HP 70611A, 70612A,C 70613A,C Range	Min	Actual Results	Max
Voltage	21 Vdc	_____	27 Vdc
Current	175 mA	_____	225 mA
Switching Speed:			
Sensing Disabled	25 ms	_____	35 ms
Sensing Enabled	45 ms	_____	55 ms

Microwave Verification Tests — HP 70612A,C and HP 70613A,C Only

Reflection and Insertion Loss Test

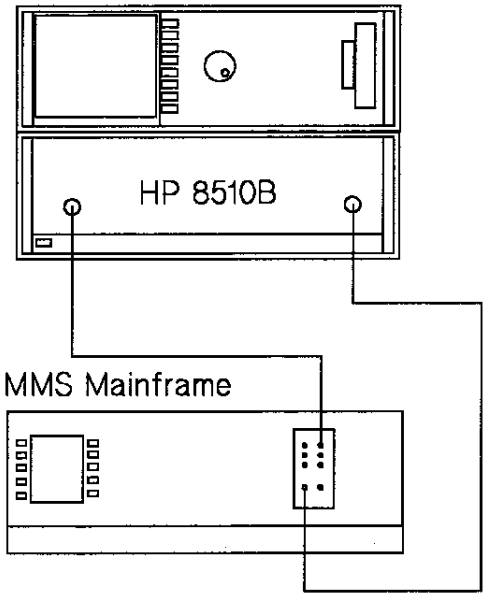


Figure 4-2. Reflection and Insertion Loss Test Setup

Equipment

Modular Measurement System Display/Mainframe ..... HP 70004
Network Analyzer ..... HP 8510B,C
Synthesized Sweeper ..... HP 83651A
S Parameter Test Set ..... HP 8517A
3.5 mm Calibration Kit ..... HP 85052B

Procedure

To Measure Reflection

1. Connect the equipment as shown in Figure 4-2.
2. Set the system's LINE switch to ON.
3. Press (INST PRESET) on the network analyzer.
4. Calibrate the HP 8510B,C using the 3.5 mm (male - male) calibration procedure.
5. Press (S_{11}) on the network analyzer.
6. Set the network analyzer as follows:

   Reflection ..... 50 milliunits per division,
   Reference ..... 0 milliunits
   Reference position 0

a. Press Local.
b. Press Cal.
c. Press Load Cal 3.5 mm (male - male).
d. Press Full 2 Port.
e. Connect a THRU device (f - f).
f. Press FWD Trans Thru, FWD Match Thru.
g. Press REV Trans Thru, REV Match Thru.
h. Press Trans Done.
i. Press Reflection.

7. Connect a short to Port 1 of the switch driver. Press S11 SHORT.
8. Remove the short and connect an open to Port 1. Press S11 OPEN.
9. Remove the open and connect a lowband load to Port 1. Press S11 LOAD AND LOWBAND.
10. Remove the lowband load and connect a sliding load to Port 1. Press SLIDING LOAD.
11. Set the sliding load to the first mark. Press SLIDING LOAD SET.
12. Repeat the above step for all sliding load marks.
13. Press SLIDING LOAD DONE.
14. Press LOADS DONE.
15. Press S22 SHORT.
16. Repeat steps 7 through 13 for Port 2 (S22).
17. When the calibration of Port 2 is complete press REFLECTION DONE.
18. Press ISOLATION.
19. Connect a broadband load to Port 1 and Port 2.
20. Press FWD ISOLATION.
21. Press REV ISOLATION.
22. Press ISOLATION DONE.
23. **IMPORTANT!** Be sure to save the calibration in an empty cal set on the network analyzer.

Measure the reflection for all desired paths. See chapters 5 or 6, Programming Internal Switches and Optional Step Attenuators for information on selecting paths or attenuators.

HP 70612A and 70613A	Reflection (SWR) _____	0.17 (<1.4:1)
HP 70612C and 70613C	Reflection (SWR) _____	0.26 (<1.7:1) 18 GHz
	Reflection (SWR) _____	*0.46 (<2.7:1) 18–26.5 GHz*

To Measure Insertion Loss

1. Press [S21] on the network analyzer.
2. Set the network analyzer as follows:

   Insertion loss ..... 1 dB per division
   Reference level ..... 0 dBm
   Reference position 10

Measure the insertion loss for all desired paths. See chapters 5 or 6, Programming Internal Switches and Optional Step Attenuators for information on selecting paths or attenuators.

	f = Frequency in GHz	
HP 70612A and 70613A	Insertion Loss _____	<0.8 + 0.2f dB
Option 003, 004	Insertion Loss _____	<1.0 + 0.25f dB
Option 005, 006	Insertion Loss _____	<1.0 + 0.25f dB
Option 007	Insertion Loss _____	<1.0 + 0.4f dB
HP 70612C and 70613C	Insertion Loss _____	<1.5 + 0.22f dB (18 GHz)
	Insertion Loss _____	*<6.5 dB (18–26.5 GHz)*
Option 003, 004	Insertion Loss _____	<1.5 + 0.28f dB (18 GHz)
	Insertion Loss _____	*<8.0 dB (18–26.5 GHz)*
Option 005, 006	Insertion Loss _____	<1.5 + 0.28f dB (18 GHz)
	Insertion Loss _____	*<8.0 dB (18–26.5 GHz)*
Option 007	Insertion Loss _____	<2.0 + 0.35f dB (18 GHz)
	Insertion Loss _____	*<10.0 dB (18–26.5 GHz)*

Note When measuring insertion loss >80 dB on the HP 70612C and 70613C options 003, 004 or 007 the Isolation test setup should be used. See Figure 4-3. Measure the desired path by connecting the HP 83651A synthesized sweeper to the input port and the HP 71209A signal analyzer front end to the desired output.

Note When measuring the attenuation levels for option 003, 004 or 007, the measurement should be made by cycling through each attenuation step and comparing the measured value to the insertion loss of the 0 dB position. The HP 70612A and 70613A option 004 will be measured to 110 dB. The HP 70612C and 70613C option 004 range is 0 to 90 dB. The HP 70612A,C and HP 70613A,C option 003 range is 0 to 11 dB. Option 007 combines options 003 and 004.

Each attenuator may be tested separately. It is not necessary to make the complete set of attenuation insertion loss measurements for every possible switch path.

Isolation Measurement

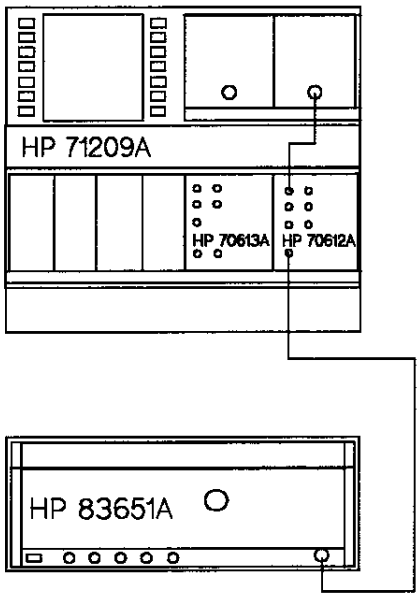


Figure 4-3. Isolation Test Setup

Equipment

Modular Measurement System display/mainframe ..... HP 70004A
Spectrum Analyzer ..... HP 71209A
Synthesized Sweeper ..... HP 83651A
50 Ohm Load, 3.5 mm (m) ..... HP 909D

Note The HP 70612A,C or 70613A,C may be plugged into the HP 71209A spectrum analyzer if space is available. This will eliminate the need for the HP 7004A MMS mainframe.

Procedure

1. Connect the equipment as shown in Figure 4-3
2. Set the system's LINE switch to ON.
3. Set the sweeper as follows:

   HP 70612A and 70613A (50 MHz–6.5 GHz)
   HP 70612C and 70613C (50 MHz–26.5 GHz)

   Output level ..... 0 dBm
   Span ..... 50 Hz
   Center frequency ..... 0 to 26.5 GHz in 1 GHz steps
   Power level ..... 10 dBm (0.5–18 GHz)
   ..... 1 dBm (18–26.5 GHz)

4. Set the spectrum analyzer as follows:

   HP 70612A and 70613A (50 MHz–6.5 GHz)
   HP 70612C and 70613C (50 MHz–26.5 GHz)

   Frequency span ..... 50 Hz
   Resolution bandwidth ..... 10 Hz
   Center frequency ..... 0 to 26.5 GHz in 1 GHz steps
   Input attenuator ..... 0 dB
   Reference level ..... –60 dBm
   Sweep ..... Continuous
   Sweep time ..... Auto
   Trace data format ..... Binary

Note If option 003, 004 or 007 is included, the switch driver's attenuators should be set to 0 dB for the isolation tests.

---

5. Measure any HP 70612 or 70613 thru path by connecting the sweeper to the input and the spectrum analyzer to the output.

   The measured value may be stored in memory. It will be the reference level to which all subsequent isolation measurements are compared.

6. Connect the 50 ohm load to the thru path.

7. Connect the sweeper to the input and the spectrum analyzer to the output of the desired path.

8. Measure isolation for all desired paths. The high dynamic range needed by the isolation test requires a narrow resolution bandwidth setting on the signal analyzer. This makes it practical to step through the 0 to 26.5 GHz bandwidth in 1 GHz steps (more steps may be measured if desired).

   Isolation is calculated as:

   Isolation (in dB) = (Source power – Thru loss) – Measured power

	f = Frequency in GHz
HP 70612A and 70613A	Isolation _____ <120 – 4.2f dB
Option 002	Isolation _____ <100 dB
HP 70612C and 70613C	Isolation _____ <110 – 2.8f dB
Option 002	Isolation _____ <60 dB

5

Local Operation

This chapter describes those functions of the HP 70611A, 70612A,C and 70613A which are accessed through softkeys via the display module. This is known as the *manual interface.*

The organization of this chapter is as follows:

- **Preparation For Switch Driver Operation** describes how to prepare the switch driver for initial operation.
- **Display Keys Overview** describes general concepts that pertain to the hardkeys and softkeys and their functions. A command tree for each dedicated softkey or "firmkey" (left side of the MMS display) is available here.
- **Operating Example** describes the set up and operation of a four-section (step) attenuator. Everyone who programs or uses the switch driver should perform the steps described in this example. Performing these steps takes about an hour and will provide the user with a working knowledge of the switch driver operation. More detailed descriptions of softkey parameters are listed alphabetically following the example.
- **Softkey Reference** is an alphabetized list of commands for the manual interface (display keys). Remote commands associated with that function are also referred to for easy reference in the "Remote Operation" section of this manual.

Preparation for Switch Driver Operation

If you are an experienced MMS user, not interested in descriptions of the common MMS display softkeys, preset conditions of the switch driver, and just want to drive a few switches, ignore this section and go to the "Operating Example" section.

The display front panel keys are necessary to access the functions of the switch driver.

- The (DISPLAY) or (DSP) key accesses the entire Display Main Menu, which enables all the display functions. For more information on the display, refer to the display documentation.
- The (MENU) or (MNU) key accesses the functions of the switch driver.
- The (USER) or (USR) key performs the same function as the (MENU) key.
- The (INSTR PRESET), or (I-P) (Instrument Preset) key sets the switch driver to the state described under * RST.

The switch driver system must be properly installed and configured prior to performing any manual operations. Refer to the "Installation" section of this manual for correct installation and configuration instructions for a switch driver system.

Use the following procedure to prepare the switch driver for operation.

1. Press the (DISPLAY) or (DSP) key on the display front panel to access the Display Main Menu.
2. Press SELECT INSTR or NEXT INTR until the display at the bottom of the screen indicates the HP 70611A switch driver has been selected as the active module.
3. Press the (MENU) key to display the Main Menu of the switch driver.
4. If desired, press (INSTR PRESET) or (I-P) to set the switch driver to a known state.

Note To return to the Main Menu from the second-level menu structure, press the (Menu) or (←) key on the front panel of the display.

Display Keys Overview

The HP 70611A switch driver Main Menu is shown in Figure 5-1. The Main Menu contains two types of softkeys. The softkeys on the left side of the display are dedicated softkeys. The functions associated with these keys do not change. Only the functions associated with the softkeys on the right side of the display change. The functions for the softkeys on the right side of the display are dependent upon the dedicated softkey selected.

If a key is shown in lower case, this indicates that a lower-level menu exists. A key shown in upper-case letters indicates that there are no further lower-level menus.

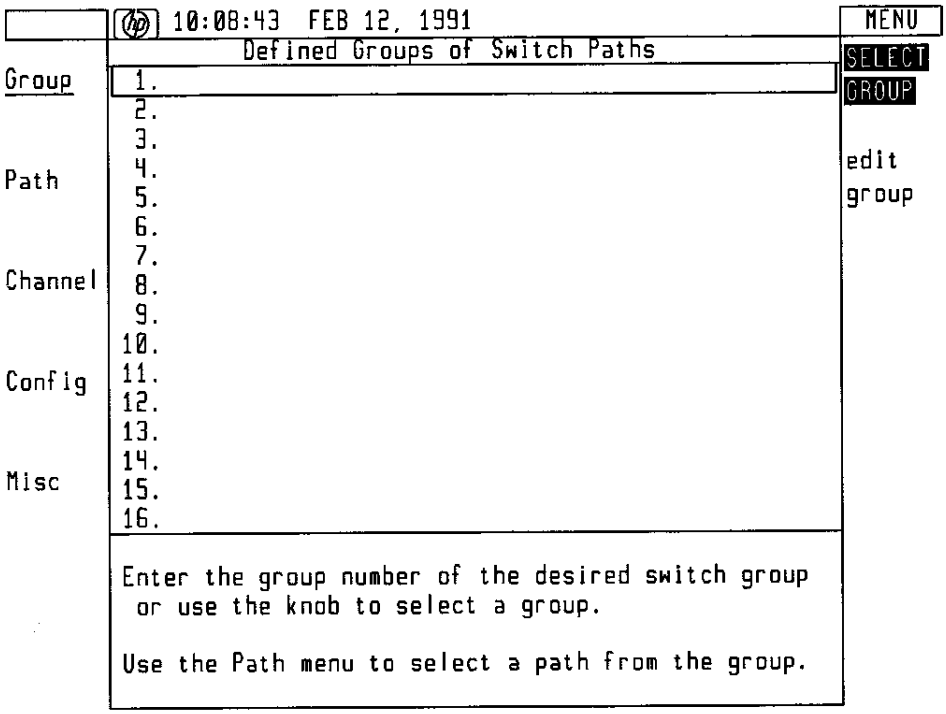


Figure 5-1. HP 70611A Switch Driver Main Menu

When a dedicated softkey is selected the label for the key will flash in inverse video and the label will then be underlined. When a softkey is selected whose function is performed immediately, the label for the key will flash in inverse video for the duration of the function.

If a softkey is selected that requires data to be entered, the label for the softkey will be displayed in inverse video, and will not flash.

For some softkey functions, alphanumeric data values are required. These are values that you set for features like switching delay, or naming groups and paths. These values may be entered using the numeric keypad, HP-IL keyboard, the labeling function of the display interface, or the controller. This chapter refers only to the display keys.

If a function requires that data be entered, the data will appear in the lower left portion of the screen.

A graphic representation of all the HP 70611A switch driver softkeys and how they relate to the overall Main Menu of the switch driver is shown in "Display Key Sequence". Corresponding remote commands are described in the "Remote Operation" section of this manual.

Operating Example

This operating example is for those users who are already familiar with MMS operation and want to quickly see how the switch driver works. It should take under an hour to complete. There is a detailed explanation of each function of the manual interface listed alphabetically in "Softkey Reference".

The example describes a common setup of a four-section, 10 dB step attenuator. (HP 8496H).

If you have an HP 70611A Option 001, you will have different setup and slightly different screens than those provided in this example.

Although advisable, it is not necessary to set up the switching attenuator described in this example. Switches of your choice can be substituted or you may elect to perform the activities without a setup.

If you have elected to set up a four-section, 10 dB step attenuator like the HP 8496H:

Note Notice that we have setup attenuators so a CLOSE position will add attenuation and an OPEN position will remove attenuation. See Figures 2-4, 2-5, and 2-6.

CAUTION Make sure your MMS Mainframe is **OFF** before wiring relays or adding driver boards or miswiring the +24 V red wire could occur. Miswiring the +24 V wire will cause catastrophic driver board failure.

1. Make sure the mainframe is OFF.
2. Refer to Table 5-1.
3. Refer to section 2, "Installation" (Figures 2-3, 2-4, 2-5, and 2-6) to connect the attenuators.
4. Connect J1 through J4 of the first driver card to the attenuator according to Table 5-1.

Table 5-1. Attenuator Switching Order

Atten.	J1-10 dB	J2-20 dB	J3-40 dB	J4-40 dB
0 dB	–	–	–	–
10 dB	X	–	–	–
20 dB	–	X	–	–
30 dB	X	X	–	–
40 dB	–	–	–	X
50 dB	X	–	X	–
60 dB	–	X	X	–
70 dB	X	X	X	–
80 dB	–	–	X	X
90 dB	X	–	X	X
100 dB	–	X	X	X
110 dB	X	X	X	X

Power Up

Turn the LINE switch on your MMS mainframe to the ON position. Select the switch driver module. The screen should look like Figure 5-2. (If not, press `Misc` `INIT RAM`.)

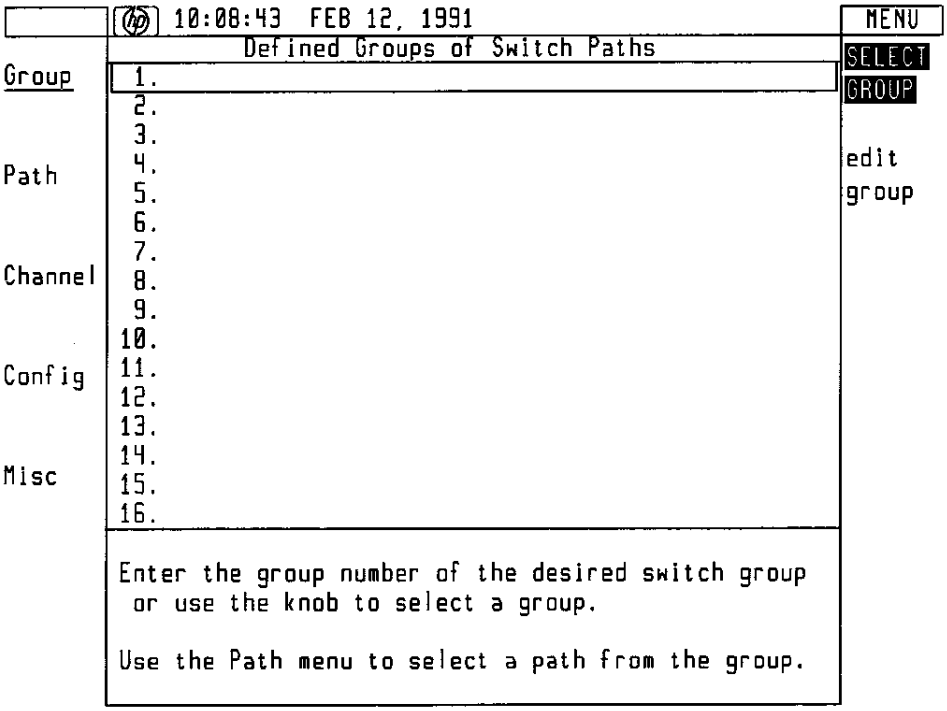


Figure 5-2. Initial Switch Driver Power Up Display

Toggling Switches

To check switch position, toggle the switching attenuators.

1. Press Channel. The display should look like Figure 5-3.

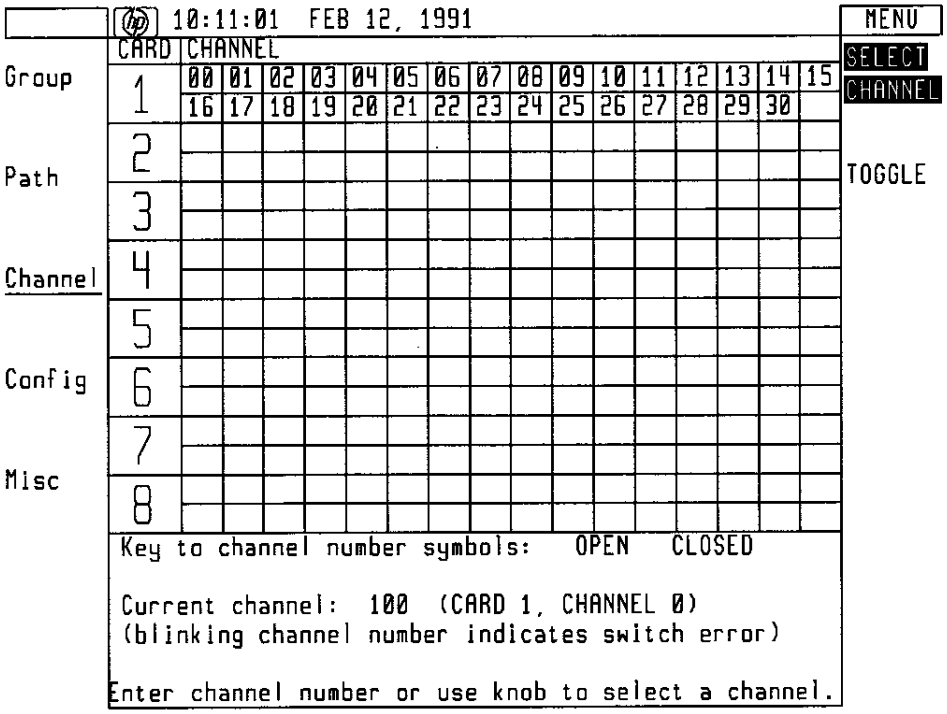


Figure 5-3. Channel Display

2. Press TOGGLE. Inverse video on the 00 box, indicates the switch is closed. 10 dB of attenuation would be in the signal path. You should be able to hear the switch as it toggles.
3. Press TOGGLE again, the 00 box returns to normal video, indicating an open (thru) position.

Explanation

At this point the display is intuitive. The highlighted box shows which switch is being selected. Each switch is called a channel. The rotary knob, the ▲ or ▼ keys, the front panel number keypad, or the HP-IL interface, will move the highlighted box through the channel selections.

Each channel has its own unique address. However, the switch driver begins numbering channels at 0 instead of 1. Switch one, wired to J1 on driver card 1, would have a channel address of 100. This address appears graphically in the highlighted box as switch 00 and numerically at the bottom of the display as 100.

Configuring Switches

Now that you know how the switch driver toggles switches, you should be ready to explore the features of the switch driver.

1. Press `Config`. The display should look like Figure 5-4.

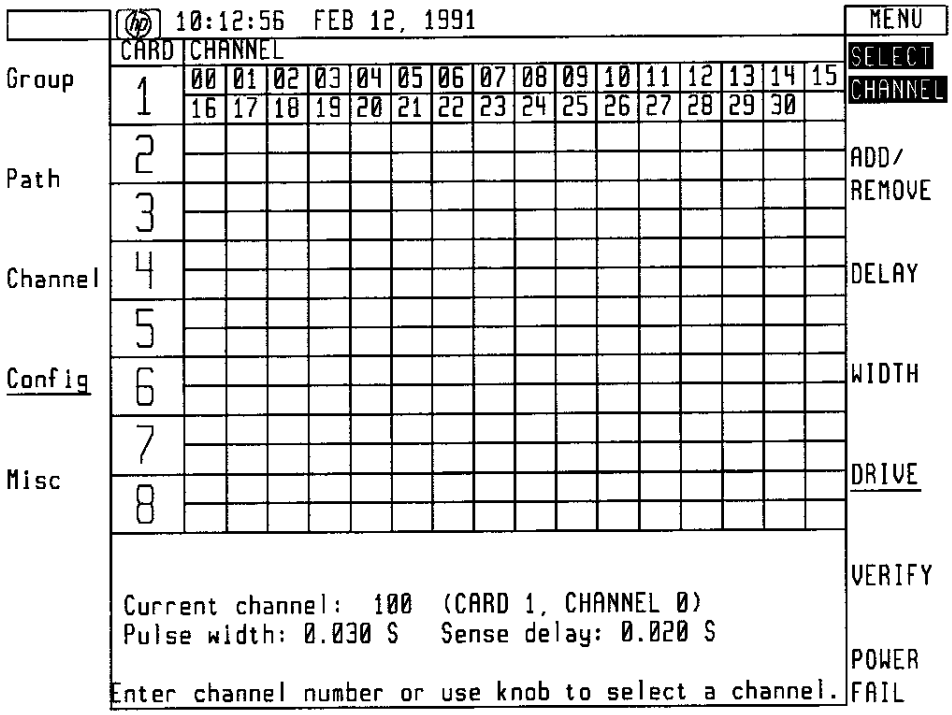


Figure 5-4. Config Display (Drive Menu)

There are three menu screens under `Config`:

a. DRIVE
b. VERIFY
c. POWER FAIL

Notice that the `DRIVE` softkey is underlined. This means you are in the Drive Menu.

2. Press `ADD/REMOVE`. The box becomes blank. This means that the switch will not toggle. You have removed it from the Drive List.
3. Press the `Channel` softkey.
4. Press `TOGGLE`. Nothing happened. You will notice that 00 has been removed from the display and will not toggle.
5. Press `Config` again. Notice DRIVE is still underlined.

If you leave the `Config` area by pressing `Group`, `Path`, `Channel`, or `Misc`, you will return to the menu it was in when you left.

6. Press ADD/REMOVE to add 00 channel back to the Drive List.

   If you wish to add channels on other driver cards you will need to press ADD/REMOVE to add switches on driver cards 2 through 8. These switches are not displayed when the instrument is initially switched on.

7. Press DELAY. The softkey will highlight in inverse video. The value you set will apply only to the switch in the highlighted box. Although this parameter can be set from the Drive, Verify, or Power Fail Menu, it does not activate until the switch is selected in the Verify Menu. The default value is 0.020 S.

   Press 4, 0, and ms. Notice the sense delay field at the bottom of the display changes to 0.040 S. Values from 0.005 seconds to 1.275 seconds can be entered in 0.005 second increments for each switch selected from the display. The :DELay command listed in the "Remote Operation" section will let this parameter be specified for more than one switch at a time.

8. Press WIDTH. The softkey will highlight in inverse video. The value set will apply only to the switch in the highlighted box.

9. Press ., 0, 4 and s. Notice the pulse width field changes to 0.040 S. WIDTH can be selected from the Drive, Verify, or Power Fail Menus. Values from 0.005 seconds to 1.275 seconds can be entered for each switch selected from the display. The :WIDTh command listed in the "Remote Operation" section will let you specify this parameter for more than one switch at a time.

10. Press VERIFY. The menu changed. Notice that VERIFY is underlined. The underline indicates that you are in the Verify Menu. See Figure 5-5.

11. Place the highlighted box on 100.

    Press ADD/REMOVE. The number 00 should appear in the box. This means the verify (or sensing) function of the switch driver is active for that channel. When a channel is selected to the Verify List, the sense delay applies to the channel. If the channel is removed from the Verify List, sense delay does not apply.

Note When a channel is removed from the Verify List, the sense line to the relay is not being read. When the channel is then toggled, a pulse is sent and the switch driver will indicate the relay changed state. In other words, when Verify is OFF for the relay, the switch driver *assumes* the state of the relay as if the relay is functioning normally.

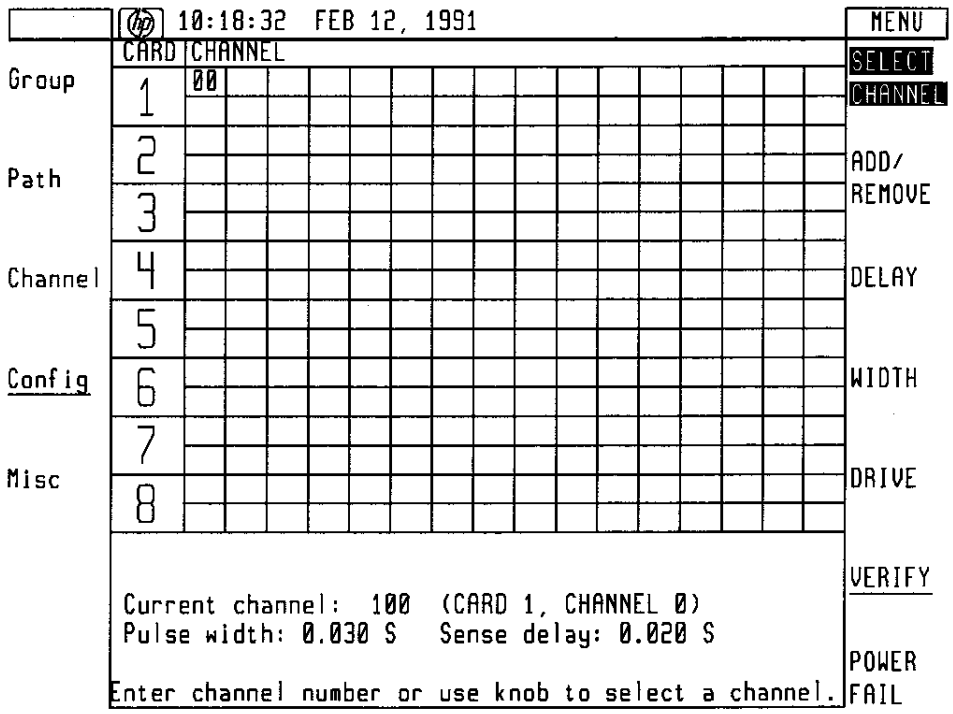


Figure 5-5. Config Display (VERIFY Menu)

12. Press ADD/REMOVE again, the box will go blank, removing the channel from the verify function.

Power Fail Menu

This menu enables you to set the switch positions wanted at power up. This function was specifically designed so the switch matrix can be set to switch positions which will prevent damage at power up.

For example, in this exercise you might want to select all the attenuators to be on line (110 dB, all switches closed) at power up.

1. Press POWER FAIL.

2. Press the ADD/REMOVE key to close (inverse video) channel 00. Continue closing channels 01, 02, and 03 by using the SELECT CHANNEL and ADD/REMOVE keys.

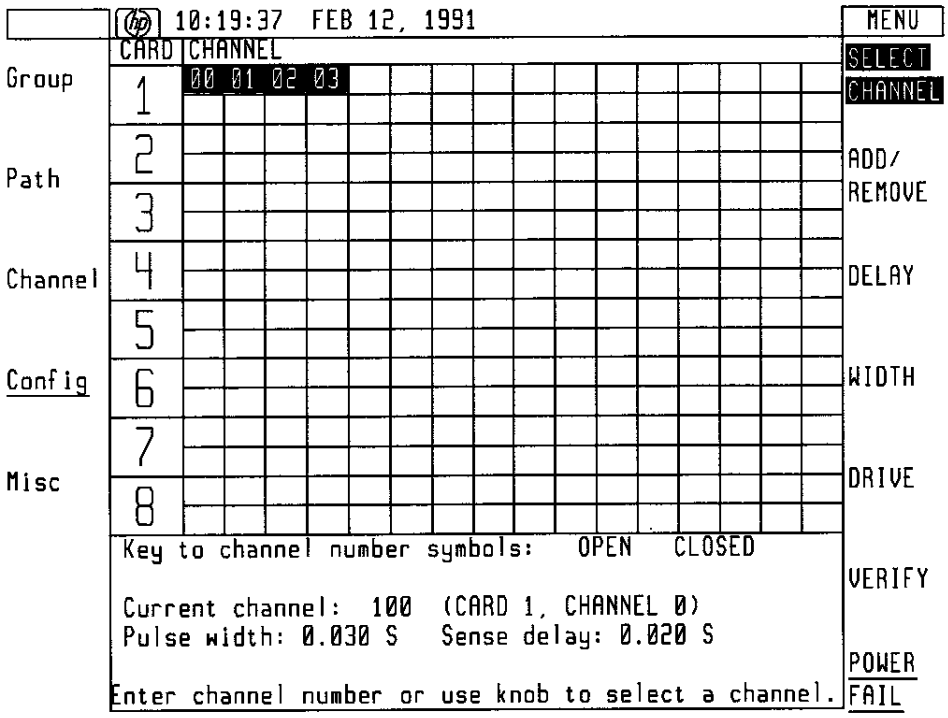


Figure 5-6. Config Display (POWER FAIL Menu)

To save the POWER FAIL switch positions:

3. Press `Misc`.
4. Press `SAVE TO EEROM`.

To test this function:

1. Press `Channel`.
2. Press `TOGGLE` to put each 00, 01, 02, and 03 into the open position (normal video).
3. Then turn OFF the mainframe.
4. Turn ON the mainframe. The switches should audibly toggle closed. This can be verified by pressing `Channel` and checking switch position (inverse video on channel 00 thru 03).

Note The power up condition of the switch driver and related switches depends on which instrument condition the user saves to EEROM. If *nothing* has ever been saved to EEROM, then all connected switches will power up in the OPEN state. If some switch positions have been saved, then those switches saved in Group1 will come on in the state saved in EEROM. Switch positions saved in EEROM from the Power Fail Menu take absolute precedence over any other saved path at power up.

Defining Paths

So far, you have learned to toggle and configure (setting delay, width, and sensing) the switch channels and save to EEROM. In this step, you will learn how to identify switch positions that define a signal path. Later, you will learn how to arrange the paths into logical groups.

Refer back to Table 5-1 for the switch positions.

1. Press `Path`.
2. Press `EDIT PATH`. Figure 5-7 should appear on your screen.

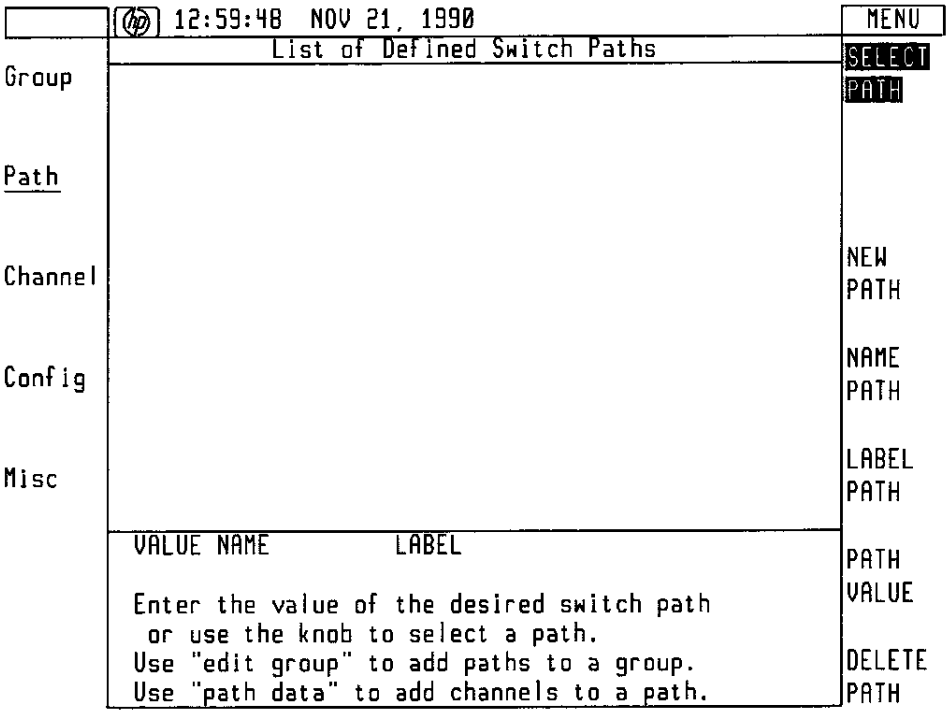


Figure 5-7. Edit Path Menu

3. Press `NEW PATH`.
4. Press `PATH VALUE`. Figure 5-8 should appear on the display.

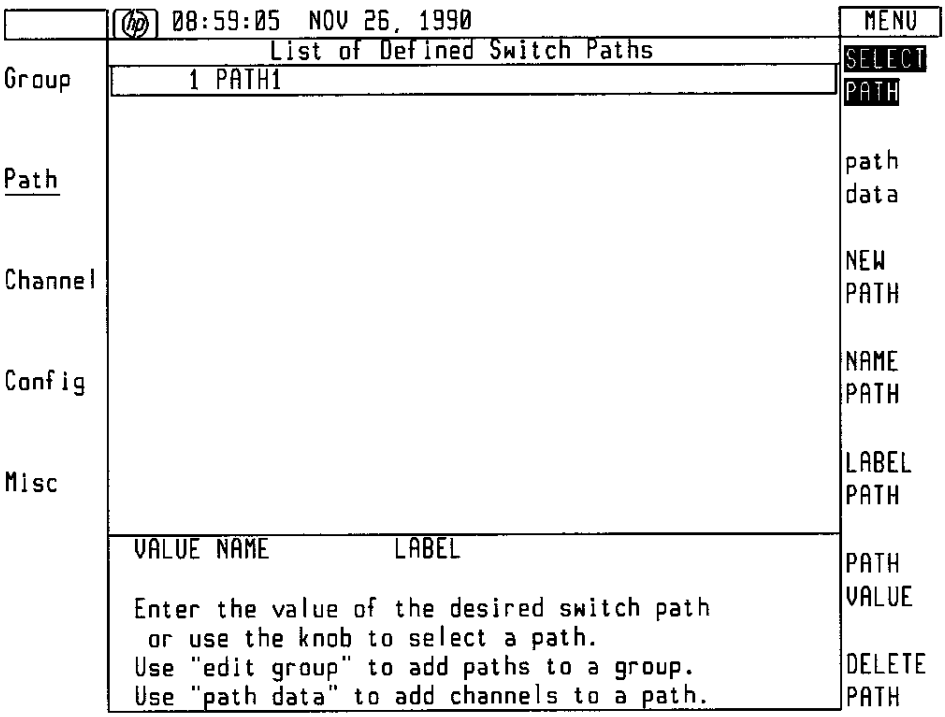


Figure 5-8. Path Value Menu

PATH VALUE can be used to enter any three-digit path value you choose. For this example choose the number 0, because the value of attenuation for the first attenuator setting is 0 dB.

5. Press (0) on the number keypad.
6. Press ENTER.

Note If you make a mistake use (←) to erase the last character. You may have difficulty finding a blank space character. The blank space character is close to the "!" character. You can enter data faster if your mainframe has an HP-IL keyboard.

---

7. Press LABEL PATH. Notice the labeling function at the bottom of the display. Use the knob and the SELECT CHAR key to label the path **0 dB**.

Note The path data softkey will not appear if no paths are defined.

---

8. Press ENTER.
9. Press NAME PATH. This field is used by the controller to access the path by name and will not let you enter a number, lower case letter or space as the first character.

10. Use the knob and SELECT CHAR to enter the path name as AODB.

11. Press ENTER. Your first defined path should look like Figure 5-9.

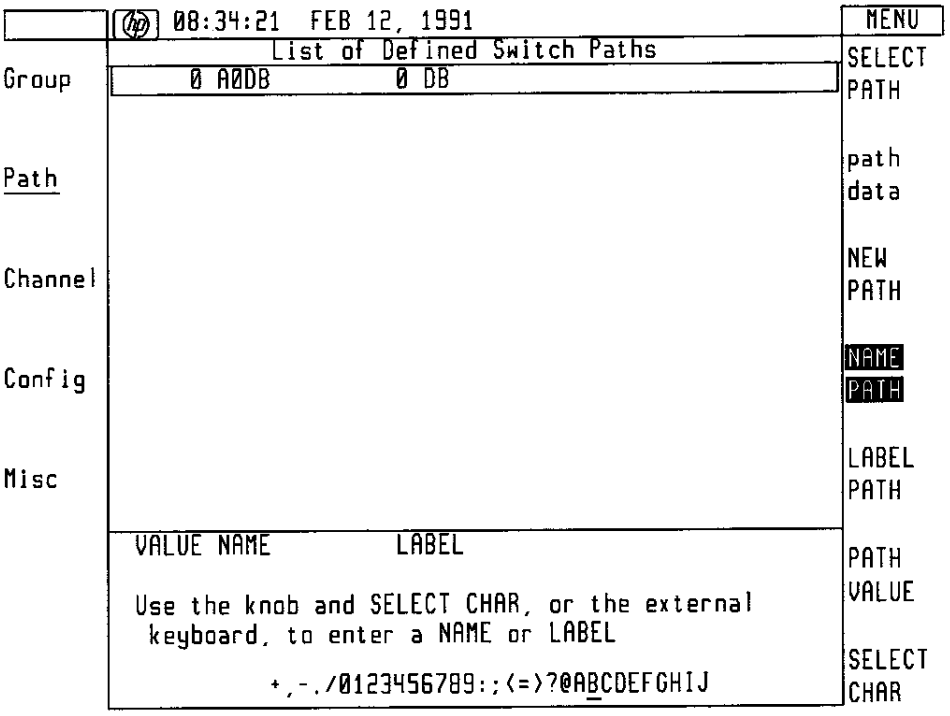


Figure 5-9. First Path Definition

12. Now press path data. Your channel menu for that path will appear on the display.

13. Use the knob and the ADD/REMOVE key to add channels 100, 101, 102 and 103. Your screen should look like Figure 5-10.

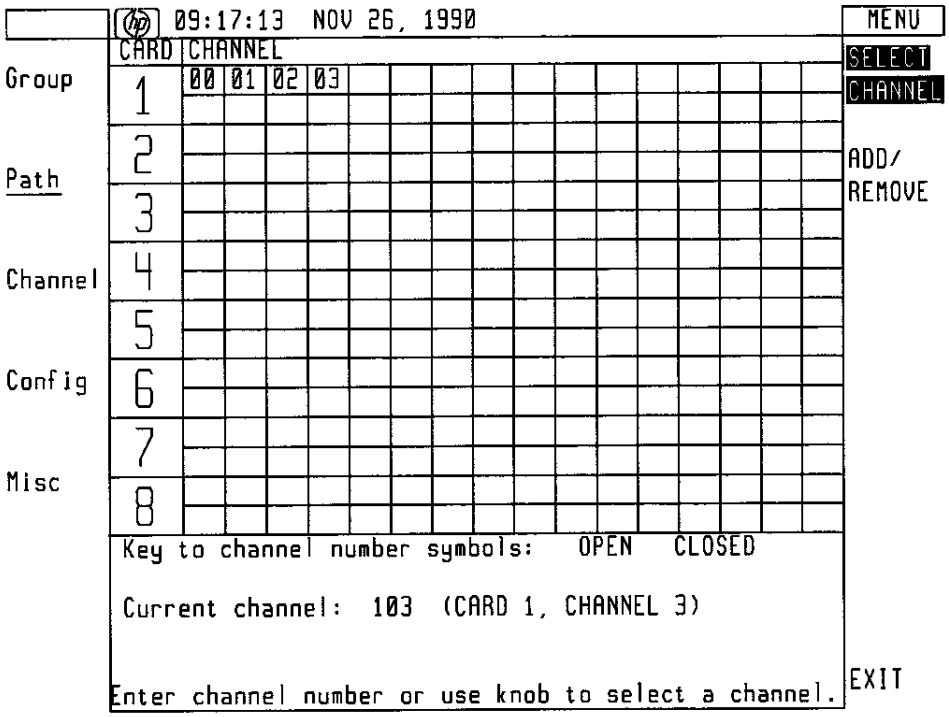


Figure 5-10. First Path Definition

a. Press EXIT.

b. Press NEW PATH.

c. Press PATH VALUE.

d. Press 1, 0, and ENTER.

e. Press LABEL PATH, 10 dB. Press ENTER

f. Press NAME PATH, A10DB. Press ENTER.

14. Press path data and refer to Table 5-1.

15. Close channel 00 (inverse video) and leave channels 01, 02, and 03 in the open (normal video) position. This will bring 10 dB of attenuation into the defined path.

16. Continue to name, label, and value the paths until the List of Defined Switch Paths looks like Figure 5-11.

    Define each attenuation path, like you did in Figure 5-10 according to Table 5-1.

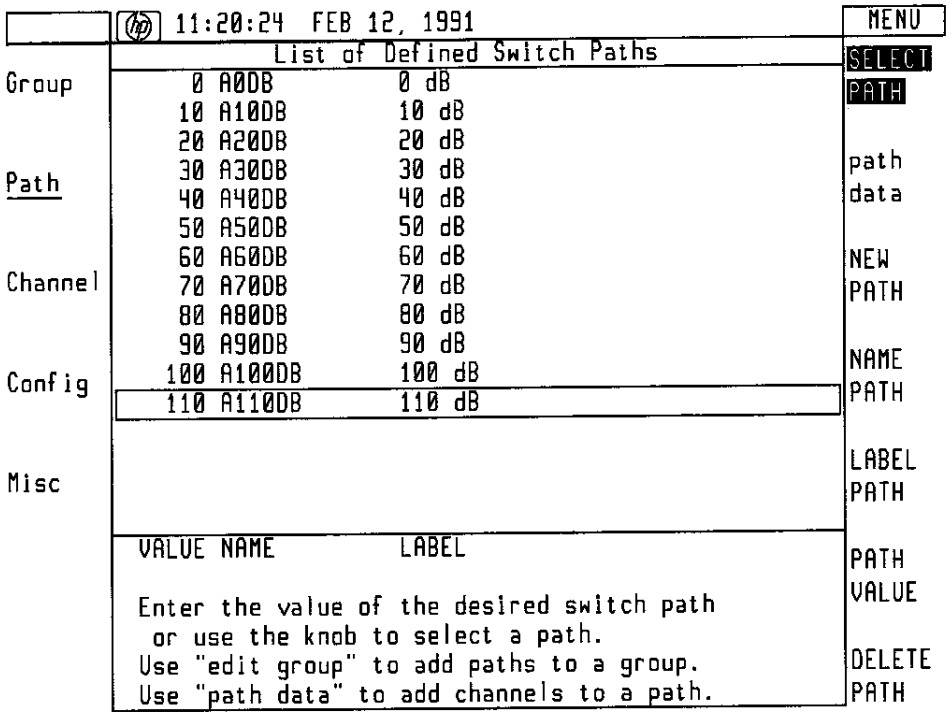


Figure 5-11. List of Defined Switch Paths

Defining Groups

When a group is defined any of the defined signal paths may be chosen. For this example you will use the 12 signal paths just defined.

1. Press `Group`. You can define up to 16 different groups. Right now, you are in the first group.
2. Press `edit group`. At the bottom of the display you see that the switch driver automatically assigns a group name of GROUP1 to the first group. The group name is used only by the controller and will not accept a number, lower case letter, or a blank space as the first character.
3. Press `NAME GROUP`.
4. Use the knob and `SELECT CHAR` key to enter `AT110DB`.
5. Press `ENTER`.
6. Press `LABEL GROUP`.
7. Use the knob and the `SELECT CHAR` key or HP-IL interface to enter `Atten 110 dB by 10 dB steps`.
8. Press `ENTER`. The screen should look like Figure 5-12.

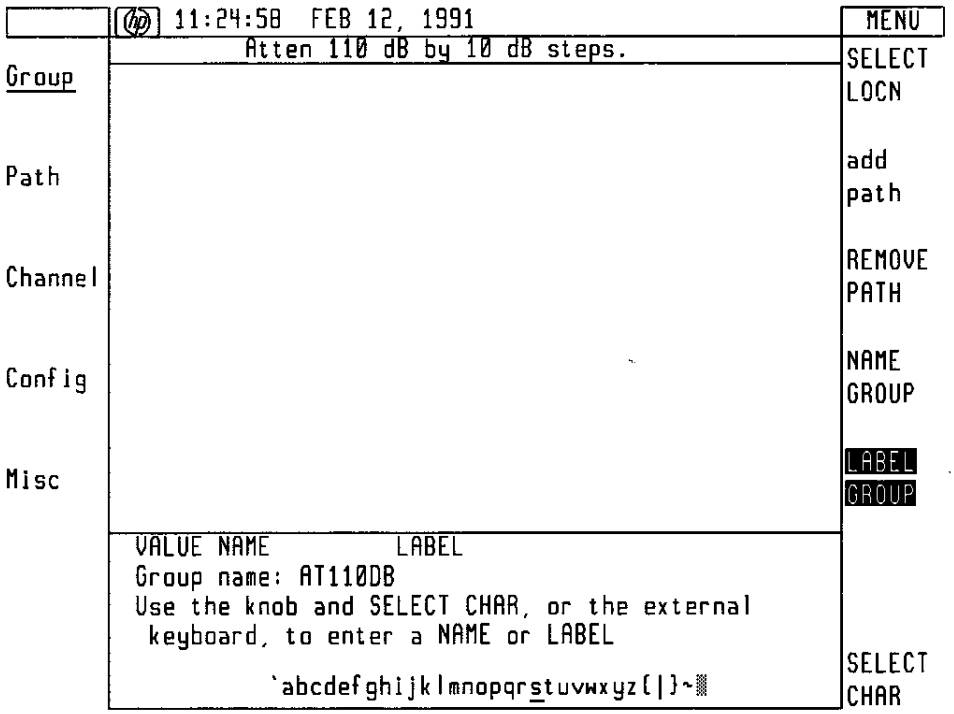


Figure 5-12. Edit Group Menu

Adding Paths to a Group

A group is just a label and a name until you add signal paths.

1. Press `add path`. Your list of defined switch paths as shown in Figure 5-11 should appear.

Note The `add path` key will not appear if no paths are defined.

---

2. Place the highlighted box on the 0 dB switch path.
3. Press `ADD TO GROUP`. The first switch path has just been added to the group.
4. Press `add path` again. Use the knob to place the highlighted box on the 10 dB switch path.
5. Press `ADD TO GROUP` again. Continue until all of the attenuator switch paths are selected. The screen should look like Figure 5-13. Notice the group name `Atten 0 to 110 dB by 10 dB steps` appears at the top of the display. This screen tells you the switch paths listed are part of that group.

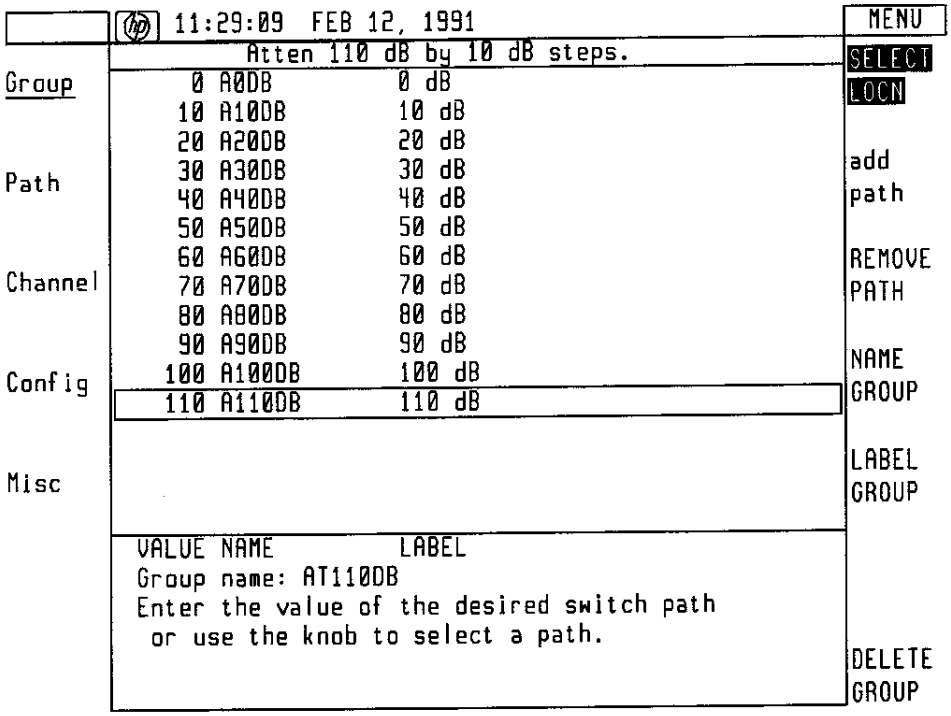


Figure 5-13. Group Paths

Note A group can be defined as any collection of switch paths. Switch paths become subsets of groups. This allows switch paths to belong to more than one group. Also, switch paths may be defined and stored but not selected to any group.

Exploring Features

Now that you have defined a group of 12 switch paths, the attenuators can be toggled automatically.

1. Press `Group`. This screen allows you to select any group from a total of 16 possible groups. Since you currently have only one group, the first group is automatically selected.
2. Press `Path`. Your screen should look like Figure 5-14. Notice that the group label `Atten 110 dB by 10 dB steps` is at the top of the screen and `Off` is underlined for the `AutoSel On Off` softkey.

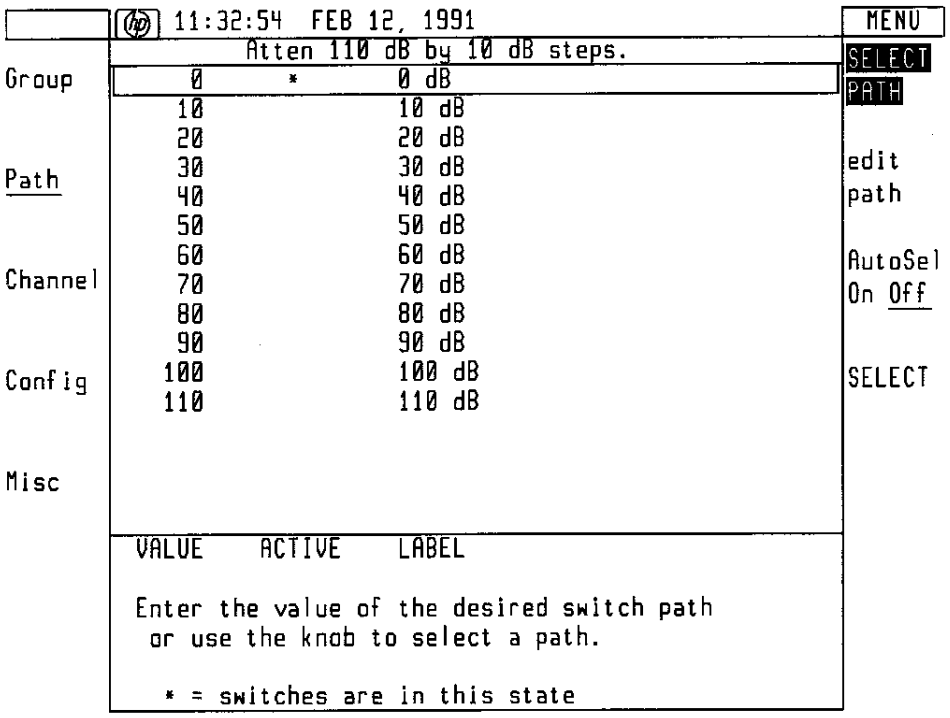


Figure 5-14. Auto Select Screen

3. Now use the rotary knob, the ▲, ▼ keys, or the number keys to move the highlighted box to the 40 dB switch path.
4. Press SELECT. Notice the asterisk (*) appear in the box. Move the highlighted box to the 80 dB switch path. Notice how the asterisk stayed in the 40 dB switch path. The asterisk indicates the switch position *at the present time.*
5. Press SELECT again. The switch positions changed (audible) and the asterisk moved to the 80 dB switch path.
6. Press AutoSel On Off. The On should be underlined. The SELECT key should disappear.
7. Now use the rotary knob, the ▲ or ▼ keys, or the number key to move the highlighted box while watching the asterisk. You should be able to hear the attenuators toggle as the asterisk changes position.
8. Now move the highlighted box rapidly while watching the asterisk carefully. Notice how the asterisk will always seek out the switch path further down the list before it settles on a path of lower attenuation.

Saving to EEROM

If you want to save switch paths and groups through a power cycle, you *must* save (or write) them to EEROM.

The number of times you can write to the EEROM is limited (approximately 10,000 writes). There is a program called "READMEM" which saves switch driver configurations to the controller. This program is located in the "Remote Operation" section of this manual.

1. Press Misc. The screen should look like Figure 5-15.

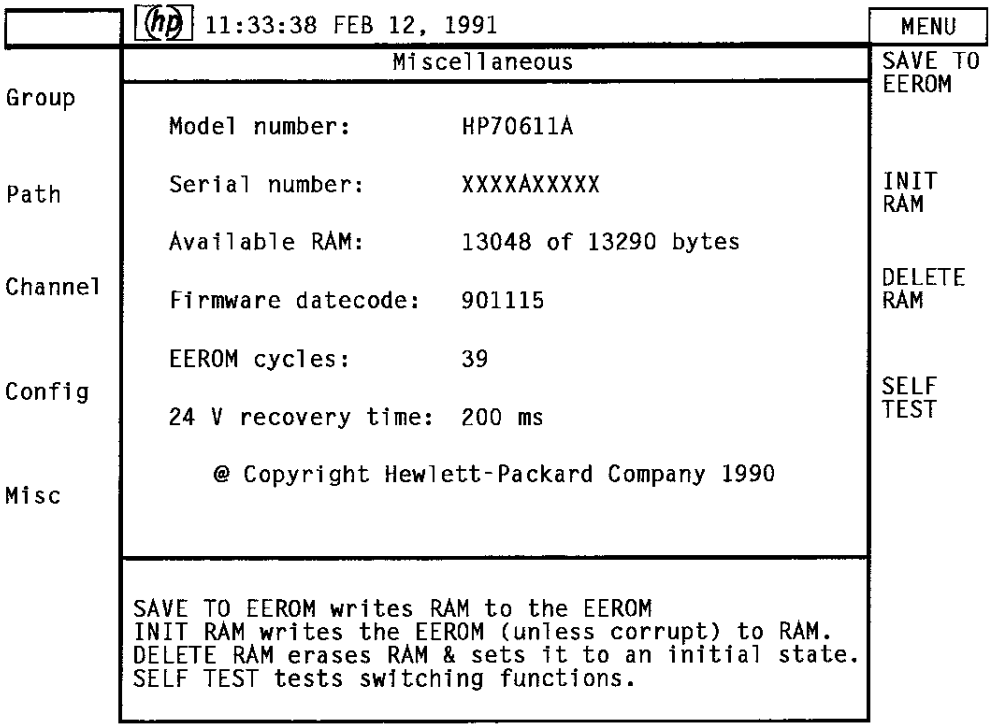


Figure 5-15. Miscellaneous Data Screen

2. Press SAVE TO EEROM.

Note Wait until the flashing message at the bottom of the screen goes away before doing anything else. This can take from several seconds to over a minute.

Error Reporting

The switch driver can find a faulty or improperly configured switch. An improperly configured switch could be one that has 0.000 s pulse width or 0.000 s sense delay. Extreme configuration settings could cause an error condition when the switch itself is not at fault.

1. Press Config.
2. Press VERIFY.
3. Press ADD/REMOVE to add channels 100, 101, 102, 103. The numbers 00, 01, 02, and 03 should appear for card 1.
4. Remove the connector to J4 from your driver board.
5. Press Channel. Place the highlighted box on channel 103.
6. Press TOGGLE. Three things should happen:
   a. An E appears in the upper left box.
   b. The channel box blinks, telling you the address of the problem switch.
   c. ERR is lit on the switch driver module front panel.

7. Press DISPLAY, REPORT ERRORS.

   This will clear the error register by giving a code which can be looked up. See also ":ERRor?" in section 6, "Remote Operation".

8. Press MENU to get back to the Channel display.

9. Replace the connector to J4, or remove channel 103 from the Verify Menu.

10. Press TOGGLE to clear the blinking channel.

Double Asterisk

A double asterisk may appear in the Path Menu of a group if the same switch channel positions are set for two different paths.

To see what happens perform the following steps:

- Press Path
- Press edit path
- Use the rotary knob or (▼) key to select 110.
- Press NEW PATH Your List of Defined Switch Paths should highlight 13 PATH13.
- Press path data
- Press ADD/REMOVE to add channels 100, 101, 102, 103, and 104.
- Press ADD/REMOVE to close channels 100, 101, 102, 103, and 104. Inverse video should be lit for all five channels.

A new path, 13 PATH13, has just been created. PATH13 has the same switch channel configuration as 110 dB. Add it to the group Atten 110 dB by 10 dB steps.

- Press Group.
- Press edit group
- Select 110.
- Press add path
- Select 13 PATH13.
- Press ADD TO GROUP.
- Press Path.
- With AutoSel in the ON position, select 110.

The screen should look like Figure 5-16

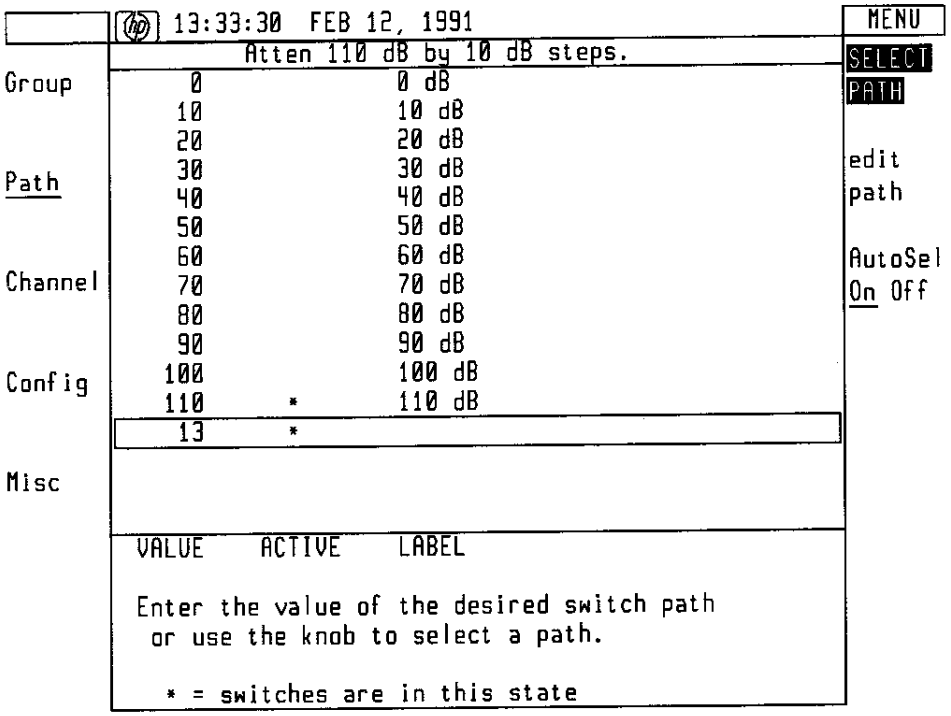


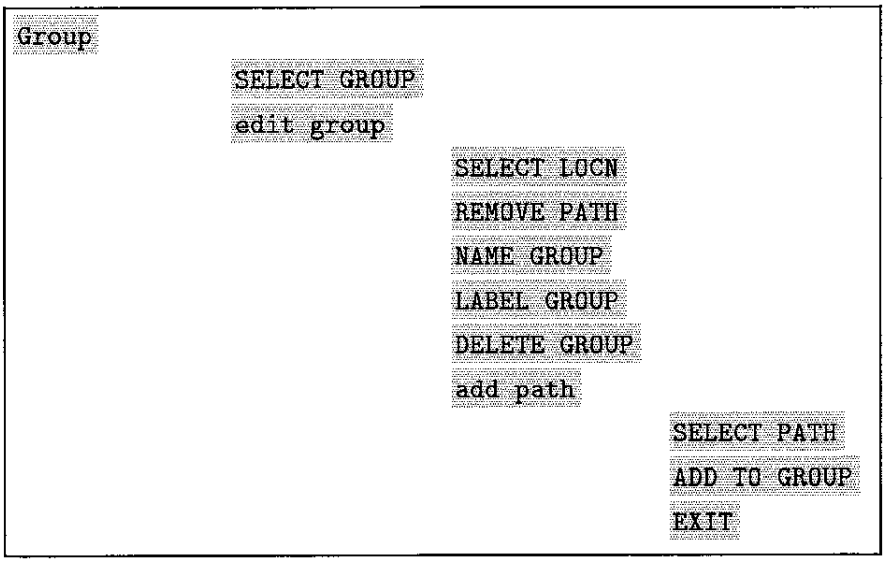
Figure 5-16. Double Asterisk Appears in Path Menu

A path can be defined as any collection of channels. Paths can contain the same channels as other paths. Even though path 13 contains one more channel than path 110, it contains four channels that are the same. When those four channels CLOSE, the requirements for path 110 are satisfied and so the double asterisk appears.

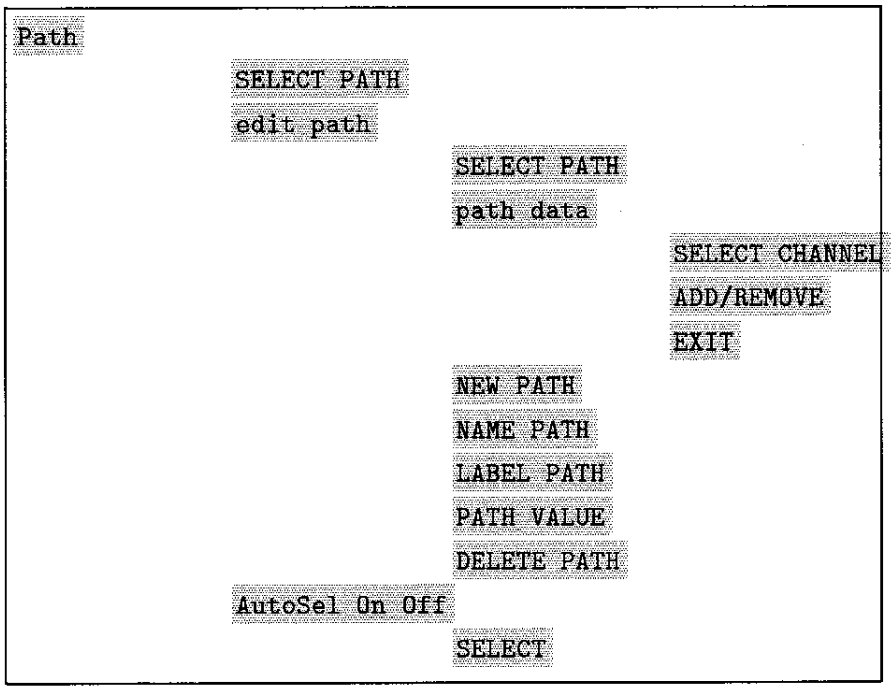
Display Key Sequence

The following represents the sequence of keys to press to access switch driver data entry from the display.

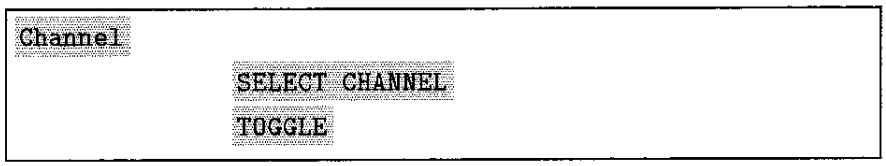
Group Menu



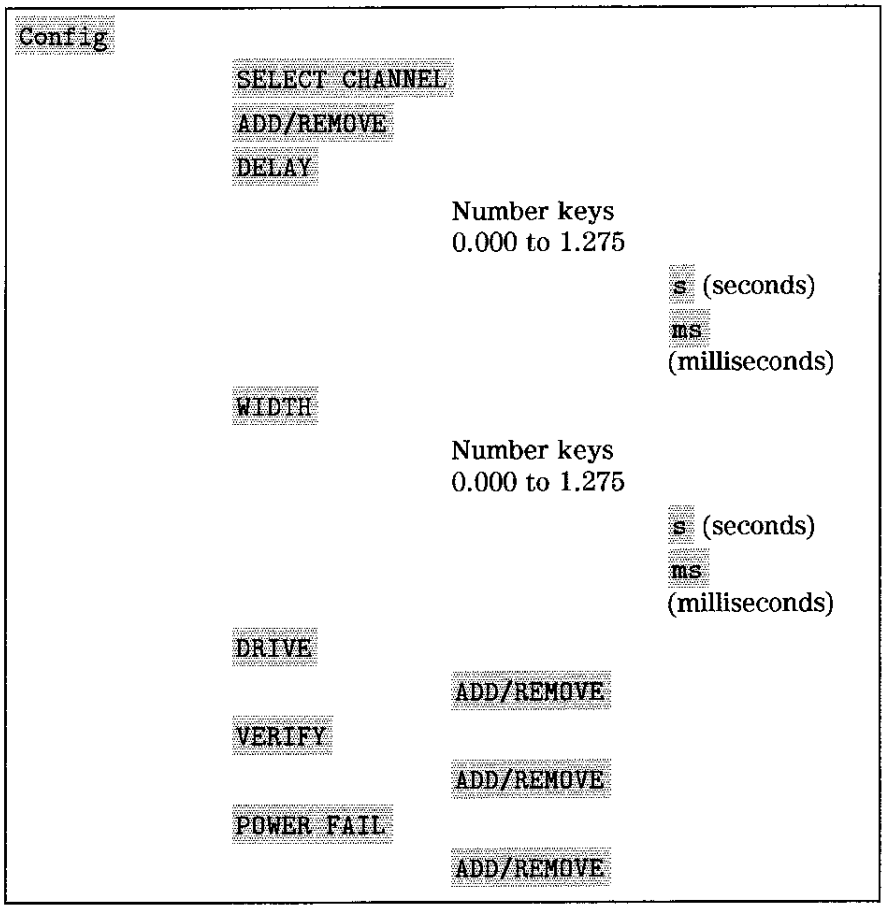
Path Menu



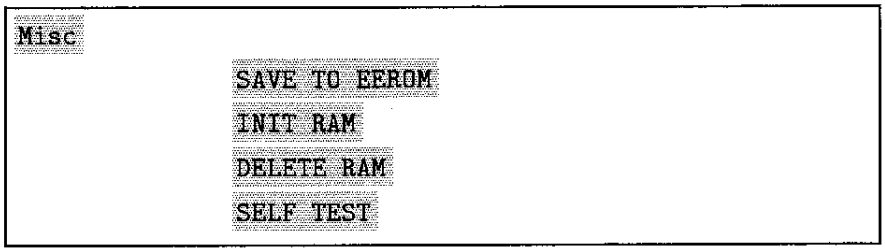
Channel Menu



Config Menu



Misc Menu



Display Command Reference

This section lists all of the display (front panel) command sequences for the HP 70611A, 70612A,C and 70613A,C.

Channels, Paths, and Groups

HP 70611A

The HP 70611A can control up to eight different driver cards. Each driver card can drive up to 31 different relays. The cards are numbered from 1 to 8. The relays on each card are numbered from 0 to 30. Each relay is referred to as a *channel* by the switch driver. Therefore, there are a total of 248 relays (channels) that can be driven from one switch driver.

HP 70612A,C and HP 70613A,C

The HP 70612A,C and HP 70613A,C can control up to seven external driver cards. Each driver card can control up to 31 different relays. The cards are numbered from 1 to 8. The relays on each card are numbered from 0 to 30. Each relay is referred to as a *channel* by the switch driver. Therefore, there are a total of 217 relays (channels) that can be driven from one switch driver.

Once the channels are configured (pulse width, sensing, drive, and so forth) they may be selected to form signal paths. Signal paths can be selected to form groups. Up to 16 groups can be selected in switch driver memory. To use more than 16 groups, see the "Save Memory" and "Restore Memory" programs in section 6, "Remote Operation".

add path

Key Sequence

`Group` `edit group` `add path`

Description

The `add path` key selects a lower level menu from which you can select paths to add to a group.

Related Remote Commands

Look up the following remote commands in the Remote Reference:

```
ROUTe:GROUP:ADD <path name>
```

ADD/REMOVE

Key Sequence

`Path` `edit path` `path data` ADD/REMOVE

`Config` ADD/REMOVE

`Config` `DRIVE` ADD/REMOVE

`Config` `VERIFY` ADD/REMOVE

`Config` `POWER FAIL` ADD/REMOVE

Description

The ADD/REMOVE key actually functions as an ADD/TOGGLE/REMOVE key. This allows a channel to be added or removed to either the CLOSE or OPEN side of the path. The CLOSEd switches in the path are the ones that will be closed when the path is SELECTed in the Path Menu or when ROUTE:CLOSE is sent with a path parameter. See also ROUTE:OPEN for what happens when a path parameter is used with it.

If memory is nearly full, and an attempt is made to add data to a path, some of the old data may be erased to make room for the new data. A `Memory capacity exceeded` error is declared if memory is too full.

Related Remote Commands

```
ROUTe: { :PFAil  | :VERify | :DRIVe | :WIDTh | :DELay | :PATH } { :DEFine | :DELete | :ON | :OFF | :CLOSe | :OPEN }
```

ADD TO GROUP

Key Sequence

`Group` `edit group` `add path` `ADD TO GROUP`

Description

Pressing the `ADD TO GROUP` key selects a pre-defined path from the highlighted box on the display and adds it to a group.

After pressing `ADD TO GROUP`, the display will change to the `edit path` Menu.

Related Remote Commands

```
ROUTe:GROUP{ :ADD    }<path name>
           { :REMove }
```

AutoSel On/Off

Key Sequence

Path AutoSel On/Off

Description

Pressing the Autosel On/Off key to the On position (On will be underlined) will automatically cause the relays to be switched as you move the highlighted box through predefined switch paths.

An asterisk will appear when the path is selected. An asterisk will appear two or more times if the same switch path is detected under different path names.

Related Remote Commands

ROUTe:GROUP:AUTOselect { :ON | :OFF }

Channel

Key Sequence

Channel

Description

Pressing the Channel key selects a menu from which relays may be toggled.

When the Channel Menu is entered, the screen will show a pictorial representation of the current state of the relay hardware. A cursor, consisting of a highlighted box, shows the position of the selected channel, which will drive the relay when TOGGLE is pressed.

On this screen, a channel number in inverse video means the switch is closed. A blinking channel number means an error was detected on that channel during the last switching operation.

Turning the knob rolls quickly through all the switches, wrapping around at the edges, top and bottom.

If a mouse is plugged into the 70004A, it functions the same as the knob, regardless of whether it is generating x- or y-counts.

Before channels may be toggled they must be added to the Drive List. Only channels which appear on the display may be toggled. Unused channels (DRIVE:OFF) are indicated by empty boxes at their location. The `current channel` line at the bottom of the screen still lists them, so even on an empty screen you can find your way around.

Note Channels 100 to 130 automatically appear in the display when power is initially switched on. If you wish more channels to appear for other driver cards, (standard HP 70611A) they must be added to the Drive List See DRIVE in this reference.

Related Remote Commands

ROUTe{ :CLOSe | :OPEN }

Config

Key Sequence

Config

Description

Pressing the Config key selects a menu from which channels may be selected and configured for: sensing delay (DELAY), pulse width (WIDTH), the Drive List (DRIVE), relay sensing (VERIFY), and setting up the Power Fail configuration, (POWER FAIL).

In the Config Menu, any switch may be selected so that various parameters relating to that switch may be modified. This includes whether sensing is on or off for that switch, whether the switch is used or unused, what position the switch will take on at powerup, and what the pulse width and sense delay are for that switch.

Only one of DRIVE, VERIFY, or POWER FAIL can be active at any given time. Whichever is active, the screen will apply to that list. A switch not in the current list is indicated by an empty box at its location (the "current channel" line at the bottom of the screen still lists it, so even on an empty screen you can find your way around).

The current channel can be added or removed from a list with the ADD/REMOVE key. In the Power Fail List, this key functions as ADD/TOGGLE/REMOVE key (although the label does not change). This allows a switch to be added or removed to either the Close or Open List.

The sense delay and pulse width for the current channel are read out on the fourth line of the information window. These can be modified using the DELAY or WIDTH keys. The entered values are truncated to the next lower 5 ms.

Related Remote Commands

```
                  { :PFAil  }
                  { :VERify }
ROUTe:GROUP       { :DRIVe  }
                  { :WIDTh  }
                  { :DELay  }
```

DELAY

Key Sequence

`Config` `DELAY`

Description

Sensing delay is selected to allow relay sense lines to settle before the switch driver reads the state of the relay. Read the documentation of the relay to find how much delay is recommended. A list of compatible Hewlett-Packard relays are shown in Table 1-1 and 1-2.

Pressing the `DELAY` key effects no apparent change to the display until numbered keys or numbers from the display labeling function are selected.

Sensing delay values from 0.005 s to 1.275 s can be entered in 0.005 s increments. Values in `s` (seconds) or `ms` (milliseconds) may be entered. Pressing the `s` or `ms` key enters the value. If the value is a legal value (0.005 s to 1.275 s in 0.005 s increments), the display response area will show the value in seconds.

Sensing delay is implemented only if the channel is declared as part of the Verify and Drive Lists. The sense delay and pulse width for the current channel are read out on the fourth line of the information window. These can be modified using the DELAY or WIDTH keys. The entered values are truncated to the next lower 5 ms.

Related Remote Commands

```
ROUTe:GROUP { :VERify }
            { :DRIVe  }
            { :DELay  }
```

DELETE GROUP

Key Sequence

Group edit group DELETE GROUP

Description

Pressing the DELETE GROUP key deletes the group displayed and returns the display to the Group top menu.

To recover from deleting the wrong group, cycle the power off, then on. However, all changes made since the last save will be lost.

Related Remote Commands

```
ROUTe:GROUP:DELete:<:ALL>
```

DELETE PATH

Key Sequence

`Path` `edit path` `DELETE PATH`

Description

Pressing `DELETE PATH` deletes the path selected in the highlighted box on the display.

If the last path in the list is selected to delete, it will be deleted with no message. An `(empty path register)` message will appear if the path deleted is not the last path in the list.

To recover from deleting the wrong group, cycle the power off, then on. However, all changes made since the last save will be lost.

Related Remote Commands

`ROUTe:PATH:DELete:<:ALL>`

DELETE RAM

Key Sequence

Misc DELETE RAM

Description

Pressing DELETE RAM deletes all memory in HP 70611A RAM memory.

See the "Save Memory" and "Restore Memory" example programs toward the end of section 6, "Remote Operation".

The preset state of the RAM is described in MEMory:DElete, chapter 6.

Related Remote Commands

```
MEMory:DELete
```

DRIVE

Key Sequence

`Config` `DRIVE`

Description

A channel will not be driven unless it is part of the Drive List.

Pressing `DRIVE` selects the Drive Menu to the display. Use the highlighted box to select the channel you wish to remove or add to the Drive Menu. Press `ADD/REMOVE`. If the channel is removed, the box reserved for that channel will become blank. If the channel is added, the number will appear.

Note Channels 100 to 130 automatically appear in the display at initial power up. If you wish more channels to appear for other driver cards, (standard HP 70611A) they must be added to the Drive List.

Related Remote Commands

ROUTe:DRIVE { :ON | :OFF }

edit group

Key Sequence

Group edit group

Description

The edit group key selects a lower level menu from which you can edit groups.

The box outlines the currently selected group. Use the rotary knob or numbered keys to select a group. Press edit group. The switch paths of that group are displayed on the screen.

This screen shows all of the paths in the current group, in the order in which they appear in the group. If more paths exist than can be shown on the screen, the screen will scroll up or down as appropriate when the cursor (box) hits the top or bottom of the list. The cursor shows the location in the group after which the next path will be added. See add path earlier in this section. This is also the path that will be removed if REMOVE PATH key is pressed.

After leaving any group or path menu and then returning, the highlighted box will be in the same place as it was before leaving.

Related Remote Commands

```
ROUTe:GROUP { :NAME
              :CATalog
              :ADD
              :REMove
              :DEFine?
              :LABel
              :AUTOselect
              :DELete }
```

edit path

Key Sequence

`Path` `edit path`

Description

The `edit path` key selects a lower level menu from which you can edit paths.

Related Remote Commands

```
ROUTe:PATH { :DEFine
             :CATalog?
             :LABel
             :VALue
             :DELete }
```

Group

Key Sequence

Group

Description

The HP 70611A, 70612A,C and 70613A,C power up in the Group Menu, which show a list of the currently defined groups.

Press Group to select a group to edit.

Use the rotary knob or number keys to enter the group you wish to edit.

To enter a group number numerically, press one of the number keys on the display. An entry will begin in the command line at the bottom of the screen, the left side menu will blank, and the right side menu will contain only two keys, CLEAR and ENTER. When ENTER is pressed, the group with the entered number (1–16) will be selected.

Related Remote Commands

```
ROUTe:GROUP { :NAME
              :CATalog
              :ADD
              :REMove
              :DEFine?
              :LABel
              :AUTOselect
              :DELete }
```

INIT RAM

Key Sequence

Misc INIT RAM

Description

Pressing INIT RAM downloads the EEROM to RAM. The EEROM is examined for corruption. If the EEROM is not corrupt, it is downloaded into RAM. It is not accessed again. (This is similar to the power up sequence.)

INIT RAM does not affect the last switch state in RAM.

Related Remote Commands

```
MEMory:INITialize
```

LABEL GROUP

Key Sequence

Group edit group LABEL GROUP

Description

When LABEL GROUP is pressed, the entry of an alphanumeric quantity is enabled. In this case the prompt in the information screen changes to read Use the knob and SELECT CHAR, or the external keyboard, to enter a NAME or LABEL. At the bottom of the information area, a line of characters appears, which represents the characters available for this entry. A cursor underlines one character, which is the character that will get entered when SELECT CHAR (the lower right softkey) is pressed. The plug-in HP-IL keyboard may also be used to enter characters.

A group name is any collection of up to 12 uppercase letters (lowercase letters are automatically uppercased), numbers, or underscore characters, starting with a letter. A group label may contain any character with a value between 32 and 127.

Related Remote Commands

```
ROUTe:GROUP:LABel
```

LABEL PATH

Key Sequence

Path edit path LABEL PATH

Description

When LABEL PATH is pressed, the entry of an alphanumeric label is enabled. In this case the prompt in the information screen changes to read Use the knob and SELECT CHAR, or the external keyboard, to enter a NAME or LABEL. At the bottom of the information area, a line of characters appears representing the characters available for this entry. A cursor underlines the character that will get entered when SELECT CHAR (the lower right softkey) is pressed. The plug-in HP-IL keyboard may also be used to enter characters.

A path label may contain any character with ASCII values between 32 and 127.

Related Remote Commands

```
ROUTe:PATH:LABel
```

Misc

Key Sequence

Misc

Description

When Misc is pressed, the Misc Menu appears on the display and the memory functions of the switch driver are accessed.

The following keys will appear on the display:

SAVE TO EEROM

INIT RAM

DELETE RAM

SELF TEST

POWER RECOVERY

Related Remote Commands

MEMory { :DELete | :INITialize | :SAVE | :FREE? }

TRIGger[:SEQence]:DELay

NAME GROUP

Key Sequence

`Group` `edit group` `NAME GROUP`

Description

When `NAME GROUP` is pressed, the entry of an alphanumeric quantity is enabled. In this case the prompt in the information screen changes to read `Use the knob and SELECT CHAR, or the external keyboard, to enter a NAME or LABEL.` At the bottom of the information area, a line of characters appears representing the characters available for this entry. A cursor underlines the character that will get entered when SELECT CHAR (the lower right softkey) is pressed. The plug-in HP-IL keyboard may also be used to enter characters.

A group name is any collection of up to 12 uppercase letters (lowercase letters are automatically uppercased), numbers, or underscore characters, starting with a letter. Group names are used to access groups via remote programming.

Related Remote Commands

```
ROUTe:GROUp:NAME
```

NAME PATH

Key Sequence

Path edit path NAME PATH

Description

When NAME PATH is pressed, the entry of an alphanumeric quantity is enabled. In this case the prompt in the information screen changes to read Use the knob and SELECT CHAR, or the external keyboard, to enter a NAME or LABEL. At the bottom of the information area, a line of characters appears, representing the characters available for this entry. A cursor underlines the character that will get entered when SELECT CHAR (the lower right softkey) is pressed. The plug-in HP-IL keyboard may also be used to enter characters.

A path name is any collection of up to 12 uppercase letters (lowercase letters are automatically uppercased), numbers, or underscore characters, starting with a letter.

Path names are used to access paths via remote programming. Path names serve little function during local operation.

Related Remote Commands

ROUTe:PATH:DEFine

NEW PATH

Key Sequence

`Path` `edit path` `NEW PATH`

Description

When `NEW PATH` is pressed, a new path is created with a value equal to the number of its path register and the name PATHXX, where "XX" corresponds to the path register number (if there is already a path with that number, a number is found by counting up until there is no conflict). The cursor is moved to this path and it can then be edited just like an existing path.

Related Remote Commands

```
ROUTe:PATH:DEFine
```

Path

Key Sequence

Path

Description

When Path is pressed, the Path Menu appears on the display. From the Path Menu edit path and AutoSel On/Off can be accessed.

Related Remote Commands

```
ROUTe:PATH{ :DEFine
          | :CATalog?
          | :LABel
          | :VALue
          | :DELete }
```

PATH VALUE

Key Sequence

`Path` `edit path` `PATH VALUE`

Description

`PATH VALUE` can be used to enter an arbitrary value between −32768 to +32767 to be associated with a path in the Path Menu. Entering the assigned number will move the user to the given path. Note that in the operating example, each attenuation setting has an assigned value that matches its attenuation value.

Related Remote Commands

```
ROUTe:PATH:VALue
```

POWER RECOVERY

Key Sequence

Misc POWER RECOVERY

Description

The POWER RECOVERY key allows the operator to change the power supply recovery time through the keypad. If the value entered is not between 0 and 200 ms, it is clipped to the limit. Power Up and (INSTR PRESET) reset this value to the default of 200 ms.

Related Remote Commands

TRIGger[:SEQence]:DELay

SAVE TO EEROM

Key Sequence

`Misc` `SAVE TO EEROM`

Description

Pressing `SAVE TO EEROM` key causes a MEM:SAVE operation.

During a save to the EEROM, the copyright message is replaced by the blinking label, `SAVING MEMORY. MAY TAKE SEVERAL MINUTES. DO NOT DISTURB.`

Note Use care to limit the saves to EEROM because of the 10,000 write limit.

When power is turned on the switch driver will initialize the channels to the states in the Power Fail List (see "Power Fail"). If the Power Fail List is empty, then the switch driver will turn on in the last state saved in EEROM.

Related Remote Commands

```
MEMory:SAVE

DIAG:EEROM:CYCLes?
```

SELECT CHANNEL

Key Sequence

Path SELECT CHANNEL

Channel SELECT CHANNEL

Config SELECT CHANNEL

Description

Pressing SELECT CHANNEL in the Config Menu allows the channel select cursor to select a different channel for configuration.

Pressing SELECT CHANNEL in the Path or Channel Menu has no effect.

Related Remote Commands

There are no directly related remote commands for this key.

SELECT GROUP

Key Sequence

`Group` `SELECT GROUP`

Description

Pressing `SELECT GROUP` allows the rotary knob to be used to select a different group for configuration.

Related Remote Commands

There are no directly related remote commands for this key.

SELECT PATH

Key Sequence

Path SELECT PATH

Description

Pressing SELECT PATH allows the to rotary knob to be used to select a different group for configuration.

Related Remote Commands

There are no directly related remote commands for this key.

SELF TEST

Key Sequence

Misc SELF TEST

Description

The SELF TEST key initiates a *TST? operation. No result is sent out to HP-IB or HP-MSIB).

Related Remote Commands

*TST?

VERIFY

Key Sequence

Config VERIFY

Description

Pressing VERIFY and then pressing ADD/REMOVE will add or delete channels from the Verify List.

A channel must be part of the Verify List in order for delay to be initiated for that channel.

Related Remote Commands

ROUTe:VERIFY { :ON | :OFF }

WIDTH

Key Sequence

Config WIDTH

Description

WIDTH is used to adjust the pulse width to the width necessary to drive the relays. Read the documentation on the relays to determine the recommended pulse width. A list of compatible Hewlett-Packard relays are shown in Table 1-2.

Pressing the WIDTH key effects no apparent change to the display until numbered keys or numbers from the display labeling function are selected.

Pulse width values from 0.005 s to 1.275 s can be entered in 0.005 s increments. Values in s (seconds) or ms (milliseconds) may be entered. The s or ms key must be pressed in order for the value to be entered. If the value is a legal value (0.005 s to 1.275 s in 0.005 s increments), the display response area will show the value in seconds.

Pulse width is implemented only if the channel is declared as part of the Drive List. The sense delay and pulse width for the current channel are read out on the fourth line of the information window. These can be modified using the WIDTH key. The entered values are truncated to the next lower 5 ms.

Related Remote Commands

ROUTe:GROUP { :VERify | :DRIVe | :WIDTh }

Programming Internal Switches and Optional Step Attenuators

The switches inside the HP 70612A,C and HP 70613A,C interface modules have preprogrammed switch path definitions and front panel light controls.

The HP 70612A,C and HP 70613A,C come standard with five SPDT switches. The HP 70612A,C are configured to provide a single input and six outputs. The HP 70613A,C provide routing for two inputs to five outputs. See Figure 5-17. The interface module has the path definition, names and labels stored inside the EEROM.

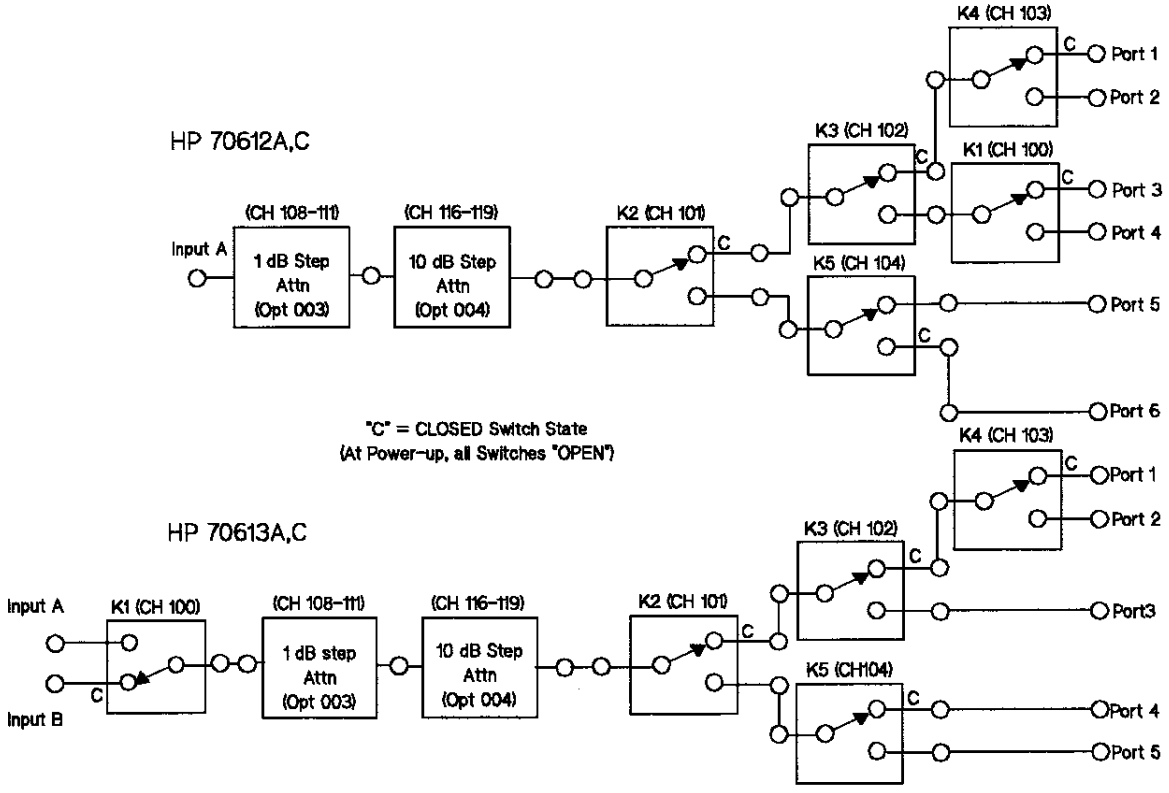


Figure 5-17. Schematics of HP 70612A,C, 70613A,C

Table 5-2. HP 70612A,C Switch Paths

From	To	Logical Name	Label	Close	Open
1	A	P1TOA	Port 1 to A	101, 102, 103, 120, 121, 122, 126, 127	100, 104, 125
2	A	P2TOA	Port 2 to A	101, 102, 120, 121, 122, 125, 127	100, 103, 104, 126
3	A	P3TOA	Port 3 to A	100, 101, 120, 121, 122, 125, 126	102, 103, 104, 127
4	A	P4TOA	Port 4 to A	101, 121, 122, 125, 126, 127	100, 102, 103, 104, 120
5	A	P5TOA	Port 5 to A	120, 122, 125, 126, 127	100, 101, 102, 103, 104, 121
6	A	P6TOA	Port 6 to A	104, 120, 121, 125, 126, 127	100, 101, 102, 103, 122

Table 5-3. HP 70613A,C Switch Paths

From	To	Logical Name	Label	Close	Open
1	A	P1TOA	Port 1 to A	101, 102, 103, 120, 121, 124, 126, 127	100, 104, 125, 129
2	A	P2TOA	Port 2 to A	101, 102, 120, 121, 124, 125, 127	100, 103, 104, 126, 129
3	A	P3TOA	Port 3 to A	101, 120, 121, 124, 125, 127	100, 102, 103, 104, 127, 129
4	A	P4TOA	Port 4 to A	104, 121, 124, 125, 126, 127	100, 101, 102, 103, 120, 129
5	A	P5TOA	Port 5 to A	120, 124, 125, 126, 127	100, 101, 102, 103, 104, 121, 129
1	B	P1TOB	Port 1 to B	100, 101, 102, 103, 120, 121, 126, 127, 129	104, 124, 125
2	B	P2TOB	Port 2 to B	100, 101, 102, 120, 121, 125, 127, 129	103, 104, 124, 126
3	B	P3TOB	Port 3 to B	100, 101, 120, 121, 125, 126, 129	102, 103, 104, 124, 127
4	B	P4TOB	Port 4 to B	100, 104, 121, 125, 126, 127, 129	101, 102, 103, 120, 124
5	B	P5TOB	Port 5 to B	100, 120, 125, 126, 127, 129	101, 102, 103, 104, 121, 124

Options 003, 004 and 007 add step attenuators to the standard HP 70612A,C and 70613A,C. The following tables contain the preprogrammed attenuator setting definitions, path names and labels.

Table 5-4.
HP 70612A,C and HP 70613A,C Option 003 (11 dB, 1 dB steps)

Value	Name	Label	Close	Open
0	SA1_00	0 dB		108, 109, 110, 111
1	SA1_01	1 dB	108	109, 110, 111
2	SA1_02	2 dB	109	108, 110, 111
3	SA1_03	3 dB	108, 109	110, 111
4	SA1_04	4 dB	110	108, 109, 111
5	SA1_05	5 dB	108, 110	109, 111
6	SA1_06	6 dB	109, 110	108, 111
7	SA1_07	7 dB	108, 109, 110	111
8	SA1_08	8 dB	110, 111	108, 109
9	SA1_09	9 dB	108, 110, 111	109
10	SA1_10	10 dB	109, 110, 111	108
11	SA1_11	11 dB	108, 109, 110, 111	

Table 5-5. HP 70612A and 70613A Option 004 (110 dB, 10 dB steps)

Value	Name	Label	Close	Open
0	SA10_000	00 dB		116, 117, 118, 119
10	SA10_010	10 dB	116	117, 118, 119
20	SA10_020	20 dB	117	116, 118, 119
30	SA10_030	30 dB	116, 117	118, 119
40	SA10_040	40 dB	118	116, 117, 119
50	SA10_050	50 dB	116, 118	117, 119
60	SA10_060	60 dB	117, 118	116, 119
70	SA10_070	70 dB	116, 117, 118	119
80	SA10_080	80 dB	118, 119	116, 117
90	SA10_090	90 dB	116, 118, 119	117
100	SA10_100	100 dB	117, 118, 119	116
110	SA10_110	110 dB	116, 117, 118, 119	

Table 5-6. HP 70612C and 70613C Option 004 (90 dB, 10 dB steps)

Value	Name	Label	Close	Open
0	SA10_000	00 dB		116, 117, 118, 119
10	SA10_010	10 dB	116	117, 118, 119
20	SA10_020	20 dB	117	116, 118, 119
30	SA10_030	30 dB	118	116, 117, 119
40	SA10_040	40 dB	116, 118	117, 119
50	SA10_050	50 dB	117, 118	116, 119
60	SA10_060	60 dB	118, 119	116, 117
70	SA10_070	70 dB	116, 118, 119	117
80	SA10_080	80 dB	117, 118, 119	116
90	SA10_090	90 dB	116, 117, 118, 119	

6

Remote Operation

Programming

This chapter introduces the basic concepts of programming the HP 70611A, 70612A/C and 70613A/C modules.

There are four operations that can be performed using a controller:

1. Set up the switch driver and start programming groups and paths for switches.
2. Set switch delay, pulse width, and sensing.
3. Sense switch status.
4. Store and retrieve switch parameters via remote interface.

Other more complicated tasks are accomplished using a combination of these four basic functions.

Note To speed remote programming take the switch driver off the display. If another instrument is on the bus press `NEXT INSTR` or `SELECT INSTR`. If you cannot select another instrument try the following:

1. Press (DISPLAY).
2. `Config Display`
3. `purge window`
4. `EXECUTE`

How to Use this Chapter

First perform the "Operating Example" in chapter 5, "Local Operation". This will introduce you to how the switch driver operates.

If you are already familiar with *Standard Commands for Programmable Instruments* (SCPI) programming techniques go to the "Speed Calculation Example" at the end of this chapter for a few additional concepts. The alphabetical listing and command tree can be used for your own applications.

This chapter contains:

- A command tree of SCPI commands.
- An alphabetical list of common commands.
- An alphabetical list of SCPI commands.
- Three programming examples:
  - Save Memory

- Restore Memory
- Speed Calculation

Standard Commands

The instrument command language is *Standard Commands for Programmable Instruments* (SCPI). The programming examples and information in this chapter use the SCPI format. SCPI follows IEEE 488.2-1987 Codes, Formats, Protocols and Common Commands. Refer to *Beginner's Guide to SCPI* (HP part number H2325-90001) for more information.

Note Commands are sent over an HP-IB bus which follows IEEE 488.1. Refer to *Tutorial Description of the Hewlett-Packard Interface Bus* (HP part number 5952-0156) for more information. Commands are also sent over the HP-MSIB bus. Refer to *Communication Protocol Design Guide* (HP part number 5958-6631) for more information.

Language

The programming examples in this manual are written in HP BASIC 5.0 for an HP 9000 Series 200/300 Controller operating over HP-IB. HP BASIC handles some of the redundant miscellaneous overhead associated with IEEE Standard 488.1 (HP-IB). For instance, when a BASIC "OUTPUT" statement is used (by the Active Controller) to send data to an HP-IB device, the following sequence of commands and data are sent over the bus:

```
OUTPUT 709;"Data"
```

1. The unlisten command is sent.
2. The talker's address command is sent (the address of the computer).
3. The listener's address command (09) is sent.
4. The data bytes "D", "a", "t", and "a" are sent.
5. Terminators CR and LF are sent.

All bytes are sent using the HP-IB's interlocking handshake to ensure that the listener has received each byte.

The example shows that the HP BASIC "OUTPUT" statement causes more than just the output of data to take place. For controllers other than Hewlett-Packard which are using a programming language other than HP BASIC, additional steps may have to be added to the program examples given in the manual.

For more information, refer to IEEE Standard 488.1 and the programming language reference.

Programming Syntax

Talking to the Switch Driver

In general, computers acting as controllers communicate with the switch driver by passing messages over a remote interface using the I/O statements provided in the instruction set of the controller's host language. Therefore, the messages for programming the switch driver described in this manual, will normally appear as ASCII character strings imbedded inside the I/O statements of your controller's program. For example, the HP 9000 Series 200/300 BASIC and PASCAL language systems use the OUTPUT statement for sending program messages to the Switch Driver, and the ENTER statement for receiving response messages from the switch driver.

Messages are placed on the bus by using an output command and passing the device selector, program message, and terminator. Passing the device selector ensures that the program message is sent to the correct interface and instrument.

The following query command reads out the firmware datecode:

```
OUTPUT < device selector > ;":SYSTEM:VERSION?"
```

where < device selector > represents the address of the device being programmed.

Note

The programming examples in this manual are written in HP Basic 5.0 for an HP 9000 Series 200/300 Controller.

The actual OUTPUT command used when programming is dependent on the controller and the programming language being used. Angular brackets "< >," in this manual, enclose words or characters that symbolize a program code parameter or a bus command.

Information that is displayed in quotes represents the actual message that is sent across the bus. The message terminator (NL or EOI) is the only additional information that is also sent across the bus.

For HP 9000 Series 200/300 controllers, it is not necessary to type in the actual <terminator> at the end of the program message. These controllers automatically supply the program message terminator when the return key is pressed.

Addressing the Switch Driver

Since HP-IB can address multiple devices through the same interface card, the device selector passed with the program message must include not only the correct interface code, but also the correct instrument address.

Interface Select Code (Selects Interface) Each interface card has a unique interface select code. This code is used by the controller to direct commands and communications to the proper interface. The default is typically 7 for HP-IB controllers.

Instrument Address (Selects Instrument) Each instrument on an HP-IB / HP-MSIB bus must have a unique instrument address between decimal 0 and 30. The address must not be the address of the controller, see chapter 2, "Installation". The device address passed with the program message must include *both* the correct instrument address *and* the correct interface select code.

DEVICE SELECTOR = (Interface Select Code × 100) + (Instrument Address)

For example, if the instrument address for the switch driver is 9 and the interface select code is 7, when the program message is passed, the routine performs its function on the instrument at device selector 709.

For the switch driver, the instrument address is typically set to 9 at the factory.

Note The program examples in this manual assume the switch driver is set to device address 709.

Program Message Syntax

To program the switch driver over the bus, you must have an understanding of the command format and structure expected by the switch driver. The switch driver is remotely programmed with program messages. These are composed of sequences of program message units, with each unit representing a program command or query.

A program command or query is composed of a sequence of functional elements that include separators, headers, program data, and terminators. These elements are sent to the switch driver over the system interface as a sequence of ASCII data messages.

Separator The <separator> shown in the program message refers to a blank space which is required to separate the program mnemonic from the program data.

Commands

A command is composed of a header, any associated data, and a terminator. The header is the mnemonic or mnemonics that represent the operation to be performed by the switch driver. The different types of headers are discussed in the following paragraphs.

Compound Command Header Compound command headers are a combination of two or more program mnemonics. The first mnemonic selects the subsystem, and the last mnemonic selects the function within that subsystem. Additional mnemonics appear between the subsystem mnemonic and the function mnemonic when there are additional levels within the subsystem that must be transversed. The mnemonics within the compound message are separated by colons.

For example:

To execute a single function within a subsystem, use the following:

:<subsystem>:<function><separator><program data><terminator>

For example:

```
ROUTE:GROUP <group name>:AUTOSELECT:OFF;
```

To transverse down a level of a subsystem to execute a subsystem within that subsystem:

:<subsystem>:<subsystem>:<function><separator>
<program data><terminator>

For example:

```
ROUTE:GROUP:LABEL "Atten 0 to 110 dB by 10 dB steps";
```

Selecting Multiple Subsystems You can send multiple program commands and program queries for different switch driver subsystems on the same line by separating each command with a semicolon. The colon following the semicolon enables you to enter a new subsystem.

:<subsystem>:<function><separator><data>;
<function><separator><data><terminator>

```
ROUTE:DRIVE:OFF:ALL;:SYSTEM:VERSION?
```

Common Command Header Common command headers control IEEE 488.2 functions within the switch driver (such as clear status, and so forth). Their syntax is:

*<command header><terminator>

No space or separator is allowed between the asterisk and the command header. *CLS is an example of a common command header. For example:

```
*CLS;ROUTE:DRIVE:ON (@100,102,104,106,....);
```

Common commands used by the switch driver are explained in more detail in the "Common Command Reference".

Program Header Options

Program headers can be sent using any combination of uppercase or lowercase ASCII characters.

Both program command and query headers may be sent in either longform (complete spelling), shortform (abbreviated spelling), or any combination of longform and shortform.

Note ONLY the longform or shortform of a command will be accepted by the switch driver. Either of the following examples read out the firmware datecode:

SYSTEM:VERSION? – longform SYST:VERS? – shortform

Programs written in longform are easy to read and are almost self-documenting. The shortform syntax conserves the amount of controller memory needed for program storage and reduces the amount of I/O activity.

Note The shortform abbreviation is given for each command in the "SCPI Command Reference".

Program Data

Program data is used to convey a variety of types of parameter information related to the command header. At least one space must separate the command header or query header from the program data.

<program mnemonic><separator><data>
<terminator>

When a program mnemonic or query has multiple data parameters a comma separates sequential program data.

<program mnemonic><separator><data>,<data><terminator>

For example:

```
ROUTE:DELAY .02,(@101,103,105);
```

Character Program Data Character program data is used to convey parameter information as alpha or alphanumeric strings.

For example, ROUTE:VERIFY:ON:ALL

where the :VERIFY function is specified to be ON for *all* channels.

Numeric Program Data Some command headers require program data to be a number.

For example, ROUTE:DELAY .03,(@101,103,105)

where the :DELAY function is specified to be 30 ms on channels 101, 103, and 105.

Program Message Terminator

The program codes within a data message are executed after the program message terminator is received. The terminator may be either an NL (New Line) character, an EOI (End-Or-Identify) asserted, or a combination of the two. All three ways are equivalent with the exact encodings for the program terminators listed in the chapter "Message Communication and System Functions." Asserting EOI sets the HP-IB EOI control line low on the last byte of the data message. The NL character is an ASCII linefeed (decimal 10).

Query Command

Command headers immediately followed by a question mark (?) are queries. After receiving a query, the switch driver interrogates the requested function and places the answer in its output queue. The output message remains in the queue until it is read or another command is issued. When read, the message is transmitted across the bus to the designated listener (typically a controller).

For example, the query ROUTE:PATH:VALUE? <path name> places the value of the named path in the output queue. In conjunction with this, the controller input statement:

```
ENTER <device selector>;Values$
```

passes the value across the bus to the controller and places it in the BASIC variable "Values$".

Query commands are used to find out how the switch driver is currently configured. They are also used to get results of switch status made by the switch driver, with the query actually activating the switch. For example, the command ROUTe:CLOSE? <channel spec> instructs the Driver to sense the status of the switch and place the result in the output queue.

Note

The output queue must be read before the next program message is sent. For example, when the query ROUTE:VERIFY:ON? is sent that query must be followed with a program statement like, ENTER 709; Verify$ to read the result of the query and place the result in a BASIC variable (Verify$).

Sending another command before reading the result of the query will cause the output buffer to be cleared and the current response to be lost. This will also generate an error in the error queue.

Programming the Switch Driver

Initialization

To make sure the bus and all appropriate interfaces are in a known state, begin every program with an initialization statement. For example:

```
CLEAR 709 ! initializes the interface of the driver.
```

Then, initialize the switch driver to a preset state. For example:

```
OUTPUT 709;"*RST" ! initializes the instrument to a preset state.
```

Note The actual commands and syntax for initializing the switch driver are discussed in the chapter "Common Commands." Refer to the controller manual and programming language reference manual for information on initializing the interface.

Setting Up the Switch Driver

A typical switch driver setup would set the drive (ON or OFF) paths, delay time, sensing (ON or OFF), and pulse width. Some typical examples of the commands sent to the driver are:

```
OUTPUT 709;"*CLS;ROUTE:DRIVE:ON (@100,102,104,106,....);"

OUTPUT 709;"ROUTE:DRIVE:OFF (@101,103,105,107,....);"

OUTPUT 709;"ROUTE:VERIFY:ON (@100,102,104,106,....);"

OUTPUT 709;"ROUTE:WIDTH .04,(@100,102,104,106,....);"

OUTPUT 709;"ROUTE:DELAY .03,(@100,102,104,106,....);"
```

Returning to Local

When placing the switch driver in local, use the BASIC command LOCAL <interface select code><device selector>. Using the BASIC command LOCAL <interface select code><device selector> returns the switch driver to display operation, but the switch driver still accepts remote commands. For example:

```
10 REMOTE 709 !Switch driver is placed in remote.
20 !Manual operation is disabled.
30 LOCAL 709 !Switch driver accepts
40 !remote commands and softkey commands
50 !from the MMS display interface.
60 OUTPUT 709;"ROUTE:GROUP:CATALOG?"
70 !Send a command
70 !Switch driver will respond
```

Ordinarily, any command from the computer will place the switch driver into remote mode. The exception to this is when you send LOCAL 709 prior to a switch driver command. The switch driver is placed in local mode but the command still works.

Receiving Information from the Switch Driver

After receiving a query (command header followed by a question mark), the switch driver interrogates the requested function and places the answer in its output queue. The answer remains in the output queue until it is read or another command is issued. When read, the message is transmitted across the bus to the controller.

The input statement for receiving a response message from an instrument's output queue typically has two parameters; the device address and a format specification for handling the response message. For example, to read the result of the query command :GROUP:LABEL?, you would execute the statement:

```
10 OUTPUT 709;"ROUT:GROUP:LABEL? GROUP1
20 ENTER 709;Setting$
```

"GROUP1" represents the name of the desired group. This would enter the current label of the group in the string variable Setting$.

Note All results for queries sent in a program message must be read before another program message is sent. For example, when you send the query:

```
ROUTe:CLOSE? (@101)
```

you must follow that query with the program statement:

```
ENTER 709;Sense$
```

to read the result of the query and place the result in a variable (SENSE$). Sending another command before reading the result of the query will cause the output buffer to be cleared and the current response to be lost. This will also cause an error to be placed in the error queue. Executing an ENTER statement before sending a query will cause the controller to wait indefinitely. The actual ENTER program statement used when programming is dependent on the programming language being used. The format specification for handling the response message is dependent on both the controller and the programming language.

String Variables

If you want to observe the headers for queries, you must bring the returned data into a BASIC string variable. Reading queries into string variables is simple and straightforward, requiring little attention to formatting.

For example:

```
ENTER 709;Result$
```

places the output of the query in the string variable Result$.

The output of the switch driver may be either numeric or character data depending on what is queried. Refer to the specific commands for the formats and types of data returned from queries.

Note For the example programs, assume that the device being programmed is at device selector 709. The actual address will vary according to how you have configured the bus for your own application.

The following example shows the data being returned to a string variable:

```
10 DIM Rang$[40]
20 OUTPUT 709;"ROUTE:VERIFY:OFF:ALL;"
30 OUTPUT 709;"ROUTE:VERIFY:OFF? (@101:105);"
40 ENTER 709;Rang$
50 PRINT Rang$
60 END
```

After running this program, the controller displays a list of 1's or 0's separated by commas for every channel in the list.

```
1,1,1,1,0
```

Instrument Status

Status registers track the current status of the switch driver. By checking the instrument status, you can find out whether an operation has been completed, whether the switch driver is receiving triggers, and more. The chapter "Message Communication and System Functions" explains how to check the current status of the instrument.

Common Commands Reference

The common commands are defined by the IEEE 488.2 standard. These commands will be common to all instruments that comply with this standard.

The common commands control some of the basic instrument functions, such as instrument identification and reset and how status is read and cleared.

The common commands used in this instrument are shown in the following table:

IEEE 488.2 Common Commands

Command	Command Name
*CLS	Clear Status Command
*ESE	Event Status Enable Command
*ESE?	Event Status Enable Query
*ESR?	Event Status Register Query
*IDN?	Identification Query
*OPC	Operation Complete Command
*OPC?	Operation Complete Query
*RST	Reset Command
*SRE	Service Request Enable Command
*SRE?	Service Request Enable Query
*STB?	Read Status Byte Query
*TST?	Self-Test Query
*WAI	Wait-to-Continue Command

*CLS (Clear Status)

Syntax

```
*CLS
```

Description

The *CLS (clear status) common command clears the status data structures, including the device defined error queue. This command also clears *OPC and *OPC?.

If the *CLS command immediately follows a PROGRAM MESSAGE TERMINATOR, the output queue and the MAV bit will be cleared.

Example Command

```
OUTPUT 709;"*CLS"
```

*ESE (Event Status Enable)

Syntax

*ESE *mask*

*ESE?

Description

The *ESE command sets the Standard Event Status Enable Register bits. The Standard Event Status Enable Register contains a mask value for the bits to be enabled in the Standard Event Status Register. A one in the Standard Event Status Enable Register will enable the corresponding bit in the Standard Event Status Register, a zero will disable the bit. Refer to the table below for the information about the Standard Event Status Enable Register bits, bit weights, and what each bit masks. Valid number range is 0 to 255.

The *ESE query returns the current contents of the register.

Event Status Enable Register Bit Definitions

Bit	Weight	Enables
7	128	PON- Power ON
6	64	(not used)
5	32	CME- Command Error
4	16	EXE- Execution Error
3	8	DDE- Device Dependent Error
2	4	QYE- Query Error
1	2	(not used)
0	1	OPC- Operation Complete

Example Command

```
OUTPUT 709;"*ESE 64"
```

Example Query

```
OUTPUT 709;"*ESE?"
ENTER 709; Event
PRINT Event
```

*ESR? (Event Status Register Query)

Syntax

```
*ESR?
```

Description

The *ESR query returns the contents of the Standard Event Status Register.

The table below shows the Event Status Register. The table shows each bit in the Event Status Register, and the bit weight. When you read the Event Status Register, the value returned is the total bit weights of all bits that are high at the time you read the byte. The register is cleared to 0 on a *CLS and after *ESR? is executed.

Note See the *STB? command for how the ESR is reported through the Status Byte.

Event Status Register Bit Definitions

Bit	Weight	Name	Condition
7	128	PON	1 = an OFF to ON transition has occurred
6	64	URQ	(not used) always 0
5	32	CME	0 = no command errors 1 = a command error has been detected
4	16	EXE	0 = no execution error 1 = an execution error has been detected
3	8	DDE	0 = no device dependent errors 1 = a device dependent error has been detected
2	4	QYE	0 = no query errors 1 = a query error has been detected
1	2	RQC	(not used) always 0
0	1	OPC	0 = operation is not complete 1 = operation is complete

Example Query

```
OUTPUT 709;"*ESR?"
ENTER 709; Event
PRINT Event
```

*IDN? (Identification Number)

Syntax

```
*IDN?
```

Description

The *IDN query allows the instrument to identify itself. It returns a string such as:

```
HEWLETT-PACKARD,70611A,1234A56789,910101
```

Where 910101 is the firmware version number and 1234A56789 is the serial number.

Example Command

```
DIM Id$[72]
OUTPUT 709;"*IDN?"
ENTER 709;Id$
PRINT Id$
```

*OPC (Operation Complete)

Syntax

```
*OPC

*OPC?
```

Description

The *OPC and *OPC? commands are used to synchronize remote interface software to internal module events. The *OPC (operation complete) command will cause the instrument to set the operation complete bit in the Standard Event Status Register when any switching operations that were in process at the time the *OPC command was received have completed. *OPC? causes a 1 to be put into the output buffer when any switching operations that were in process at the time the *OPC? command was received have completed.

If no switching operations were in process at the time the command was sent, the response will be generated immediately. Hence *OPC or *OPC? should only be sent after an operation has been initiated. *OPC is also used to signal the end of MEM:SAVE operation.

Example Command

```
OUTPUT 709;"*OPC"
```

Example Query:

The following sequence is *correct*, because the OPC command is sent *after* the operation is initiated:

```
OUTPUT 709; "ROUT:CLOS (@1(1,3,5,7,9));*OPC?"
ENTER 709;A
PRINT A
```

The following sequence is *incorrect*, because the OPC command is sent *before* the operation is initiated:

```
*OPC?;ROUT:CLOSE (@1(1,3,5,7,9));
```

*RST (Reset)

Syntax

```
*RST
```

Description

*RST is equivalent to a power up condition for the switch hardware. All relays for which DRIVE is ON are set to the positions determined by ROUTe:PFAil. For any relays not in either the ROUTe:PFAil:OPEN or ROUTe:PFAil:CLOSE list, the positions which are stored in the "last state" list in RAM are used to set the initial switch position. The "last state" list contains the programmed positions of the switch hardware that existed the last time a MEM:SAVE command or a SAVE TO EEROM keypress took place.

The setting of the switches during *RST or power up is done with VERIFY turned OFF, to get all the relays and sense lines into a known state. VERIFY is then turned on for any switches in the VERIFY list. *RST does not affect the configuration data stored in RAM (DRIVE and VERIFY lists, drive and delay times, etc), only the switches themselves.

The (IP) or (Instr Preset) key does a *RST operation, as does the *TST? command.

Example Command

```
OUTPUT 709;"*RST"
```

*SRE (Service Request Enable)

Syntax

*SRE *mask*

*SRE?

Description

The *SRE command sets the Service Request Enable Register bits. When controlling over the HP-MSIB bus, instead of asserting SRQ, the HP-MSIB STATUS message is sent. This is equivalent to asserting SRQ and participating in a serial poll on HP-IB. This will indicate whether or not the device has at least one reason for requesting service. A one in the Service Request Enable Register will enable the corresponding bit in the Status Byte Register, a zero will disable the bit. Refer to the table below for the bits in the Service Request Enable Register and what they mask. Legal number range is 0 to 255.

At power up the SRE register is 0.

The *SRE query returns the current value.

Service Request Enable Register

Bit	Weight	Enables
7	128	SCPI Operation Summary
6	64	RQS- Request Service
5	32	ESR- Event Status Register
4	16	MAV- Message Available
3	8	SCPI Questionable Summary
2	4	Not used
1	2	Not used
0	1	Not used

Example Command

```
OUTPUT 709;"*SRE 32"
```

Example Query

```
OUTPUT 709;"*SRE?"
ENTER 709;Value
PRINT Value
```

*STB? (Status Byte)

Syntax

```
*STB?
```

Description

The *STB query returns the current value of the instrument's status byte. Refer to the table below for the definitions of the bits in the status byte.

Note The MAV bit in the status byte is essentially useless when controlling the switch driver over HP-MSIB because the output queue empties onto the HP-MSIB without any action being required from the destination address (unlike HP-IB, where the module must be addressed to talk before it will send data). Hence MAV would not be a reliable indicator of data being available from a module over HP-MSIB.

Status Byte Bit Definitions

Bit	Weight	Name	Condition
7	128	OPER	0 = no operation status events have occurred 1 = an operation status event has occurred
6	64	RQS/MSS	0 = instrument has no reason for service 1 = instrument is requesting service
5	32	ESR	0 = no event status conditions have occurred 1 = an enabled event status condition has occurred
4	16	MAV	0 = no output messages are ready 1 = an output message is ready
3	8	QUES	0 = no questionable conditions have occurred 1 = a questionable condition has occurred
2	4	—	always 0
1	2	—	always 0
0	1	—	always 0

Example Query

```
OUTPUT 709;"*STB?"
ENTER 709;Value
PRINT Value
```

See the STATus command in the "SCPI Command Reference" in this chapter for more information on the OPERATION register and summary bit.

*TST? (Test)

Syntax

```
*TST?
```

Description

*TST? causes all relays to cycle through both of their positions (first all the CLOSE paths are set, then all the OPEN paths), then get placed in the appropriate power up positions. See *RST. All relays for which sensing is enabled (VERIFY:ON) are checked for proper operation each time they are switched. Unused relays (DRIVE:OFF) are neither switched or checked. The result of the test will be placed in the output queue. A 0 indicates that the test passed and a non-zero value indicates the test failed.

Example Query

```
OUTPUT 709;"*TST?"
ENTER 709;Result
PRINT Result
```

*WAI (Wait)

Syntax

```
*WAI
```

Description

The *WAI command causes the instrument to wait for all pending HP-IB operations to finish before processing any further commands.

Example

```
OUTPUT 709;"*WAI"
```

Hierarchy

Table 6-1. Command Tree

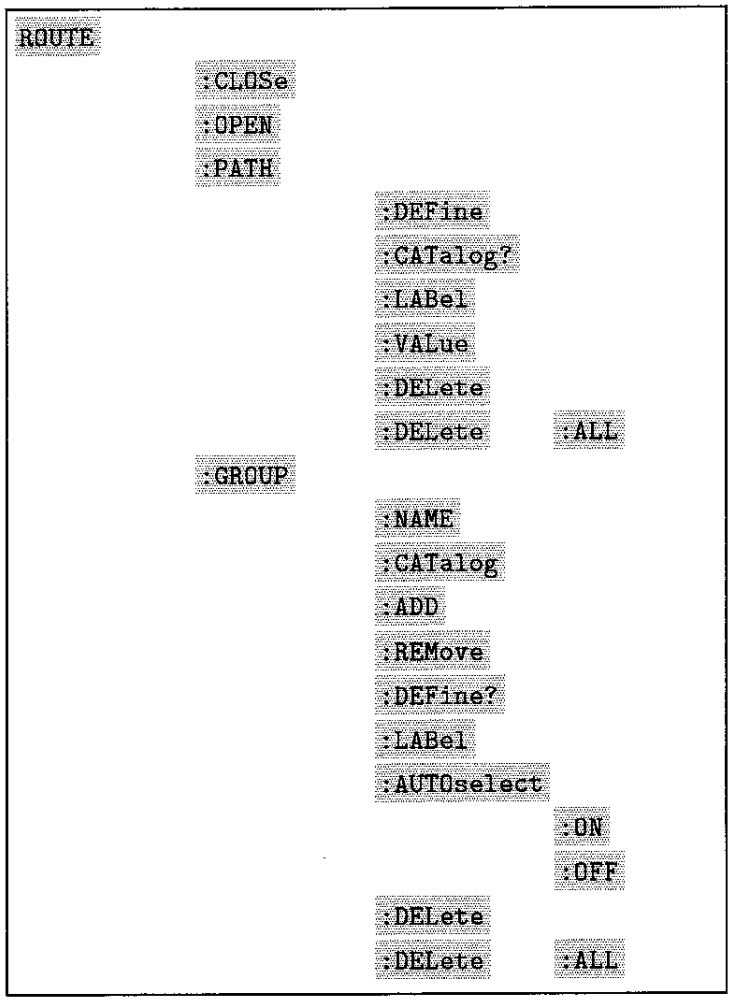


Table 6-1. Command Tree (continued)

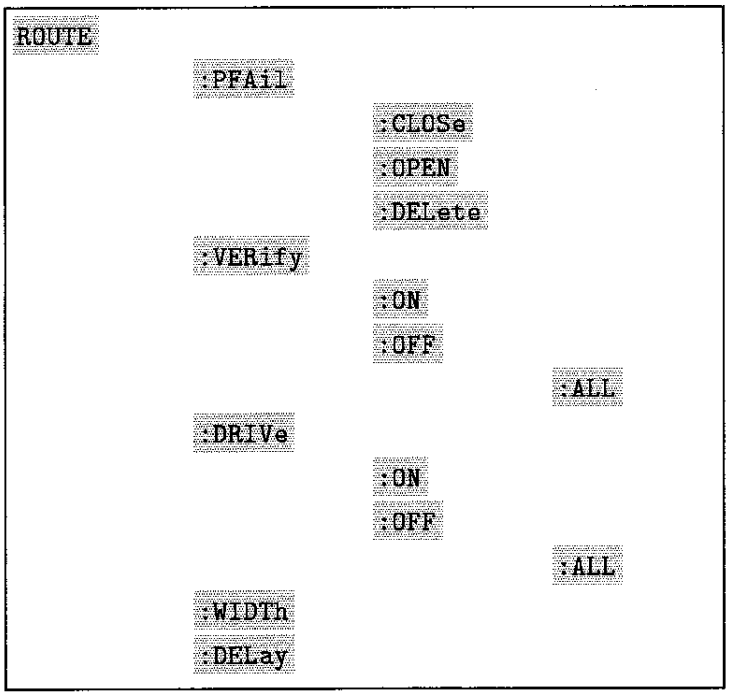
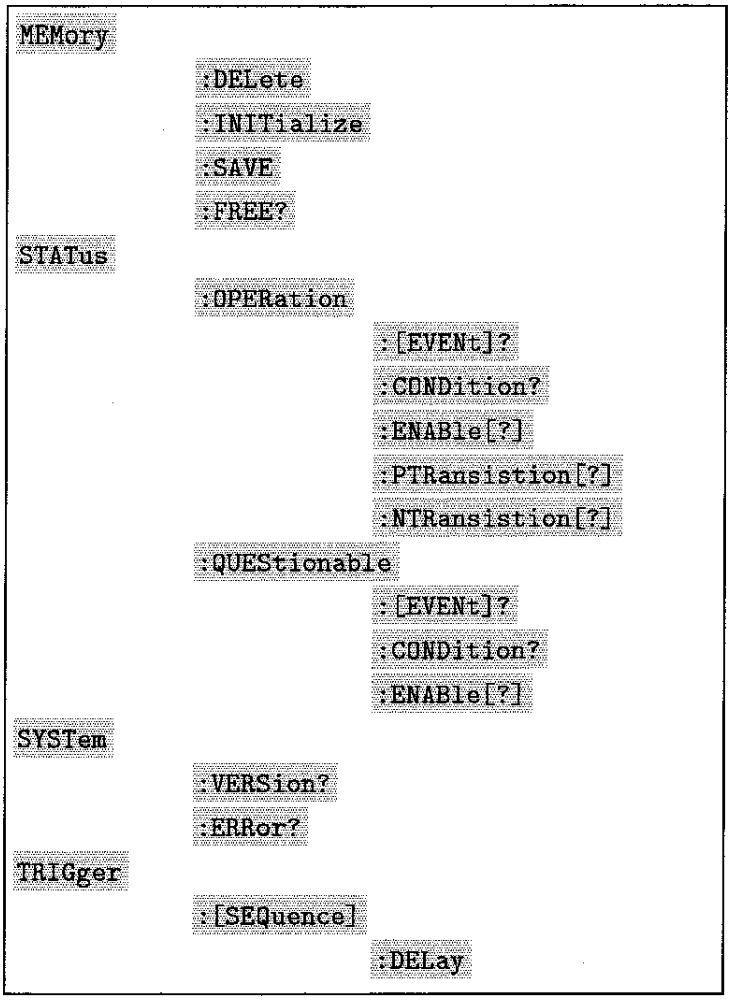


Table 6-1. Command Tree (continued)



SCPI Command Reference

In this section all of the SCPI command sequences honored by the HP 70611A, HP 70612A/C, and HP 70613A/C are listed.

Channel Lists

HP 70611A

The HP 70611A can control up to eight different driver cards, each of which can drive up to 31 different relays. The cards are numbered from 1 to 8, the relays on each card are numbered from 0 to 30. Each relay is referred to as a *channel* by the switch driver. Therefore, there are a total of 248 relays (channels) that can be driven from a single switch driver.

Note The hardware on the HP 84940A driver is capable of driving 31 relays.

HP 70612A/C and HP 70613A/C

The HP 70612A/C and HP 70613A/C can control up to seven external driver cards. There are a total of 217 relays (channels) that can be driven from a single switch driver.

In order to realize the capability of the switch driver, many of the commands listed in the "SCPI Command Reference" utilize a language construct called a channel list. A single remote command may specify single or multiple relays by means of this channel list. The syntax for channel lists is as follows:

```
(@channel number,channel number,...),
```
or
```
(@channel number:channel number,), (a range)
```
or
```
(@card number, (channel number, channel   number,...)),
```
or
```
(@card number, (channel number:channel   number)),
```
or
```
(@) (empty channel list)
```

The card number must always be sent, either as the card number parameter or as part of a channel number (or range). When sent as part of a channel number, the card number is multiplied by 100 and added to the channel number.

For example, 214 would mean channel 14 on card 2.

An example of the above syntax is:

```
(@101,2(0:5),3(1,3,5),406:410)
```

This means channel 1 on card 1, channels 0 through 5 on card 2, channels 1, 3 and 5 on card 3, and channels 6 through 10 on card 4.

:ADD

Syntax

```
ROUTE:GROUP:ADD <group name>,<path name>
```

Description

This command adds an existing path to the end of an existing group. The group name and path name must have been previously defined using GROUP:NAME and PATH:DEF. A path may be added to a group in several places by issuing this command several times. Only one path can be added for each issuance of ADD.

Example Command

```
ROUTE:GROUP:ADD ATTEN,ATTEN_14;
```

A previously defined path `ATTEN_14` is added to group `ATTEN`. See the query :DEFine? <group name> to list all paths in a group.

:AUTOselect

Syntax

ROUTe:GROUP:AUTOselect[?] { [:ON] / :OFF } <group name>

Description

This turns the current Auto Select state for the group on or off. See section 5 for more on AUTOselect.

Example Command

```
ROUTE:GROUP:AUTO:ON ATTEN;
```

This turns the current Auto Select state for the group ATTEN on.

```
ROUTE:GROUP:AUTO:OFF ATTEN;
```

This turns the current Auto Select state for the group ATTEN off.

Example Query

```
ROUTE:GROUP:AUTO? ATTEN;
```

or

```
ROUTE:GROUP:AUTO:ON? ATTEN;
```

This queries the current autoselect state for the group. If the current state of autoselect for group ATTEN is ON, a 1 will be returned.

```
ROUTE:GROUP:AUTO:OFF? ATTEN;
```

If the current state of autoselect for group ATTEN is OFF, a 1 will be returned.

:CATalog?

Syntax

ROUTe:{:PATH / :GROUP}:CATALOG?:

Description

Returns a list of groups (up to 16) *or* all defined paths in the module.

Example Query

```
ROUTE:GROUP:CATALOG?
```

This query returns a list of all of the group names, in order from 1 to 16, separated by commas.

```
ROUTE:PATH:CATALOG?
```

This query returns a list of all the defined paths in the module, separated by commas.

CLOSe

Syntax

ROUTe:CLOSe[?] { <pathname> | <channel list> }

ROUTe:PFAil:CLOSe[?] { <pathname> | <channel list> }

Description

Each channel has a CLOSE or OPEN position. On Hewlett-Packard relays, the CLOSE path is the path between the input terminal labelled 2 on the relay and the input terminal labelled C. It is recognized that CLOSE and OPEN are abitrary for this type of switch; they are, however, in keeping with the SCPI language specification.

Example Command

```
ROUTe:CLOSe (@101,2(0:5),3(1,3,5),406:410);
```

Sending the above command causes channel 1 on card 1, channels 0 through 5 on card 2, channels 1, 3 and 5 on card 3, and channels 6 through 10 on card 4 to be closed.

Note Channels must have DRIVe:ON to be closed or they will be ignored. During any switching operation (OPEN or CLOSE) the Settling Bit in the OPER status register is set (1). It is cleared (0) when the operation completes.

Example Query

```
ROUTE:CLOSE? (@101,103,105);
```

Sending the query (optional question mark) causes the channels in the channel list parameter to be checked for closed channels. The readback is a list of 1's and 0's separated by commas, one for each channel in the list. A 1 is sent if the specified channel is closed, otherwise a 0 is sent.

Devices for which sensing is on (VERify:ON) read back the position in which they were sensed the last time a switching operation took place. Devices with sensing off simply read back the currently programmed state (which, if they haven't been switched since power up, will be the state they were set to at power up). Devices with DRIVE:OFF read back the last value to which they were set.

Example Command

```
ROUTE:CLOSE ATTEN_14;
```

Sending the above command causes the set of switch OPENs and CLOSEs defined by the PATH (see PATH in this section) with name ATTEN_14 to be executed. The first group of switch settings in the PATH is interpreted as CLOSE settings and the second group as OPEN settings. The CLOSE settings are all executed first, followed by the OPEN settings.

For example, if ATTEN_14 had been defined as:

```
ROUTE:PATH:DEF ATTEN_14,(@101,102),(@103,104);
```

When that path is sent by ROUTE:CLOSE ATTEN_14, switches 101 and 102 will first be closed, then switches 103 and 104 will be opened.

Note The fact that CLOSE settings are executed before OPEN settings when a path is sent should be kept in mind by switch box designers when configuring hardware. For example, multistage attenuators should be set up so that a CLOSE operation always adds attenuation and an OPEN operation removes attenuation. This ensures that in moving from one attenuation setting to another, the imtermediate stage (after the CLOSEs and before the OPENs) is a stage representing higher attenuation, to avoid signal spikes that could damage sensitive hardware.

The query form is not available when using a path name, due to the potential for confusion between the first and second groups in the path.

Example Command

```
ROUTE:PFAIL:CLOSE (@101,2(0:5),3(1,3,5));
```

The ROUTe:PFAil:CLOSe command lists the channels desired to be closed on power up or after *RST or *TST?. The channel list has the same restrictions as those for the ROUTE:CLOSE command. Sending the command in the example above causes channel 1 on card 1, channels 0 through 5 on card 2, and channels 1, 3 and 5 on card 3 to be closed on power up.

```
ROUTe:PFAil:CLOSE ATTEN_14;
```

Sending the above command causes the set of switch OPENs and CLOSEs defined by the PATH with name ATTEN_14 to be added to the PFAIL list. The first group of switch settings in the PATH is interpreted as CLOSE settings and the second group as OPEN settings.

Example Query

```
ROUTE:PFAIL:CLOSE? (@101,205);
```

The inclusion of an optional question mark causes a readback of the power up state of the requested channels as a list of 1's and 0's separated by commas. A 1 means the channel is in the PFA:CLOS list. A 0 means that it is not. Note that when querying the PFAil state, the PFA:OPEN list must be checked as well to determine whether the power up state for a given channel is programmed at all.

Note If a relay is not in the PFAil:OPEN list or the PFAil:CLOSe list, its power up state is determined by the last save stored to EEROM for that relay.

:CYCLes?

Syntax

```
DIAGnostics:EERom:CYCLes?
```

Description

This query causes the HP 70611A, 70612A/C or 70613A/C to read back the number of times to which the EEROM has been written. If this number exceeds 10,000 the EEROM should be replaced. If the EEROM has never been written to, then 0 is returned.

Example Command

```
DIAG:EEROM:CYCLES?
```

:DEFine

Syntax

```
ROUTe:PATH:DEFine <path name>,<channel list> [,<channel list>]

ROUTe:GROUP:DEFine? <group name>

ROUTe:PATH:DEFine? <path name>
```

Description

Under the "PATH" subsystem, this command is used to define or redefine the switch settings that make up a path. This is the command that effectively "creates" a path by assigning the path name to one of the 256 internal path registers (if no register is available, a memory error will be declared). No other command referencing that path name may be sent before the DEFine command is sent.

A path name is any collection of up to 12 uppercase letters (lowercase letters are automatically uppercased), numbers, or underscore characters, starting with a letter. If the path name already exists, the old settings (both CLOSE and OPEN) will be erased and the new settings established from the new channel list.

The channel lists used by PATH:DEF follow all the normal rules for channel lists, and may contain any combination of switches from one or more driver cards. The second channel list is optional; if not sent it will be treated as empty. The empty channel list (@) may be sent for either parameter.

If a channel is included in both of the channel lists in a path, no error is declared, but the channel will be removed from the first list and only retained in the second.

The interpretation of the data in a path depends on how it is used. If sent using ROUTE:CLOSE <path name> or by the manual interface, the first channel list is a CLOSE list and the second an OPEN list. If sent using ROUTE:OPEN <path name>, the first channel list is an OPEN list and the second a CLOSE list.

Example Command

```
ROUTE:PATH:DEF ATTEN_14,(@101,2(0:5)),(@102);
```

This command defines a path whose name is ATTEN_14 whose first channel list affects channel 1 on card 1 and channels 0 through 5 on card 2, and whose second channel list affects channel 2 on card 1.

Example Query

```
ROUTE:PATH:DEFine? ATTEN_14;
```

The query form returns a path description as two channel lists separated by a comma. It can be sent back by appending it to a PATH:DEF command to recreate the path. For the example command above, the response should look like:

```
(@101,2(0:5)),(@102)
```

Example Query

```
ROUTE:GROUP:DEF? ATTEN;
```

This query returns a list of all of the path names in the group ATTEN, in order, separated by commas.

:DELay

Syntax

```
ROUTe:DELay:<delay time>,{ <channel list> }
                         { <path name>    }

ROUTe:DELay? <channel list>
```

Description

This commands sets the delay time in seconds required to validate the sense lines on a relay for which sensing will be used. The drive signal will be held on the relay for this amount of time after the pulse width requirement (see ":WIDTh") has been satisfied.

The delay time may be set in 5 ms increments up to 1275 ms. The delay time defaults to 20 ms when memory is initialized. The delay parameter may be an integer or real number.

CAUTION The :DELete and the DELay shortform is the same. The :DELete command applies only in syntax with other subsystems and not directly to channel lists.

Example Command

```
ROUTE:DELAY .02,(@101,103,105);

ROUT:DEL 20ms,(@101,103,105);
```

In the above example, the delay time is set to 20 ms for channels 1, 3, and 5.

```
ROUTE:DELAY .02,ATTEN_14;
```

This command causes the drive to the set of relays (defined by the ROUTe:PATH command) with path name ATTEN_14 to be set to 20 ms. If the path includes two channel lists, all relays in both lists are affected.

Example Query

```
ROUTE:DELAY? (@101,103,105);
```

In this case, the sense delay for channels 101, 103 and 105 is read back, with the values separated by commas. For example, if all three are set to 20 ms, then the readback is:

```
+2.000E-02,+2.000E-02,+2.000E-02
```

Note The query form is not available when using a path name, due to the potential for confusion between the first group and the second in the path.

:DELete

Syntax

```
ROUTE{ :PATH  }:DELete { <path name>  }
     { :GROUP }        { <group name> }
                       { [:ALL]       }
```

```
ROUTe:PFAIl:DELETE
```

```
MEMory:DELete
```

Description:

This deletes :

- All data associated with the specified path or group and frees up the path storage register.
- All channels from the PFAIL list.
- Sets memory to an initial state.

CAUTION The :DELete and the DELay shortform is the same. The :DELete command applies only in syntax with other subsystems and not directly to channel lists from ROUTe.

Example Command

```
ROUTE:PATH:DELETE ATTEN_14;
```

This deletes the path with pathname ATTEN_14 and all data in it.

```
ROUTE:PATH:DELETE:ALL;
```

This deletes all paths.

```
ROUTE:GROUP:DEL ATTEN;
```

This deletes all data associated with the group ATTEN. The group name is set to the default (see MEM:DELETE, below).

```
ROUTE:GROUP:DEL:ALL;
```

This deletes all data associated with all the groups. The group names are set to the default (see MEM:DELETE).

```
ROUTe:PFAil:DELete;
```

This command removes all data from the PFAIL:OPEN and PFAIL:CLOSE lists.

```
MEMory:DELete;
```

MEMory:DELete erases all data from CMOS RAM, by filling it with zeroes, and then sets it to an initial state. That state is as follows:

- The power fail channel lists are empty ("ROUT:PFA:CLOS" and "ROUT:PFA:OPEN").
- Sensing (VERIFY) is OFF for all devices.
- The ROUT:DRIVE:ON list has channels 0–30 on card 1 μsed and all other channels unused.
- The WIDTH is set to 30 ms pulse width; DELAY is set to 20 ms for all 256 devices.
- The group names are defaulted to GROUP1, GROUP2, and so on through GROUP16.

- The path VALues are defaulted to the path register number, 1–256.
- The GROUP and PATH registers are empty.

This command should be followed by a MEM:SAVE command to copy this state to the EEROM if it is desired to also delete the EEROM data.

This command does not affect the "last switch state" area in the RAM image, even though there is a "last switch state" stored in the EEROM, because the last state must always the match the actual last state of the switches. Nor does it affect the model number and serial number.

:DRIVe

ROUTe:DRIVe{[:ON] / :OFF}:ALL

ROUTe:DRIVe{[:ON] / :OFF}[?]<channel list>

ROUTe:DRIVe{[:ON] / :OFF}<path name>

Description

There is a list of relays considered unused or "not there" by the firmware. Unused channels are not driven even if included in a channel list or path and are not checked for proper sense line state and cannot generate errors. Turning :DRIVE:OFF for a channel adds it to the Unused List.

CAUTION In systems without CMOS RAM it is necessary to execute a write to EEROM to ensure that the DRIVe data will survive a power cycle. See the MEM:SAVE command.

Example Command

```
ROUTe:DRIVe:ON (@101,103,105);
```

This command removes channels 1, 3, and 5 on card 1 from the Unused List.

```
ROUTE:DRIVE:OFF (@101,103,105);
```

This command adds channels 1, 3, and 5 on card 1 to the Unused List.

```
ROUTE:DRIVE:OFF ATTEN_14;
```

This command causes the set of relays (defined by the ROUTe:PATH command) with name ATTEN_14 to be added to Unused List.

If the path includes two channel lists, all relays in both lists are affected.

```
ROUTE:DRIVE:ON:ALL;
```

This turns drive on for all channels.

```
ROUTE:DRIVE:OFF:ALL;
```

Drive is turned off for all channels; that is, all channels are "unused".

Example Query

```
ROUTE:DRIVE:ON? (@101,103,105);
```

This command returns a list of 1's and 0's, separated by commas, depending on whether drive is on or off for the indicated channels. For example if it is on for channels 101 and 105 and off for 103, the switch driver will return:

```
1,0,1
```

```
ROUTE:DRIVE:OFF? (@101,103,105);
```

:DRIVe

This command returns a list of 1's and 0's, separated by commas, depending on whether drive is off or on for the indicated channels. For example if it is on for channels 101 and 105 and off for 103, the switch driver will return:

```
0,1,0
```

Note The query form is not available when using a path name, due to the potential for confusion between the first group and the second in the path.

:EERom

Syntax

```
DIAGnostics:EERom:CYCLes?
```

Description

This function allows EERom information to be read out. (See ":CYCLes".)

:ERRor?

Syntax

```
SYSTem:ERRor?
```

Description

As SCPI specifies, this reads out the full error number and error description for the first error in the error queue. It can be issued repeatedly until the queue is empty (indicated by 0,"No error").

Here are all possible error numbers, along with their descriptions.

Command Errors

These set the Cmd Err bit in ESR.

-100,Command error

-100,Command error;SCPI unused invalid character. ''

-101,Invalid character;bad type Syntax error ''

-103,Invalid separator

-104,Data type error

-105,GET not allowed

-108,Parameter not allowed

-108,Parameter not allowed;invalid

-109,Missing parameter

-112,Program mnemonic too long

-113,Undefined header

-121,Invalid character in number

-123,Exponent too large

-124,Too many digits

-128,Numeric data not allowed

-131,Invalid suffix

-138,Suffix not allowed

-141,Invalid character data

-148,Character data not allowed

-150,String data error

-151,Invalid string data

-158,String data not allowed

-161,Invalid block data

-168,Block data not allowed

-170,Expression error;too long

-171,Invalid expression

-178,Expression data not allowed

-181,Invalid outside macro definition

-183,Invalid inside macro definition

Execution Errors

These set the Exec Err bit in ESR.

-200,Execution error

-222,Data out of range

-223,Too much data

-270,Macro error

-272,Macro execution error

-273,Illegal macro label

-276,Macro recursion error

-277,Macro redefinition not allowed

Device Specific Errors

These set the Cmd Err bit in ESR.

-310,System error

-310,System error;SCPI internal

-310,System error;no memory

-310,System error;formatter

777,Queue Overflow

1001,Sense error;<17 hex digits> This error is generated when an apparently impossible state of the sense lines from one or more relays is detected. The first of the 17 hex digits represents the card number on which the failure was detected; the rest represent a 64-bit binary number which indicates which of the 32-channels experienced failures. Each channel has two associated bits; the leftmost indicates that the error was detected on the CLOSed side of the relay; the rightmost that the error was detected on the OPEN side. A failure is indicated with a 1. The least signifigant (rightmost) two bits are channel 0, the most signifigant (leftmost) are channel 31. If more than one card experiences failures then more than one error will be reported.

1002,Memory capacity exceeded An attempt has been made to store more data than will fit in the 16 Kbyte nonvolatile memory area.

1003,Timer unstable Instablity has been detected in the 6840 timer chip, so the operating system cannot run reliably.

1004,EEROM data invalid Corruption has been detected in the EEROM; it needs to be replaced, or, if brand new, it needs to have "MEM:SAVE" executed once.

1006,Channel timeout;<17 hex digits> This error is generated when a relay apparently fails to switch, based on the detected state of the sense lines. The 17 hex digits indicate which card and which of the 32 channels experienced failures just as for error 1001. Each

channel has two associated bits; the leftmost indicates that the error was detected on the CLOSed side of the relay; the rightmost that the error was detected on the OPEN side. A failure is indicated with a 1. Note that a "Channel Timeout" without an accompanying "Sense error" indicates that the sense lines were in a valid state, but it was the wrong state. A "Channel Timeout" with a "Sense error" indicates that both sense lines appeared to be at 0 V. A "Sense error" without a "Channel timeout" means both sense lines appeared to be at 24 V.

`1007,Label too long` A path or group label was more than 32 characters long.

`1008,Nonexistent group` An attempt was made to use a group name which was not previously set up with a GROUP:NAME command.

`1009,Group already exists` An attempt was made to name a group with a name already in use by another group.

`1010,Nonexistent path`
An attempt was made to use a path name which was not previously set up with a PATH:DEF command.

`4000,Divide by Zero`

`4001,Float Overflow`

`4002,Float Underflow`

`4003,Logarithm Error`

`4004,Integer Overflow`

`4005,Square Root Error`

Query Errors

These set the Query Err bit in ESR.

`-400,Query error`

`-410,Query INTERRUPTED`

`-420,Query UNTERMINATED`

`-430,Query DEADLOCKED`

:FREE?

Syntax

```
MEMory:Free?
```

Description

This is a query which returns the number of bytes that remain in RAM for storing configuration data, followed by the number of bytes initially available. The two quantities are separated by commas. For a brand new system there are around 13,000 bytes initially available.

The group names and titles, power fail, verify and drive lists, and device switching times are saved in a fixed size area of memory, and available RAM is unaffected by changing this data.

For the rest of the data, it is allocated as needed. For any given PATH, one or more of the eight cards in the HP 70611A will be represented. It takes nine bytes to store the complete state of a card and only those cards actually referenced in a given path are saved. Path titles take up the number of characters in title, and path names take up the number of characters in the name. Every path added to a group takes up one byte. It is up to the user to allocate this memory as appropriate; for example, if a lot of path data is going to be used, path names and titles can be kept short to conserve space.

:GROUP

Syntax

```
ROUTE:GROUP:{ :NAME
            | :CATalog?
            | :ADD
            | :REMove
            | :DEFine[?]
            | :LABEL[?]
            | :AUTOselect[?]
            | :DELete[:ALL] }
```

Description:

The GROUP subsystem allows grouping of paths, to customize the manual interface to the HP 70611A, 70612A/C or 70613A/C.

A "group" is an ordered collection of up to 256 paths. The HP 70611A can store up to 16 groups. Each group may be defined and labelled as described below.

Note In systems without CMOS RAM it is necessary to execute a write to EEROM after configuring custom groups to ensure that the group data will survive a power cycle. See the MEM:SAVE command and section

:INITialize

Syntax

```
MEMory:INITialize
```

Description

When this command is issued, RAM is initialized according to the following algorithm:

1. RAM is initialized to the state described in MEMory:DELete. This command essentially erases any changes that have been made to RAM since the last power cycle.
2. The model number is initialized to HP 70611A. The serial number is initialized to XXXXAXXXXX.
3. If the EEROM tests as good, its data is then downloaded into RAM, which cancels the effect of steps 1 and 2. If the EEROM tests bad, no download is performed.

Note This initialization algorithm is the same algorithm used at power up to initialize RAM, except that at power up, before step three is performed, the "last state" in RAM is set to all relays OPEN. Hence, in the case of a failed EEROM, "last state" defaults to all relays OPEN.

:LABel[?]

Syntax

ROUTe{ :PATH / :GROUP }:LABEL { <path name,> / <group name> }"<label>";

Description:

Specifies a label (32 characters max) to be used when labelling the group on manual interface screens. Any character may be used within the quotes as long as its value is between 32 and 127. These values are treated as ASCII charactrs.

Example Command

```
ROUTE:PATH:LABEL ATTEN_14,"14 dB ATTEN";
```

The above commands assigns the label `14 dB ATTEN` to the previously defined path with the pathname `ATTEN_14`.

Example Query

```
:LABel? <path name>
ROUTE:PATH:LABEL? ATTEN_14;
```

The query form returns the programmed label:

```
14 dB ATTEN
```

Example Command

```
ROUTE:GROUP:LABEL ATTEN,"Attenuation";
```

The above commands assigns the label `Attenuation` to the group with the group name `ATTEN`.

Example Query

```
:LABel? <group name>
ROUTE:GROUP:LABEL? ATTEN;
```

The query form returns the programmed label:

```
Attenuation
```

MEMory

Syntax

```
MEMory { :DELete      }
       { :INITialize  }
       { :SAVE        }
       { :FREE?       }
```

Description

The MEMory subsystem is used to delete, initialize RAM, and save EEROM information to the controller.

:NAME

Syntax

```
ROUTE:GROUP:NAME <number>,<group name>
```

Description

The groups are numbered from 1 to 16. They may be named or renamed using this command. An attempt to name a group using a name aleady in use for another group will result in an error.

A group name is any collection of up to 12 uppercase letters (lowercase letters are automatically uppercased), numbers, or underscore characters, starting with a letter.

See the `MEM:DELETE` command description for the default group names assigned when memory is intiialized or a group is deleted.

Example Command

```
ROUTE:GROUP:NAME 1,ATTEN;
```

This command associates the name ATTEN with group 1 for programming purposes.

:OPEN

Syntax

```
ROUTe:OPEN[?] { <pathname>      }
              { <channel list>  }

ROUTe:PFAil:OPEN[?] { <pathname>      }
                    { <channel list>  }
```

Description

Each channel has a CLOSe or OPEN position. On Hewlett-Packard relays, the OPEN path is the path between the input terminal labelled 1 on the relay and the input terminal labelled C. It is recognized that CLOSE and OPEN are abitrary for this type of switch; they are, however, in keeping with the SCPI language specification.

Example Command

```
ROUTE:OPEN (@101,2(0:5),3(1,3,5),406:410);
```

Note During any switching operation (OPEN or CLOSE) the Settling Bit in the OPER status register is set (1). It is cleared (0) when the operation completes.

Sending the above command causes channel 1 on card 1, channels 0 through 5 on card 2, channels 1, 3 and 5 on card 3, and channels 6 through 10 on card 4 to be opened. Channels must be part of the drive list (DRIVE:ON) to be opened or they will be ignored.

Example Query

```
ROUTE:OPEN? (@101,103,105);
```

Sending the query (optional question mark) causes the channels in the channel list parameter to be checked for opened channels. The readback is a list of 1's and 0's separated by commas, one for each channel in the list. A 1 is sent if the specified channel is opened, otherwise a 0 is sent. Although this command is not strictly necessary (ROUTE:CLOSE? is sufficient) it is included for completeness.

Devices for which sensing is on read back the position in which they were sensed the last time a switching operation took place. Devices with sensing off simply read back the currently programmed state (which, if they haven't been switched since power up, will be the state they were set to at power up). Devices with DRIVE:OFF read back the last value to which they were set.

It is possible to combine OPEN and CLOSE in a single command since they are both part of the ROUTe subsystem. For example:

```
ROUTE:CLOSE (@406:410);OPEN (@202);
```

This command will close channels 6 thru 10 on card 4 and open channel 2 on card 2.

Example Command

```
ROUTE:OPEN ATTEN_14;
```

Sending the above command causes the set of switch OPENs and CLOSEs defined by the PATH with name ATTEN_14 to be executed. The first group of switch settings in the PATH is interpreted as OPEN settings and the second group as CLOSE settings. The CLOSE settings are all executed first, followed by the OPEN settings.

For example, if ATTEN had been defined as:

```
ROUTE:PATH:DEF ATTEN_14,(@101,102),(@103,104);
```

then when that path is sent by ROUTE:OPEN ATTEN_14 switches 103 and 104 will first be closed, then switches 101 and 102 will be opened.

Note The fact that CLOSE settings are executed before OPEN settings when a path is sent should be kept in mind by switching system designers when configuring their hardware. For example, multistage attenuators should be set up so that a CLOSE operation always adds attenuation and an OPEN operation removes attenuation, so that in moving from one attenuation setting to another, the imtermediate stage (after the CLOSEs and before the OPENs) is a stage representing higher attenuation, to avoid signal spikes that could damage sensitive hardware.

Example Command

```
ROUTE:PFAil:OPEN (@101,2(0:5),3(1,3,5));
```

The ROUTe:PFAil:OPEN command lists the channels desired to be opened on power up or after *RST or *TST?. The channel list has the same restrictions as those for the ROUTe:OPEN command. Sending the command in the example above causes channel 1 on card 1, channels 0 through 5 on card 2, and channels 1, 3 and 5 on card 3 to be opened on power up.

```
ROUTE:PFAil:OPEN ATTEN_14;
```

Sending the above command causes the set of switch OPENs and CLOSEs defined by the PATH with name to ATTEN_14 to be added to the PFAIL list. The first group of switch settings in the PATH is interpreted as OPEN settings and the second group as CLOSE settings.

Example Query

```
ROUTE:PFAil:OPEN? (@101,205);
```

The inclusion of an optional question mark causes a readback of the power up state of the requested channels as a list of 1s and 0s seperated by commas. A 1 means the channel is in the PFA:OPEN list. A 0 means that it is not.

Note that when querying the PFAIL state, the PFA:CLOS list must be checked as well to determine whether the power up state for a given channel is programmed at all.

Note The query form is not available when using a path name, due to the potential for confusion between the first group and the second in the path. If a relay is in neither the PFAil:OPEN or PFAil:CLOSe lists, its power up state is determined by the last save stored to EEROM for that relay.

:PATH

Syntax

```
                    ┌ :DEFine[?]    ┐
                    │ :CATalog?     │
ROUTe:PATH          │ :LABEL[?]     │
                    │ :VALue[?]     │
                    └ :DELete[:ALL] ┘
```

Description

The PATH subsystem allows storing of channel lists to simplify remote access and to customize the manual interface to the HP 70611A.

Paths are specified using CLOSE and OPEN channel lists. Each relay contains one CLOSE and one OPEN path. See ":CLOSe" and "OPEN" sections for more information.

A path is defined as a specification of switch positions for a range of switches. Thus it may require one or two channel lists to fully specify a path, depending on the mix of OPEN's and CLOSE's in the path.

The paths can be defined, labelled, and/or sent to the hardware. Each path has a name by which it is referenced for the purpose of programming, which is established by the PATH:DEF command.

The paths can be collected into meaningful groups using the GROUP command. They can also be sent in place of channel lists by the ROUTE and other commands.

CAUTION In systems without CMOS RAM it is necessary to execute a write to EEROM after configuring custom paths to ensure that the path data will survive a power cycle. See the "MEM:SAVE" command section.

:PFAil

Syntax

```
ROUTe:PFAil { :CLOSe[?] | :OPEN[?] | :DELete } { <path name> | <channel list> }
```

The ROUTe:PFAil subsystem of SCPI allows specification of which channels will be closed on a power cycle (or *RST or *TST?). Channels not specified by `ROUTE:PFAIL:CLOSE` or `ROUTE:PFAIL:OPEN` are set during power up by reading the last switch state out of EEROM or CMOS RAM, or if the EEROM data is corrupt, by OPENing the channel. See section 5 for more information on the nonvolatile memory system.

Channels not on the drive list (DRIVE:OFF) are not affected at power up even if in the PFAIL list.

Note In systems without CMOS RAM it is necessary to execute a write to EEROM to ensure that the PFAIL lists will survive a power cycle. See the "MEM:SAVE" command section.

:REMove

Syntax

```
ROUTe:GROUP:REMove <group name>,<path name>
```

Description

This command removes all instances of the specified path from a group. The group name and path name must have been previously defined using GROUP:NAME and PATH:DEF.

Example Command

```
ROUTE:GROUP:REMOVE ATTEN,ATTEN_14;
```

Removes all paths named ATTEN_14 from group ATTEN. See the query :DEFine? <group name> to list all paths in a group.

ROUTe

Syntax

See command tree.

Description

Relay switching and configuration is accomplished by the "ROUTe" command tree.

:SAVE

Syntax

```
MEMory:SAVE
```

Description

This command copies the RAM image to the EEROM. Care should be taken to do this only when necessary, due to the limited life of the EEROM. (See "DIAG:EEROM:CYCLES?"). Because this is time consuming (over a minute in some cases), it is made to turn on the "switching" light while saving. The CALIBRATING bit in the OPER status register is set when a save begins and cleared when it ends. *OPC can also be used to detect the end of a save.

The following data will be saved:

- the VERIFY list
- the DRIVE list
- the PFAIL list
- the serial number and model number
- the WIDTH and DELAY times for all switches
- all GROUP data, including group names, titles, AUTOSELECT state,
- and what PATHs are in each group
- all PATH data, including path names, titles, and values, and
- what channels are in each PATH

In addition, in the "last state" list will be saved:

- the current state of all switches in the DRIVE list
- the programmed state of all switches NOT in the DRIVE list

If you know that you have performed a valid SAVE to the EEROM (one that was not interrupted by turning OFF power and which did not generate an error), and you subsequently get an `EEROM invalid` error message, you should replace the EEROM.

STATus

Syntax

```
STATus:OPERation { :[EVENt]?
                 | :CONDition?
                 | :ENABle[?]
                 | :PTRansition[?]
                 | :NTRansition[?] }

STATus:QUEStionable { :[EVENt]?
                    | :CONDition?
                    | :ENABle[?] }
```

Description

The STATus subsystem is fully specified by SCPI. See section 5, "Beginner's Guide to SCPI", HP part number H2325-90001. Also refer to the following commands: *STB?, *SRE, *ESE, and *ESR?

- `STATus:OPERation` In the STATus:OPERation subsystem, only the SETTLING bit (bit 1) is implemented by the HP 70611A, 70612A/C or 70613A/C; it is set during a switching operation (and when saving to EEROM) and cleared when it completes. The "SWITCHING" led is on whenever this bit is set. The following commands are applicable:
  - `STATus:OPERation:EVENt`
  - `STATus:OPERation:CONDITION?`
  - `STATus:OPERation:ENABle`
  - `STATus:OPERation:PTRansition[?]`
  - `STATus:OPERation:NTRansition[?]`
- `STATus:QUEStionable`

  The QUEStionable susbsytem is required by SCPI but is not used by the HP 70611A, 70612A/C or 70613A/C. The following commands are implemented:
  - `STATus:QUEStionable:EVENt?`
  - `STATus:QUEStionable:CONDition?`
  - `STATus:QUEStionable:ENABle`

SYSTem

Syntax

```
SYSTEM:{ :VERSion? }
       { :ERRor?   }
```

Description

These are SYSTem commands from the SCPI specification.

- VERSion?
- ERRor?

TRIGger

Syntax

```
TRIGger[:SEQuence]:DELay <time>
```

Description:

This command accepts a power supply recovery time. Values not in the range of 0 to 200 ms return an error. The default time is 200 ms and is restored on Power Up or (INSTR PRESET). This delay time allows the 24 V power supply to recover between each command. The required time is dependent on the relay power requirements and must be long enough for the specific application.

:VALue[?]

Syntax

```
ROUTe:PATH:VALUE <path name,> <number>;
```

Description:

Specifies a number (integer in the range −32768 to 32767) to be used when labelling the path on manual interface screens. This number, when entered manually from the user interface, can be used to select paths directly without using the RPG or step keys.

Example Command

```
ROUTE:PATH:VALUE ATTEN_14,14;
```

This example assigns a value of 14 to a path with pathname ATTEN_14.

Example Query

```
ROUTE:PATH:VALUE? ATTEN_14;
```

The query form returns the programmed number. For the example above, it would return

```
+14.
```

:VERify

Syntax

ROUTe:VERify{ :[ON] | :OFF } { :ALL | <path name> | <channel list> }

ROUTe:VERify{ :[ON] | :OFF } [?] <channel list>

Description

This command adds or removes relays from the "sense list"; the list of relays for which sensing is enabled.

This command only works with relays that have the ability to sense the state of the switch. See Table 1-1 and 1-2 for a list of Hewlett-Packard switches and attenuators that have this capability.

Note In systems without CMOS RAM it is necessary to execute a write to EEROM to ensure that the VERify data will survive a power cycle. See the MEM:SAVE command and section

Example Command

```
ROUTE:VERIFY:ON (@101,103,105);
```

This command adds channels 1, 3, and 5 on card 1 to the `sense list`. Due to the nature of sensing relays, enabling this sensing mode of operation may increase switching times, as the sense lines must settle after the switch is thrown. The default sensing delay is 20 ms. See ":DELay" to adjust switching time when sensing is enabled.

With sensing on for a given switch, if that switch fails to switch, either on a ROUTe command or on *TST?, an error is generated. Furthermore, after any switching operation, all of the relays for which sensing is on (and for which DRIVe is also on, see below) have their sense lines checked; erroneous values generate errors.

```
ROUTE:VERIFY:OFF (@101,103,105);
```

This command removes channels 1, 3, and 5 on card 1 from the `sense list`.

```
ROUTE:VERIFY:ON ATTEN_14;
```

This command causes the set of switches defined by the PATH with the pathname `ATTEN_14` to be added to (ON) or removed from (OFF) the `sense list`. All switches referenced in either channel list in the path are added (ON) or removed (OFF).

```
ROUTE:VERIFY:OFF:ALL;
```

This turns sensing off for all channels.

Example Query

```
ROUTE:VERIFY:ON? (@101,103,105);
```

This command returns a list of 1's and 0's, separated by commas, depending on whether sensing is on or off for the indicated channels. For example if sensing is on for channels 101 and 105 and off for 103, the switch driver responds with:

```
1,0,1
```

```
ROUTE:VERIFY:OFF? (@101,103,105);
```

This command returns a list of 1's and 0's, separated by commas, depending on whether sensing is off or on for the indicated channels. For example if it is on for channels 101 and 105 and off for 103, the switch driver responds with:

```
0,1,0
```

Note The query form is not available when using a path name, due to the potential for confusion between the first group and the second in the path.

:VERSion?

Syntax

```
SYSTem:VERSion?
```

Description

This reads out the firmware datecode.

:WIDTh

Syntax

```
ROUTe:WIDTh <pulse width>,{<channel list>}
                          {<path name>   }

ROUTe:WIDTh? <channel list>
```

Description

This commands sets the pulse width in seconds required to close a relay. The pulse width may be set in 5 ms increments up to 1275 ms. The pulse width defaults to 30 ms when memory is initialized. The WIDTh parameter may be an integer or a real number.

Example Command

```
ROUTE:WIDTH .03,(@101,103,105);
```

In the above example, the pulse width is set to 30 ms for channels 1, 3, and 5.

```
ROUTE:WIDTH .03,ATTEN_14;
```

This command causes the drive to the set of relays (defined by the ROUTe:PATH command) with path name ATTEN_14 to be set to the specified pulse width. If the path includes two channel lists, all relays in both lists are affected.

Example Query

```
ROUTE:WIDTH? (@101,103,105);
```

In this case, the pulse width for channels 101, 103 and 105 is read back, with the values separated by commas. For example, if all three are set to 30 ms, then the readback is:

```
+3.000E-02,+3.000E-02,+3.000E-02
```

Note The query form is not available when using a path name, due to the potential for confusion between the first group and the second in the path.

Example Programs

This section contains programs that may be helpful with the HP 70611A, 70612A/C and 70613A/C. The programs are written in HP Rocky Mountain Basic .

Save Memory

In order to use the following program, you must first create a file named SWDATA. The following program can be used to read configuration data out of the EEROM so that it can be replaced.

```
10 ! READMEM program.  Takes data from HP 70611A and outputs to a file
20 DIM A$[32767]
30 DIM Serialnumber$[10],Modelnumber$[6]
40 DIM Groupnames$(15)[12],Grouptitles$(15)[32]
50 DIM Pathnames$(255)[12],Pathtitles$(255)[32],Pathval(255)
60 DIM Groupdata$(15,255)[12],Groupauto(15)
70 COM @Sw,@File
80 MAT Pathnames$= ("")
90 MAT Groupnames$= ("")
100 MAT Pathtitles$= ("")
110 MAT Grouptitles$= ("")
120 MAT Groupdata$= ("")
130 ASSIGN @File TO "SWDATA"
140 ASSIGN @Sw TO 709
150 Read_bitmap("ROUT:VERIFY:ON")
160 Read_bitmap("ROUT:DRIVE:ON")
170 Read_bitmap("ROUT:PFA:CLOS")
180 Read_bitmap("ROUT:PFA:OPEN")
190 OUTPUT @Sw;"DIAG:SER?"
200 ENTER @Sw;Serialnumber$
210 OUTPUT @File;Serialnumber$
220 OUTPUT @Sw;"DIAG:MOD?"
230 ENTER @Sw;Modelnumber$
240 OUTPUT @File;Modelnumber$
250 Read_bitmap("ROUT:WIDT")
260 Read_bitmap("ROUT:DELAY")
270 OUTPUT @Sw;"ROUTE:GROUP:CATALOG?"
280 ENTER @Sw;A$
290 I=-1
300 WHILE LEN(A$)>0
310 Comma=POS(A$,",")
320 IF Comma=0 THEN
330 A$=A$&","
340 Comma=LEN(A$)
350 END IF
360 I=I+1
370 Groupnames$(I)=A$[1;Comma-1]
380 A$=A$[Comma+1]
390 END WHILE
400 OUTPUT @File;Groupnames$(*)
410 Max_group=I
420 FOR G=0 TO Max_group
430 OUTPUT @Sw;"ROUT:GROUP:LABEL? "&Groupnames$(G)
440 ENTER @Sw;Grouptitles$(G)
450 OUTPUT @Sw;"ROUT:GROUP:AUTOSELECT:ON? "&Groupnames$(G)
```

```
460 ENTER @Sw;Groupauto(G)
470 OUTPUT @Sw;"ROUT:GROUP:DEF? "&Groupnames$(G)
480 ENTER @Sw;A$
490 I=-1
500 WHILE LEN(A$)>0
510 Comma=POS(A$,",")
520 IF Comma=0 THEN
530 A$=A$&","
540 Comma=LEN(A$)
550 END IF
560 I=I+1
570 Groupdata$(G,I)=A$[1;Comma-1]
580 A$=A$[Comma+1]
590 END WHILE
600 NEXT G
610 OUTPUT @File;Groupdata$(*)
620 OUTPUT @File;Groupauto(*)
630 OUTPUT @File;Grouptitles$(*)
640 OUTPUT @Sw;"ROUTE:PATH:CATALOG?"
650 ENTER @Sw;A$
660 I=-1
670 WHILE LEN(A$)>0
680 Comma=POS(A$,",")
690 IF Comma=0 THEN
700 A$=A$&","
710 Comma=LEN(A$)
720 END IF
730 I=I+1
740 Pathnames$(I)=A$[1;Comma-1]
750 A$=A$[Comma+1]
760 END WHILE
770 OUTPUT @File;Pathnames$(*)
780 Max_path=I
790 FOR P=0 TO Max_path
800 OUTPUT @Sw;"ROUT:PATH:LABEL? "&Pathnames$(P)
810 ENTER @Sw;Pathtitles$(P)
820 OUTPUT @Sw;"ROUT:PATH:VALUE? "&Pathnames$(P)
830 ENTER @Sw;Pathval(P)
840 OUTPUT @Sw;"ROUT:PATH:DEF? "&Pathnames$(P)
850 ENTER @Sw;A$
860 OUTPUT @File;A$ ! HAVE TO OUTPUT THIS DATA ON THE FLY, AS
870 ! IT IS A POTENTIALLY HUGE ARRAY
880 NEXT P
890 OUTPUT @File;Pathtitles$(*)
900 OUTPUT @File;Pathval(*)
910 ASSIGN @File TO *
920 END
930 SUB Read_bitmap(S$)
940 COM @Sw,@File
950 DIM Response(31),Bitmap(7,31)
960 FOR I=0 TO 7
970 OUTPUT @Sw;S$&"? (@"&VAL$(I+1)&"00:"&VAL$(I+1)&"31);"
980 ENTER @Sw;Response(*)
990 MAT Bitmap(I,*)= Response
```

```
1000 NEXT I
1010 OUTPUT @File;Bitmap(*)
1020 SUBEND
```

Restore Memory

The following program can be used to restore the EEROM state read out by READMEM:

```
10 ! WRITEMEM program.  Takes a file written by READMEM and sends it to
the HP 70611A
20 DIM A$[32767]
30 DIM Respond(31),Sense(7,31),Unused(7,31),Pfac(7,31),Pfao(7,31),
Widt(7,31),Delay(7,31)
40 DIM Serialnumber$[10],Modelnumber$[6]
50 DIM Gpnames$(15)[12],Gptitles$(15)[32]
60 DIM Pathnames$(255)[12},Pathtitles$(255)[32],Pathval(255)
70 DIM Groupdata$(15,255)[12],Groupauto(15)
80 COM @File,@Sw
90 MAT Pathnames$= ("")
100 MAT Gpnames$= ("") ! Group names
110 MAT Pathtitles$= ("")
120 MAT Gptitles$= ("") ! Group titles
130 MAT Groupdata$= ("")
140 ASSIGN @File TO "SWDATA"
150 ASSIGN @Sw TO 709
160 OUTPUT @Sw;"MEM:DELETE;"
170 OUTPUT @Sw;"ROUT:VERIFY:OFF:ALL;"
180 Getandsend_bmap("ROUT:VERIFY:ON")
190 OUTPUT @Sw;"ROUT:DRIVE:OFF:ALL;"
200 Getandsend_bmap("ROUT:DRIVE:ON")
210 Getandsend_bmap("ROUT:PFA:CLOS")
220 Getandsend_bmap("ROUT:PFA:OPEN")
230 ENTER @File;Serialnumber$
240 OUTPUT @Sw;"DIAG:SER """&Serialnumber$&""";"
250 ENTER @File;Modelnumber$
260 OUTPUT @Sw;"DIAG:MOD """&Modelnumber$&""";"
270 Getandcalc_bmap("ROUT:WIDT")
280 Getandcalc_bmap("ROUT:DELAY")
290 ENTER @File;Gpnames$(*)
300 ENTER @File;Groupdata$(*)
310 ENTER @File;Groupauto(*)
320 ENTER @File;Gptitles$(*)
330 ENTER @File;Pathnames$(*)
340 FOR I=0 TO 255 ! send path data
350 IF Pathnames$(I)"" THEN
360 ENTER @File;A$
370 OUTPUT@Sw;"ROUT:PATH:DEF"&Pathnames$(I)&","&A$&";"
380 END IF
390 NEXT I
400 FOR I=0 TO 15 ! send group data
410 IF Gpnames$(I)"" THEN
420 OUTPUT @Sw;"ROUT:GROUP:NAME"&VAL$(I+1)&","&Gpnames$(I)&";"
430 IF Groupauto(I) THEN
440 OUTPUT @Sw;"ROUT:GROUP:AUTOSELECT:ON "&Gpnames$(I)&";"
450 ELSE
```

```
460 OUTPUT @Sw;"ROUT:GROUP:AUTOSELECT:OFF" &Gpnames$(I)&";"
470 END IF
480 IF Gptitles$(I)"" THEN OUTPUT
@Sw;"ROUT:GROUP:LABEL""&Gpnames$(I)&",
"""&Gptitles$(I)&""";"
490 J=0
500 WHILE Groupdata$(I,J)""
510 OUTPUT @Sw;"ROUT:GROUP:ADD
"&Gpnames$(I)&","&""&Groupdata$(I,J)&""&";"
520 J=J+1
530 END WHILE
540 END IF
550 NEXT I
560 ENTER @File;Pathtitles$(*)
570 ENTER @File;Pathval(*)
580 FOR I=0 TO 255
590 IF Pathnames$(I)"" THEN
600 OUTPUT @Sw;"ROUT:PATH:LAB "&Pathnames$(I)&",
"""&Pathtitles$(I)&""";"
610 OUTPUT @Sw;"ROUT:PATH:VAL"&Pathnames$(I)&",
"&VAL$(Pathval(I))&";"
620 END IF
630 NEXT I
640 ASSIGN @File TO *
650 END
660 SUB Getandsend_bmap(B$)
670 ! Loads a query response from file and outputs it as a channel
list
680 COM @File,@Sw
690 DIM Bitmap(7,31),A$[32767]
700 ENTER @File;Bitmap(*)
710 FOR I=0 TO 7
720 A$=""
730 FOR J=0 TO 31
740 IF Bitmap(I,J) THEN A$=A$&","&VAL$(100*(I+1)+J)
750 NEXT J
760 IF A$[1;1]="," THEN A$=A$[2]
770 IF A$"" THEN OUTPUT @Sw;B$&" (@"&A$&");"
780 NEXT I
790 SUBEND
800 SUB Getandcalc_bmap(B$)
810 ! Loads a query response from a file and outputs it to set
drive/delay time
820 COM @File,@Sw
830 DIM Bitmap(7,31),A$[32767]
840 ENTER @File;Bitmap(*)
850 FOR I=0 TO 7
860 FOR J=0 TO 31
870 OUTPUT @Sw;B$&""&VAL$(Bitmap(I,J)&",
(@"&VAL$(100*(I+1)+J)&");"
880 IF Bitmap(I,J) THEN A$=A$&","&VAL$(100*(I+1)+J)
890 NEXT J
900 IF A$[1;1]="," THEN A$=A$[2]
910 NEXT I
```

```
920 SUBEND
```

Example Speed Calculation

If you are beginning to learn to program the switch driver, start here. This section uses a sample program and a timing diagram to describe how to calculate switching time. The sample program also gives information that can help you minimize switching time.

Note Switching speed is a function of pulse widths, sensing delays, the state of the chosen channels, and the sequence of relays driven. Pulse widths, sensing delays and which channels are opened or closed are determined by the user, and cannot be predicted here.

Explanation The MMS power supply limits the switch driver to a total of 800 mA to drive relays at any one time. This means that four throws of 200 mA each is the limit for one switching operation. If it is your objective to increase the speed at which your switch matrix operates, you need to know which four relays, when connected, will be on the same drive lines.

Table 6-2 show which connectors (J1 to J31) are on the same drive lines. Refer to section 2, "Installation", to wire your relay into the arbitrary positions of OPEN and CLOSE.

Table 6-2. Relay Drive Sequence

Drive Line	Connector Locator	Channel List
1	J1, J2, J3, J4	00, 01, 02, 03
2	J5, J6, J7, J8	04, 05, 06, 07
3	J9, J10, J11, J12	08, 09, 10, 11
4	J13, J14, J15, J16	12, 13, 14, 15
5	J17, J18, J19, J20	16, 17, 18, 19
6	J21, J22, J23, J24	20, 21, 22, 23
7	J25, J26, J27, J28	24, 25, 26, 27
8	J29, J30, J31	28, 29, 30

The channel number is a three digit number where the first digit is the driver card number. Channel 130 is channel 30 on driver card 1. Channel 825 is channel 25 on driver card 8. The following program along with Figure 6-1 can be used to learn how to determine switching speed. It is intended to show how the drive line architecture of the switch driver/driver board(s) and the programmed variables of :DELay and :WIDTh can be calculated for a total switching time for any switching operation.

Example Speed Calculation

```
10 DIM Closl$[40]
20 OUTPUT 709:"*RST"
30 OUTPUT 709;"ROUT:DRIV:ON (@100:111);"
40 !
50 ! Drive is set to ON for channels 100 through 111 using a range.
60 !
70 OUTPUT 709;"ROUT:DRIV:OFF (@112:130);"
80 !
90 ! Drive is set to OFF for remaining channels on driver card 1.
100 ! Unless channels are part of Drive list, no pulse (:WIDTh) is sent.
110 !
120 OUTPUT 709;"ROUT:VER:ON (@100:111);"
130 !
140 ! Sensing is ON for channels 100 through 111.
150 ! VERify:ON works at switching time, and errors (if they exists)
160 ! are reported back immediately.
170 !
180 ! Unless channels are part of Verify list no sensing (:DELay) can be
190 ! valid.  In other words, you can choose to sacrifice sensing for
200 ! speed.
210 !
220 OUTPUT 709;"ROUT:CLOS (@100:111);"
230 !
240 ! This command ensures all channels start in the same (CLOSE) state.
250 !
260 OUTPUT 709;"ROUT:CLOS? (@100:111);"
270 !
280 ! Queries CLOSe list.
290 !
300 ENTER 709;Closl$
310 PRINT Closl$
320 !
330 ! Switch driver response should look like: 1,1,1,1,1,1,1,1,1,1,1,1
340 ! This indicates all 12 active channels are in the (CLOSE) state.
350 !
360 PAUSE
```

Note For this example, all relays start at the same (CLOSE) state and have delays and pulse widths to make the calculation easier to follow. In real situations, relays may be in different states. You must programmatically keep track of these relays for your time calculations to be correct.

```
370 DIM Open1$[40]
380 OUTPUT 709;"ROUT:WIDT .04,(@100,102,104,108);"
390 !
400 ! Pulse (:WIDTh) is set to 40 ms for channels 100,102, 104, and 108.
410 ! When :OPEN is sent, 100 and 102 will OPEN at the same time.
420 !
430 ! Channels 104 and 108 will each OPEN at different times, because they
440 ! are connected to different drive lines.  See the Relay Drive
450 ! Sequence table and Figure 6-1, Timing Diagram.
460 ! In the absense of a pulse width declaration for channels 101 and
470 ! 103, the default pulse (WIDTh) of 30 ms seconds is applied.
480 !
490 OUTPUT 709;"ROUT:DEL .015,(@100:103);"
500 !
510 ! Sensing (:DELay) is set to 15 ms for channels 100 to 103.
520 !
530 OUTPUT 709;"ROUT:VER:OFF (@104:107);"
540 !
550 ! Example of sensing sacrificed for speed.
560 ! :DELay is invalid for channels 104, 105, 106, 107.
570 !
580 OUTPUT 709;"ROUT:WIDT 0.05,(@109:111);"
590 !
600 ! Channels 109, 110, 111 set to 50 ms pulse (WIDTh).
610 !
620 OUTPUT 709;"ROUT:DEL 0.025,(@109:111);"
630 !
640 ! Sensing delays for 109, 110, 111 set to 25 ms.
650 !
660 OUTPUT 709;"ROUT:OPEN (@100:111);"
670 !
680 ! See timing chart to predict when each relay will open.
690 !
700 OUTPUT 709;"ROUT:OPEN? (@100:104,108:111);"
710 !
720 ! You turned sensing off for 104 thru 107, remember?
730 ! About OPEN?: you could still query for the entire
740 ! open list for channels 100 to 111.  Channels 104 to 107
750 ! would still report back 1,1,1,1.  The query :OPEN? (or :CLOSe?)
760 ! queries the channel list, not the relay.  The switch driver reports
770 ! the state the switch should be in.
780 !
790 ENTER 709;Open1$
800 PRINT Open1$
810 !
820 ! Switch driver should respond with: 1,1,1,1,1,1,1,1,1,1
830 !
840 END
```

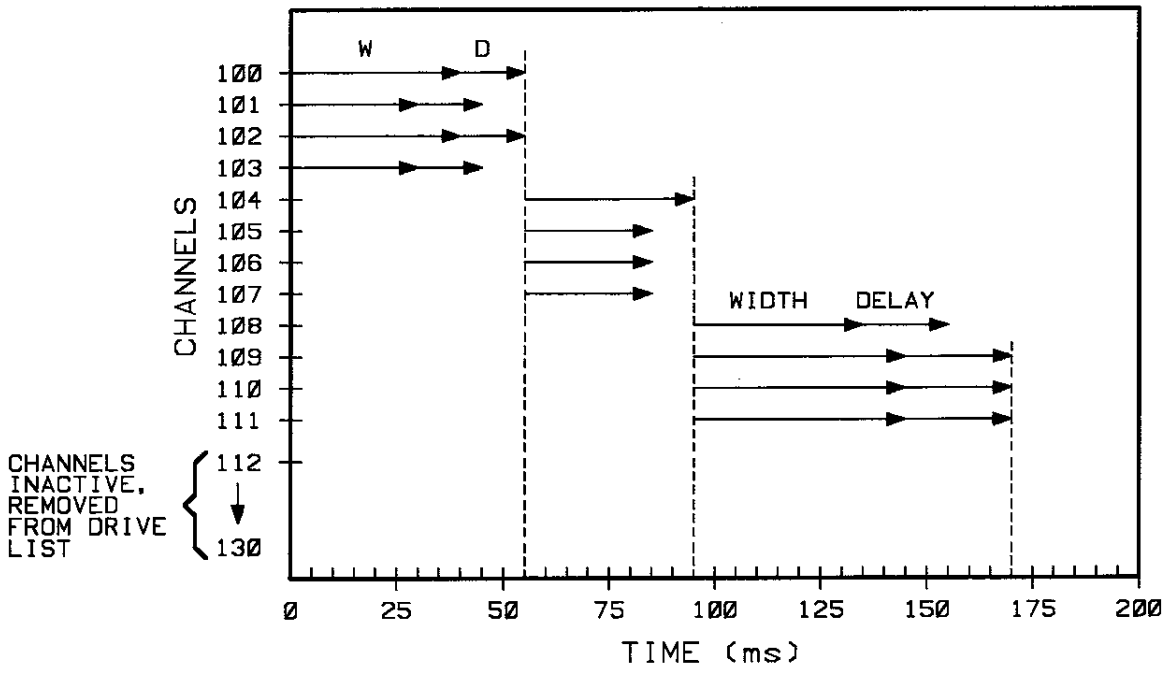


Figure 6-1. Timing Chart

Programming Internal Switches and Optional Step Attenuators

The switches inside the HP 70612A/C and HP 70613A/C interface modules have preprogrammed switch path definitions and front panel light controls.

The HP 70612A/C and HP 70613A/C come standard with five SPDT switches. The HP 70612A/C are configured to provide a single input and six outputs. The HP 70613A/C provide routing for two inputs to five outputs. See Figure 6-2. The interface module has the path definition, names and labels stored inside the EEROM.

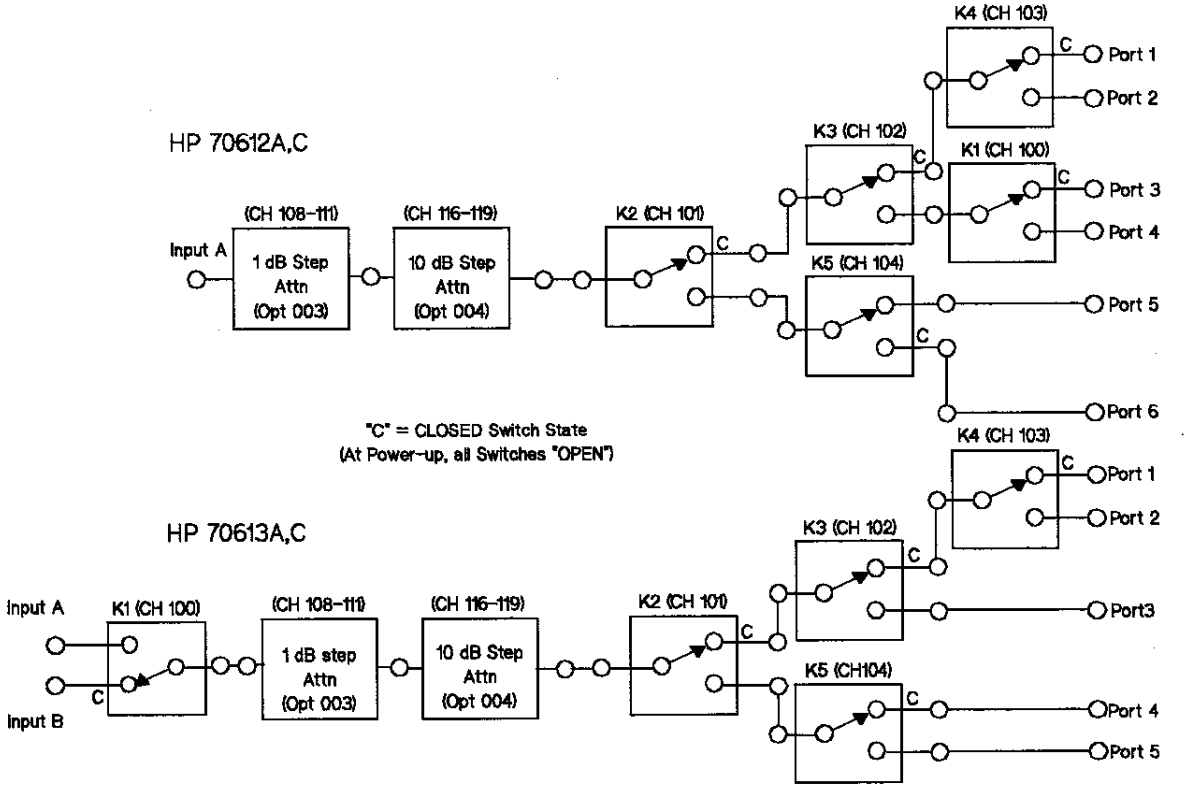


Figure 6-2. Schematics of HP 70612, 70613

Table 6-3. HP 70612A,C Switch Paths

From	To	Logical Name	Label	Close	Open
1	A	P1TOA	Port 1 to A	101, 102, 103, 120, 121, 122, 126, 127	100, 104, 125
2	A	P2TOA	Port 2 to A	101, 102, 120, 121, 122, 125, 127	100, 103, 104, 126
3	A	P3TOA	Port 3 to A	100, 101, 120, 121, 122, 125, 126	102, 103, 104, 127
4	A	P4TOA	Port 4 to A	101, 121, 122, 125, 126, 127	100, 102, 103, 104, 120
5	A	P5TOA	Port 5 to A	120, 122, 125, 126, 127	100, 101, 102, 103, 104, 121
6	A	P6TOA	Port 6 to A	104, 120, 121, 125, 126, 127	100, 101, 102, 103, 122

Table 6-4. HP 70613A/C Switch Paths

From	To	Logical Name	Label	Close	Open
1	A	P1TOA	Port 1 to A	101, 102, 103, 120, 121, 124, 126, 127	100, 104, 125, 129
2	A	P2TOA	Port 2 to A	101, 102, 120, 121, 124, 125, 127	100, 103, 104, 126, 129
3	A	P3TOA	Port 3 to A	101, 120, 121, 124, 125, 127	100, 102, 103, 104, 127, 129
4	A	P4TOA	Port 4 to A	104, 121, 124, 125, 126, 127	100, 101, 102, 103, 120, 129
5	A	P5TOA	Port 5 to A	120, 124, 125, 126, 127	100, 101, 102, 103, 104, 121, 129
1	B	P1TOB	Port 1 to B	100, 101, 102, 103, 120, 121, 126, 127, 129	104, 124, 125
2	B	P2TOB	Port 2 to B	100, 101, 102, 120, 121, 125, 127, 129	103, 104, 124, 126
3	B	P3TOB	Port 3 to B	100, 101, 120, 121, 125, 126, 129	102, 103, 104, 124, 127
4	B	P4TOB	Port 4 to B	100, 104, 121, 125, 126, 127, 129	101, 102, 103, 120, 124
5	B	P5TOB	Port 5 to B	100, 120, 125, 126, 127, 129	101, 102, 103, 104, 121, 124

Options 003, 004 and 007 add step attenuators to the standard HP 70612A/C and 70613A/C. The following tables contain the preprogrammed attenuator setting definitions, path names and labels.

Table 6-5.
HP 70612A/C and HP 70613A/C Option 003 (11 dB, 1 dB steps)

Value	Name	Label	Close	Open
0	SA1_00	0 dB		108, 109, 110, 111
1	SA1_01	1 dB	108	109, 110, 111
2	SA1_02	2 dB	109	108, 110, 111
3	SA1_03	3 dB	108, 109	110, 111
4	SA1_04	4 dB	110	108, 109, 111
5	SA1_05	5 dB	108, 110	109, 111
6	SA1_06	6 dB	109, 110	108, 111
7	SA1_07	7 dB	108, 109, 110	111
8	SA1_08	8 dB	110, 111	108, 109
9	SA1_09	9 dB	108, 110, 111	109
10	SA1_10	10 dB	109, 110, 111	108
11	SA1_11	11 dB	108, 109, 110, 111	

Table 6-6. HP 70612A and 70613A Option 004 (110 dB, 10 dB steps)

Value	Name	Label	Close	Open
0	SA10_000	00 dB		116, 117, 118, 119
10	SA10_010	10 dB	116	117, 118, 119
20	SA10_020	20 dB	117	116, 118, 119
30	SA10_030	30 dB	116, 117	118, 119
40	SA10_040	40 dB	118	116, 117, 119
50	SA10_050	50 dB	116, 118	117, 119
60	SA10_060	60 dB	117, 118	116, 119
70	SA10_070	70 dB	116, 117, 118	119
80	SA10_080	80 dB	118, 119	116, 117
90	SA10_090	90 dB	116, 118, 119	117
100	SA10_100	100 dB	117, 118, 119	116
110	SA10_110	110 dB	116, 117, 118, 119	

Table 6-7. HP 70612C and 70613C Option 004 (90 dB, 10 dB steps)

Value	Name	Label	Close	Open
0	SA10_000	00 dB		116, 117, 118, 119
10	SA10_010	10 dB	116	117, 118, 119
20	SA10_020	20 dB	117	116, 118, 119
30	SA10_030	30 dB	118	116, 117, 119
40	SA10_040	40 dB	116, 118	117, 119
50	SA10_050	50 dB	117, 118	116, 119
60	SA10_060	60 dB	118, 119	116, 117
70	SA10_070	70 dB	116, 118, 119	117
80	SA10_080	80 dB	117, 118, 119	116
90	SA10_090	90 dB	116, 117, 118, 119	

7

Replaceable Parts

Introduction

This section contains information for ordering parts. Table 7-1 lists accessories available for the switch driver by part number and description. Table 7-2 lists abbreviations used in the parts list and throughout the manual. Table 7-3 lists all replaceable parts referenced in the figures.

Abbreviations

Table 7-2 lists abbreviations used in the parts list, schematics, and throughout the manual. Standard abbreviations may be in upper or lower-case letters. However, the replaceable parts list is a computer printout using only upper-case letters. Thus, abbreviations in the replaceable parts list are in upper-case letters only.

Replaceable Parts List

The information given for each part consists of the following:

a. Reference designation
b. Hewlett-Packard part number
c. Total quantity (Qty) used in the instrument
d. Part description

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

Firmware Revisions

Firmware for the HP 70611A, 70612A/C and 70613A/C is listed in the replaceable parts list, Table 7-3, Replaceable Parts, page 7-18, item 7. Older versions of these instruments may have firmware part numbers different from those listed in Table 7-3, Replaceable Parts, however, the firmware parts listed are the most current versions of the firmware and are the preferred replacement parts. The current firmware versions are backward compatible for all instruments.

Ordering Information

When ordering a part listed in the replaceable parts list, include the Hewlett-Packard part number and the quantity required. Address the order to the nearest Hewlett-Packard office.

Note Within the USA, it is better to order directly from the HP Parts Center. Ask your nearest HP office for information and forms for the "Direct Mail Order System".

Accessories

Table 7-1. Accessories

HP Part Number	Description
70611-60008	32 cables with connectors. HP 84940A - to - switches.
70611-60010	Cable, 36-pin SCSI II to 36 pin SCSI II, Shielded
70611-60011	Cable, Ribbon, 36-pin SCSI II to 34-pin
1251-7090	34-pin connector
84940A	Driver Board
70611-60014	Service Aid. For use in Verification and Troubleshooting

REFERENCE DESIGNATIONS

A ..... assembly
AT ..... attenuator; isolator; termination
B ..... fan; motor
BT ..... battery
C ..... capacitor
CP ..... coupler
CR .... diode; diode thyristor; varactor
DC ..... directional coupler
DL ..... delay line
DS .... annunciator; signaling device (audible or visual); lamp; LED
E miscellaneous electrical part
F ..... fuse
FL ..... filter
H ..... hardware
HY ..... circulator
J ..... electrical connector (stationary portion); jack
K ..... relay
L ..... coil; inductor
M ..... meter
MP . miscellaneous mechanical part
P ..... electrical connector (movable portion); plug
Q ..... transistor; SCR; triode thyristor
R ..... resistor
RT ..... thermistor
S ..... switch
T ..... transformer
TB ..... terminal board
TC ..... thermocouple
TP ..... test point
U ..... integrated circuit; microcircuit
V ..... electron tube
VR ..... voltage regulator; breakdown diode
W .. cable; transmission path; wire
X ..... socket
Y crystal unit (piezoelectric or quartz)
Z . tuned cavity; tuned circuit

ABBREVIATIONS

A ..... ampere
ac ..... alternating current
ACCESS ..... accessory
ADJ ..... adjustment
A/D ..... analog-to-digital
AF ..... audio frequency
AFC .... automatic frequency control
AGC .. automatic gain control
AL ..... aluminum
ALC .. automatic level control
AM .... amplitude modulation
AMPL ..... amplifier
APC . automatic phase control
A/R ..... as required
ASSY ..... assembly
AUX ..... auxiliary
avg ..... average
AWG ... American wire gauge
BAL ..... balance
BCD .... binary coded decimal
BD ..... board
BE CU ..... beryllium copper
BFO beat frequency oscillator
BH ..... binder head
BKDN ..... breakdown
BP ..... bandpass
BPF ..... bandpass filter
BRS ..... brass
BWO ..... backward-wave oscillator
CAL ..... calibrate
ccw ..... counterclockwise
CER ..... ceramic
CHAN ..... channel
cm ..... centimeter
CMO ..... cabinet mount only
COAX ..... coaxial
COEF ..... coefficient
COM ..... common
COMP ..... composition
COMPL ..... complete
CONN ..... connector
CP ..... cadmium plate
CRT ..... cathode-ray tube
CTL complementary transistor logic
CW ..... continuous wave
cw ..... clockwise
cm ..... centimetre
D/A ..... digital-to-analog
dB ..... decibel
dBm decibel referred to 1 mW
dc ..... direct current
deg ..... degree (temperature interval or difference)
... ° ... degree (plane angle)
°C degree Celsius (centigrade)
°F ..... degree Fahrenheit
°K ..... degree Kelvin
DEPC ..... deposited carbon
DET ..... detector
diam ..... diameter
DIA .. diameter (used in Parts List)
DIFF AMPL ..... differential amplifier
div ..... division
DPDT ..... double-pole, double-throw
DR ..... drive
DSB ..... double sideband
DTL .... diode transistor logic
DVM ..... digital voltmeter
ECL .... emitter coupled logic
EMF ..... electromotive force
EDP electronic data processing
ELECT ..... electrolytic
ENCAP ..... encapsulated
EXT ..... external
F ..... farad
FET .... field-effect transistor
F/F ..... flip-flop
FH ..... flat head
FIL H ..... fillister head
FM .... frequency modulation
FP ..... front panel
FREQ ..... frequency
FXD ..... fixed
g ..... gram
GE ..... germanium
GHz ..... gigahertz
GL ..... glass
GRD ..... ground(ed)
H ..... henry
h ..... hour
HET ..... heterodyne
HEX ..... hexagonal
HD ..... head
HDW ..... hardware
HF ..... high frequency
HG ..... mercury
HI ..... high
HP ..... Hewlett-Packard
HPF ..... high-pass filter
HR .. hour (used in Parts List)
HV ..... high voltage
Hz ..... Hertz
IC ..... integrated circuit
ID ..... inside diameter
IF .... intermediate frequency
IMPG ..... impregnated
in ..... inch
INCD ..... inncandescent
INCL ..... include(s)
INP ..... input
INS ..... insulation
INT ..... internal
kg ..... kilogram
kHz ..... kilohertz
kΩ ..... kilohm
kV ..... kilovolt
lb ..... pound
LC ... inductance-capacitance
LED ..... light-emitting diode
LF ..... low frequency
LG ..... long
LH ..... left hand
LIM ..... limit
LIN linear taper (used in Parts List)
lin ..... linear
LK WASH ..... lock washer
LO ..... low; local oscillator
LOG logarithmic taper (used in Parts List)
log ..... logrithm(ic)
LPF ..... low pass filter
LV ..... low voltage
m ..... metre (distance)
mA ..... millampere
MAX ..... maximum
MΩ ..... megohm
MEG . meg (10^6) (used in Parts List)
MET FLM ..... metal film
MET OX ..... metallic oxide
MF ..... medium frequency; microfarad (used in Parts List)
MFR ..... manufacturer
mg ..... milligram
MHz ..... megahertz
mH ..... millihenry
mho ..... mho
MIN ..... minimum
min ..... minute (time)
... ' ... minute (plane angle)
MINAT ..... miniature
mm ..... millimetre
MOD ..... modulator
MOM ..... momentary
MOS ..... metal-oxide semiconductor
ms ..... millisecond
MTG ..... mounting
MTR meter (indicating device)
mV ..... millivolt
mVac ..... millivolt, ac
mVdc ..... millivolt, dc
mVpk ..... millivolt, peak
mVp-p millivolt, peak-to-peak
mVrms ..... millivolt, rms
mW ..... milliwatt
MUX ..... multiplex
MY ..... mylar
μA ..... microampere
μF ..... microfarad
μH ..... microhenry
μumho ..... micromho
μs ..... microsecond
μV ..... microvolt
μVac ..... microvolt, ac
μVdc ..... microvolt, dc
μVpk ..... microvolt, peak
μVp-p microvolt, peak-to-peak
μVrms ..... microvolt, rms
μW ..... microwatt

ABBREVIATIONS (con't)

nA ..... nanoampere
NC ..... no connection
N/C ..... normally closed
NE ..... neon
NEG ..... negative
nF ..... nanofarad
NI PL ..... nickel plate
N/O ..... normally open
NOM ..... nominal
NORM ..... normal
NPN ..... negative-positive-negative
NPO ..... negative-positive zero ..... (zero temperature coefficient)
NRFR .. not recommended for field replacement
NSR ..... not separately replaceable
ns ..... nanosecond
nW ..... nanowatt
OBD ..... order by description
OD ..... outside diameter
OH ..... oval head
OP AMPL ..... operational amplifier
OPT ..... option
OSC ..... oscillator
OX ..... oxide
oz ..... ounce
Ω ..... ohm
P .... peak (used in Parts List)
PAM ..... pulse-amplitude modulation
PC ..... printed circuit
PCM .. pulse-code modulation; pulse-count modulation
PDM ..... pulse-duration modulation
pF ..... picofarad
PH BRZ ..... phosphor bronze
PHL ..... Phillips
PIN ..... positive-intrinsic-negative
PIV ..... peak inverse voltage
pk ..... peak
PL ..... phase lock
PLO ..... phase lock oscillator
PM ..... phase modulation
PNP positive-negative-positive
P/O ..... part of
POLY ..... polystyrene
PORC ..... porcelain
POS positive; position(s) (used in Parts List)
POSN ..... position
POT ..... potentiometer
p-p ..... peak-to-peak
PP peak-to-peak (used in Parts List)
PPM pulse-position modulation
PREAMPL ..... preamplifier
PRF ..... pulse-repetition frequency
PRR ..... pulse repetition rate
ps ..... picosecond
PT ..... point
PTM ... pulse-time modulation
PWM . pulse-width modulation
PWV ... peak working voltage
RC .... resistance-capacitance
RECT ..... rectifier
REF ..... reference
REG ..... regulated
REPL ..... replaceable
RF ..... radio frequency
RFI ..... radio frequency interference
RH ... round head; right hand
RLC ... resistance-inductance-capacitance
RMO ..... rack mount only
rms ..... root-mean-square
RND ..... round
RAM . random-access memory
ROM ..... read-only memory
R&P ..... rack and panel
RWV reverse working voltage
S ..... scattering parameter
s ..... second (time)
... " ... second (plane angle)
S-B ..... slow-blow (fuse) (used in Parts List)
SCR ..... silicon controlled rectifier; screw
SE ..... selenium
SECT ..... sections
SEMICON ..... semiconductor
SHF .... super-high frequency
SI ..... silicon
SIL ..... silver
SL ..... slide
SNR ..... signal-to-noise ratio
SPDT ..... single-pole, double-throw
SPG ..... spring
SR ..... split ring
SPST single-pole, single-throw
SSB ..... single sideband
SST ..... stainless steel
STL ..... steel
SQ ..... square
SWR ..... standing-wave ratio
SYNC ..... synchronize
T ..... timed (slow-blow fuse)
TA ..... tantalum
TC temperature compensating
TD ..... time delay
TERM ..... terminal
TFT ..... thin-film transistor
TGL ..... toggle
THD ..... thread
THRU ..... through
TI ..... titanium
TOL ..... tolerance
TRIM ..... trimmer
TSTR ..... transistor
TTL . transistor-transistor logic
TV ..... television
TVI ... television interference
TWT ..... traveling wave tube
U ..... micro (10^{-6}) (used in Parts List)
UF . microfarad (used in Parts List)
UHF .... ultra-high frequency
UNREG ..... unregulated
V ..... volt
VA ..... voltampere
Vac ..... volts, ac
VAR ..... variable
VCO ..... voltage-controlled oscillator
Vdc ..... volts, dc
VDCW volts, dc, working (used in Parts List)
V(F) ..... volts, filtered
VFO ..... variable-frequency oscillator
VHF ..... very-high frequency
Vpk ..... volts, peak
Vp-p ..... volts, peak-to-peak
Vrms ..... volts, rms
VSWR . voltage standing-wave ratio
VTO .. voltage-tuned oscillator
VTVM vacuum-tube voltmeter
V(X) ..... volts, switched
W ..... watt
W/ ..... with
WIV . working inverse voltage
WW ..... wirewound
W/O ..... without
YIG ..... yttrium-iron-garnet
Z_o .. characteristic impedance

Abbreviation	Prefix	Multiple
T	tera	10^{12}
G	giga	10^{9}
M	mega	10^{6}
k	kilo	10^{3}
da	deka	10
d	deci	10^{-1}
c	centi	10^{-2}
m	milli	10^{-3}
μ	micro	10^{-6}
n	nano	10^{-9}
p	pico	10^{-12}
f	femto	10^{-15}
a	atto	10^{-18}

Parts Identification

To identify a part not shown in the following parts list or in the MANUAL CHANGES supplement, contact the parts identification department of your nearest Hewlett-Packard service center. Be prepared to identify the instrument by model and serial number, and to describe the part by type, function, and location within the instrument.

Table 7-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description
			HP 70611A
1	0515-1851	10	SCREW TORX METRIC
2	0515-1851		SCREW TORX METRIC
3	70611-00005	1	COVER
			HP 70612A/C and 70613A/C
1	0515-1851	12	SCREW TORX METRIC
2	0515-1851		SCREW TORX METRIC
3	70612-00004	1	COVER

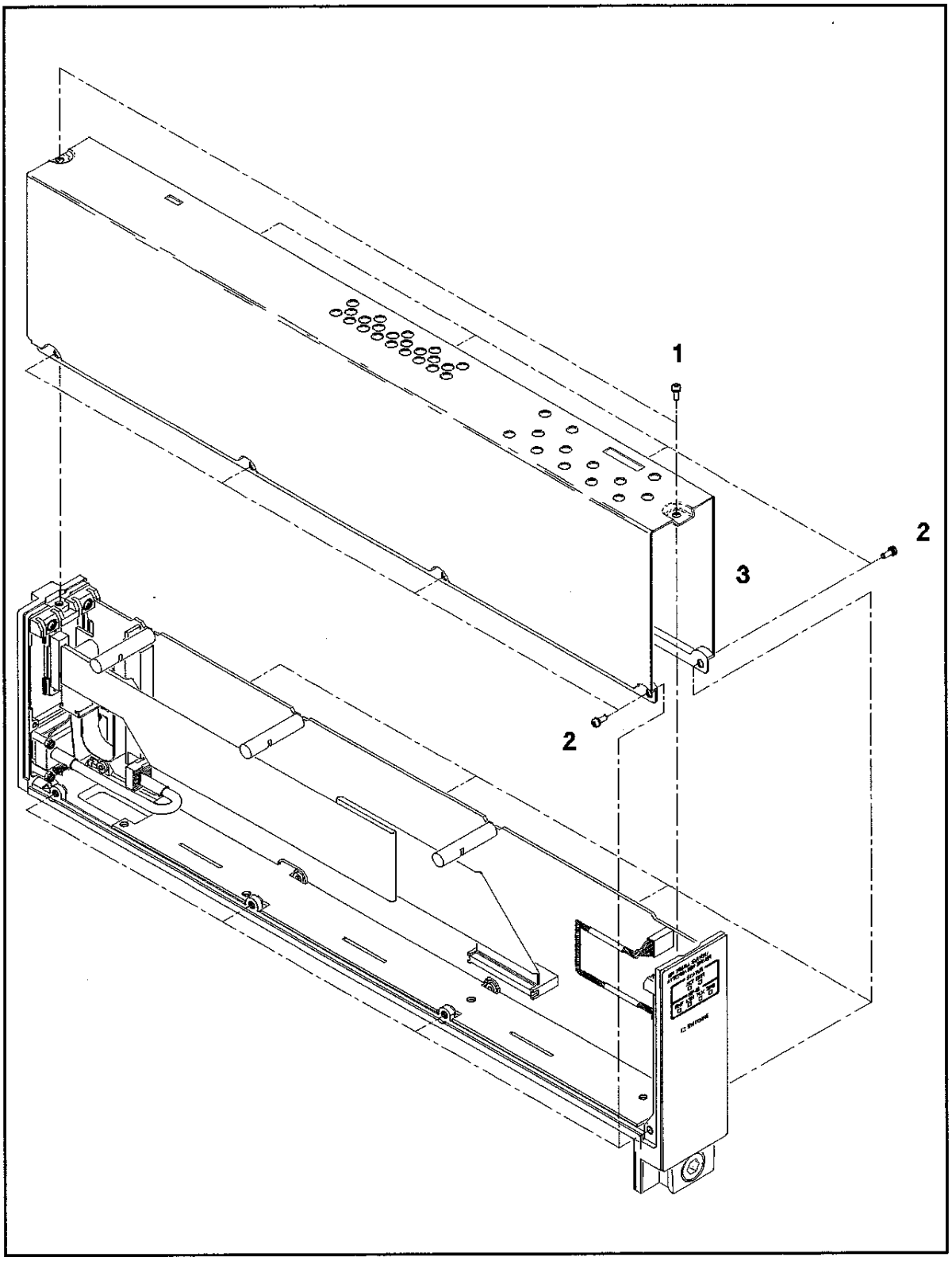


Figure 7-1. Cover Removal

Table 7-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description
			HP 70611A
1	70611-60006	1	DISPLAY CABLE ASSY
2	0515-1851	7	SCREW TORX
3	0515-1851		SCREW TORX
4	70700-40002	1	GUIDE PC BD BLK
5	70611-60003	1	STATUS PC BD ASSY
6	0510-1244	1	RTNR PUSH ON
7	0900-0012	1	O RING
8	70611-20009	1	FRAME FRONT
9	0515-1851		SCREW TORX METRIC
10	5180-2350	1	MMS SERIAL TAG & OPT
11	5022-0051	1	LATCH FRONT
12	70611-00008	1	FRONT PANEL

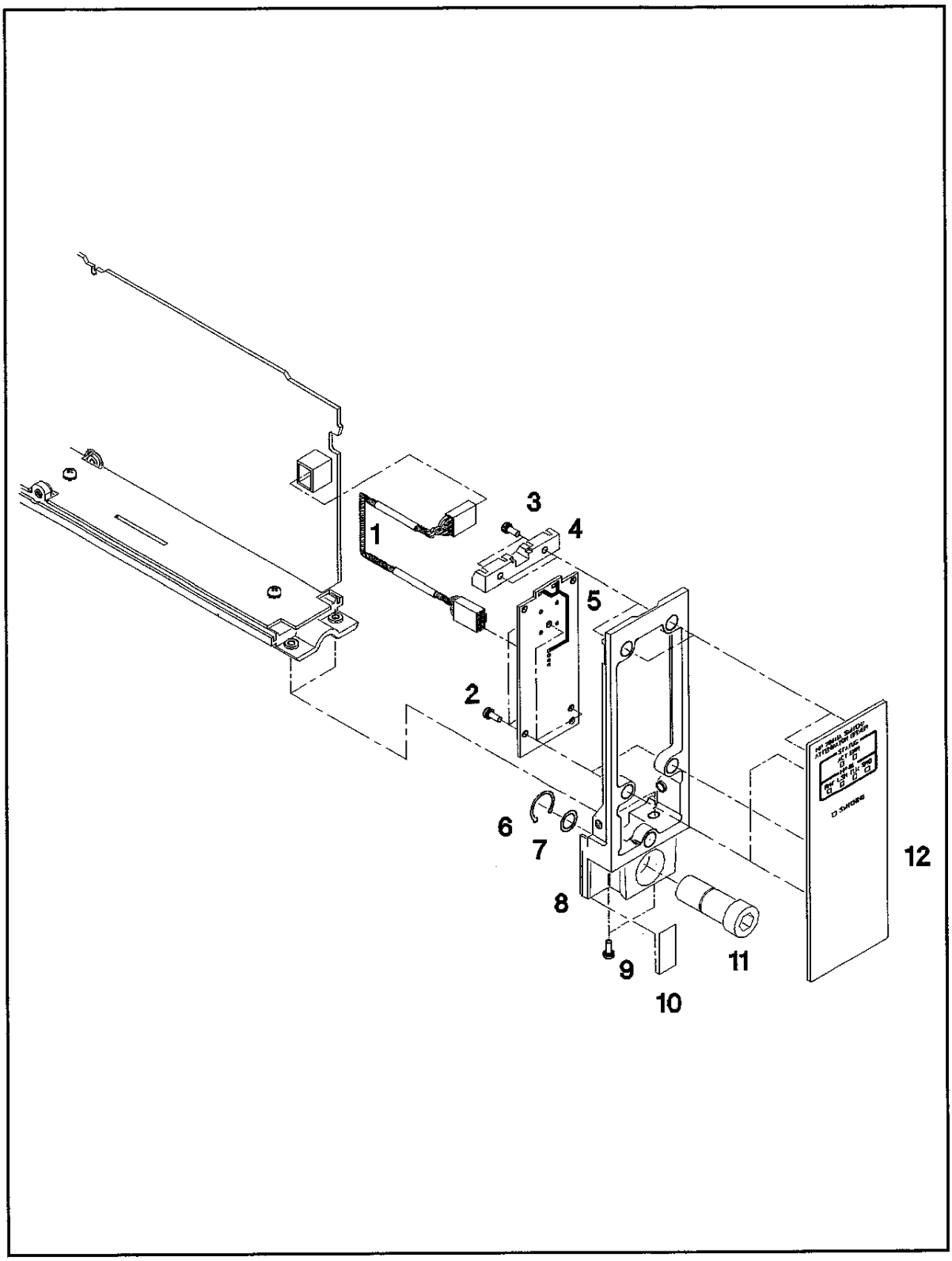


Figure 7-2. HP 70611A Front Panel

Table 7-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description
			HP 70611A
1	0535-0042	1	NUT HEX PLSTC LKG M3 X0.5 4MM THK
2	1460-2095	2	SPRING COMPRESS. 5.49-MM-OD 16.8-MM-OA-LG
3	5001-5835	2	BAR CONN
4	0535-0042	1	NUT HEX PLSTC LKG M3 X0.5 4MM THK
5	1460-2095		SPRING COMPRESS. 5.49-MM-OD 16.8-MM-OA-LG
6	5001-5835		BAR CONN
7	0515-1851	8	SCREW TORX METRIC
8	70700-40002	1	GUIDE PC BD BLK
9	70611-60011	1	CABLE ASSY 36/34 STD
10	70700-20007	1	FRAME REAR
11	0515-1851		SCREW TORX METRIC
12	70611-00006	1	STD REAR PANEL
13	0515-1851		SCREW TORX METRIC
14	0515-2028	2	SCREW MACH TORX M2.5 X0.45 6MM-LG

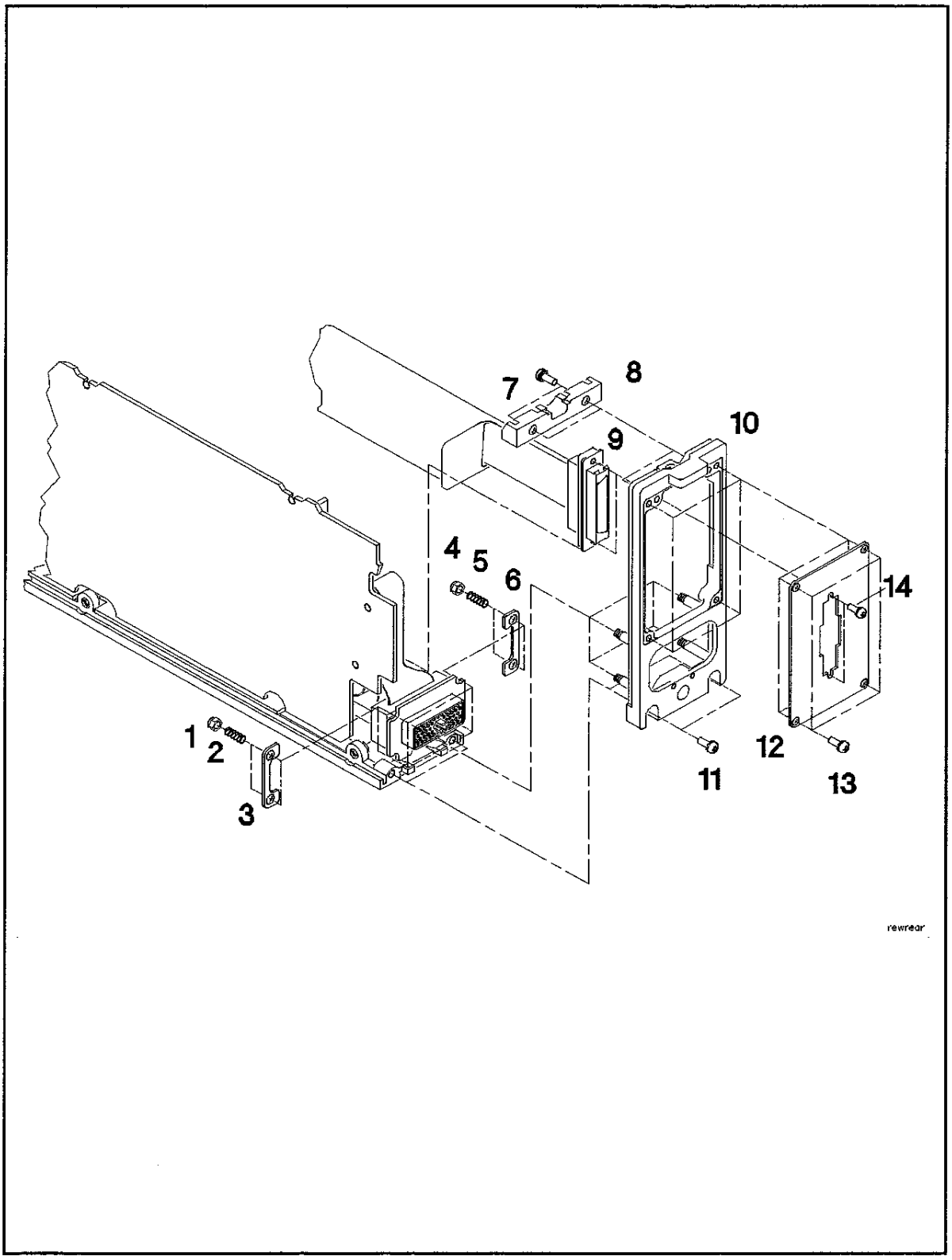


Figure 7-3. HP 70611A Rear Panel Removal

Table 7-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description
			HP 70611A OPTION 001
1	0535-0042	2	NUT HEX PLSTC LKG M3 X0.5 4MM THK
2	1460-2095	2	SPRING COMPRESS. 5.49-MM-OD 16.8-MM-OA-LG
3	5001-5835	2	BAR CONN
4	0535-0042		NUT HEX PLSTC LKG M3 X0.5 4MM THK
5	1460-2095		SPRING COMPRESS. 5.49-MM-OD 16.8-MM-OA-LG
6	5001-5835		BAR CONN
7	0515-1851	6	SCREW TORX METRIC
8	70700-40002	1	GUIDE PC BD BLK
9	70611-60011	1	CABLE ASSY 36/34 STD
10	70700-20007	1	FRAME REAR
11	0515-1851		SCREW TORX METRIC
12	70611-00004	1	OPT 001 REAR PANEL
13	0515-1851		SCREW TORX METRIC
14	0515-2028	2	SCREW MACH TORX M2.5 X0.45 6MM-LG

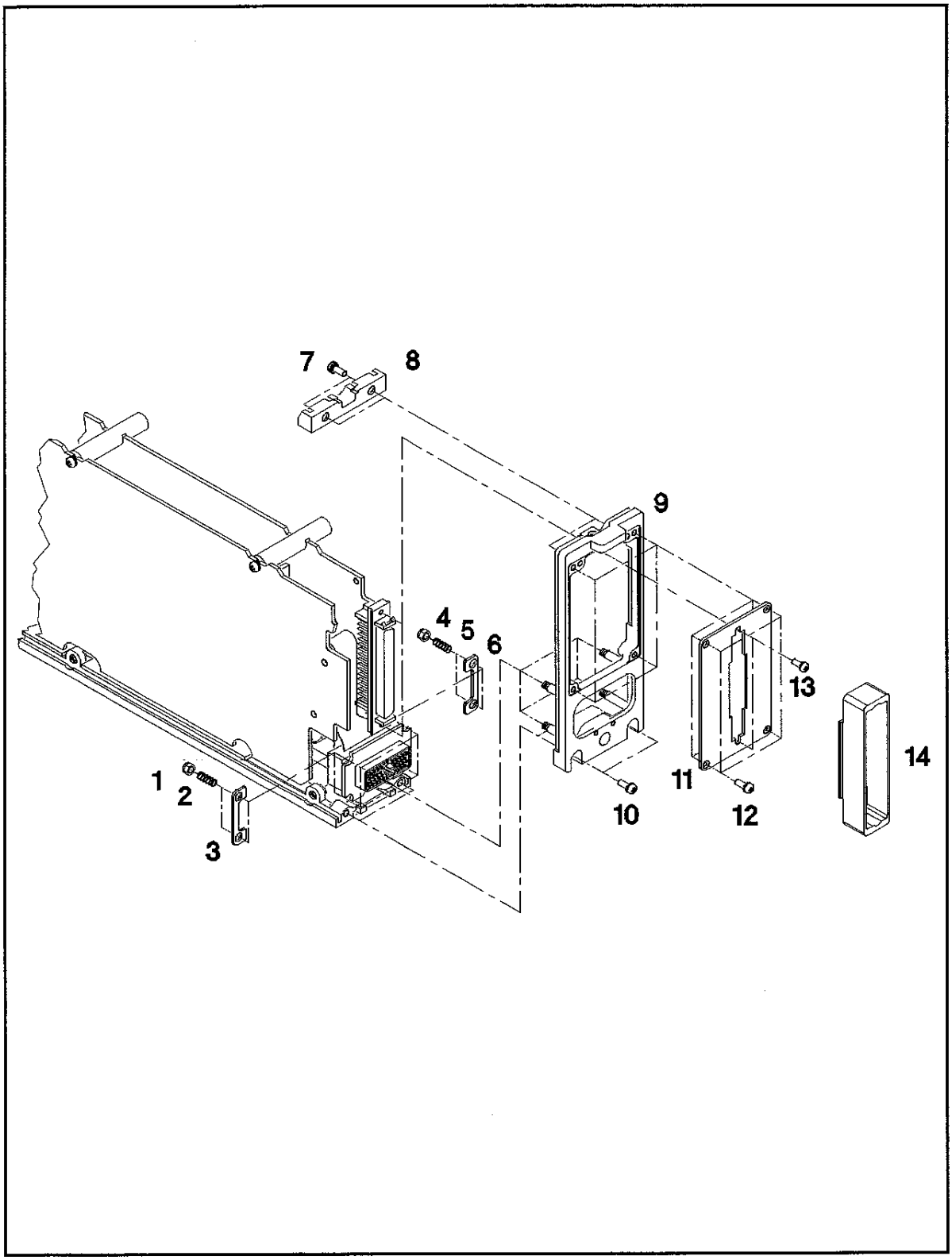


Figure 7-4. HP 70611A Option 001 Rear Panel Removal

Table 7-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description
			HP 70611A
1	70700-00004	1	BRACKET FERRITE
2	70700-60001	1	FLEX ASSY
3	70611-20008	1	BASE MOUNTING
4	70611-20004	3	SPACER CONT BD
5	70611-00007	1	BOTTOM PANEL
6	0515-0430	11	SCREW TORX METRIC
7	0515-0430		SCREW TORX METRIC
8	0515-0430		SCREW TORX METRIC
9	70611-20004		SPACER CONT BD
10	0515-0430		SCREW TORX METRIC
11	70611-20004		SPACER CONT BD
12	0515-0430		SCREW TORX METRIC
13	0515-0430		SCREW TORX METRIC
14	70611-60001	1	CONTROLLER BD ASSY

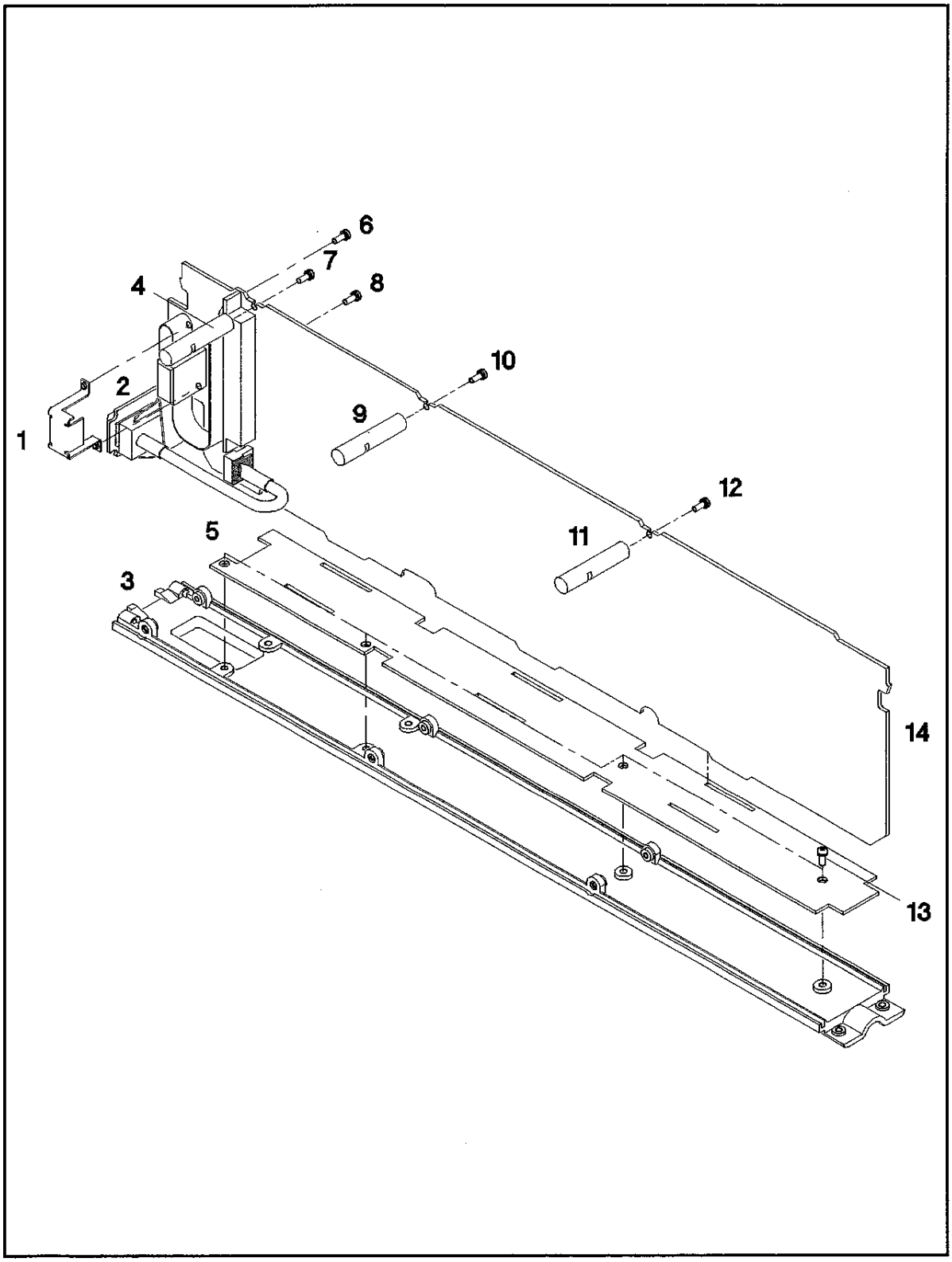


Figure 7-5. HP 70611A Controller Board Removal

Table 7-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description
			HP 70611A OPTION 001
1	70700-00004	1	BRACKET FERRITE
2	70700-60001	1	FLEX ASSY
3	70611-20008	1	BASE MOUNTING
4	70611-20004	3	SPACER CONT BD
5	70611-00007	1	BOTTOM PANEL
6	0515-1851	11	SCREW TORX METRIC
7	0515-1851		SCREW TORX METRIC
8	0515-1851		SCREW TORX METRIC
9	70611-20004		SPACER CONT BD
10	0515-1851		SCREW TORX METRIC
11	70611-20004		SPACER CONT BD
12	0515-1851		SCREW TORX METRIC
13	0515-1851		SCREW TORX METRIC
14	70611-60001	1	CONTROLLER BD ASSY
	70611-80015	1	EPROM (version 930810)
	70611-80016	1	EPROM (version 930810)
15	70611-60005	1	CABLE ASSY 34/34 UNSHLD OPT 001
16	70611-60002	1	DRIVER SELECT BD ASSY OPT 001

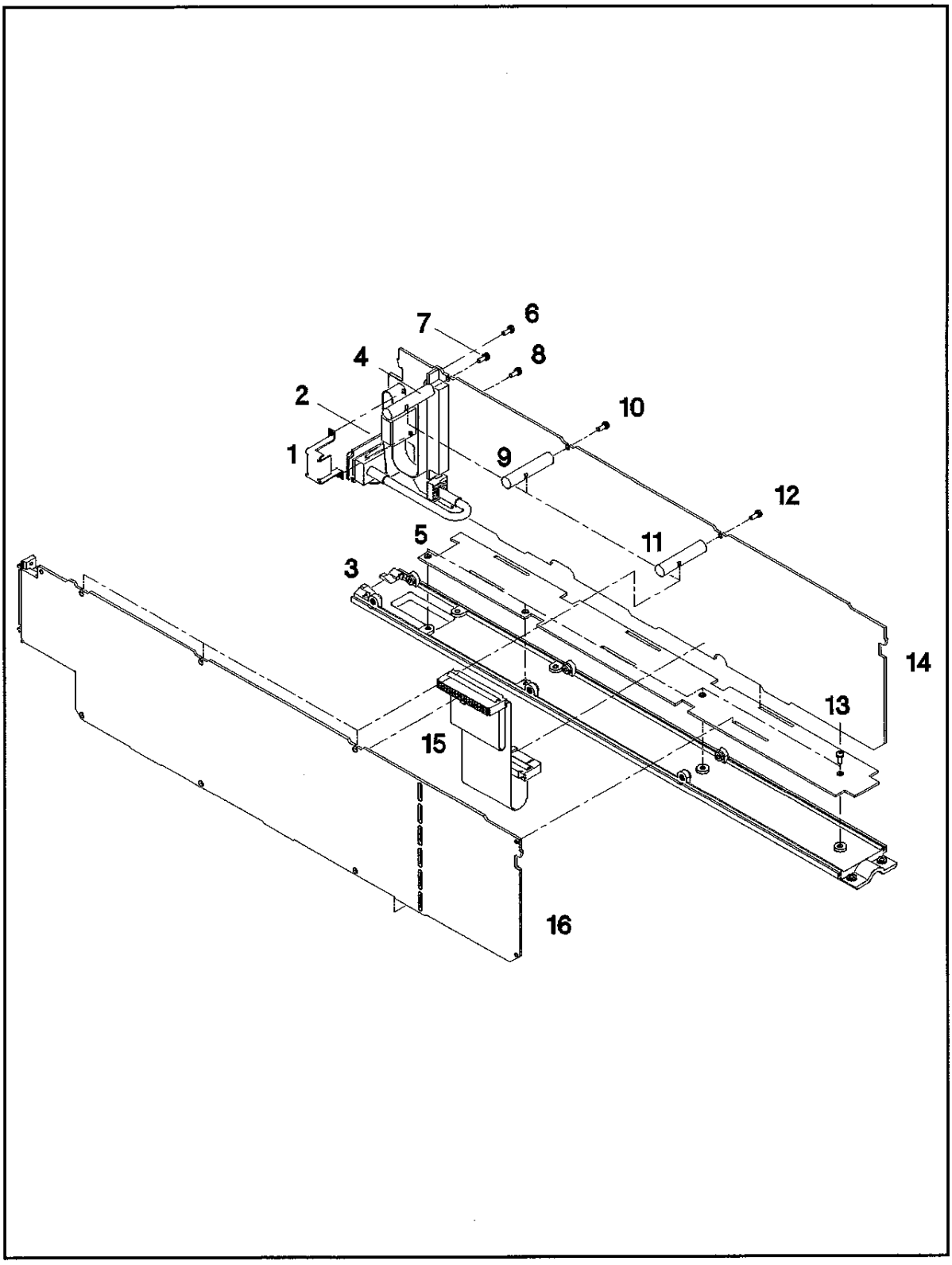


Figure 7-6. HP 70611A Option 001 PCA Removal

Table 7-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description
			HP 70612A/C 70613A/C Standard
1	70612-00026	1	HP 70612A FRONT PANEL
	70612-00030	1	OPT 005
	70612-00032	1	OPT 006
	70612-00028	1	OPT 011
	70612-00027	1	HP 70612C FRONT PANEL
	70612-00031	1	OPT 005
	70612-00033	1	OPT 006
	70612-00029	1	OPT 011
	70613-00013	1	HP 70613A FRONT PANEL
	70613-00017	1	OPT 005
	70613-00019	1	OPT 006
	70613-00015	1	OPT 011
	70613-00014	1	HP 70613C FRONT PANEL
	70613-00018	1	OPT 005
	70613-00020	1	OPT 006
	70613-00016	1	OPT 011
2	70612-00004	1	COVER TOP
3	70611-20009	2	FRAME FRONT
4	1250-2366	7	ADAPTER-COAX STR F-SMA F-SMA
5	70611-60003	1	STATUS BD ASSY (NOT USED OPT 006 & 011)
6	70612-60010	1	DISPLAY BD
7	70611-60001	1	CONTROLLER BD ASSY
	70611-80015	1	EPROM (NOT USED OPT 006 & 011) version 930810
	70611-80016	1	EPROM (NOT USED OPT 006 & 011) version 930810
8	70612-20038	3	SPACE CONT BD (NOT USED OPT 006 & 011)
9	70612-20039	2	GUIDE PC BD
10	0515-1851	30	SCREW TORX METRIC
		24	OPT 006 & 011
11	70700-60001	1	50-PIN CONNECTOR
12	70700-20007	2	FRAME REAR
13	0515-2028	2	SCREW MACH TORX M2.5 X0.45 6MM-LG
		4	OPT 006 & 011

Table 7-3. Replaceable Parts (continued)

Reference Designation	HP Part Number	Qty	Description
14			REAR PANEL
	70612-00018	1	HP 70612A/C STANDARD & OPT 005
	70612-00019	1	HP 70612A/C OPT 006 & 011
	70613-00011	1	HP70613A/C STANDARD & OPT 005
	70613-00012	1	HP70613A/C OPT 006 & 011
15	70612-60009	1	DRIVER BD ASSY
16	5001-5840	1	SPRING-GROUNDING
17	0515-1950	8	SCREW MACH ASSEMBLY M3 X 0.5 8MM-LG
18	0460-1476	A/R	TAPE-ELEC 33MM LONG
19	70700-00004	1	BRACKET FERRITE (NOT USED OPT 006 & 011)
20	5001-5835	2	BAR CONN (NOT USED OPT 006 & 011)
21	1460-2095	8	SPRING COMPRESS. 5.49-MM-OD 16.8-MM-OA-LG
22	0535-0042	8	LOCK NUT
23	70611-20008	2	BASE MOUNTING
24	70612-00003	1	BOTTOM PANEL
25	0510-1244	1	RTNR-PUSH ON CIRCULAR-EXT
26	0900-0012	1	O RING .364-IN-ID .07-IN-XSECT-DIA NTRL
27	5022-0051	1	LATCH FRONT
28	8160-0731	A/R	CONDUCTIVE TAPE
29	8160-0687	A/R	O RING GASKET MAT
30	0515-1946	30	SCREW-MACH M3 X 0.5 6MM-LG 90-DEG-FLH-HD
		32	OPT 003 & 004
		34	OPT 007
32	5180-2350	2	MMS SERIAL TAG AND OPT
33			REAR SUB PANEL
	70612-00018	1	HP 70612A/C & 70613A/C STANDARD & OPT 005
	70612-00019	1	HP 70612A/C & 70613A/C OPT 006 & 011
	70612-00022	1	HP 70612A/C & 70613A/C OPT 006 & 011
34	70612-00023	1	REAR SUB PANEL (ALL MODULES)
35	70612-00006	1	CONN COVER
		2	OPT 006 & 011
36	70612-00021	2	BRACKET-RIGHT
		1	OPT 006 & 011
37	70612-00020	2	BRACKET-LEFT
		1	OPT 006 & 011

Table 7-3. Replaceable Parts (continued)

Reference Designation	HP Part Number	Qty	Description
38	70612-00024	1	ATTEN BRACKET (OPT 003, 004 & 007)
	70612-60007	1	ATTEN 110 DB ASSY (HP 70612A, 70613A OPT 004 & 007)
	70612-60015	1	ATTEN 11 dB ASSY (HP 70612A, 70613A OPT 003 & 007)
	70612-60008	1	ATTEN 90 DB ASSY (HP 70612C, 70613C OPT 004 & 007)
	70612-60014	1	ATTEN 11 dB ASSY (HP 70612C, 70613C OPT 003 & 007)
39	70612-00025	1	P.C. BD GUARD
40	70612-00005	1	BOARD BRACKET

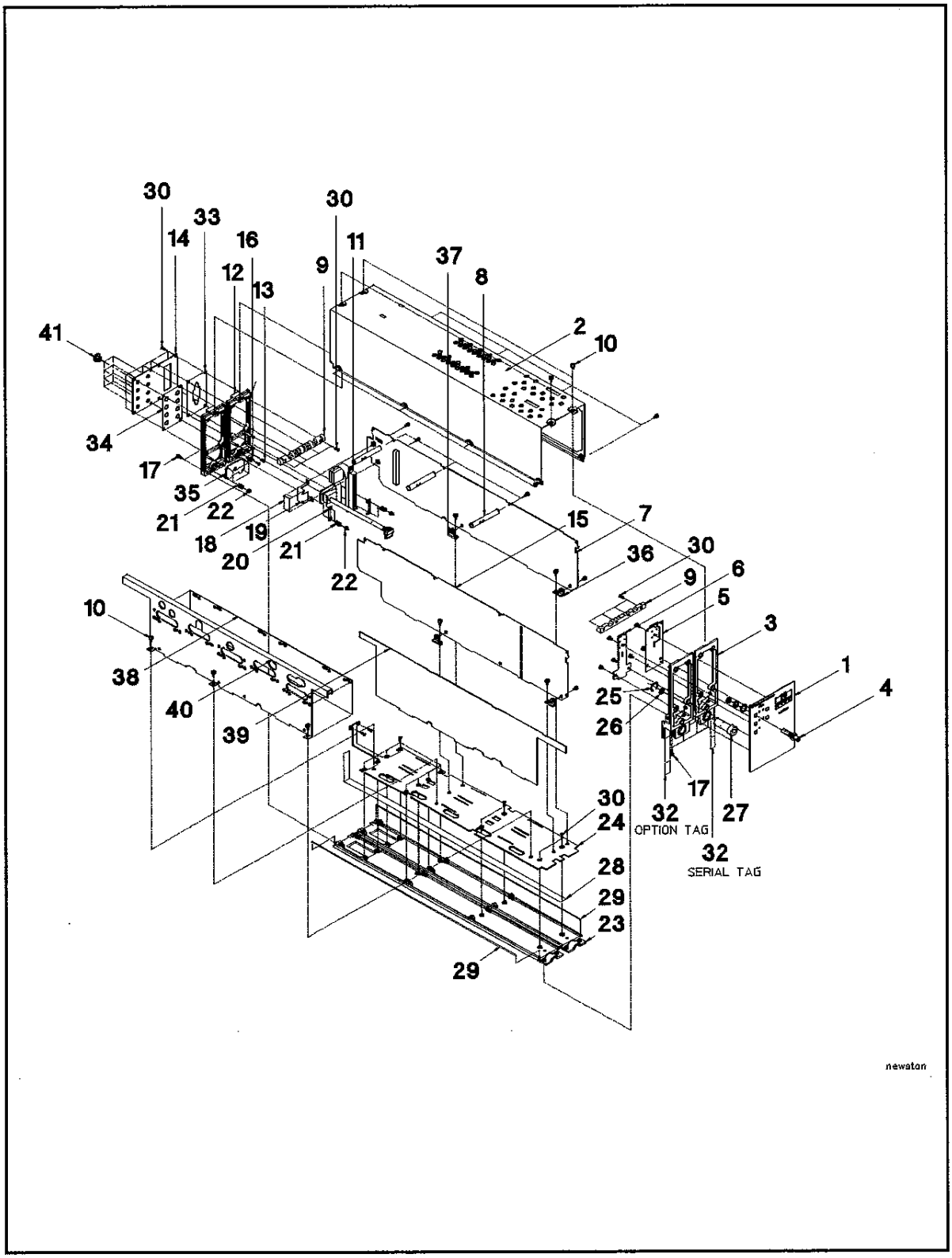


Figure 7-7. HP 70612A/C and HP 70613A/C Standard

Table 7-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description
			HP 70612A/C 70613A/C OPTION 011
1	70612-00028	1	FRONT PANEL HP 70612A OPT 011
	70612-00029	1	HP 70612C OPT 011
	70613-00015	1	HP 70613A OPT 011
	70613-00016	1	HP 70613C OPT 011
2	5022-0051	1	LATCH FRONT
3	70611-20009	2	FRAME FRONT
4	70612-20039	2	GUIDE PC BD
5	70612-60010	1	DISPLAY BD ASSY
6	70612-00021	1	BRACKET-RIGHT
7	70612-00020	1	BRACKET-LEFT
8	1250-2366	7	ADAPTER-COAX STR F-SMA F-SMA
9	70612-00004	1	COVER TOP
10	0515-1851	22	SCREW TORX METRIC
11	70612-00006	2	CONN COVER
12	70700-20007	2	FRAME REAR
13	8160-0731	A/R	TAPE CONDUCTIVE
14	70612-00019	1	REAR PANEL HP 70612A,C OPT 011
	70613-00012	1	HP 70613A,C OPT 011
15	70612-60009	1	DRIVER BD ASSY
16	5001-5840	1	SPRING-GROUNDING
17	70612-00022	1	REAR SUB PANEL
18	70612-00023	1	REAR SUB PANEL
19	70612-00025	1	PC BD GUARD
20	70612-00024	1	ATTENUATOR BRACKET
21	1460-2095	8	SPRING COMPRESS. 5.49-MM-OD 16.8-MM-OA-LG
22	0535-0042	8	LOCK NUT
23	70611-20008	2	BASE MOUNTING
24	70612-00003	1	BOTTOM PANEL
25	0510-1244	1	RTNR-PUSH ON CIRCULAR-EXT
26	0900-0012	1	O RING .364-IN-ID .07-IN-XSECT-DIA NTRL
27	5180-2350	2	MMS SERIAL TAG AND OPT
28	0515-2028	4	SCREW-MACHINE M2.5 X 0.45 6MM-LG
29	8160-0687	A/R	O RING GASKET MAT
30	0515-1946	28	SCREW-MACH M3 X 0.5 6MM-LG 90-DEG-FLH-HD
32	0515-1950	8	SCREW MACH ASSEMBLY M3 X 0.5 8MM-LG
33	70612-00005	1	BOARD BRACKET

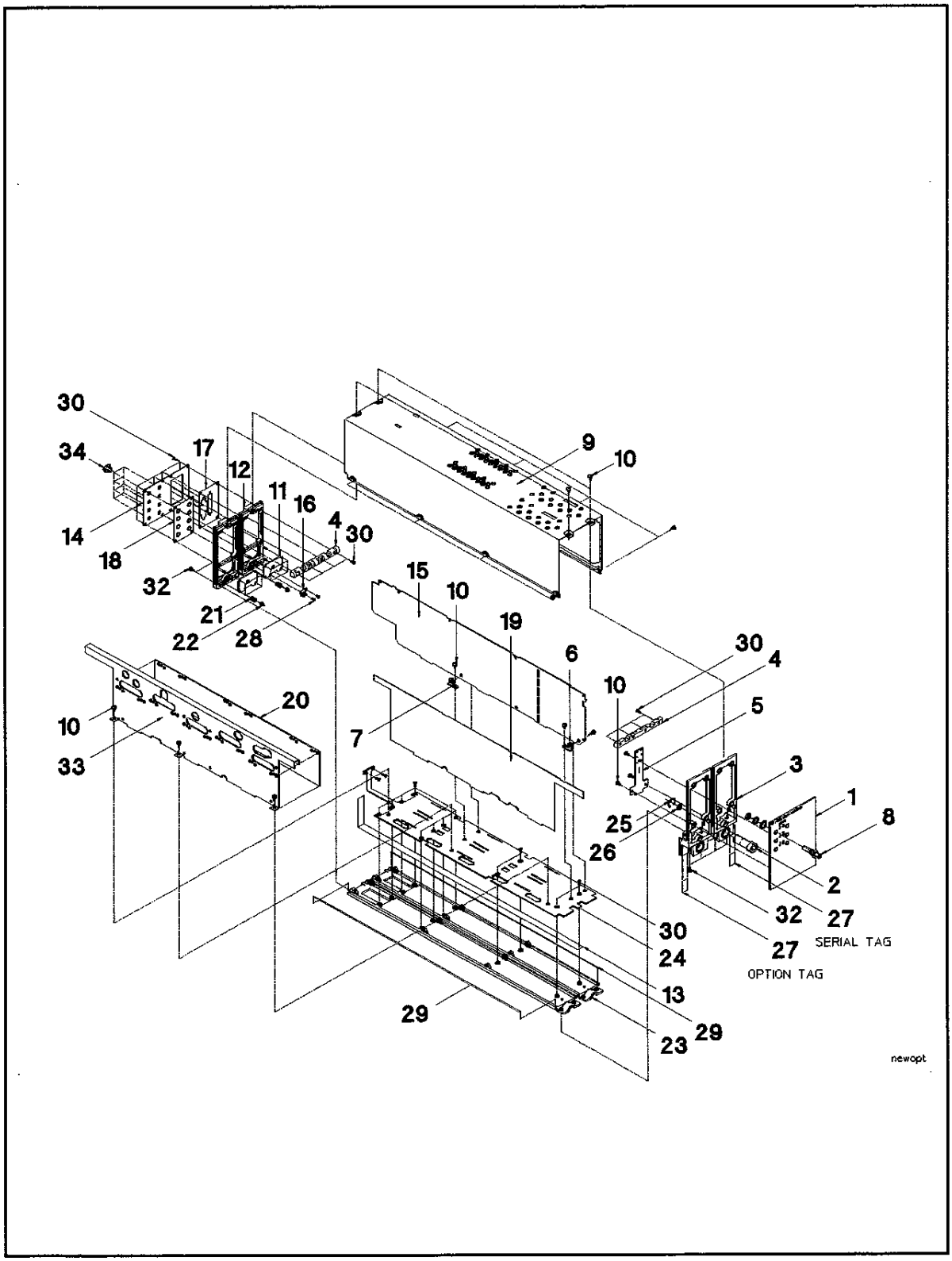


Figure 7-8. HP 70612A/C and 70613A/C Option 011

Table 7-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description
			HP 70612A/C AND 70613A/C
1	70612-60002	1	RIBBON CABLE ASSY
2	70612-60019	4	RIBBON CABLE ASSY
3	70611-60006	1	WIRE HARNESS
4	70612-60018	1	SWITCH HARNESS ASSY
5	70612-60016	1	ATTEN CABLE ASSY HP 70612C & 70613C OPT 003 & 007
6	70612-60017		CABLE ASSY/VIKING CONN ATT
		1	HP 70612A, 70613A OPT 003 & 004
		2	HP 70612A, 70613A OPT 007
		1	HP 70612C, 70613C OPT 004 & 007

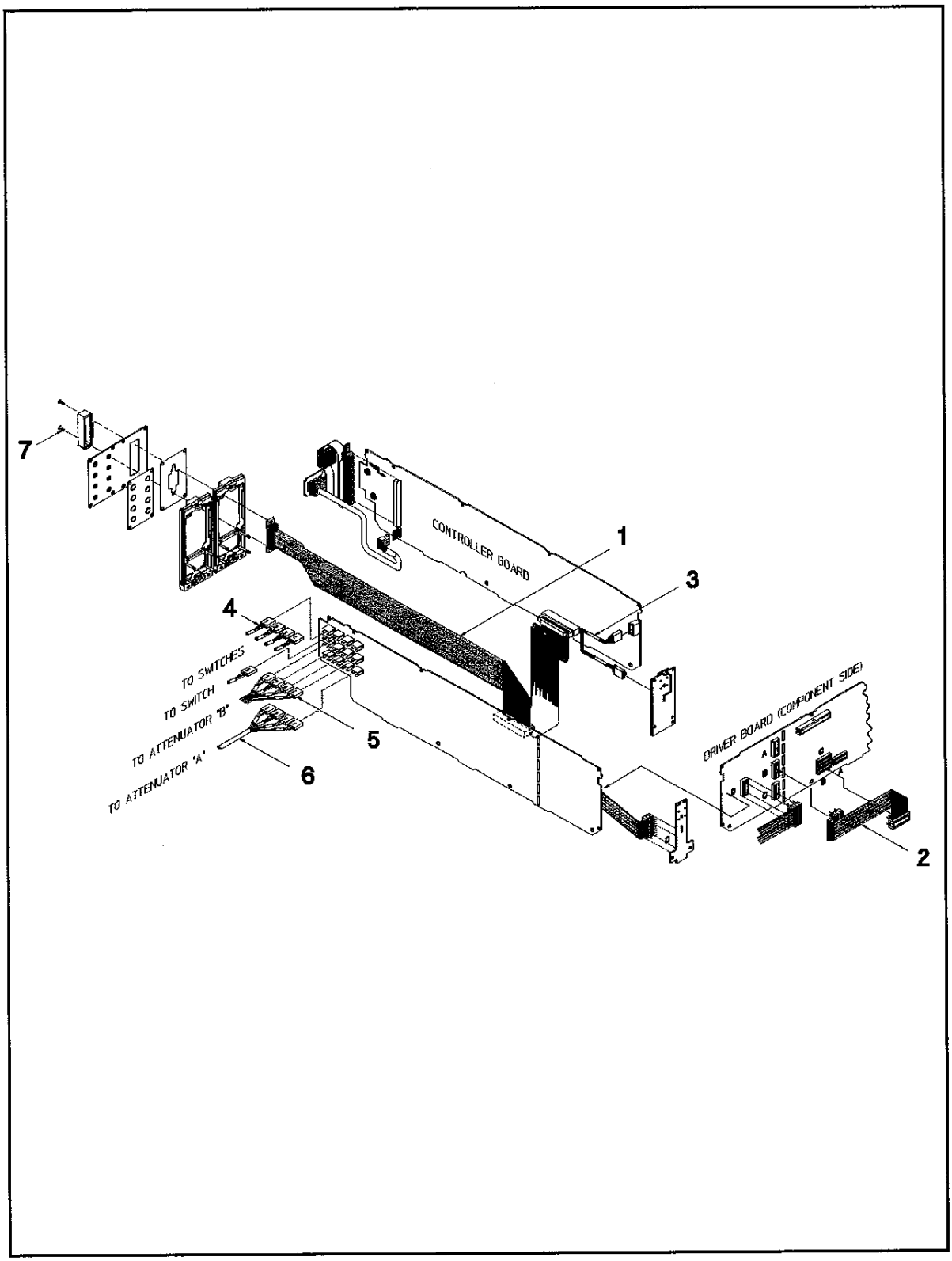


Figure 7-9. HP 70612A/C and 70613A/C PC Board Cable Diagram

Table 7-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description
			HP 70612A/C AND 70613A/C OPTION 011
1	70612-60011	1	RIBBON CABLE ASSY
2	70612-60019	4	RIBBON CABLE ASSY
3	70612-60018	1	SWITCH HARNESS ASSY
4	70612-60016	1	ATTEN CABLE ASSY HP 70612C & 70613C OPT 003 & 007
5	70612-60017		CABLE ASSY/VIKING CONN ATT
		1	HP 70612A, 70613A OPT 003 & 004
		2	HP 70612A, 70613A OPT 007
		1	HP 70612C, 70613C OPT 004 & 007

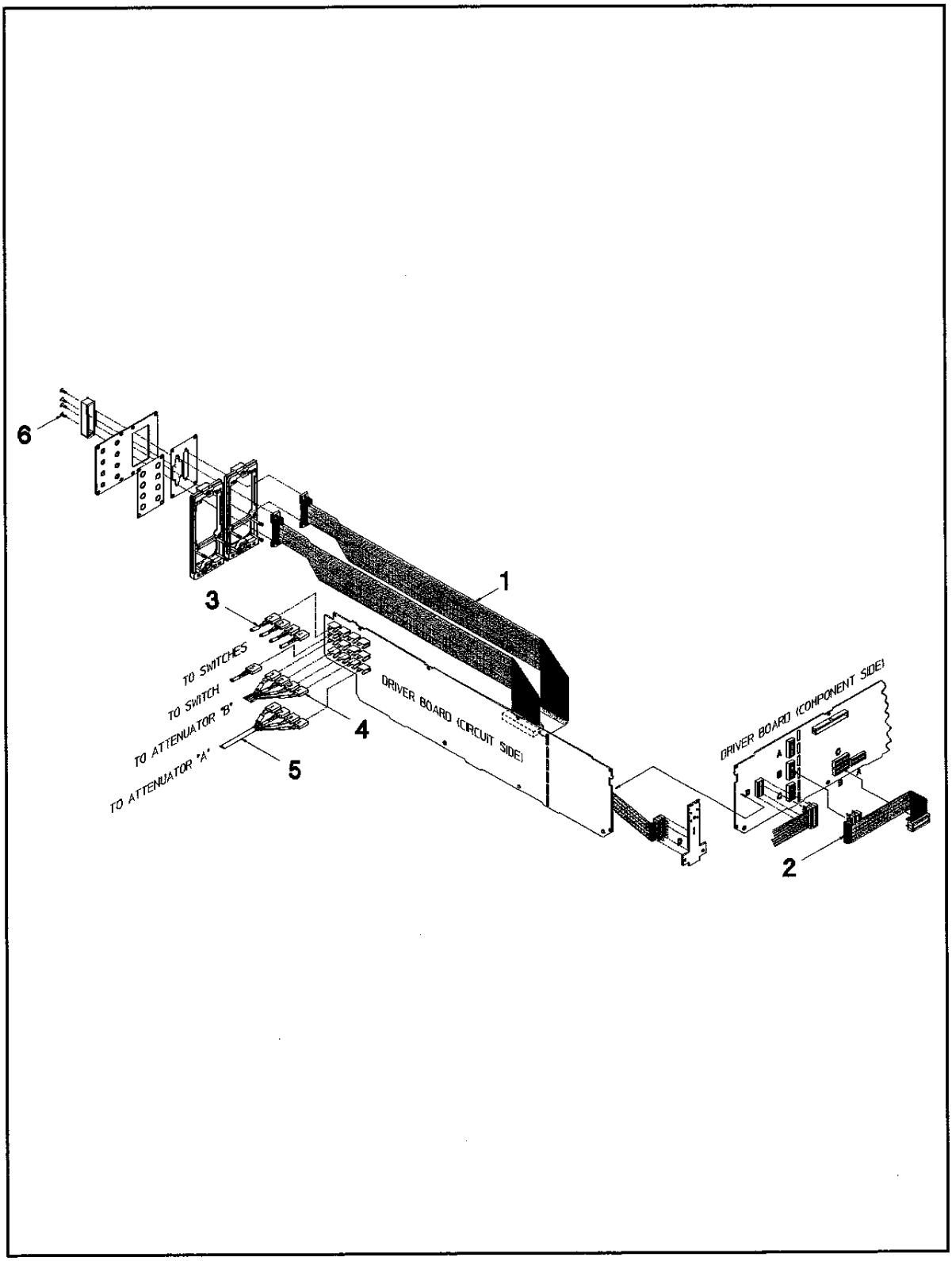


Figure 7-10. HP 70612A/C and 70613A/C Option 011 PC Board Cable Diagram

Table 7-4. Switch and Attenuator Assembly Chart

Module	Switch Part Number	Attenuator Part Number	
		Position A	Position B
HP 70612A	70612-60003		
Opt 002	70612-60005		
Opt 003		70612-60015	
Opt 004		70612-60007	
Opt 007		70612-60007	70612-60015
HP 70613A	70612-60003		
Opt 002	70612-60005		
Opt 003		70612-60015	
Opt 004		70612-60007	
Opt 007		70612-60007	70612-60015
HP 70612C	70612-60004		
Opt 002	70612-60006		
Opt 003		70612-60014	
Opt 004		70612-60008	
Opt 007		70612-60008	70612-60014
HP 70613C	70612-60004		
Opt 002	70612-60006		
Opt 003		70612-60014	
Opt 004		70612-60008	
Opt 007		70612-60008	70612-60014

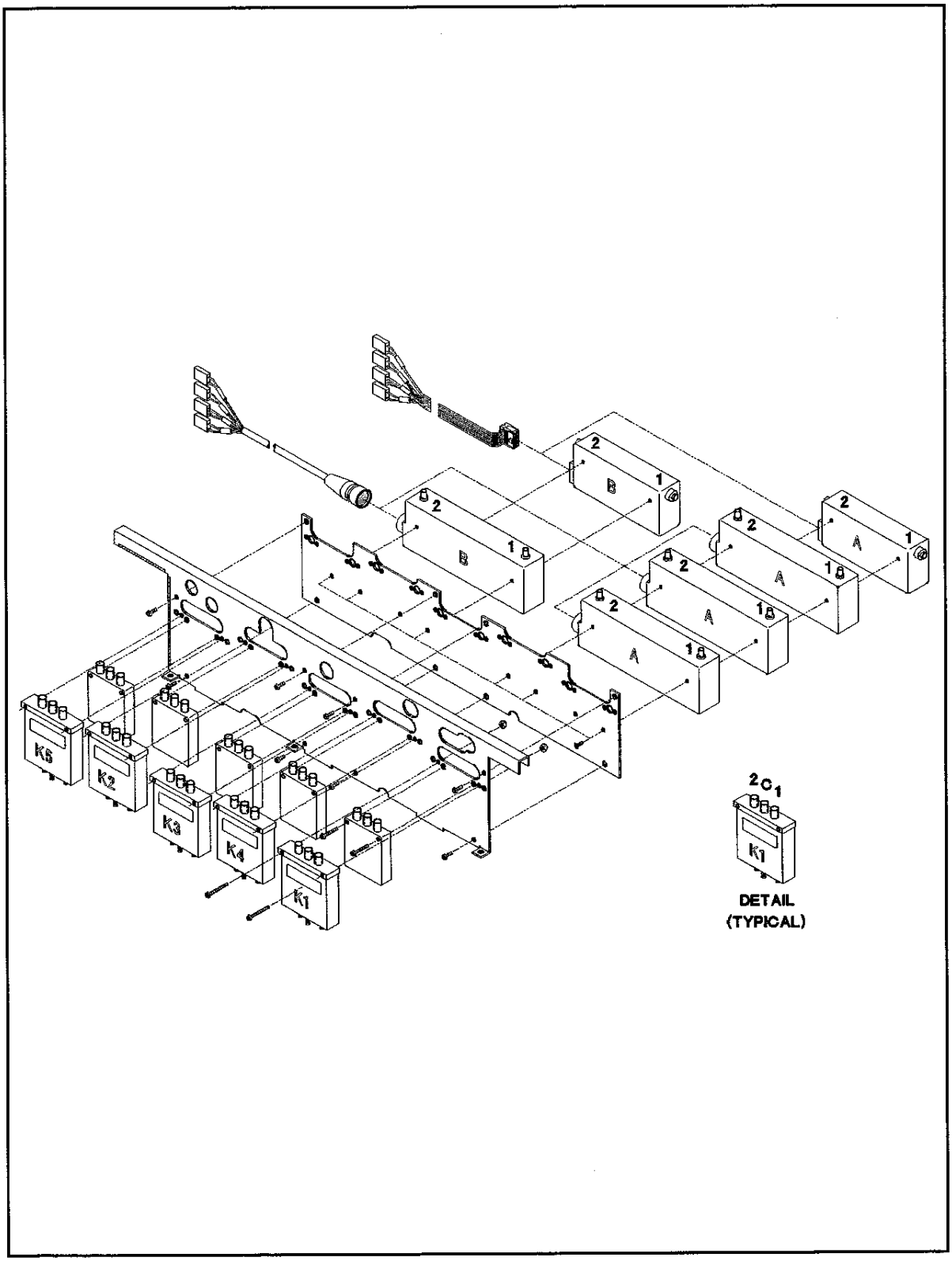


Figure 7-11. HP 70612A/C and 70613A/C Attenuator/Switch Configuration

Table 7-5.
HP 70612A/C and 70613A/C Attenuator/Switch Semi-Rigid Cable Chart

Cable Part Number	FROM Component	TO		Interface Modules
		Component	Port	
70612-20011	K1 (C)	ATT 'A' LONG (1)		HP 70613A OPT 003, 004, & 007 HP 70613C OPT 004 & 007
70612-20012	K5 (2)		5	All modules
70612-20013	ATT 'B' SHORT (2)	K2 (C)		HP 70612C OPT 007 HP 70613C OPT 007
70612-20014	K4 (1)		1	All modules
70612-20015	K3 (2)		3	All HP 70613 modules
70612-20016	K5 (1)		4	All HP 70613 modules
70612-20017	K1 (1)		B (FRONT)	All HP 70613 modules
70612-20018	K1 (2)		A (FRONT)	All HP 70613 modules
70612-20019	K4 (C)	K3 (1)		All modules
70612-20019	K3 (C)	K2 (1)		All modules
70612-20019	K2 (2)	K5 (C)		All modules
70612-20020	K4 (2)		2	All modules EXCEPT HP 70613A OPT 004 HP 70613C OPT 004
70612-20021	ATTN 'A' LONG (2)	ATT 'B' SHORT (1)		HP 70612C OPT 007 HP 70613C OPT 007
70612-20022	K5 (1)		6	All HP 70612 modules
70612-20023	K1 (1)		3	All HP 70612 modules
70612-20024	K1 (2)		4	All HP 70612 modules
70612-20025	ATT 'A' LONG (2)	ATT 'B' LONG (1)		HP 70612A OPT 007 HP 70613 OPT 007
70612-20027	K1 (C)	ATT 'A' SHORT (1)		HP 70613C OPT 003
70612-20028	ATT 'A' SHORT (1)		A (FRONT)	HP 70612C OPT 003
70612-20029	ATT 'A' LONG (1)		A (FRONT)	HP 70612A OPT 003,004, & 007 HP 70612C OPT 004 & 007
70612-20030	K2 (C)		A (FRONT)	HP 70612A & 70612C
70612-20031	K1 (C)	K2 (C)		HP 70613A & 70613C
70612-20032	K1 (C)	K3 (2)		All HP 70612 modules
70612-20033	K1 (2)		A (REAR)	HP 70613A OPT 005 HP 70613C OPT 005
70612-20034	K1 (1)		B (REAR)	HP 70613A OPT 005 HP 70613C OPT 005
70612-20035	K2 (C)		A (REAR)	HP 70612A OPT 005 HP 70612C OPT 005
70612-20036	ATT 'A' LONG (2)	K2 (C)		HP 70612A OPT 003 & 004 HP 70612C OPT 004 HP 70613A OPT 003 & 004 HP 70613C OPT 004
70612-20037	ATT 'A' SHORT (2)	K2 (C)		HP 70612A OPT 003 HP 70613C OPT 003
70612-20040	ATT 'B' LONG (2)	K2 (C)		HP 70612A OPT 007 HP 70613A OPT 007

Table 7-6.
HP 70612A/C and 70613A/C Attenuator/Switch Semi-Rigid Cable Chart

Cable Part Number	FROM Component	TO		Cable I.D.
		Component	Port	
HP 70612A/C Standard				
70612-20012	K5 (2)		5	W1
70612-20014	K4 (1)		1	W2
70612-20019	K4 (C)	K3 (1)		W3
70612-20019	K3 (C)	K2 (1)		W4
70612-20019	K2 (2)	K5 (C)		W5
70612-20020	K4 (2)		2	W6
70612-20022	K5 (1)		6	W7
70612-20023	K1 (1)		3	W8
70612-20024	K1 (2)		4	W9
70612-20030	K2 (C)		A (FRONT)	W10
70612-20032	K1 (C)	K3 (2)		W11
HP 70613A/C Standard				
70612-20012	K5 (2)		5	W1
70612-20014	K4 (1)		1	W2
70612-20015	K5 (1)		3	W3
70612-20016	K3 (2)		4	W4
70612-20017	K1 (1)		B (FRONT)	W5
70612-20018	K1 (2)		A (FRONT)	W6
70612-20019	K2 (2)	K5 (C)		W7
70612-20019	K2 (1)	K3 (C)		W8
70612-20019	K4 (C)	K3 (1)		W9
70612-20020	K4 (2)		2	W10
70612-20031	K1 (C)	K2 (C)		W11
HP 70612A Option 003				
70612-20012	K5 (2)		5	W1
70612-20014	K4 (1)		1	W2
70612-20019	K4 (C)	K3 (1)		W3
70612-20019	K3 (C)	K2 (1)		W4
70612-20019	K2 (2)	K5 (C)		W5
70612-20020	K4 (2)		2	W6
70612-20022	K5 (1)		6	W7
70612-20023	K1 (1)		3	W8
70612-20024	K1 (2)		4	W9
70612-20029	ATT 'A' LONG (1)		A (FRONT)	W10
70612-20032	K1 (C)	K3 (2)		W11
70612-20036	ATT 'A' LONG (2)	K2 (C)		W12

Table 7-6.
HP 70612A/C and 70613A/C Attenuator/Switch Semi-Rigid Cable Chart (continued)

Cable Part Number	FROM Component	TO		Cable I.D.
		Component	Port	
HP 70612C Option 003				
70612-20012	K5 (2)		5	W1
70612-20014	K4 (1)		1	W2
70612-20019	K4 (C)	K3 (1)		W3
70612-20019	K3 (C)	K2 (1)		W4
70612-20019	K2 (2)	K5 (C)		W5
70612-20020	K4 (2)		2	W6
70612-20022	K5 (1)		6	W7
70612-20023	K1 (1)		3	W8
70612-20024	K1 (2)		4	W9
70612-20028	ATT 'A' SHORT (1)		A (FRONT)	W10
70612-20032	K1 (C)	K3 (2)		W11
70612-20037	ATT 'A' SHORT (2)	K2 (C)		W12
HP 70613A Option 003				
70612-20011	ATT 'A' LONG (1)	K1 (C)		W1
70612-20012	K5 (2)		5	W2
70612-20014	K4 (1)		1	W3
70612-20015	K3 (2)		3	W4
70612-20016	K5 (1)		4	W5
70612-20017	K1 (1)		B (FRONT)	W6
70612-20018	K1 (2)		A (FRONT)	W7
70612-20019	K4 (C)	K3 (1)		W8
70612-20019	K3 (C)	K2 (1)		W9
70612-20019	K2 (2)	K5 (C)		W10
70612-20020	K4 (2)		2	W11
70612-20036	ATT 'A' LONG (2)	K2 (C)		W12
HP 70613C Option 003				
70612-20012	K5 (2)		5	W1
70612-20014	K4 (1)		1	W2
70612-20015	K3 (2)		3	W3
70612-20016	K5 (1)		4	W4
70612-20017	K1 (1)		B (FRONT)	W5
70612-20018	K1 (2)		A (FRONT)	W6
70612-20019	K4 (C)	K3 (1)		W7
70612-20019	K3 (C)	K2 (1)		W8
70612-20019	K2 (2)	K5 (C)		W9
70612-20020	K4 (2)		2	W10
70612-20027	K1 (C)	ATT 'A' SHORT (1)		W11
70612-20037	ATT 'A' SHORT (2)	K2 (C)		W12

Table 7-6.
HP 70612A/C and 70613A/C Attenuator/Switch Semi-Rigid Cable Chart (continued)

Cable Part Number	FROM Component	TO		Cable I.D.
		Component	Port	
HP 70612A/C Option 004				
70612-20012	K5 (2)		5	W1
70612-20014	K4 (1)		1	W2
70612-20019	K2 (2)	K5 (C)		W3
70612-20019	K3 (C)	K2 (1)		W4
70612-20019	K4 (C)	K3 (1)		W5
70612-20020	K4 (2)		2	W6
70612-20022	K5 (1)		6	W7
70612-20023	K1 (1)		3	W8
70612-20024	K1 (2)		4	W9
70612-20029	ATT 'A' LONG (1)		A (FRONT)	W10
70612-20032	K1 (C)	K3 (2)		W11
70612-20036	ATT 'A' LONG (2)	K2 (C)		W12
HP 70613A/C Option 004				
70612-20011	ATT 'A' LONG (1)	K1 (C)		W1
70612-20012	K5 (2)		5	W2
70612-20014	K4 (1)		1	W3
70612-20015	K3 (2)		3	W4
70612-20016	K5 (1)		4	W5
70612-20017	K1 (1)		B (FRONT)	W6
70612-20018	K1 (2)		A (FRONT)	W7
70612-20019	K4 (C)	K3 (1)		W8
70612-20019	K3 (C)	K2 (1)		W9
70612-20019	K2 (2)	K5 (C)		W10
70612-20036	ATT 'A' LONG (2)	K2 (C)		W11
HP 70612A/C Option 005				
70612-20012	K5 (2)		5	W1
70612-20014	K4 (1)		1	W2
70612-20019	K4 (C)	K3 (1)		W3
70612-20019	K3 (C)	K2 (1)		W4
70612-20019	K2 (2)	K5 (C)		W5
70612-20020	K4 (2)		2	W6
70612-20022	K5 (1)		6	W7
70612-20023	K1 (1)		3	W8
70612-20024	K1 (2)		4	W9
70612-20032	K1 (C)	K3 (2)		W10
70612-20035	K2 (C)		A REAR (J11)	W11

Table 7-6.
HP 70612A/C and 70613A/C Attenuator/Switch Semi-Rigid Cable Chart (continued)

Cable Part Number	FROM Component	TO Component	TO Port	Cable I.D.
HP 70613A/C Option 005				
70612-20012	K5 (2)		5	W1
70612-20014	K4 (1)		1	W2
70612-20015	K3 (2)		3	W3
70612-20016	K5 (1)		4	W4
70612-20019	K4 (C)	K3 (1)		W5
70612-20019	K3 (C)	K2 (1)		W6
70612-20019	K2 (2)	K5 (C)		W7
70612-20020	K4 (2)		2	W8
70612-20033	K1 (2)		A REAR (J11)	W9
70612-20034	K1 (1)		B REAR (J12)	W10
HP 70612A Option 007				
70612-20012	K5 (2)		5	W1
70612-20014	K4 (1)		1	W2
70612-20019	K4 (C)	K3 (1)		W3
70612-20019	K3 (C)	K2 (1)		W4
70612-20019	K2 (2)	K5 (C)		W5
70612-20020	K4 (2)		2	W6
70612-20022	K5 (1)		6	W7
70612-20023	K1 (1)		3	W8
70612-20024	K1 (2)		4	W9
70612-20025	ATT 'A' LONG (2)	ATT 'B' LONG (1)		W10
70612-20029	ATT 'A' LONG (1)		A (FRONT)	W11
70612-20032	K1 (C)	K3 (2)		W12
70612-20040	ATT 'B' LONG (2)	K2 (C)		W13
HP 70612C Option 007				
70612-20012	K5 (2)		5	W1
70612-20013	ATT 'B' SHORT (2)	K2 (C)		W2
70612-20014	K4 (1)		1	W3
70612-20019	K4 (C)	K3 (1)		W4
70612-20019	K3 (C)	K2 (1)		W5
70612-20019	K2 (2)	K5 (C)		W6
70612-20020	K4 (2)		2	W7
70612-20021	ATTN 'A' LONG (2)	ATT 'B' SHORT (1)		W8
70612-20022	K5 (1)		6	W9
70612-20023	K1 (1)		3	W10
70612-20024	K1 (2)		4	W11
70612-20029	ATT 'A' LONG (1)		A (FRONT)	W12
70612-20032	K1 (C)	K3 (2)		W13

Table 7-6.
HP 70612A/C and 70613A/C Attenuator/Switch Semi-Rigid Cable Chart (continued)

Cable Part Number	FROM Component	TO		Cable I.D.
		Component	Port	
HP 70613A Option 007				
70612-20011	K1 (C)	ATT 'A' LONG (1)		W1
70612-20012	K5 (2)		5	W2
70612-20014	K4 (1)		1	W3
70612-20015	K3 (2)		3	W4
70612-20016	K5 (1)		4	W5
70612-20017	K1 (1)		B (FRONT)	W6
70612-20018	K1 (2)		A (FRONT)	W7
70612-20019	K4 (C)	K3 (1)		W8
70612-20019	K3 (C)	K2 (1)		W9
70612-20019	K2 (2)	K5 (C)		W10
70612-20020	K4 (2)		2	W11
70612-20025	ATT 'A' LONG (2)	ATT 'B' LONG (1)		W12
70612-20040	ATT 'B' LONG (2)	K2 (C)		W13
HP 70613C Option 007				
70612-20011	K1 (C)	ATT 'A' LONG (1)		W1
70612-20012	K5 (2)		5	W2
70612-20013	ATT 'B' SHORT (2)	K2 (C)		W3
70612-20014	K4 (1)		1	W4
70612-20015	K3 (2)		3	W5
70612-20016	K5 (1)		4	W6
70612-20017	K1 (1)		B (FRONT)	W7
70612-20018	K1 (2)		A (FRONT)	W8
70612-20020	K4 (2)		2	W9
70612-20021	ATTN 'A' LONG (2)	ATT 'B' SHORT (1)		W10

8

Troubleshooting

Introduction

The procedures in this chapter are intended to identify problems and allow troubleshooting to the subassembly level. Chapter 7, "Replaceable Parts", lists the replaceable assemblies.

Note If the troubleshooting tests are to be considered valid, the following conditions must be met:

- The HP 70611A, 70612A,C or 70613A,C must have one-half hour warm-up.
- The module must be a component in an MMS mainframe.
- The ambient temperature must be 0° to 55° C.
- The HP 70611A, 70612A,C or 70613A,C must pass all self tests.

Troubleshooting

To isolate the possible failure the following tests may be performed.

Fuse Test	Verifies condition of internal fuse.
EEROM Test	Indicates a possible user EEROM programming error.
LED Test	Indicates LED failure.
Channel Test	Indicates possible switch failure.
Continuity Test	Indicates possible microwave path failure.
Pulse Parameter Test	Indicates CPU failure or possible driver failure.
Reflection Test	Isolates frequency related problems in the microwave performance of the switches.
Insertion Loss Test	Isolates frequency related problems in the microwave performance of the switches.
Isolation Test	Used to isolate faulty switches.

Repair Strategy

If the switch driver or interface module does not meet the parameters of the following tests, we strongly recommended that you send the entire unit back to Hewlett-Packard for repair.

CAUTION Opening the switch driver may void the warranty.

Note The information in this note is intended as useful information and is *not* the recommended repair procedure. The illustrations in chapter 7, "Replaceable Parts" show how to dissassemble and reassemble the switch driver.

Test Procedures

It is assumed that the person performing the following tests understands how to operate the specified test equipment. Equipment settings, other than those for the HP 70611A, 70612A,C or 70613A,C are stated in general terms. It is also assumed the technician will select the proper cables, adapters, and probes required for the test setups illustrated in this section.

Equipment Required

The equipment and accessories required for the performance tests are listed below in Tables 8-1 and 8-2. Other equipment may be substituted if it meets or exceeds the critical specifications listed.

Table 8-1. Recommended Test Equipment for HP 70611A

Instrument	Critical Specifications	Recommended Model	Use[1]
External Driver HP 70611A Standard	No substitute.	HP 84940A	O,P,T
Modular Measurement System	No substitute.	HP 70000 (with display)	O,P,T
Oscilloscope	Bandwidth: dc – 100 MHz Vertical Sensitivity: 4 V/div Vertical Input: 50Ω impedance, dc coupled Timebase: 5 ms/div	HP 54100A,D or HP 54110D or HP 54111A,D	P,T
Multimeter	dc resistance: 0.1 ohms resolution	HP E2373A	T
Test Accessory	No substitute. Made specifically for HP MMS switch drivers.	HP 70611-60014	P,T
Cable	No substitute. Made specifically for HP MMS switch drivers.	HP 70611-60010	P,T

[1]P = Performance Tests, T = Troubleshooting, O = Operator's Checks

Table 8-2.
Recommended Test Equipment for HP 70612A,C and HP 70613A,C

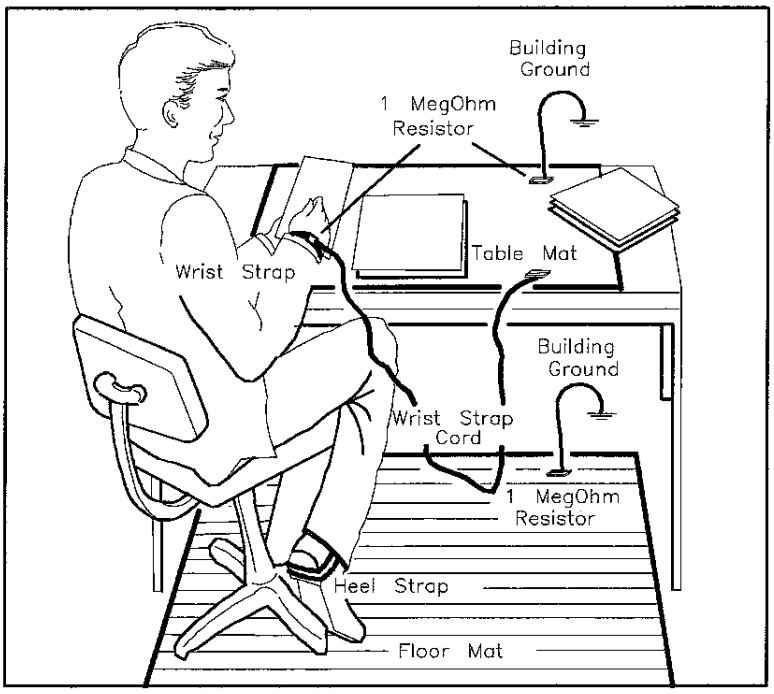
Instrument	Critical Specifications	Recommended Model	Use[1]
External Driver HP 70612A,C and HP 70613A,C Except Options 006 and 011	No substitute	HP 84940A	O,P,T
External CPU HP 70612A,C and HP 70613A,C Option 006 and 011 only	No substitute	HP 70611A, 70612A,C, or 70613A,C	O,P,T
Oscilloscope	Bandwidth: dc - 100 MHz Vertical Sensitivity: 4 V/div Vertical Input: 50Ω impedance, dc coupled Timebase: 5 ms/div	HP 54100A,D or HP 54110D or HP 54111A,D	P,T
Multimeter	dc resistance: 0.1 ohms resolution	HP E2373A	T
Test Accessory	No substitute. Made specifically for HP MMS switch drivers.	HP 70611-60014	P,T
Cable	No substitute. Made specifically for HP MMS switch drivers.	HP 70611-60010	P,T
Network Analyzer HP 70612A, 70613A HP 70612C, 70613C	 DC - 6.5 GHz DC - 26.5 GHz	 HP 8510B HP 8510B	 O,P,T O,P,T
Synthesized Sweeper	DC - 26.5 GHz	HP 83651A	O,P,T
Spectrum Analyzer HP 70612A, 70613A HP 70612C, 70613C	 DC - 6.5 GHz DC - 26.5 GHz	 HP 71209A HP 71209A	 O,P,T O,P,T
[1]P = Performance Tests, T = Troubleshooting, O = Operator's Checks			

Preparing a Static-Safe Work Station

Electrostatic discharge (ESD) can damage or destroy electronic components. Therefore, all work performed on assemblies consisting of electronic components should be done at a static-safe work station.

Figure 8-1 shows an example of a static-safe work station. Two types of ESD protection are shown:

- a conductive table mat and wrist strap combination
- a conductive floor mat and heel strap combination



ESDPARTS

Figure 8-1. Static-Safe Work Station

These two types of ESD protection must be used together. Refer to Table 8-3 for a list of static-safe accessories and their HP part numbers.

CAUTION

- Do not touch the edge-connector contacts or trace surfaces with bare hands. Always handle board assemblies by the edges.
- Do not use erasers to clean the edge-connector contacts. Erasers generate static electricity and degrade the electrical quality of the contacts by removing the thin gold plating.
- Do not use paper of any kind to clean the edge-connector contacts. Paper or lint particles left on the contact surface can cause intermittent electrical connections.

Reducing ESD Damage

To help reduce the amount of ESD damage that occurs during testing and servicing use the following guidelines:

- Be sure that all instruments are properly earth-grounded to prevent buildup of static charge.
- Personnel should be grounded with a resistor-isolated wrist strap before touching the center pin of any connector and before removing any assembly from a piece of equipment.

  Use a resistor-isolated wrist strap that is connected to the HP 70000 Series modular spectrum analyzer system mainframe's chassis. If you do not have a resistor-isolated wrist strap, touch the chassis frequently to equalize any static charge.
- Before connecting any coaxial cable to an instrument connector for the first time each day, *momentarily* short the center and outer conductors of the cable together.
- Handle all PC board assemblies and electronic components only at static-safe work stations.
- Store or transport PC board assemblies and electronic components in static-shielding containers.
- PC board assembly edge-connector contacts may be cleaned by using a lintfree cloth with a solution of 80% electronics-grade isopropyl alcohol and 20% deionized water. This procedure should be performed at a static-safe work station.

Static-Safe ESD Accessories

Table 8-3. Static-Safe ESD Accessories

HP Part Number	Description
9300-0797	Set includes: 3M static control mat 0.6 m × 1.2 m (2 ft × 4 ft) and 4.6 m (15 ft) ground wire. (The wrist-strap and wrist-strap cord are not included. They must be ordered separately.)
9300-0865	Ground wire, 4.6 m (15 ft)
9300-0980	Wrist-strap cord 1.5 m (5 ft)
9300-1383	Wrist-strap, color black, stainless steel, without cord, has four adjustable links and a 7 mm post-type connection.
9300-1169	ESD heel-strap (reusable 6 to 12 months).
Order the following by calling HP DIRECT at (800) 538-8787 or through any Hewlett-Packard Sales and Service Office.	

To Install the Module

1. Set the Modular Measurement System's LINE switch to OFF.
2. Ensure that the switch driver's HP-MSIB switch is set to 9.

Note Each module in the Modular Measurement System mainframe has a unique HP-MSIB address.

3. Open the Modular Measurement System's door and slide the HP 70611A, 70612A,C or 70613A,C into any available slot.
4. Using a hex-ball driver, tighten the hex-ball nut at the bottom of the HP 70611A, 70612A,C or 70613A,C until it is firmly seated in the Modular Measurement System.
5. Close the Modular Measurement System's door.
6. Set the Modular Measurement System's LINE switch to ON.

To Display Readings

1. Press the (DISPLAY) key on the graphics display.
2. Press the SELECT INSTR or NEXT INSTR key.
3. Press (▲) or (▼) until the following message appears at the bottom of the display: `Row 0 Column 9: 70611A, Sw Driver` (Or 70612A,C or 70613A,C as appropriate.)
4. Press the (MENU) key on the graphics display to display the module's menu.

Fuse Test

The fuse test determines if the fuse is good.

Indications

If the module's front panel indicators do not light, and the MMS mainframe does not accept commands, the fuse may be bad.

Procedure

1. Remove the module from the MMS mainframe.
2. Set the multimeter to resistance.
3. Measure the resistance between pins 1 and 40 on the rear panel MSIB connector.

Note On the HP 70611A, the MSIB connector is centered on the bottom of the rear panel. On the HP 70612A,C and HP 70613A,C it is on the lower left of the rear panel. When viewed from the rear, pin 1 is on the upper right corner of the connector and pin 40 is on the lower right corner of the connector.

4. A reading of 1.0 ohm or less indicates the fuse is good. An open circuit indicates the fuse is bad and must be replaced.

Fuse Replacement

CAUTION Fuse replacement must be performed at a static-safe work station.

1. Use a #10 Torx screwdriver to remove the ten screws securing the cover to the frame. Remove the cover (see Figure 7-1). Make sure the RFI gasket remains in the groove in the bottom of the frame.

Note If the unit is a standard HP 70611A, the controller board is the only board installed in the instrument. If the unit is an HP 70611A option 001, 70612A,C or 70613A,C there will be two or more boards installed. The controller board, HP part number 70611-60001, is located on the right side when facing the front panel.

2. If the unit is a standard HP 70611A proceed to step 4. All other models continue with step 3.
3. Remove the three screws securing the board spacers to the top of the controller board. Remove the two screws securing the controller board to the frame. Carefully lift the board up so the notch in the board clears the guide. Fold the board out to expose the component side of the board.
4. The fuse is located on the lower left of the component side of the controller board. Replace the fuse with a 1.5 A, 250 V, fast-blow type, HP part number 2110-0043.
5. After the fuse is replaced the board(s) should be secured by reversing the above steps. The switch driver may be tested in the MMS mainframe before replacing the cover.
6. After verifying the unit is working properly replace the top cover.

Note Make sure the RFI gasket is properly installed in the bottom of the frame, in the channel securing the bottom edge of the cover.

EEROM Test

The EEROM test indicates a possible user EEROM programming error.

If you want to save switch paths and groups through a power cycle, you *must* save (or write) them to EEROM.

Procedure

1. Set your MMS mainframe system's LINE switch to ON.
2. Select the switch driver module.
3. Press `Group`. Examine the information displayed on the screen. If the displayed information is correct go to the next step. If the information is incorrect reprogram the EEROM. See chapter 5, Saving to EEROM, for information on the correct procedure.
4. Press `Path`. Examine the information displayed on the screen. If the information is incorrect reprogram the EEROM. See chapter 5, Saving to EEROM, for information on the correct procedure.

LED Test

The LED test will isolate a nonfunctioning LED.

Procedure

1. Set your MMS mainframe system's LINE switch to ON. Select the switch driver module.
2. Place the highlighted box on the desired channel.
3. Press TOGGLE. The LED for the selected port will light.
4. Continue repeating steps 2 and 3 until all of the LED's have been lit.

The following table lists the ports and the channel numbers to which they are connected.

LED	Channel Number
Port 1	25
Port 2	26
Port 3	27
Port 4	20
Port 5	21
Port 6	22
Input A	29
Input B	24

Channel Test

The channel test can find a faulty or improperly configured switch.

Note An improperly configured switch could be one that has 0.000 s pulse width or 0.000 s sense delay. Extreme configuration settings could cause an error condition when the switch itself is not at fault.

1. Set your MMS mainframe system's LINE switch to ON. Select the switch driver module.
2. Press `Config`.
3. Press `VERIFY`.
4. Select the desired channel. Press `ADD/REMOVE`.
5. Press `Channel`. Place the highlighted box on the desired channel.
6. Press `TOGGLE`. If the switch fails to switch three things may happen:
   a. An E appears in the upper left box.
   b. The channel box blinks, telling you the address of the problem switch.
   c. ERR is lit on the switch driver module front panel.
7. Press `DISPLAY`, `REPORT ERRORS`.

   This will clear the error register by giving a code which can be looked up. See also ":ERRor?" in section 6, "Remote Operation".
8. Press `MENU` to get back to the Channel display.
9. Remove the failed channel from the verify menu.
10. Press `TOGGLE` to clear the blinking channel.

Continuity Test

The Continuity test will detect a possible problem in the microwave path.

Program the desired path to close. Use an ohmeter to check the continuity of the center conductor of the desired path. Care should be taken not to damage the female contacts of the center conductor of the input and output connectors.

The information in the tables and the schematics make it possible to logically isolate a possible problem area in the microwave path. Perform a continuity test between Input A and Port 1. If an open is detected, check the other output ports. If continuity to Port 2 is detected the potential problem area is switch 103. If continuity to Port 3 is detected the problem area is switch 102. If continuity to Port 4 is detected the problem area is switch 101. It may be necessary to perform continuity checks on additional paths in order to eliminate ambiguity. See Tables 8-3, 8-4 and Figure 8-1.

Table 8-4. HP 70612A,C Continuity Troubleshooting Chart

Input	Programmed Output Port	Measured Output Port	Problem Channel
A	1 (2)	—	
		2 (1)	103
		3	102
		4	102
		5 or 6	101
A	3 (4)	1	102
		2	102
		—	
		4 (3)	100
		5 or 6	101
A	5 (6)	1, 2, 3, 4	101
		6 (5)	104

Note If option 003, 004, or 007 is included, the switch driver's attenuator(s) should be set to 0 dB for the continuity tests.

Table 8-5. HP 70613A,C Continuity Troubleshooting Chart

Input	Programmed Output Port	Measured Output Port	Problem Area
A	1 (2)	—	
		2 (1)	103
		3	102
		4	101
		5	101
A	3	1	102
		2	102
		—	
		4	101
		4 or 5	101
A	4	1	101
		2	101
		3	101
		—	
		5	104
A	5	1, 2, 3	101
		4	104
A	1,2,3,4,5	—	100
B	1 (2)	—	
	2 (1)	103	
		3	102
		4	101
		5	101
B	3	1	102
		2	102
		—	
		4	101
		4 or 5	101
B	4	1	101
		2	101
		3	101
		—	
		5	104
B	5	1, 2, 3 then:	101
		4	104
B	1,2,3,4,5	—	100

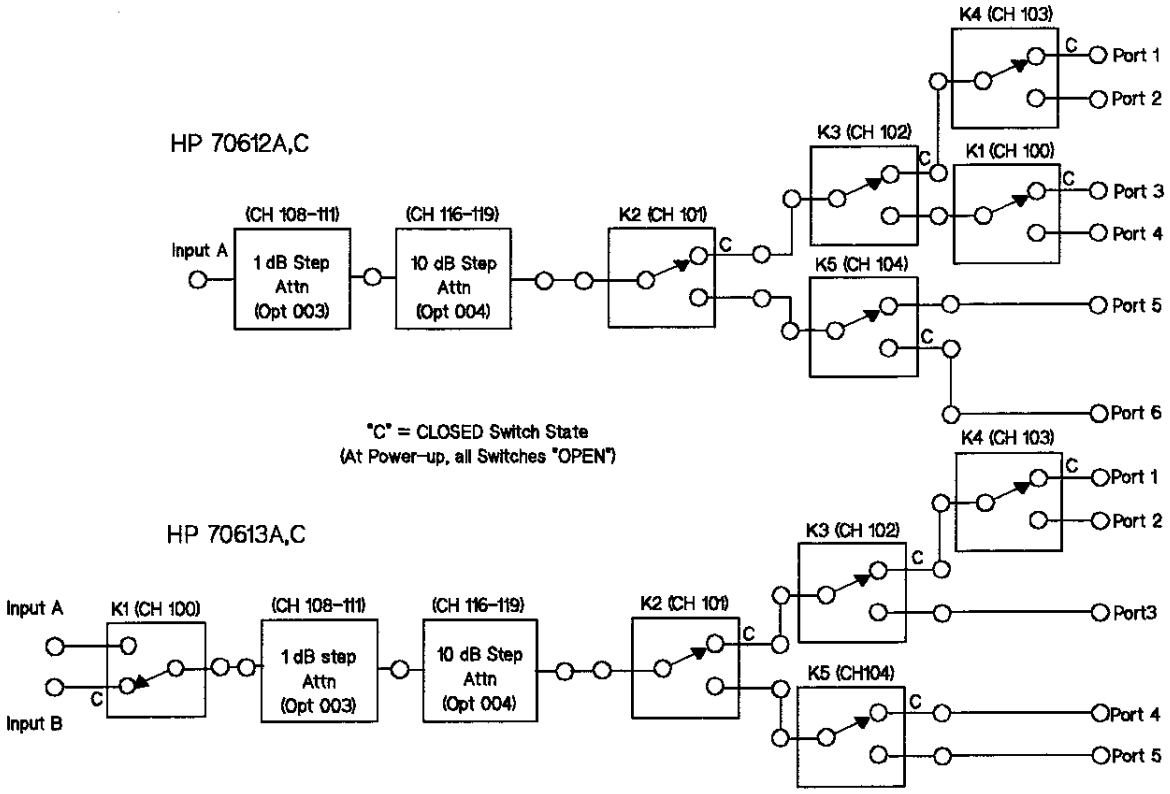


Figure 8-2. HP 70612A,C and HP 70613A,C Schematic Diagrams

Pulse Parameters Test

Specification

Electrical Characteristics	Performance Limits	Conditions
Switching Speed:	0.050 ±0.005 s	(User set). Pulse width + delay.
Pulse width:		
Maximum:	1.275 ±0.005 s	
Minimum:	0.005 ±0.005 s	
Default:	0.030 ±0.005 s	
Sensing Delay:		
Maximum:	1.275 ±0.005 s	
Minimum:	0.005 ±0.005 s	
Default:	0.020 ±0.005 s	
Power:		
Voltage	+24±3.0 Vdc	
Current	800 mA maximum	200 mA per relay

Description

Sensing Disabled

The HP 70611A, 70612A,C or 70613A,C is designed to drive electro-mechanical switches (see Table 1-1 and 1-2). Each switch coil is internally connected between the +24 V bias supply and a power transistor. The transistor provides the ground return. A DC switch for the controller assembly provides the base current to actuate the transistor. This control current is nominally set to provide a pulse width of 20 ms. At the default setting, the switch driver provides a 30 ms pulse for actuating the electro-mechanical switch.

Sensing Enabled

The switch should be driven an additional 20 ms after the initial 30 ms closure pulse to allow sense lines to settle. At this time an error and a programmed position check are performed. The combined time for the switch driver to close a switch and verify its position is 50 ms.

Hardware Limits

The +24 volt supply in the switch driver can supply sufficient current to drive up to four HP 33311/8762 Series relays at one time.

Each open collector driver IC can drive only one channel (a maximum of four switches) at a time to avoid exceeding package dissipation limits.

Performance Test

The following procedure verifies the drive pulse parameters as delivered to the switches from the rear panel (as is the case with the HP 70611A Opt 001) and from an external HP 84940A (as is the case with the HP 70611A, 70612A,C and 70613A,C).

One channel (capable of driving four switches) is tested for switching speed at 30 ms (sensing disabled) and 50 ms (sensing enabled), voltage at +24 Vdc, and current at 200 mA for each switch (800 mA for all four switches).

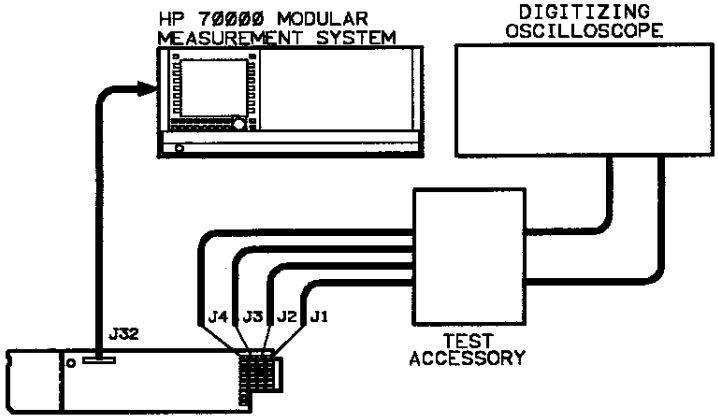


Figure 8-3. Pulse Parameters Test Setup

Equipment

Modular Measurement System	HP 70000 Series
Oscilloscope	HP 54100A,D
Load	70611-60014
Driver Board (HP 70611A, 70612A,C and 70613A,C)	HP 84940A
Cable (HP 70611A, Opt 001)	70611-60004

Procedure

In this example the HP-MSIB address is set to 9.

1. Set your MMS mainframe system's LINE switch to OFF.

CAUTION Do not connect or disconnect relays while the MMS mainframe LINE switch is ON, or an unintentional short to +24 V could occur. This will cause a catastrophic driver board failure.

---

2. Connect the equipment as shown in Figure 8-3. Connect to J1, J2, J3, J4 if using an external driver card. Connect to cable (HP part number 70611-60004) if using an HP 70611A, Option 001, 70612A,C or 70613A,C.
3. Set the oscilloscope as follows:

Volts/Div	5 V
Pulse Width	10 ms per division
Trigger	INTERNAL

4. Set the System's LINE switch to ON.
5. If necessary, bring the interface module's display onto the screen.

6. Toggle channels 100, 101, 102, and 103 by pressing (Channel) and (TOGGLE).

or

If you are using an HP Series 200/300 controller, use the following program:

```
10 OUTPUT 709:"*RST"
20 OUTPUT 709;"ROUT:DRIV:ON (@100:103);"
30 OUTPUT 709;"ROUT:DRIV:OFF (@104:130);"
40 !
50 ! OUTPUT 709;"ROUT:VER:ON (@100:103);"
60 !
70 ! For the Sensing (:VERify) Disabled test, comment out line 50
80 ! and leave line 100 in the program, as shown here.
90 !
100 OUTPUT 709;"ROUT:VER:OFF (@100:103);"
110 !
120 ! For the Sensing (:VERify) Enabled test, comment out line 100 and
130 ! leave line 50 in the program.
140 !
150 OUTPUT 709;"ROUT:WIDT .03,(@100:103);"
160 !
170 ! This sets the pulse (:WIDTh) to the default 30 ms.
180 !
190 OUTPUT 709;"ROUT:DEL .02,(@100:103);"
200 !
210 ! This sets the sensing (:DELay) to the default 20 ms.
220 ! When sensing (:VERify) is OFF (line 100), (:DEL) does not apply.
230 ! Switching speed is then the 30 ms pulse (:WIDTh).
240 !
250 OUTPUT 709;"ROUT:CLOS (@100:103);"
260 PAUSE
270 OUTPUT 709;"ROUT:OPEN (@100:103);"
280 END
```

Voltage

1. Set the oscilloscope to: 5 V/div
2. Read the oscilloscope.
3. Record this reading:

+21 V< _____ <27 V

Current

1. Divide voltage by **120 Ω** to get the value of the current.

200 mA< _____

Switching Speed (sensing disabled)

1. Set the switch driver to: 30 ms Pulse Width
2. Set the oscilloscope to: 5 ms/div
3. Read the oscilloscope.
4. Record this reading:

25 ms< _____ <35 ms

Switching Speed (sensing enabled)

1. Set the switch driver to: 20 ms Delay
2. Set the oscilloscope to: 10 ms/div
3. Read the oscilloscope.
4. Record this reading:

45 ms< _____ <55 ms

HP 70611A, 70612A,C 70613A,C Range	Min	Actual Results	Max
Voltage	21 Vdc	_____	27 Vdc
Current	175 mA	_____	225 mA
Switching Speed:			
Sensing Disabled	25 ms	_____	35 ms
Sensing Enabled	45 ms	_____	55 ms

Microwave Troubleshooting Tests — HP 70612A,C and HP 70613A,C Only

Reflection and Insertion Loss Test

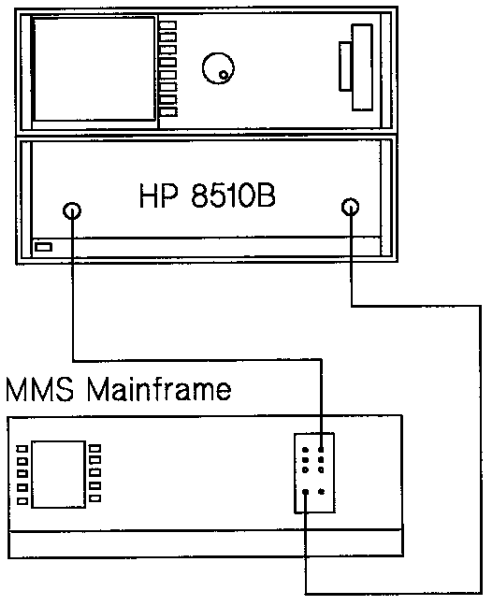


Figure 8-4. Reflection and Insertion Loss Test Setup

Equipment

Modular Measurement System Display/Mainframe ..... HP 70004
Network Analyzer ..... HP 8510B,C
Synthesized Sweeper ..... HP 83651A
S Parameter Test Set ..... HP 8517A
3.5 mm Calibration Kit ..... HP 85052B

Procedure

To Measure Reflection

1. Connect the equipment as shown in Figure 8-4.
2. Set the system's LINE switch to ON.
3. Press (INST PRESET) on the network analyzer.
4. Calibrate the HP 8510B,C using the 3.5 mm (male - male) calibration procedure.
5. Press (S_{11}) on the network analyzer.
6. Set the network analyzer as follows:

Reflection ..... 50 milliunits per division,
Reference ..... 0 milliunits
Reference position 0

a. Press (Local).
b. Press (Cal).
c. Press (Load Cal) 3.5 mm (male - male).
d. Press Full 2 Port.
e. Connect a THRU device (f - f).
f. Press FWD Trans Thru, FWD Match Thru.
g. Press REV Trans Thru, REV Match Thru.
h. Press Trans Done.
i. Press Reflection.

7. Connect a short to Port 1 of the switch driver. Press S11 SHORT.
8. Remove the short and connect an open to Port 1. Press S11 OPEN.
9. Remove the open and connect a lowband load to Port 1. Press S11 LOAD AND LOWBAND.
10. Remove the lowband load and connect a sliding load to Port 1. Press SLIDING LOAD.
11. Set the sliding load to the first mark. Press SLIDING LOAD SET.
12. Repeat the above step for all sliding load marks.
13. Press SLIDING LOAD DONE.
14. Press LOADS DONE.
15. Press S22 SHORT.
16. Repeat steps 7 through 13 for Port 2 (S22).
17. When the calibration of Port 2 is complete press REFLECTION DONE.
18. Press ISOLATION.
19. Connect a broadband load to Port 1 and Port 2.

20. Press FWD ISOLATION.

21. Press REV ISOLATION.

22. Press ISOLATION DONE.

23. **IMPORTANT!** Be sure to save the calibration in an empty cal set on the network analyzer.

Measure the reflection for all desired paths. See chapters 5 or 6, Programming Internal Switches and Optional Step Attenuators for information on selecting paths or attenuators.

HP 70612A and 70613A	Reflection (SWR) _____	0.17 (<1.4:1)
HP 70612C and 70613C	Reflection (SWR) _____	0.26 (<1.7:1) 18 GHz
	Reflection (SWR) _____	*0.46 (<2.7:1) 18–26.5 GHz*

To Measure Insertion Loss

1. Press [S21] on the network analyzer.
2. Set the network analyzer as follows:

Insertion loss ..... 1 dB per division
Reference level ..... 0 dBm
Reference position 10

Measure the insertion loss for all desired paths. See chapters 5 or 6, Programming Internal Switches and Optional Step Attenuators for information on selecting paths or attenuators.

	f = Frequency in GHz	
HP 70612A and 70613A	Insertion Loss _____	<0.8 + 0.2f dB
Option 003, 004	Insertion Loss _____	<1.0 + 0.25f dB
Option 005, 006	Insertion Loss _____	<1.0 + 0.25f dB
Option 007	Insertion Loss _____	<1.0 + 0.4f dB
HP 70612C and 70613C	Insertion Loss _____	<1.5 + 0.22f dB (18 GHz)
	Insertion Loss _____	*<6.5 dB (18–26.5 GHz)*
Option 003, 004	Insertion Loss _____	<1.5 + 0.28f dB (18 GHz)
	Insertion Loss _____	*<8.0 dB (18–26.5 GHz)*
Option 005, 006	Insertion Loss _____	<1.5 + 0.28f dB (18 GHz)
	Insertion Loss _____	*<8.0 dB (18–26.5 GHz)*
Option 007	Insertion Loss _____	<2.0 + 0.35f dB (18 GHz)
	Insertion Loss _____	*<10.0 dB (18–26.5 GHz)*

Note When measuring insertion loss >80 dB on the HP 70612C and HP 70613C options 003, 004 or 007, the Isolation test setup should be used. See Figure 8-5. Measure the desired path by connecting the HP 83651A synthesized sweeper to the input port and the HP 71209A signal analyzer front end to the desired output.

Note When measuring the attenuation levels for option 003, 004 or 007, the measurement should be made by cycling through each attenuation step and comparing the measured value to the insertion loss of the 0 dB position. The HP 70612A and 70613A option 004 will be measured to 110 dB. The HP 70612C and 70613C option 004 range is 0 to 90 dB. The HP 70612A,C and 70613A,C option 003 range is 0 to 11 dB. Option 007 combines options 003 and 004.

Each attenuator may be tested separately. It is not necessary to make the complete set of attenuation insertion loss measurements for every possible switch path.

Isolation Measurement

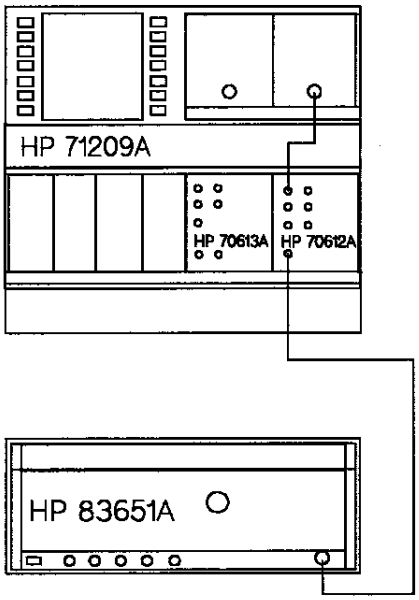


Figure 8-5. Isolation Test Setup

Equipment

Modular Measurement System display/mainframe ..... HP 70004A
Spectrum Analyzer ..... HP 71209A
Synthesized Sweeper ..... HP 83651A
50 Ohm Load, 3.5 mm (m) ..... HP 909D

Note The HP 70612A,C or 70613A,C may be plugged into the HP 71209A spectrum analyzer if space is available. This eliminates the need for the HP 70004A MMS mainframe.

Procedure

1. Connect the equipment as shown in Figure 8-5
2. Set the system's LINE switch to ON.
3. Set the sweeper as follows:

   HP 70612A and 70613A (50 MHz–6.5 GHz)
   HP 70612C and 70613C (50 MHz–26.5 GHz)

   Output level ..... 0 dBm
   Span ..... 50 Hz
   Center frequency ..... 0 to 26.5 GHz in 1 GHz steps
   Power level ..... 10 dBm (0.5–18 GHz)
   ..... 1 dBm (18–26.5 GHz)

4. Set the spectrum analyzer as follows:

   HP 70612A and 70613A (50 MHz–6.5 GHz)
   HP 70612C and 70613C (50 MHz–26.5 GHz)

Frequency span ..... 50 Hz
Resolution bandwidth ..... 10 Hz
Center frequency ..... 0 to 26.5 GHz in 1 GHz steps
Input attenuator ..... 0 dB
Reference level ..... −60 dBm
Sweep ..... Continuous
Sweep time ..... Auto
Trace data format ..... Binary

Note If option 003, 004 or 007 is included, the switch driver's attenuator(s) should be set to 0 dB for the isolation tests.

5. Measure any HP 70612 or 70613 thru path by connecting the sweeper to the input and the spectrum analyzer to the output.

   The measured value may be stored in memory. It will the reference level to which all subsequent isolation measurements are compared.

6. Connect the 50 ohm load to the thru path.
7. Connect the sweeper to the input and the spectrum analyzer to the output of the desired path.
8. Measure isolation for all desired paths. The high dynamic range needed by the isolation test requires a narrow resolution bandwidth setting on the signal analyzer. This makes it practical to step through the 0 to 26.5 GHz bandwidth in 1 GHz steps (more steps may be measured if desired).

   Isolation is calculated as:

   Isolation (in dB) = (Source power − Thru loss) − Measured power

	f = Frequency in GHz
HP 70612A and 70613A	Isolation _____ <120 − 4.2f dB
Option 002	Isolation _____ <100 dB
HP 70612C and 70613C	Isolation _____ <110 − 2.8f dB
Option 002	Isolation _____ <60 dB

Index