Agilent Technologies

Agilent Technologies
70611A Attenuator/Switch Driver
70612A,C and 70613A,C Interface Modules

Operating and Service Manual

Notice

This documentation supports a product that previously shipped under the Hewlett-Packard company brand name. The brand name has now been changed to Agilent Technologies. The two products are functionally identical; only our name has changed. The document still includes references to Hewlett-Packard products, some of which have been transitioned to Agilent Technologies.

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Agilent Technologies, Inc.
1400 Fountaingrove Parkway
Santa Rosa, CA 95403-1799, U.S.A.

NOTE

A serial number label is attached to the rear panel of each instrument. The first six entries are the same for all identical modules; they only change when a change in the electrical or physical functionality is made. The remaining digits are assigned sequentially and are different for each instrument.

This manual applies directly to instruments with the following prefix and above:

US4014

Warranty

Certification

Agilent Technologies, Inc., certifies that this product met its published specifications at the time of shipment from the factory. Agilent Technologies further certifies that its calibration measurements are traceable to the United States National Institute of Standards and Technology (NIST, formerly NBS), to the extent allowed by the Institute's calibration facility, and to the calibration facilities of other International Standards Organization members.

Warranty

This Agilent Technologies system product is warranted against defects in materials and workmanship for a period corresponding to the individual warranty periods of its component products. Instruments are warranted for a period of one year. During the warranty period, Agilent Technologies will, at its option, either repair or replace products that prove to be defective.

Warranty service for products installed by Agilent Technologies and certain other products designated by Agilent Technologies will be performed at Buyer's facility at no charge within Agilent Technologies service travel areas. Outside Agilent Technologies service travel areas, warranty service will be performed at Buyer's facility only upon Agilent Technologies' prior agreement and Buyer shall pay Agilent Technologies' round trip travel expenses. In all other areas, products must be returned to a service facility designated by Agilent Technologies.

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

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

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Assistance

Product maintenance agreements and other customer assistance agreements are available for Agilent Technologies products.

For assistance, call your local Agilent Technologies Sales and Service Office (refer to "Service and Support" on page v).

Service and Support

Any adjustment, maintenance, or repair of this product must be performed by qualified personnel. Contact your customer engineer through your local Agilent Technologies Service Center. You can find a list of local service representatives on the Web at:
`http://www.agilent.com/services/English/index.html`

If you do not have access to the Internet, one of these centers can direct you to your nearest representative:

United States:	Test and Measurement Call Center (800) 452 4844 (toll-free in US)
Canada:	(905) 206 4725
Europe:	(31 20) 547 9900
Japan:	Measurement Assistance Center (81) 426 56 7832 (81) 426 56 7840 (FAX)
Latin America:	(305) 267 4245, (305) 267-4220 (305) 267 4288 (FAX)
Australia/New Zealand:	1 800 629 485 (Australia) 0800 738 378 (New Zealand) (61 3) 9210 5489 (FAX)
Asia-Pacific:	(852) 2599 7777 (852) 2506 9285 (FAX)

Safety and Regulatory Information

Review this product and related documentation to familiarize yourself with safety markings and instructions before you operate the instrument. This product has been designed and tested in accordance with international standards.

WARNING

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

CAUTION

The **CAUTION** notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in damage to the product or loss of important data. Do not proceed beyond a **CAUTION** notice until the indicated conditions are fully understood and met.

Instrument Markings

	When you see this symbol on your instrument, you should refer to the instrument's instruction manual for important information.
	This symbol indicates hazardous voltages.
	The laser radiation symbol is marked on products that have a laser output.
	This symbol indicates that the instrument requires alternating current (ac) input.
	The CE mark is a registered trademark of the European Community. If it is accompanied by a year, it indicates the year the design was proven.
	The CSA mark is a registered trademark of the Canadian Standards Association.
	The C-tick mark is a registered trademark of the Spectrum Management Agency of Australia. This signifies compliance with the Australian EMC Framework regulations under the terms of the Radio communications Act of 1992.
1SM1-A	This text indicates that the instrument is an Industrial Scientific and Medical Group 1 Class A product (CISPER 11, Clause 4).

⏚ Safety Earth Ground

This is a Safety Class I product (provided with a protective earthing terminal). An uninterruptible safety earth ground must be provided from the main power source to the product input wiring terminals, power cord, or supplied power cord set. Whenever it is likely that the protection has been impaired, the product must be made inoperative and secured against any unintended operation.

Before Applying Power

Verify that the product is configured to match the available main power source as described in the input power configuration instructions in this manual. If this product is to be powered by autotransformer, make sure the common terminal is connected to the neutral (grounded) side of the ac power supply.

COMPLIANCE WITH GERMAN NOISE REQUIREMENTS

This is to declare that this instrument is in conformance with the German Regulation on Noise Declaration for Machines (Laermangabe nach der Maschinenlaermrerordnung-3.GSGV Deutschland).

Acoustic Noise Emmision/Geraeuschemission	
LpA <70 dB	LpA <70 dB
Operator position	am Arbeitsplatz
Normal position	normaler Betrieb
per ISO 7779	nach DIN 45635 t.19

General Safety Considerations

WARNING

- **This product has been designed and tested in accordance with IEC Publication 1010, Safety Requirements for Electronic Measuring Apparatus, and has been supplied in a safe condition. The instruction documentation contains information and warnings which must be followed by the user to ensure safe operation and to maintain the product in a safe condition.**
- **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 product is likely to make the product dangerous. Intentional interruption is prohibited.**
- **The ON/OFF switch or the detachable power cord is the instrument disconnecting device. It disconnects the mains circuits from the mains supply before other parts of the instrument. Alternately, an externally installed switch or circuit breaker, which is readily identifiable and is easily reached by the operator, may be used as a disconnecting device.**

WARNING

- **This product is designed for use in Installation Category and Pollution Degree 2 per IEC 1010 and 664 respectively.**
- **Install the instrument according to the enclosure protection provided. This instrument protects against finger access to hazardous parts within the enclosure. The instrument does not protect against the ingress of water.**
- **If this product is not used as specified, the protection provided by the equipment could be impaired. This product must be used in a normal condition (in which all means for protection are intact) only.**
- **When installing the product in a cabinet, the convection into and out of the product must not be restricted. The ambient temperature (outside the cabinet) must be less than the maximum operating temperature of the product by 4° C for every 100 watts dissipated in the cabinet. If the total power dissipated in the cabinet is greater than 800 watts forced convection must be used.**

Typeface Conventions

Italics

- Used to emphasize important information:
  Use this software *only* with the appropriate controller.
- Used for the title of a publication:
  Refer to the *Agilent 70611A, 70612A,C, 70613A,C Operating and Service Manual.*
- Used to indicate a variable:
  Type `LOAD BIN` *filename*.

`Instrument Display`

- Used to show on-screen prompts and messages that you will see on the display of an instrument:
  The system controller will display the message **`CAL1 SAVED`**.

[Keycap]

- Used for labeled keys on the front panel of an instrument or on a computer keyboard:
  Press **[Return]**.

{Softkey}

- Used for simulated keys that appear on an instrument display:
  Press ***{Prior Menu}***.

`User Entry`

- Used to indicate text that you will enter using the computer keyboard; text shown in this typeface must be typed *exactly* as printed:
  Type `LOAD PARMFILE`
- Used for examples of programming code:

```
#endif // ifndef NO_CLASS
```

`Path Name`

- Used for a subdirectory name or file path:
  Edit the file *`usr/local/bin/sample.txt`*

Computer Display

- Used to show messages, prompts, and window labels that appear on a computer monitor:
  The **Edit Parameters** window will appear on the screen.
- Used for menus, lists, dialog boxes, and button boxes on a computer monitor from which you make selections using the mouse or keyboard:
  Double-click **EXIT** to quit the program.

Contents

5. Local Operation

1 General Information

Overview

In this chapter you will find:

- Function, features, and capabilities of the 70611A attenuator/switch driver, and the 70612A,C and 70613A,C interface modules and options.
- How to unpack and check your instrument.
- How to set up a static-free workstation.
- How to contact Agilent Technologies for service.

NOTE

In some manuals, the term GPIB (General Purpose Interface Bus) may be used instead of HP-IB (Hewlett-Packard Interface Bus). The terms refer to the same protocol. In this manual, HP-IB is used to maintain consistency with the documentation for other modules in the HP/Agilent 70000 Modular Measurement system.

Module Descriptions

70611A

The 70611A attenuator/switch driver is an HP-IB/MSIB compatible device designed as a component to the HP/Agilent 70000 Modular Measurement System (MMS).

- The standard 70611A attenuator/switch driver, when externally connected to a maximum of eight 84940A driver boards, can control and sense switching states for up to 248 switches.
- An HP-HIL keyboard can be used to speed manual interface operations.

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

70612A,C and 70613A,C

The 70612A,C and 70613A,C are self-contained switching interfaces for the HP/Agilent 70000 Modular Measurement System.

The switches inside the 70612A,C and 70613A,C interface modules have preprogrammed switch path definitions and front panel light controls. Switch path definitions, names, and labels are stored inside the EEROM.

The modules can be controlled remotely through HP-IB or manually using any MMS display. Refer to "Programming Internal Switches and Optional Step Attenuators" in Chapter 5 or Chapter 6.

The standard units have a controller board, a switch driver board, and five built-in, SPDT, terminated switches.

- The 70612A,C are configured to provide a single input and six outputs.
- The 70613A,C provide routing for two inputs to five outputs.
- The controller board provides the MSIB link and protocol management. It also provides SCPI command translation, and storage for configuration information and translating and relaying "Query" results.
- The controller board communicates with the Agilent 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 require to drive the switches.
- The 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 (common+).

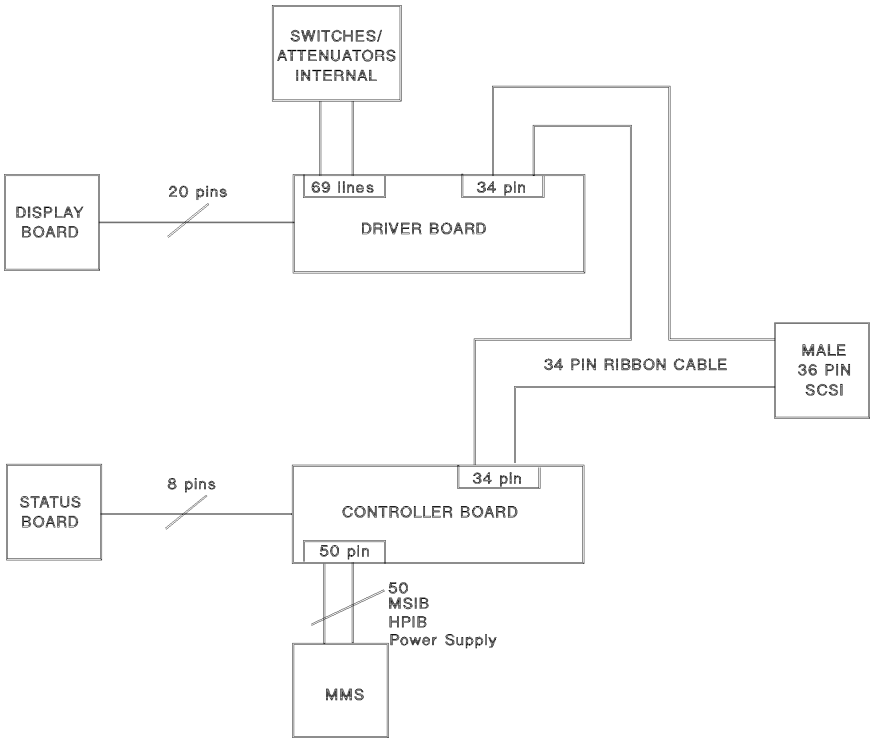


Figure 1-1 70612A,C and 70613A,C Block Diagram

Options

70612A,C and 70613A,C

Option 002 Replaces the terminated switches with unterminated switches.

Option 003 Adds an 11 dB step attenuator (1 dB/step).

Option 004 **70612A, 70613A -** Adds 110 dB step attenuator (10 dB/step).

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 70611A in the system).

Option 007 **70612A, 70613A** - Adds 11 dB and 110 dB step attenuators.

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 an 70611A in the system).

Drive Pulse and Sensing Delay

- The 84940A driver board can deliver up to 400 mA, 24 Vdc current pulses to 31 individual switch sections. These low impedance pulses can be adjusted for pulse width in order to optimize switching speed.
- The attenuator/switch driver and interface modules can verify switching operation when used with switches that can sense switch position (such as the 8762C 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 8762C 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 800 mA for switching operation at the same time. The 800 mA could switch four SPDT switches at 200 mA each or two 1x6 switches at 400 mA each. 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. Refer to the "Example Speed Calculation" on page 6-73.

Compatible Switches and Attenuators

The 70611A, 70612A,C, and 70613A,C were made to drive the Agilent switches and attenuators shown in the following tables.

NOTE

If you are using switches or attenuators made by another company, check their switching characteristic against those specified in Chapter 3, "Specifications."

All Agilent switches and attenuators have internal clamp diodes to limit reverse EMF energy from the switch solenoid. If other switches are used, this energy must be limited to less than 10 millijoules to prevent damage to the switch driver circuit.

Table 1-1 Compatible Agilent Switches

Model Number	Description	Model Number	Description
33311A,B,C,D	Terminated SPDT	8765A,B,C,F (Opt 024)	Unterminated SPDT*
33312A,B,C	Terminated transfer	8766K	SP3T
33313A,B,C	5 port switch	8767K	SP4T
33314A,B,C,D (Opt 024)	Unterminated SPDT*	8768K	SP5T
33363K	SP3T	8769K	SP6T
33364K	SP4T	87104A,B,C	SP4T*
33365K	SP5T	87106A,B,C	SP6T*
33366K	SP6T	87204A,B,C	SP4T
8762A,B,C,F	Terminated SPDT	87206A,B,C	SP6T
8763A,B,C,F	Terminated transfer	87222C,D,E	Transfer switch
8764A,B,C,F	5 port switch	87606B	Matrix switch

*No position verification

Table 1-2 Compatible Agilent Attenuators

Model Number	Description	Model Number	Description
33320G,H	11 dB, 1 dB steps	8494G,H	11 dB, 1 dB steps
33321G,H,K	70 dB, 10 dB steps	8495G,H,K	70 dB, 10 dB steps
33322G,H	110 dB, 10 dB steps	8496G,H	110 dB, 10 dB steps
33323K	90 dB, 10 dB steps	8497K	90 dB, 10 dB steps
33324K,L	11 dB, 1 dB steps	84904K,L	11 dB, 1 dB steps
33326K,L	90 dB, 10 dB steps	84906K,L	90 dB, 10 dB steps
33327K,L	70 dB, 10 dB steps	84907K,L	70 dB, 10 dB steps

Connecting Accessories

Included with each 70612A,C and 70613A,C module are seven (7) connector savers, part number 1250-2320. These connector savers are designed to be used where frequent connect/disconnects are made.

The connector savers are relatively inexpensive male to female adapters that are connected to the instrument's input and output connectors. It is more economical to sacrifice a low priced adapter than to have an expensive repair to replace the front or rear panel connectors on the interface module.

System connections are then made to the adapters, rather than to the front or rear panel connectors. The only drawback of the connector saver 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

Published specifications reflect the inclusion of connector savers in the measurement path.

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

Test Accessories

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

Front and Rear Panel Features

The front panel LEDs indicate the status of the 70611A attenuator/switch driver, 70612A,C, and 70613A,C interface modules. The front-panel LEDs should turn on and off while the attenuator/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 attenuator/switch driver ERR light indicates it is ready to report one or more error codes. The error codes may be viewed in either of two ways:

- Use the display interface keys. Press **[DISPLAY]** or **[DSP]** , and then press ***{REPORT ERRORS}.***
- Use the controller. Refer to the :ERRor? command in Chapter 6, “Remote Reference” for a description of the error codes.

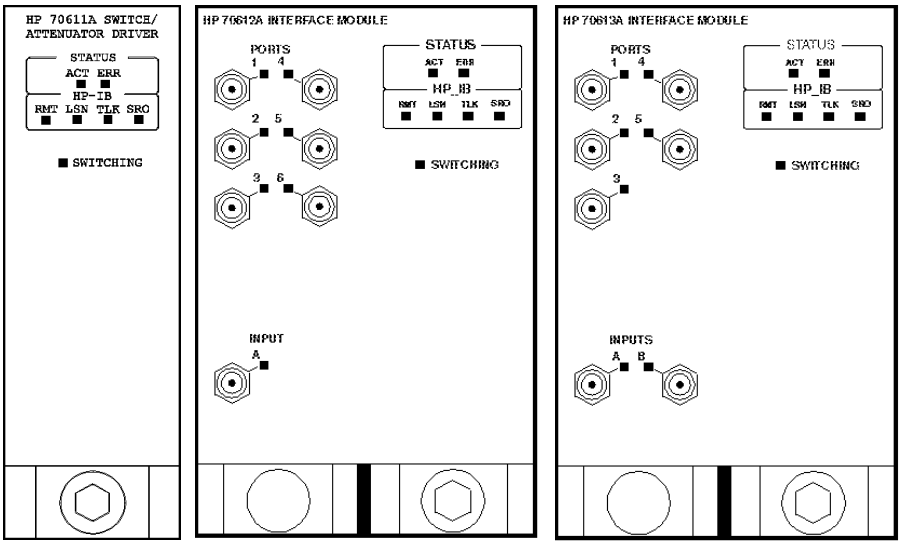


Figure 1-2 70611A, 70612A,C, and 70613A,C Front-Panel Features

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 attenuator/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/Agilent 70000 MMS mainframe. Chapter 2 contains attenuator/switch driver module installation and removal instructions.

70611A

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

70612A,C and 70613A,C

The 70612A,C and 70613A,C interface modules have high density, 36-pin (male) SCSI II type connectors, which can be connected to a maximum of seven 84940A external driver cards.

Unpacking Your Instrument

Initial Inspection

1. Inspect the shipping container for damage.

   If the shipping container or cushioning material is damaged, keep all shipping material until the contents have been checked for completeness and the instrument has been checked mechanically and electrically. Procedures for checking the electrical performance of the instrument are given in Chapter 4.

   The contents of the shipment should be as shown in Table 1-3.

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

Description	70611A	70612A,C or 70613A,C	Agilent Part Number
Attenuator/switch driver	1		70611A
Interface module		1	70612A,C or 70613A,C
Operating and Service Manual	1	1	70611-90015
Cable, 68/68 pin SCSI II (m to m) (Option 001 only)	1		70611-60004
Adapter, SMA (m) to SMA (f)		7	1250-2320
Cable, 36-pin to 36-pin SCSI II (f to f) (Options 006, 008 and 011 only)		1	70611-60010

2. If the contents are damaged or defective, Agilent will arrange for repair or replacement of the damaged or defective equipment. To contact your nearest Agilent Technologies Sales and Service Office, refer to "Service and Support" on page v. Keep the shipping materials for the carrier's inspection.

Storage and Shipment

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

Temperature	– 40 to +70 °C
Humidity	< 80% relative humidity at 40 °C, non-condensing
Altitude	< 46 000 meters (15,000 feet)

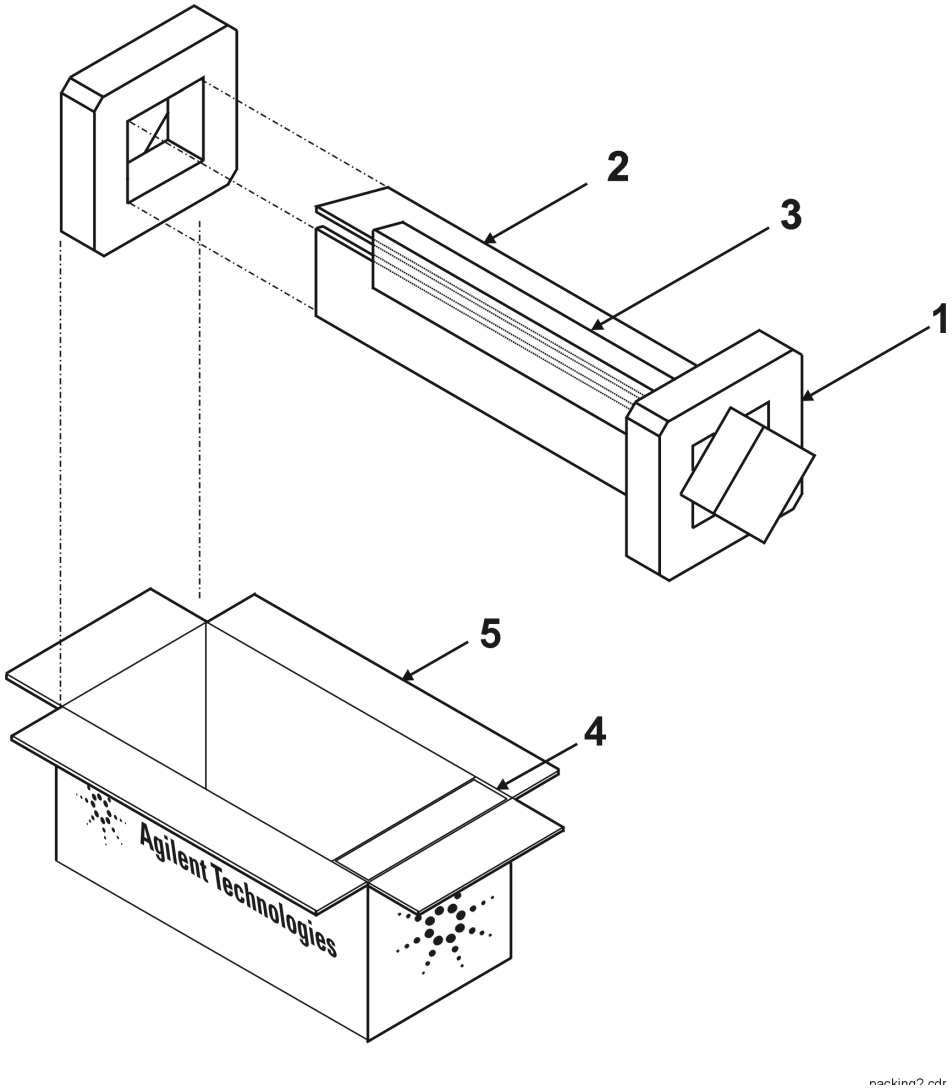


Figure 1-3 Packaging Materials for Modules (1/8 module shown)

Item	Quantity	Part Number	Description
1	1	5180-8469	Foam pad
2	1	5180-8479	Corrugated sleeve
3	A/R	4208-0493	Foam insert
4	1	9211-5130	Accessory box
5	1	9211-4781	Outer carton

Before Installing the 70611A, 70612A,C or 70613A,C

Electrostatic discharge (ESD) can damage or destroy electronic components. All work performed on assemblies consisting of electronic components should be done at a static-safe workstation.

An example of a static-safe work station is shown below using two types of ESD protection:

- conductive table mat and wrist strap combination, and
- conductive floor mat and heel strap combination

These methods may be used together or separately. A list of static-safe accessories and their part numbers is given on the following page.

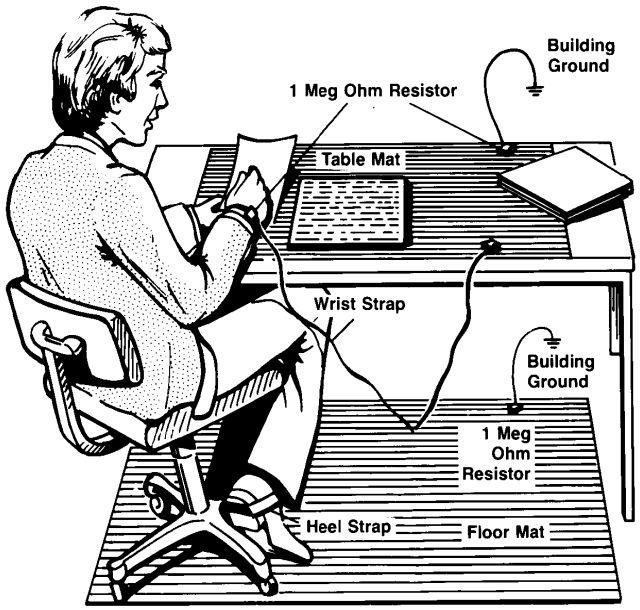


Figure 1-4 Static-Safe Work Station

Reducing ESD Damage

To help reduce the amount of ESD damage that occurs during installation, testing, or servicing instruments 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 the instrument.
- Before connecting any coaxial cable to an instrument connector for the first time each day, *momentarily* ground the center and outer conductors of the cable.
- 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.

Table 1-4 Static-Safe ESD Accessories

Part Number	Description
9300-0797	Set includes: 3M static control mat 0.6 m x 1.2 m (2 ft x 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)
9300-1367	Wrist-strap, color black, stainless steel, without cord, has four adjustable links and a 7 mm post-type connection.
9300-1308	ESD heel-strap (reusable 6 to 12 months)

Order the above by calling DIRECT at (800) 538-8787) or through any Agilent Sales and Service Office.

Returning Your Instrument for Service

If you are returning your instrument for service, repackaging the instrument requires original shipping containers and materials or their equivalents. Agilent Technologies can provide packaging materials identical to the original materials. Refer to "Service and Support" on page v for the service center nearest to you.

1. Before calling Agilent or returning your MMS module for service, please read your warranty information. In any correspondence or telephone conversations, refer to the module by it full model number and serial number. With this information, the Agilent Technologies representative can determine whether your unit is still within its warranty period.

   Module Serial Number

   When a module is manufactured by Agilent, 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. The first six entries are the same for all identical modules; they only change when a change in the electrical or physical functionality is made. The remaining entries change sequentially and are different for each module.

2. 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 70000 Series display
   - a completed performance test record
   - any other specific data on the performance of the MMS module

3. Place the module in its original packaging materials.

   - The shipping container must be large enough and strong enough to accommodate you module and allow at least 3 to 4 inches on all sides for packing material. Packaging materials should be anti-static and should cushion the module on all sides.
   - If the original packaging materials are not available, Agilent can provide packaging materials identical to the original materials. Refer to "Service and Support" on page v for the service center nearest to you.

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

5. Mark the shipping container FRAGILE, HANDLE WITH CARE.

6. Retain copies of all shipping papers.

2 Installation

Overview

In this chapter you will learn about:

- How to install your switch driver or interface modules in an HP/Agilent 70000 Modular Measurement System mainframe.
- How to verify its basic functionality.
- How to address your instrument.
- How to connect it to a switch matrix.

Getting Started

Preparing for Use

Unpack and inspect the shipping container and its contents thoroughly to ensure that nothing was damaged during shipment. If the shipping container or cushioning material is damaged, the contents should be checked both mechanically and electrically. A procedure for checking the electrical performance is given in Chapter 4, "Verification."

- If the shipping container is damaged, or the cushioning material shows signs of stress, notify the carrier as well as Agilent Technologies. Keep the shipping material for the carrier's inspection. Refer to Figure 1-3 on page 1-10.
- If the contents are damaged or defective, contact your nearest Agilent Technologies Sales and Service Office. Refer to "Service and Support" on page v. Agilent will arrange for repair or replacement of the damaged or defective equipment.

Module Installation and Removal

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

General Guidelines

1. *Always* set the MMS LINE switch to OFF before removing or installing any MMS module.
2. Swing the mainframe front door down. On some MMS mainframe models the door will not open unless the LINE switch is OFF.
3. When installing the switch driver, check the module HP-IB/MSIB address switches for the correct address. *The default address is set to 9.*
4. Slide the module into the mainframe.
5. Tighten the module latch using an 8 mm hex-ball driver.

Assigning the display window

When the system is first turned on, the softkeys of the 70611A, 70612A,C or 70613A,C may not be visible on the CRT. The usual cause is that the display window has not been assigned to the instrument.

1. Assign the display window to an instrument, with a row address of 0, by pressing **[DISPLAY]**, and then ***{NEXT INSTR}*** or ***{SELECT INSTR}***. This assigns the display to the instrument with the lowest column address.
2. Press the up arrow key to assign the display to the instrument with the next-highest column address.

3. Repeat until the label at the bottom of the screen indicates the 70611A, 70612A,C or 70613A,C has been selected, and then press the **[MENU]** key.

NOTE

The address switches on the back of the system graphics display 70205A, 70206A, or 70004A are for the display instrument only. They do *not* set the address of the modules in the system.

MSIB/HP-IB Addressing

HP/Agilent 70000 Modular Measurement Systems are made up of separate parts called elements. All elements communicate over the MSIB. To communicate and function properly, all elements must have appropriate MSIB addresses. MSIB addressing is not the same as HP-IB addressing.

If the default setting is sufficient, and you want to start using the switch driver, proceed to Chapter 5, “Local Operation”.

Modular Measurement System Terms

Understanding the following terms is essential to understanding 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 70611A switch driver) that communicates over the MSIB. In contrast, the MMS mainframe provides a path for all MSIB communication, but does not communicate over the 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 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 70206A system graphics display).

Address Matrix

The address matrix is a graphic representation of the addresses on the 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 that are used to set these addresses are given in Figure 2-2 on page 2-7.

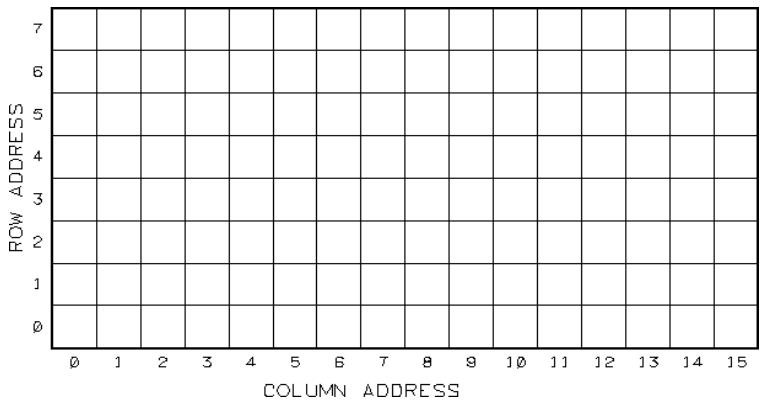


Figure 2-1 Address Matrix

To allow the elements to communicate and function properly, each element must have a binary eight-bit 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 MSIB address determine the row address.
- The five least significant bits (LSB) determine the column address.

The decimal equivalents of the binary row and column addresses are used throughout this documentation.

For example:

	Row	Column
Binary	010 (MSB)	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 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 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, the 70611A attenuator/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 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.

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. Refer to your display manual for details.

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 MSIB column address. Use the up arrow key to select an element with a higher 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. Refer to your display manual for details.

Address Switches

The address switches set the 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.

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

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

COLUMN Address Switches 1-5

These set the 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 MSIB row address. The switch labeled with a one is the least significant bit.

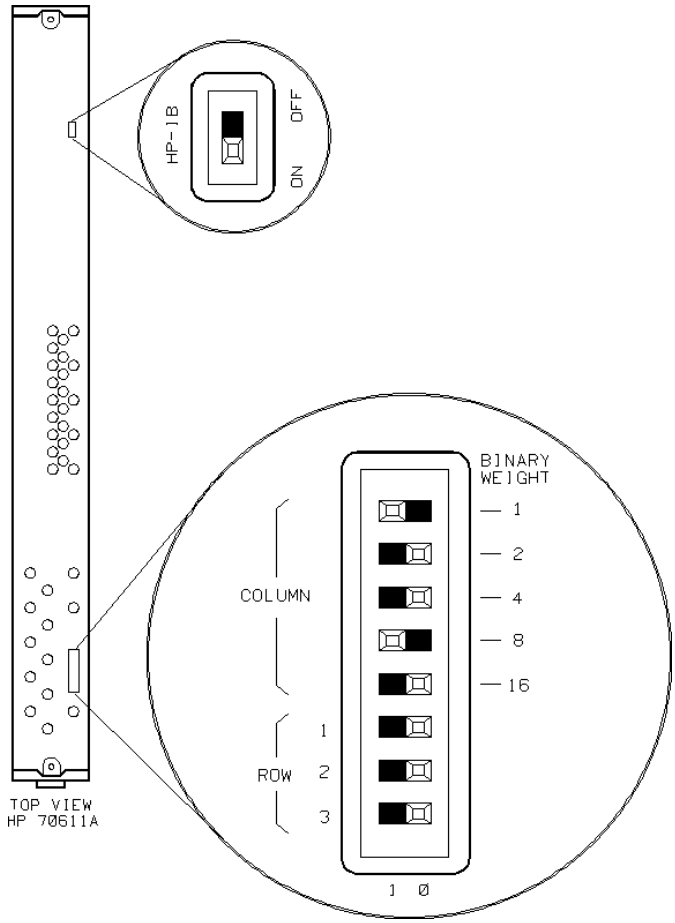


Figure 2-2 HP-IB/MSIB ON/OFF and Address Switch (Default 9 shown)

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 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 address map appears, highlight the switch driver, using the display front-panel knob and the column and row menu 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

- A standard switch driver can control up to eight 84940A driver cards. (70611A Option 001 already has the driver card installed and cannot control additional 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 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 to card 8, 800 to 830. Figure 2-3 shows a typical operating setup with one driver card.

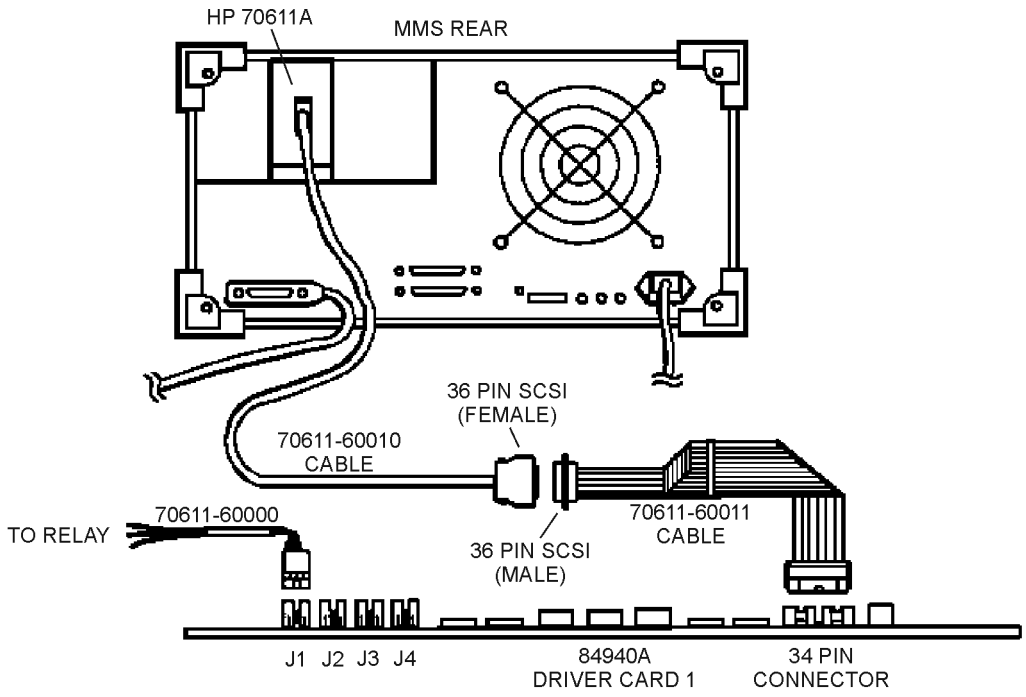


Figure 2-3 70611A Typical Operating Setup

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 84940A driver board assembly to which the switch was attached. The recommended repair procedure for an 70611A Option 001 is to return the 70611A switch driver to Agilent for repair.

Wiring Switch Channel Connectors

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

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

A typical single switch channel connector is shown below.

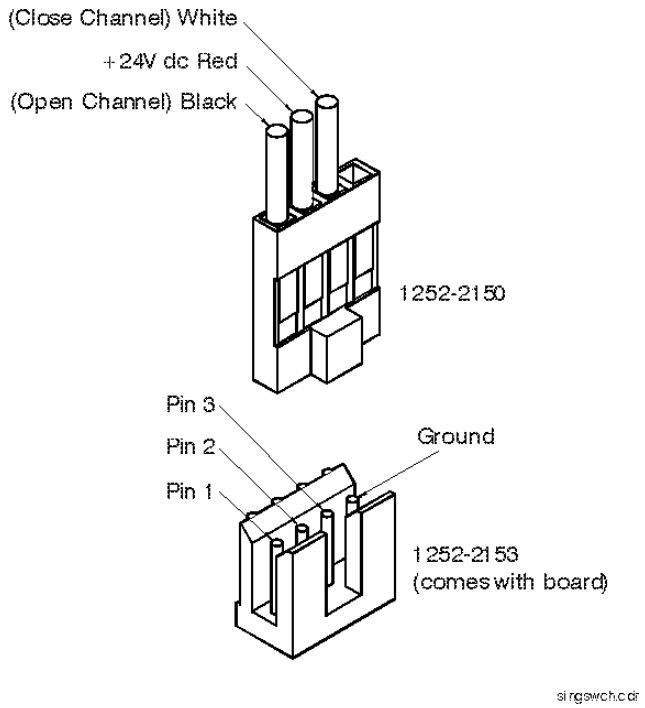


Figure 2-4 Typical Single Switch Channel Connector

Connecting Attenuators

Connect attenuator cables using a Viking connector and a ten pin connector. A typical connection of four section attenuators is shown below.

CAUTION

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

When connecting attenuators

- +A CLOSE position should add attenuation.
- An OPEN position should remove attenuation.

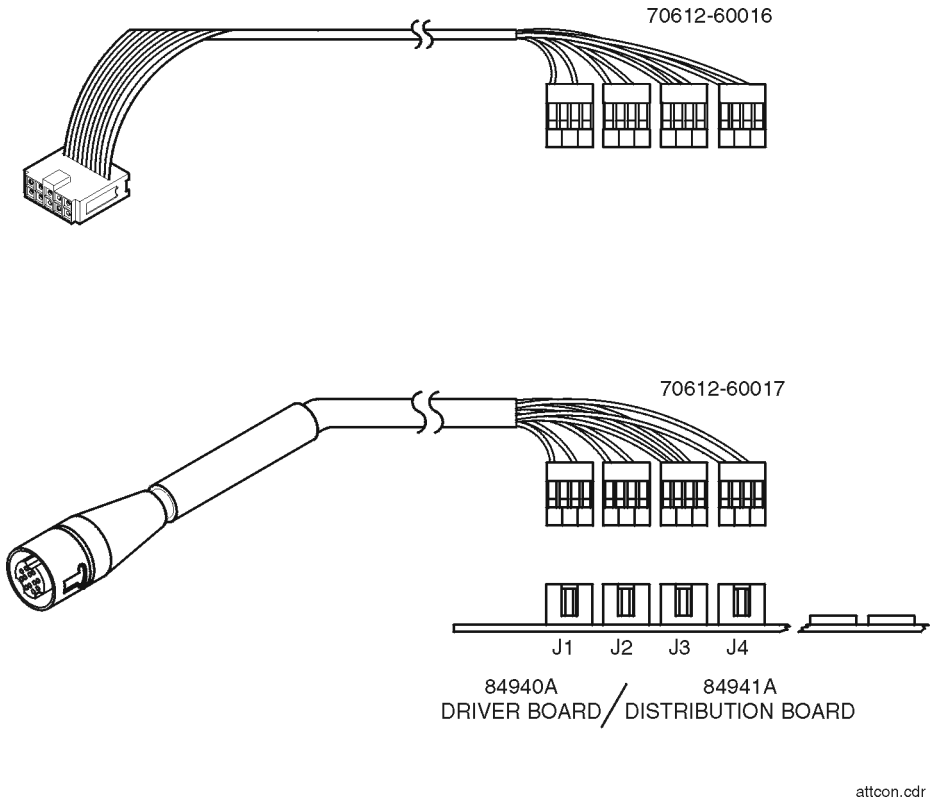


Figure 2-5 Typical Attenuator Cables Connected to an 84940A

Optimizing Switching Speed

1. To increase the speed at which your switch matrix operates, refer to the table below to determine which four relays, when connected, will be on the same drive lines.
   a. Refer to Figure 2-4 on page 2-9 to wire your relays into the arbitrary positions of OPEN and CLOSE.
   b. Refer to the "Example Speed Calculation" at the end of Chapter 6, for an explanation on calculating and minimizing overall switching time.

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.

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 (or two of 400 mA) is the limit for one switching operation.

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 to card 8, 800 to 830.

Table 2-1 Relay Drive Sequence

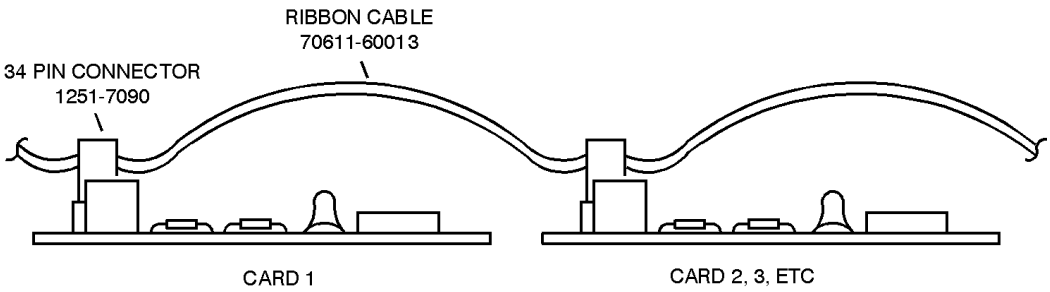
Drive Line	Connector Locator	Channel List
1	J1, J2, J3, J4	00, 01, 02, 03
2	J5, J6, J7, J8	04, 05, 06, 07
3	J9, J10, J11, J12	08, 09, 10, 11
4	J13, J14, J15, J16	12, 13, 14, 15
5	J17, J18, J19, J20	16, 17, 18, 19
6	J21, J22, J23, J24	20, 21, 22, 23
7	J25, J26, J27, J28	24, 25, 26, 27
8	J29, J30, J31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

Connecting Multiple Driver Cards

In a single enclosure, place connectors on ribbon cables to daisy chain driver cards (see Figure 2-6).

To reliably install the 34-pin connector to the ribbon cable use the following 3M™ tools. (To order from 3M™, call 1-800-225-5373).

Item	3M™ Part Number
Platen	3442-1A
Locator plate	3443-94
Hand press	3540



daisyint.cdr

Figure 2-6 Daisy Chain of Driver Cards

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

Driver Card Address

Set the 4-bit DIP switch on the 84940A driver assembly card to each address a shown in the figure below. (S1 “up” is open or away from the PC board.)

Each card must have a unique address setting. *The internal driver card is set to card 1.*

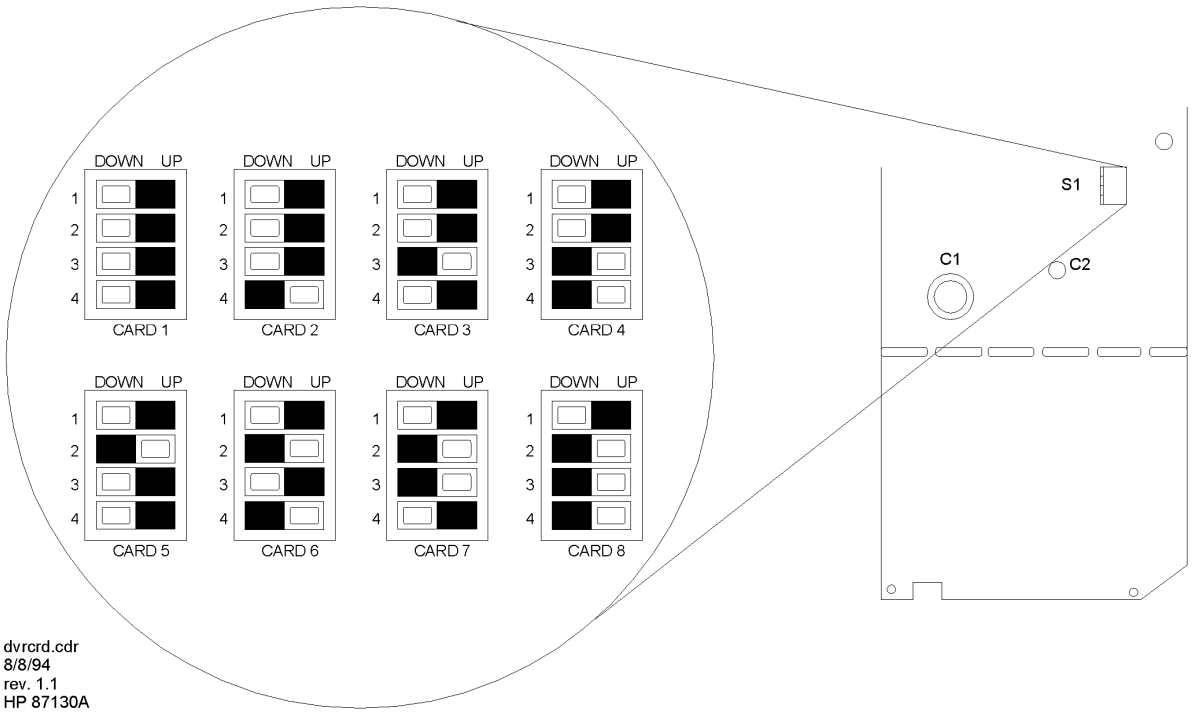


Figure 2-7 Eight Driver Card Addresses

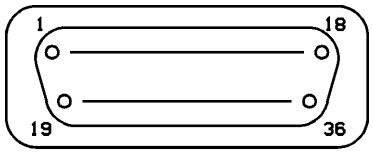
It is impossible to predict the exact configuration of your particular switch matrix. It is assumed that each 84940A driver assembly will be in a separate grounded switch matrix box.

The total length of ribbon cable should not exceed 1.8 meters (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 meters (4.4 feet).

These values are based on the maximum number of driver boards and a full switch complement. If fewer boards are used, longer cable lengths are possible. Special longer lengths of heavier-gauge driver (68 pin) and CPU (36 pin) cables are available. For ordering information, refer to “Service and Support” on page v.

Pin Functions for 36-Pin I/O Data Cable

- The 70611A standard attenuator/switch driver has a high density male, 36-pin SCSI type connector. (70612A,C and 70613A,C Option 006 and Option 011 have two high density, 36-pin SCSI II type connectors.) Pin functions are given below.
- The standard I/O data cable for the 70611A, 70612A,C, and 70613A,C is a five-foot 28 AWG cable with two female, 36-pin SCSI II type connectors (part number 70611-60010).



standio.cdr

Table 2-2 Standard 36-Pin (Male) SCSI II Type Connector Pin Functions

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 Vdc	25	D12, Data Line
8	+5 Vdc	26	D13, Data Line
9	+24 Vdc	27	D14, Data Line
10	+24 Vdc	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

Using the Internal Driver of the 70611A Option 001

The 70611A Option 001 has an internal driver card and cannot control additional cards.The internal driver board of the switch driver is terminated with a 68-pin SCSI II type connector (driver output) and connects to an 84941A distribution board.

- The standard output cable for the 70611A Option 001 is a six-foot cable with two male, 68-pin SCSI II type connectors (part number 70611-60004).
- Figure 2-3 on page 2-16 gives the pin functions for the 68-pin driver output connector.

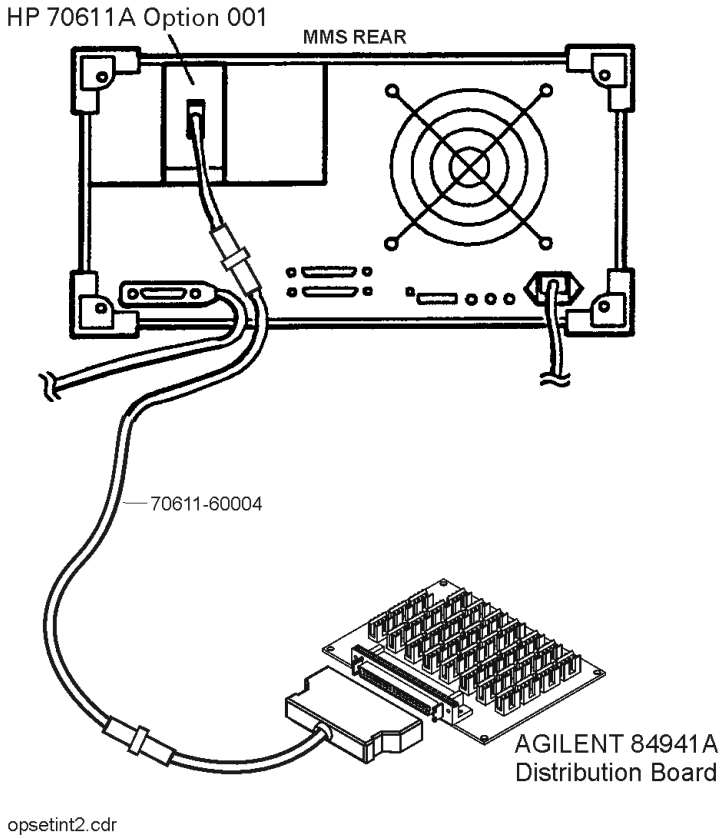


Figure 2-8 70611A Option 001 Operating Setup

70611A Option 001 Pin Functions for 68-pin Driver Output Connector

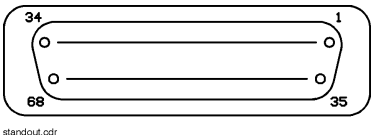


Table 2-3 68-Pin (Female) SCSI II Type Connector Pin Functions

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 Vdc	67	+24 Vdc
34	Return	68	Return

3 Specifications

Overview

Performance specifications are the performance standards or limits against which the module can be tested. The specifications are organized into two categories:

- Measurement related specifications which describe warranted performance over the temperature range of 0 to +55 °C after one hour of continuous operation, unless otherwise noted. These specifications are given in plain text.
- Characteristics which provide useful but non-warranted functional and performance information. Characteristics are denoted by italics in the tables.

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

Drive capacity	
70611A	248 relays, when mated with eight external 84940A daisy chained driver cards. *Each 84940A can drive up to 31 relays.*
70611 A Option 001	31 relays.*The equivalent of one 84940A driver card is installed within the module.*
70612A,C or 70613A,C	217 relays when mated with seven 84940A daisy chained driver cards. *Each 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 (400 mA per multithrow switch such as 87104) *Pulse width is adjustable for 5 ms to 1275 ms ± 5 ms, in 5 ms steps.*
Load inductance[1]	*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 ± 5 ms. *Refer to 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 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 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 driver cards	36-pin SCSI
Interface to relays	
70611A Opt 001	68-pin SCSI II type
70612A,C and 70613A,C	68-pin SCSI II type

1. Refer to "Compatible Switches and Attenuators" on page 1-4 if you are using switches or attenuators made by another company.

Table 3-2 70611A, 70612A,C and 70613A,C Environmental Specifications

Temperature	
Operating	0 to +55 °C
Survival	–40 to 70 °C
Humidity	80% relative humidity at 40 °C max, non-condensing
Altitude	
Operating	4 600 meters (15,000 feet)
Non-operating	4 600 meters (15,000 feet)
Vibration	MIL-PRF-28800F, Class 3, Para. 4.5.5.3.1 and 4.5.5.3.2
Shock	MIL-PRF-28800F, Class 3, Para. 4.5.5.4.1
Electromagnetic Compatibility	Conducted and radiated interference is in compliance with CISPR, Publication 11 (1990) Level A Meets the requirements of MIL-STD-461C, Part 7, Methods RE02, CE03, CS01, CS02, CS06, RS03
Weight	
70611A	3.2 kg (7 lb)
70612A,C and 70613A,C	3.9 kg (8.5 lb)
Dimensions	
70611A	Standard 1/8-width module
70612A,C and 70613A,C	Standard 2/8-width module

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

Specification	70612A, 70613A	70612C, 70613C
Frequency range	dc to 6.5 GHz	dc to 18.0 GHz *18 to 26.5 GHz typical*
Isolation *(f = frequency in GHz)*[1] (between adjacent ports)) Option 002	 >120 – 4.2f dB >100 dB	 >110 dB – 2.8f dB >60 dB
Insertion Loss *(f = frequency in GHz)*[1] (any path)	 <0.8 + 0.2f dB	 <1.5 + 0.22f dB (18 GHz) *6.5 dB (18 to 26.5 GHz) typical*
Option 003, 004 (any path)	<1 + 0.25f dB	<1.5 + 0.22f dB (18 GHz) *8.0 dB (18 to 26.5 GHz) typical*
Option 005, 006 (any path)	<1 + 0.25f dB	<1.5 + 0.28f dB (18 GHz) *8.0 dB (18 to 26.5 GHz) typical*
Option 007 (any path)	<1 + 0.4f dB	<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 X 10^6 cycles >5 X 10^6 cycles	>1 X 10^6 cycles >5 X 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)

1 To evaluate expressions such as 120 - 4.2f dB, multiply the numerical value of the frequency in GHz by 4.2 and subtract from 120.

4 Verification

Overview

In this chapter you will learn about:

- How to test the electrical performance of the 70611A, 70612A,C, or 70613A,C.
- What equipment is needed for the performance tests.
- How to perform the tests.

Performance Tests

Run performance tests for incoming inspection, troubleshooting, or preventive maintenance to test the electrical performance of the 70611A, 70612A,C, or 70613A,C.

Conditions

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

- ❏ The switch drive or interface module must have one-half hour warm-up.
- ❏ The ambient temperature must be 0 to 55° C.
- ❏ The switch driver or interface module must pass all self tests.
- ❏ During any performance test, all shields and connecting hardware must be in place.
- ❏ Proper cables, adapters, and probes must be used for the test setups.
- ❏ The user must understand how to operate the specified test equipment needed for each test.

Recommended Test Equipment

Recommended test equipment for the verification tests is given below. Other equipment may be substituted if it meets or exceeds the critical specifications listed.

Table 4-1 Recommended Test Equipment for 70611A

Instrument	Critical Specifications	Recommended Model	Use[1]
External Driver 70611A Standard	No substitute	84940A	O, P, T
Modular Measurement System	No substitute	70000 (with display)	O, P, T
Oscilloscope	Bandwidth: dc to 100 MHz Vertical sensitivity: 4 V/div Vertical input: 50 Ω impedance dc coupled Timebase: 5 ms/div	Various models	P, T
Test Accessory	No substitute. Made specifically for MMS switch drivers.	70611-60014	P, T
Cable	No substitute. Made specifically for MMS switch drivers.	70611-60010	P, T
Cable	No substitute	70611-60004	P, T

[1]P = Performance tests, T = Troubleshooting, O = Operator's checks

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

Instrument	Critical Specifications	Recommended Model	Use[1]
External driver 70612A,C and 70613A,C Except Options 006 and 011	No substitute	84940A	O, P, T
External CPU 70612A,C and 70613A,C Options 006 and 011 only	No substitute	70611A, or 70612A,C, or 70613A,C	O, P, T
Oscilloscope	Bandwidth: dc - 100 MHz Vertical sensitivity: 4 V/div Vertical input: 50 Ω impedance dc coupled Timebase: 5 ms/div	Various models	P, T
Test accessory	No substitute. Made specifically for MMS switch drivers.	70611-60014	P, T
Cable	No substitute. Made specifically for MMS switch drivers.	70611-60010	P, T
Network analyzer 70612A, 70613A, 70612C, 70613C	 dc to 6.5 GHz dc to 26.5 GHz	 8510B,C 8510B,C	O, P, T
Synthesized sweeper	dc to 26.5 GHz	83651	O, P, T
Spectrum analyzer 70612A, 70613A, 70612C, 70613C	 dc to 6.5 GHz dc to 26.5 GHz	 71209A 71209A	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 MSIB switch is set to 9. Each module in the Modular Measurement System has a unique MSIB address.
3. Open the Modular Measurement System's door and slide the 70611A, 70612A,C or 70613A,C into any available slot.
4. Using a hex-ball driver, tighten the hex-ball at the bottom of the 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 the up or down arrows until the following message appears at the bottom of the display:

   `Row 0 Column 9: 70611A. SW Driver` (or **`70612A,C`** or **`70613A,C)`**

4. Press the **[MENU]** key on the graphics display to display the module's menu.

Pulse Parameters Test

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

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

Table 4-3 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 or 400 mA per multithrow

Hardware Limits

The +24 volt supply in the switch driver can supply sufficient current to drive up to four 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.

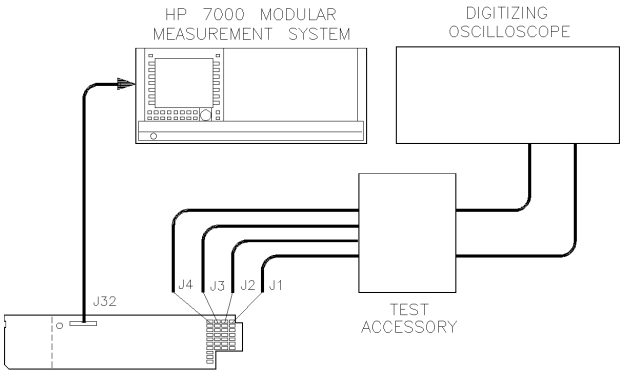


Figure 4-1 Pulse Parameters Test Setup

Equipment

Modular Measurement System . . . . . 70000 Series
Oscilloscope. . . . . Various models
Test accessory[1] 70611-60014
Driver board (70611A, 70612A,C, and 70613A,C) 84940A
Cable (70611A, Opt 001). 70611-60004

1Provides a 200 mA load for the driver.

Procedure

In this example the MSIB address is set to 9.

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

CAUTION

Do not connect or disconnect relays while the switch driver's 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 the test accessory to J1, J2, J3, J4 if you are using an external driver card.
   - ❍ Connect the test accessory to cable (70611-60004) if you are using an 70611A Option 001, 70612A,C or 70613A,C.
3. Set the oscilloscope as follows:
   - ❍ Volts/div . . . . . .5 V
   - ❍ Sweep speed . . . . . .10 ms per div
   - ❍ Trigger. . . . . .INTERNAL

4. Turn ON the MMS mainframe.
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

Use the following program if you have HP-IB and Basic capability:

```
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
80   !  line 50 and leave line 100 in the program,
90   !  as shown here.
100  OUTPUT 709;"ROUT:VER:OFF (@100:103);"
110  !
120  !  For the Sensing (:VERify) Enabled test, comment out
130  !  line 100 and 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
230  !  not apply.
240  !  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 the reading. +21 V < _____ < 27 V

Current

Divide the 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

70611A, 70612A,C or 70613A,C Range	Minimum	Actual Results	Maximum
Voltage	21 Vdc		27 Vdc
Current	175 mA		225 mA
Switching speed:			
Sensing disabled	25 ms		35 ms
Sensing enabled	45 ms		55 ms

Sensing Disabled

Each switch coil is internally connected to the +24 V bias. A power transistor on the driver board supplies the ground return that will activate the switch coil. The controller assembly actuates the transistor for a predetermined time. The default setting is 30 ms. Refer to ***{WIDTH}*** display softkey in Chapter 5 or the `Route:Width` remote command in Chapter 6.

Sensing Enabled

For switches that can be sensed, the switch coil is internally connected to the +24 V bias supply with a dc switch that removes the bias from the activated coil after the switch has changed position and applies the bias to the opposite coil. By monitoring the presence on this bias through the opposite coil, the switch controller can determine the switch position. After the initial 30 ms closure pulse, an additional 20 ms time is allowed for the sense lines to settle. At this time an error check and a programmed position check are performed. Therefore, the combined time for the switch drive and switch position verification is 50 ms.

Microwave Verification Tests (70612A,C and 70613 A,C Only)

Reflection and Insertion Loss Test

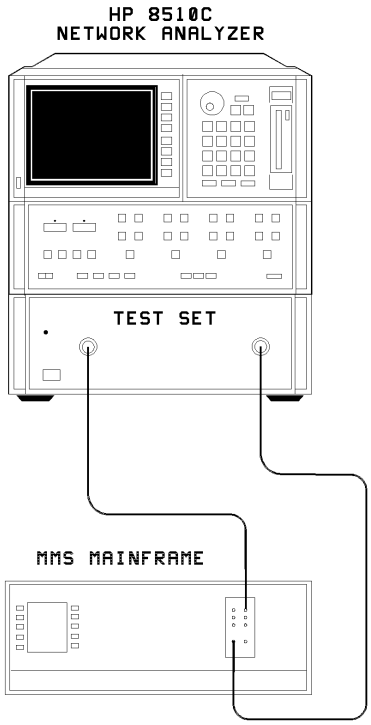


Figure 4-2 Reflection and Insertion Loss Test Setup

Equipment

Modular Measurement System display/mainframe 70004
Network analyzer 8510B,C
Synthesized sweeper. 83651A
S-parameter test set. 8517A,B
3.5 mm calibration kit. 85052B

Measurement Calibration

1. Connect the equipment as shown in Figure 4-2.
2. Set the system's LINE switch to ON.
3. Press **[Local]**, **[Recall]**, ***{More}***, ***{Factory Preset}*** on the network analyzer to set the system to a known starting point.
4. Under the Stimulus block on the front panel, press **[Menu]**.
5. Press ***{Step}*** to set to step mode.

6. Press **[Cal]**.
7. Select ***{Cal 1 3.5 mm}***.
8. Press ***{Full 2 Port}***.
9. Press ***{REFLECT'N}***.
    a. Connect a short to Port 1 of the switch driver.
    b. Press ***{(S11): SHORT}***.
    c. Remove the short and connect an open to Port 1.
    d. Press ***{(S11): OPEN}***.
    e. Remove the open and connect a lowband load to Port 1.
    f. Press ***{(S11): LOADS}***.
    g. Remove the lowband load and connect a sliding load to Port 1.
    h. Press ***{SLIDING}***.
    i. Set the sliding load to the first mark. Press ***{SLIDE is SET}***.
    j. Repeat the steps above for all sliding load marks.
    k. Press ***{SLiDING LOAD DONE}***.
    l. Press ***{LOADS DONE}***.
    m. Repeat steps 9(a-l) above for Port 2 (S22).
    n. When the calibration of Port 2 is complete, press ***{REFLECT'N DONE}***.
10. Press ***{TRANSMISSION}***.
    a. Connect a THRU device
    b. Press ***{FWD TRANS THRU}***
    c. Press ***{FWD MATCH THRU}***.
    d. Press ***{REV TRANS THRU}***.
    e. Press ***{REV MATCH THRU}***.
    f. Press ***{TRANS DONE}***.
11. Press ***{ISOLATION}***.
    a. Connect a broadband load to Port 1 and Port 2.
    b. Press ***{FWD ISOL'N} {ISOL'N STD}***.
    c. Press ***{REV ISOL'N} {ISOL'N STD}***.
    d. Press ***{ISOLATION DONE}***.
12. Save the calibration in an empty Cal set (one without a star next to it).

To measure reflection

Measure the reflection for all desired paths. Refer to Chapters 5 or 6, “Programming Internal Switches and Optional Step Attenuators” for information on selecting paths or attenuators.

70612A and 70613A	Reflection (SWR) _____0.17 (<1.4:1) 6.5 GHz
70612C and 70613C	Reflection (SWR) _____ 0.26 (<1.7:1) 18 GHz
	Reflection (SWR) _____*0.46 (<2.7:1)*
	18-26.5 GHz typical

To measure insertion loss

Press **[S_{21}]** on the network analyzer.

Measure the insertion loss for all desired paths. Refer to Chapters 5 or 6, “Programming Internal Switches and Optional Step Attenuators” for information on selecting paths or attenuators.

	f = frequency in GHz
70612A/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
70612C/70613C	Insertion loss ____ <1.5 + 0.22f dB(18 GHz)
	Insertion loss_____<6.5 dB (18 to 26.5 GHz)
Option 003, 004	Insertion loss ____<1.5 + 0.28f dB (18 GHz)
	Insertion loss____ <8.0 dB (18 to 26.5 GHz)
Option 005, 006	Insertion loss ____<1.5 + 0.28f dB
	Insertion loss_____<8.0 dB (18 to 26.5 GHz)
Option 007	Insertion loss _____<2.0 + 0.35f dB (18 GHz)
	Insertion loss_____<10.0 dB (18 to 26.5 GHz)

- When measuring insertion loss > 80 dB on the 70612C and 70613C Options 003, 004 or 007, the isolation test setup should be used as shown in Figure 4-3 on page 4-12. Measure the desired path by connecting the 83651A synthesized sweeper to the input port and the 71209A signal analyzer front end to the desired output.
- 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 70612A and 70613A Option 004 will be measured to 110 dB.
- The 70612C and 70613C Option 004 range is 0 to 90 dB.
- The 70612C and 70613C Option 004 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

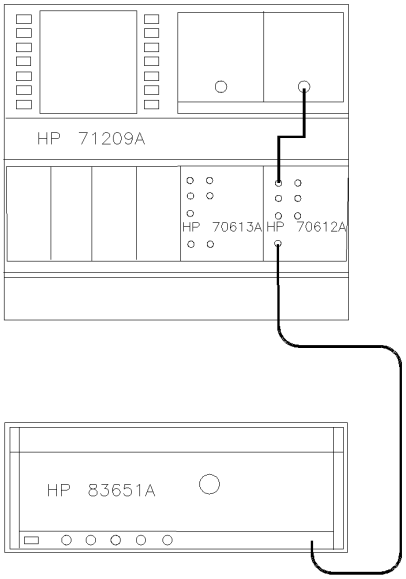


Figure 4-3 Isolation Test Setup

Equipment

Modular Measurement System display/mainframe 70004A
Spectrum analyzer 71209A
Synthesized sweeper. 83651A
50 ohm load, 3.5 mm (m) 909D

NOTE

The 70612A,C or 70613A,C may be plugged into the 71209A spectrum analyzer if space is available. This will eliminate the need for the 70004A 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:

Output level . . . . . 0 dBm
Span . . . . . .0 to 26.5 GHz in 1 GHz steps
Center frequency. . . . . .10 dBm (0.5 to 18 GHz)
Power level . . . . . 10 dBm (0.5 to18 GHz)
1 dBm (18 to 26.5 GHz)

4. Set the spectrum analyzer as follows:

   70612A and 70613A (50 MHz to 6.5 GHz)

   70612C and 70613C (50 MHz to 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 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

70612A/70613A	Insertion loss ____<120 – 4.2f dB
Option 002	Insertion loss ____<100 dB
70612C/70613C	Insertion loss ____<110 – 2.8f dB
Option 002	Insertion loss ____<60 dB

5 Local Operation

Overview

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

In this chapter you will find:

- How to prepare the attenuator/switch driver for initial operation.
- A display keys overview that describes general concepts pertaining to the hardkeys and softkeys and their functions.
- An operating example describing the setup and operation of a four-section (step) attenuator.
- A softkey reference containing an alphabetized list of commands for the manual interface (display keys).

  Corresponding remote commands associated with the display key functions are also given for easy reference in Chapter 6.

Preparation for Switch Drive Operation

If you are an experienced MMS user and you are not interested in descriptions of the common MMS display softkeys or preset conditions of the switch driver, proceed to the “Operating Example” section.

Display Front Panel Keys

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

- 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 **[NSTR 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 Chapter 2 of this manual for correct installation and configuration instructions.

Assigning the display window

When the system is first turned on, the softkeys of the 70611A, 70612A,C or 70613A,C may not be visible on the CRT. The usual cause is that the display window has not been assigned to the instrument.

9. Press the **[DISPLAY]** or **[DSP]** key on the display front panel to access the Display Main Menu.
10. Press ***{SELECT INSTR}*** or ***{NEXT INTR}*** until the display at the bottom of the screen indicates the 70611A, 70612A,C, or the 70613A,C has been selected as the active module.
11. Press the **[MENU]** key to display the main menu of the switch driver.
12. 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 back arrow key on the front panel of the display.

Display Keys Overview

The Main Menu display screen shown in Figure 5-1 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.
  - A key shown in lower case indicates that a lower-level menu exists.
  - A key shown in upper-case letters indicates that there are no further lower-level menus.

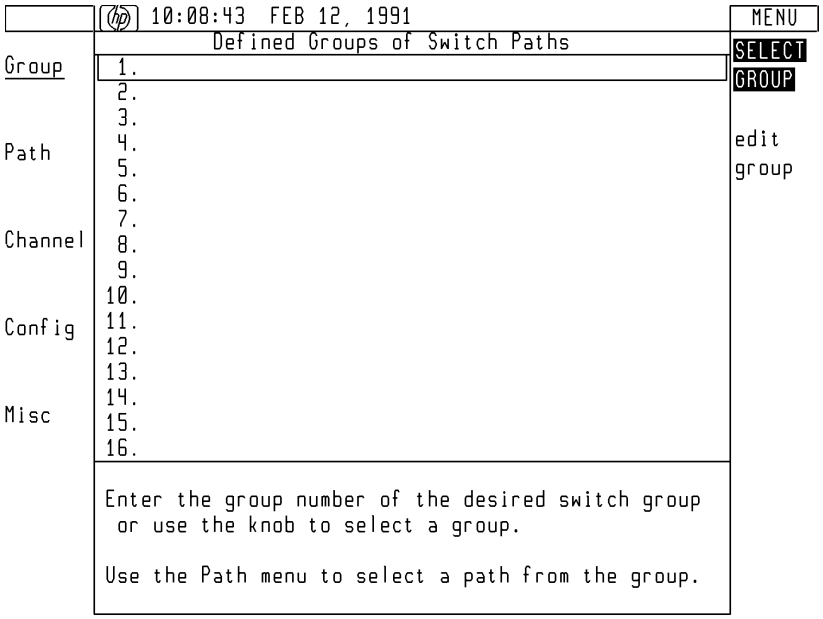


Figure 5-1 70611A Switch Driver Main Menu

- 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.

Entering Data

For some softkey functions, alphanumeric data values are required. If a function requires that data be entered, the data will appear in the lower left portion of the screen.

These values, which allow you to set features such as switching delay, or naming groups and paths, 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. A graphic representation of all the softkeys and how they relate to the overall Main Menu of the switch driver is shown in "Display Key Sequence" on page 5-23. Corresponding remote commands are described in Chapter 6, "Remote Operation" in this manual.

Operating Example

This operating example describes a common setup of a four-section, 10 dB step attenuator (8496H). It is intended for those users who are already familiar with MMS operation and want to quickly see how the switch driver works. It should take about an hour to complete. Refer to "Display (Front Panel) Command Sequences" on page 5-25 for a detailed, alphabetical explanation of each function of the manual interface.

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.

NOTE

The switches inside the 70612A,C and 70613A,C interface modules and attenuators in some standard options have preprogrammed groups, switch path definitions, and labels that are stored inside the EEROM. Therefore some display screens in this example will be different for these modules but manual control of the switches and attenuators remains the same. Refer to "Programming Internal Switches and Optional Step Attenuators" in Chapter 5 or Chapter 6 for schematics and switch paths for the 70612A,C and 70613A.C interface modules and options.

If you have elected to set up a four-section, 10 dB step attenuator like the 8496H, follow the procedure given below. (If you have an 70611A Option 001, you will have different setup and slightly different screens than those provided in this example.)

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 on page 5-6 for attenuator switching order.
3. Refer to Chapter 2, "Installation" (Figure 2-4 on page 2-9, Figure 2-5 on page 2-10, and Figure 2-6 on page 2-12) to connect the attenuators. (Notice that we have setup attenuators so a CLOSE position will add attenuation and an OPEN position will remove attenuation.)

4. Connect J1 through J4 of the first driver card to the attenuator according to Table 5-1.

Table 5-1 Attenuator Switching Order

Attenuation	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 it does not, press ***{Misc} {INIT RAM}.***

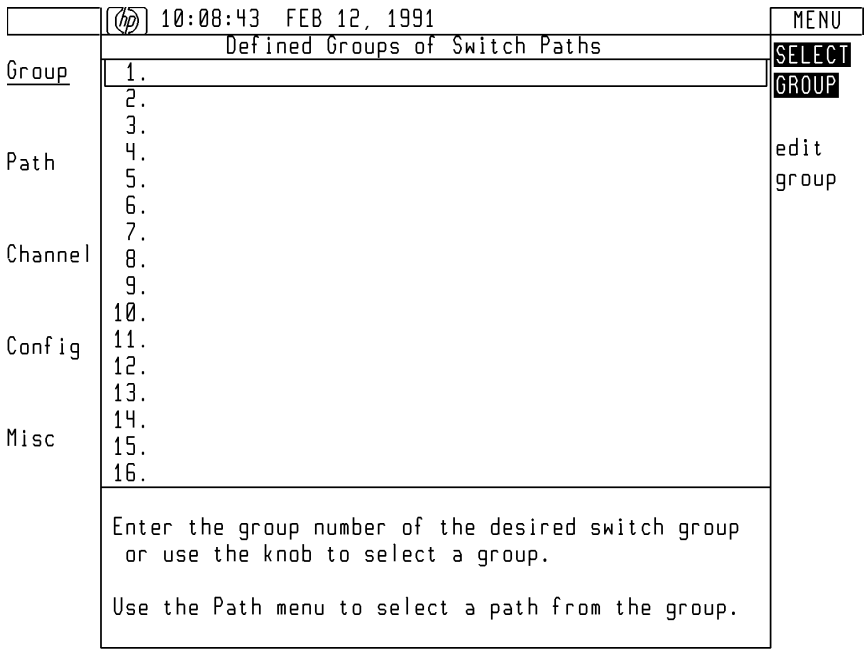


Figure 5-2 Initial Switch Driver Power Up Display

Toggling Switches

To check switch position, toggle the switching attenuators.

1. Press ***{Channel}***. The display should look like this.

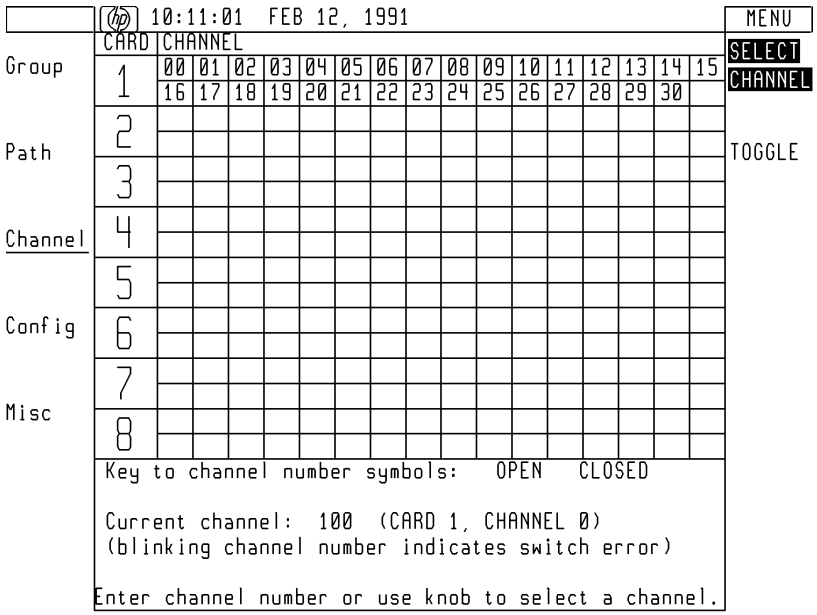


Figure 5-3 Channel Display

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.

The highlighted box shows which switch is being selected. Each switch is called a channel. The rotary knob, the up or down arrow 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}.***

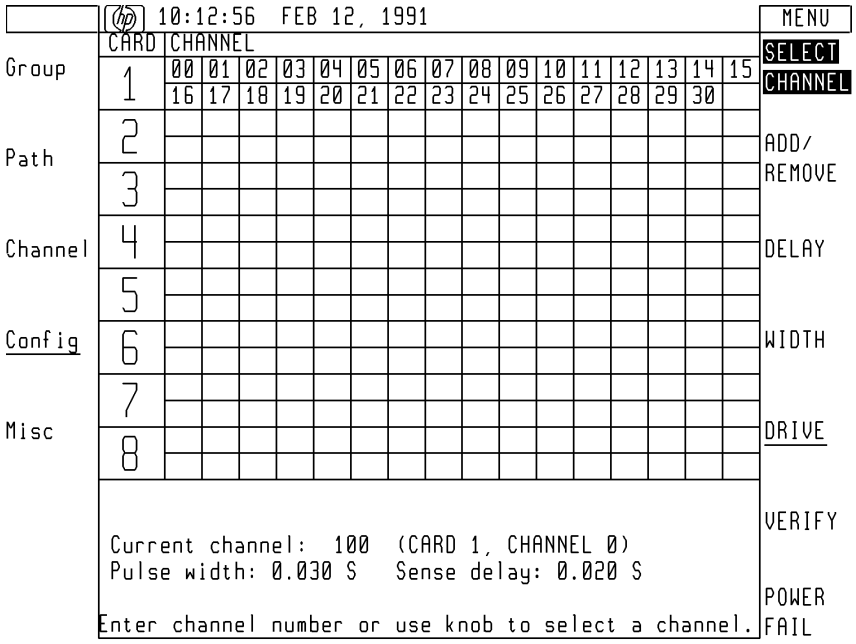


Figure 5-4 Config Display (Drive Menu)

There are three menu screens under ***{Config}:***

a. DRIVE

b. VERIFY

c. POWER FAIL

Notice in Figure 5-4 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}***. the menu will remain as you left it.

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 Chapter 6, “Remote Operation” 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 sec. 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 Chapter 6, “Remote Operation”, 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. Refer to Figure 5-5 on page 5-10.

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 that 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.

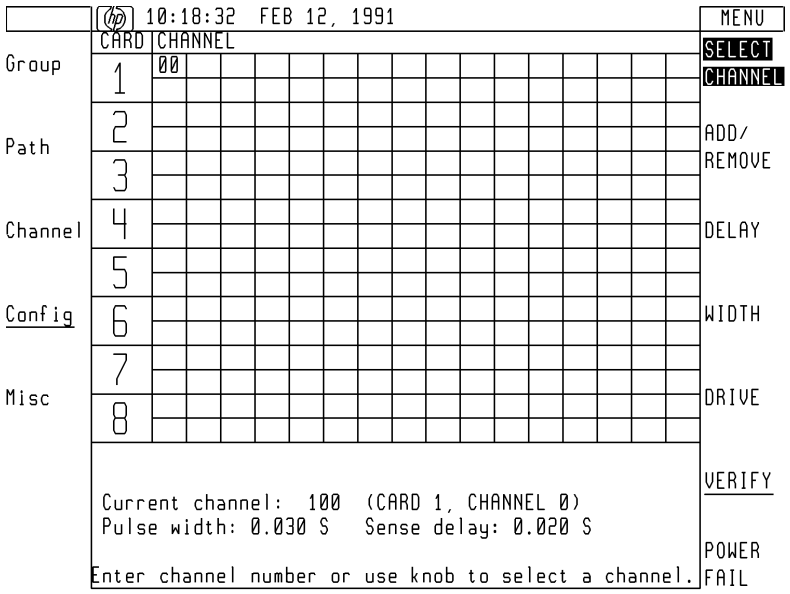


Figure 5-5 Config Display (VERIFY Menu)

12. Press ***{ADD/REMOVE}***

    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.

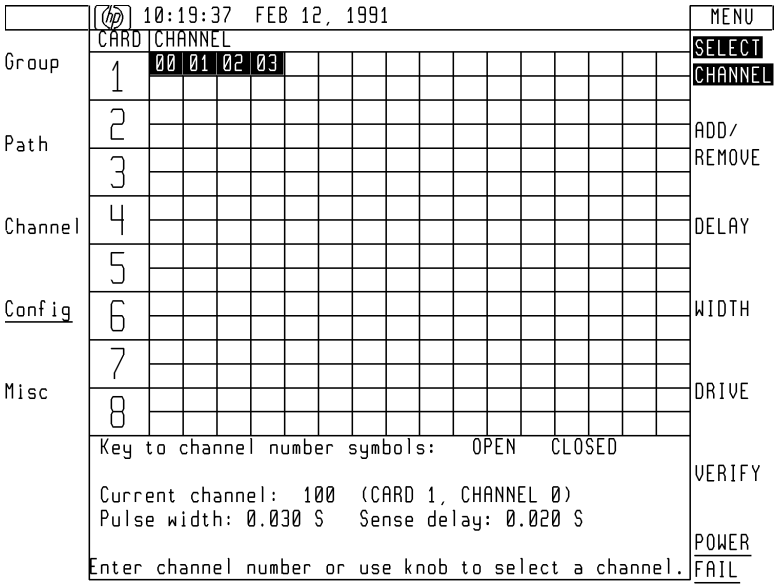


Figure 5-6 Config Display (POWER FAIL Menu)

To save the POWER FAIL switch positions:

1. Press ***{Misc}.***
2. 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 to Table 5-1 on page 5-6 for the switch positions.

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

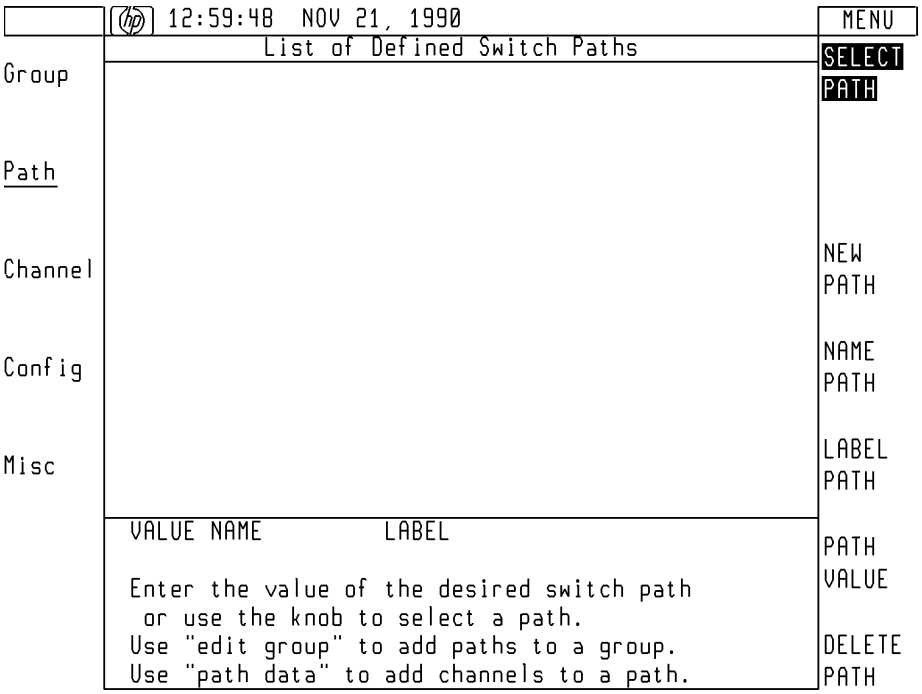


Figure 5-7 Edit Path Menu

3. Press ***{NEW PATH}***.
4. Press ***{PATH VALUE}***. Figure 5-8 should appear on your display.

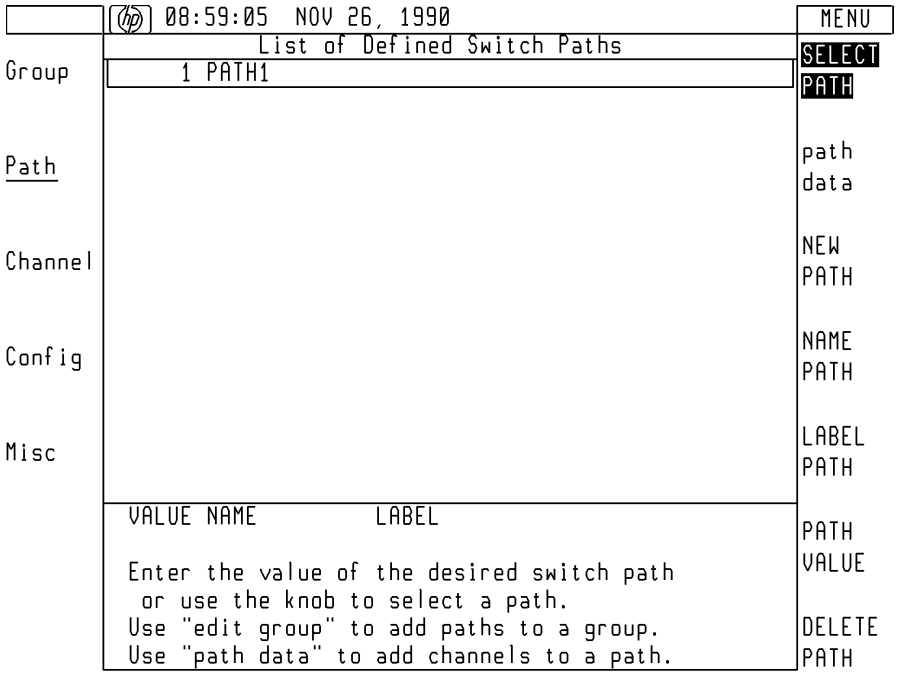


Figure 5-8 Path Value Menu

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 the back arrow key 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 `A0DB`.

11. Press ***{ENTER}***.

    Your first defined path should look Figure 5-9.

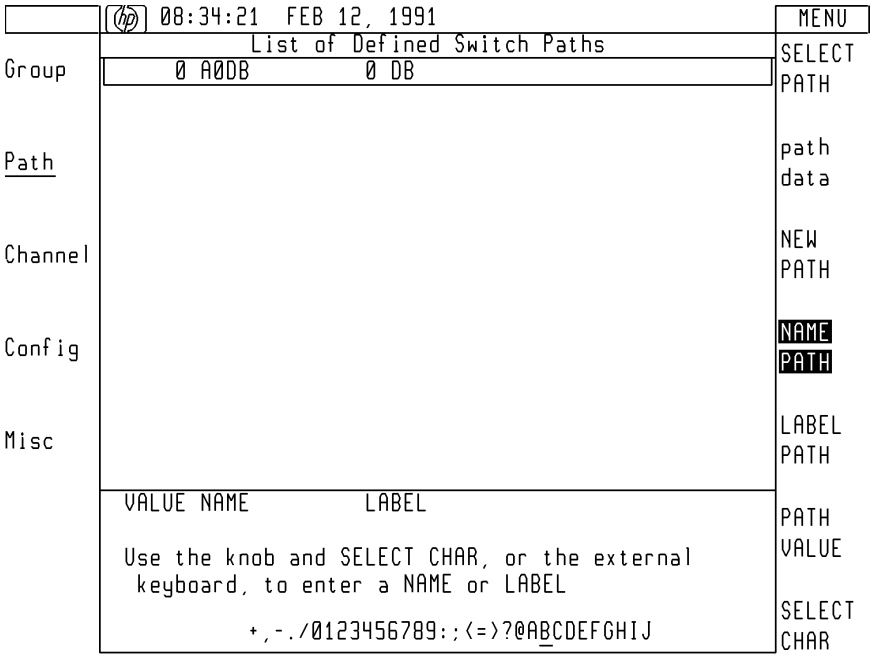


Figure 5-9 First Path Definition

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.

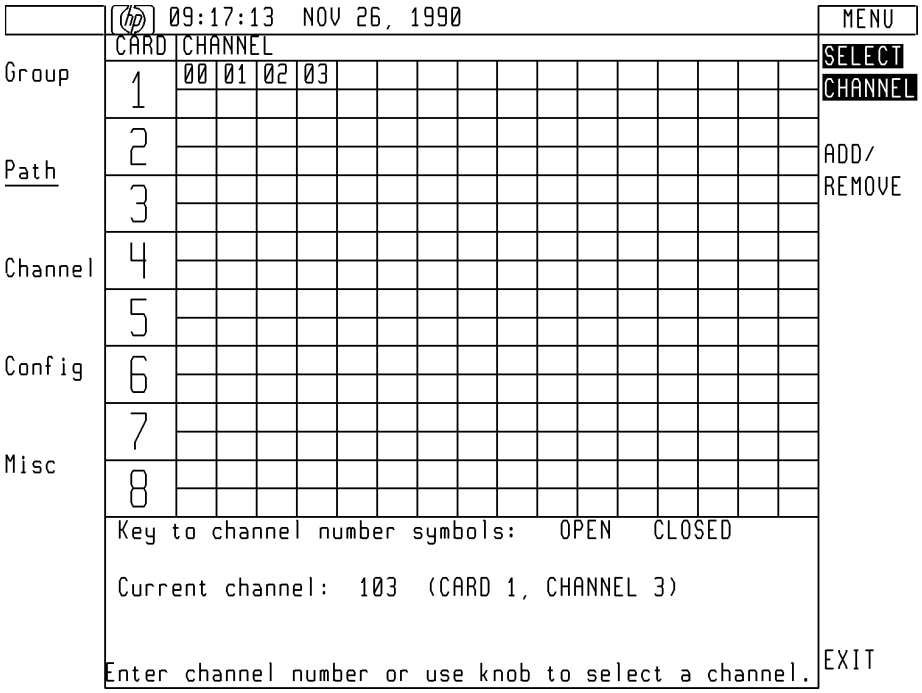


Figure 5-10 First Path Definition (continued)

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 on page 5-6.

15. Close channel **`00`** (inverse video) and leave **`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, just as you did in Figure 5-10 according to Table 5-1.

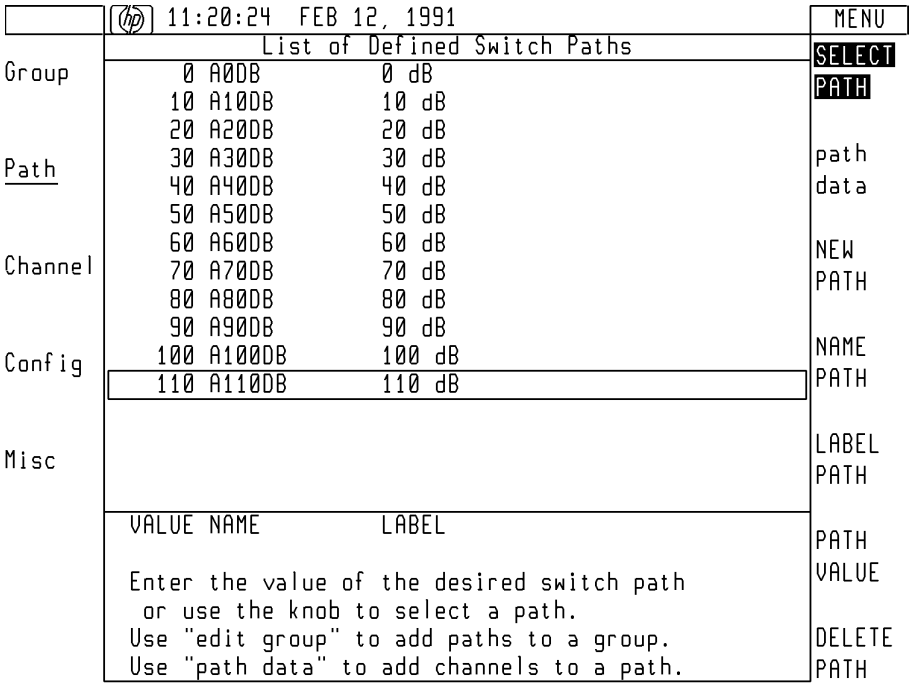


Figure 5-11 List of Defined Switch Paths

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.

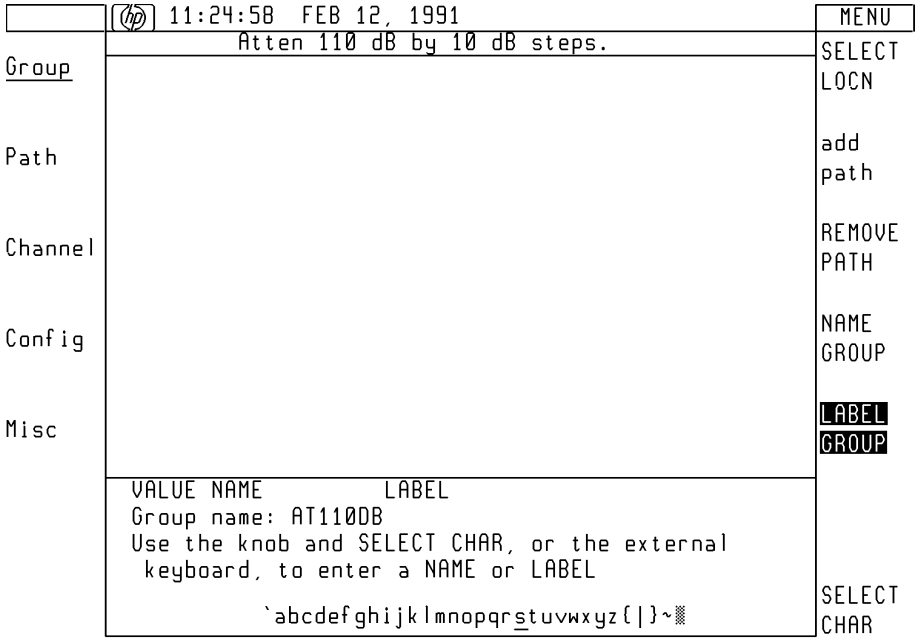


Figure 5-12 Edit Group Menu

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. (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.

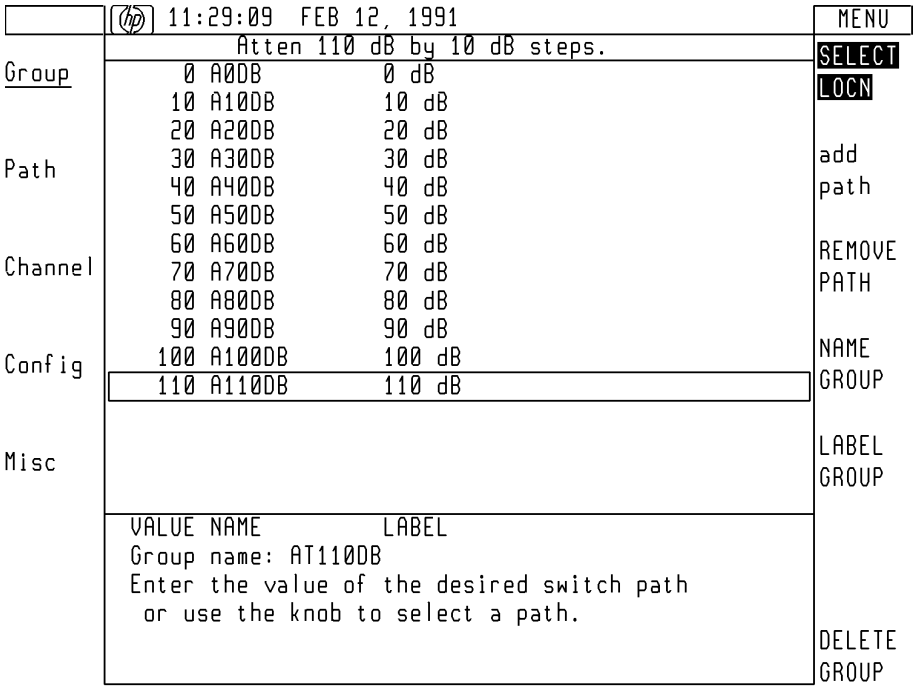


Figure 5-13 Group Paths

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 i`**s at the top of the screen and ***Off*** is underlined for the ***{AutoSel On Off}*** softkey.

3. Now use the rotary knob, the up or down arrow key, or the number keys to move the highlighted box to the 40 dB switch path.

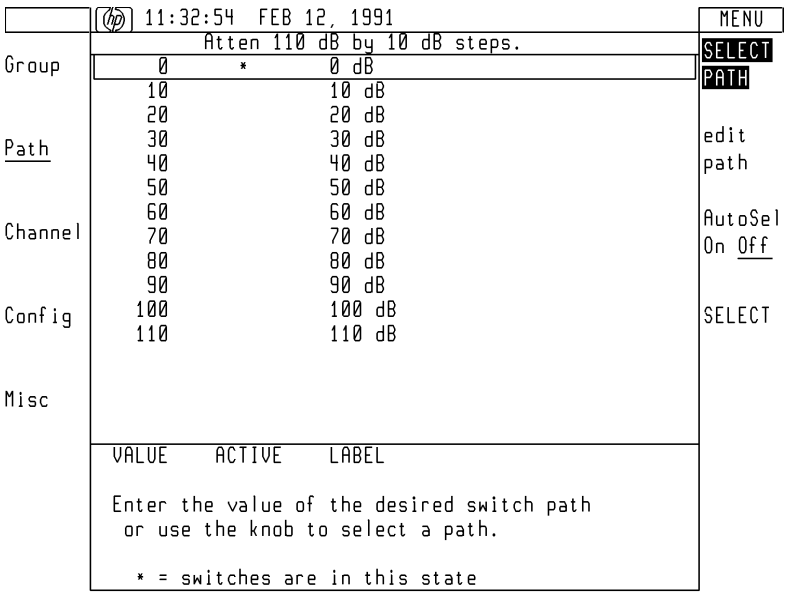


Figure 5-14 Auto Select Screen

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 up or down arrow 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 paths 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 Chapter 6, “Remote Operation”.

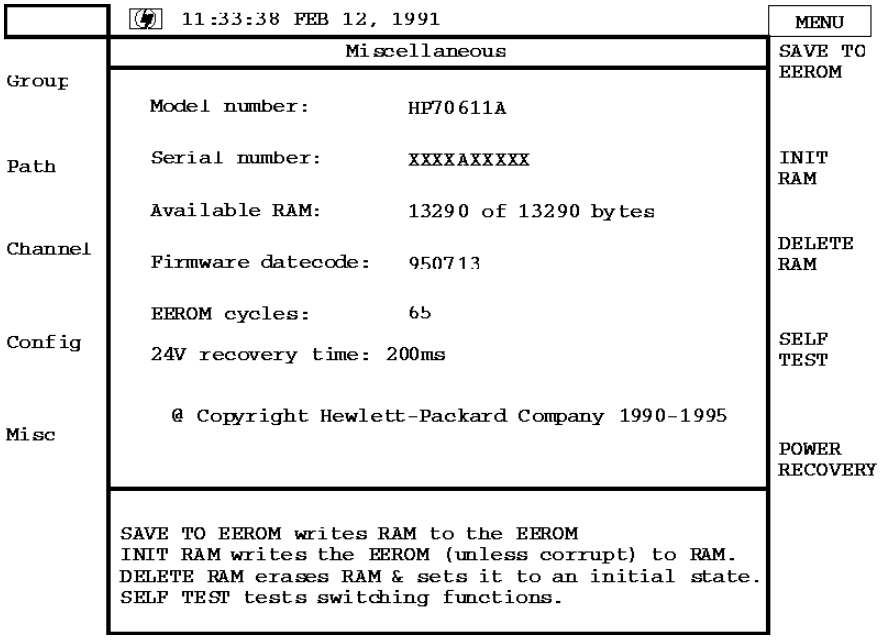


Figure 5-15 Miscellaneous Data Screen

1. Press ***{MISC}***. The screen should look like Figure 5-15.
2. Press ***{SAVE TO EEROM}***.

   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. Refer to `:ERROr?` in Chapter 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:

1. Press ***{Path}***.
2. Press ***{edit path}***. Use the rotary knob or down arrow key to select **110**.
3. Press ***{NEW PATH}***. Your **List of Defined Switch Paths** should highlight **13 PATH13**.
4. Press ***{path data}***.
5. Press ***{ADD/REMOVE}*** to add channels 100, 101, 102, 103, and 104.
6. 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. Now add it to the group **Atten 110 dB by 10 dB steps.**

1. Press ***{Group}***.
2. Press ***{edit group}***.
3. Select **110**.
4. Press ***{add path}***.
5. Select **13 PATH13**.
6. Press ***{ADD TO GROUP}***.
7. Press ***{Path}***.
8. With ***{AutoSel}*** in the ON position, select **110**.

The screen should look like Figure 5-16.

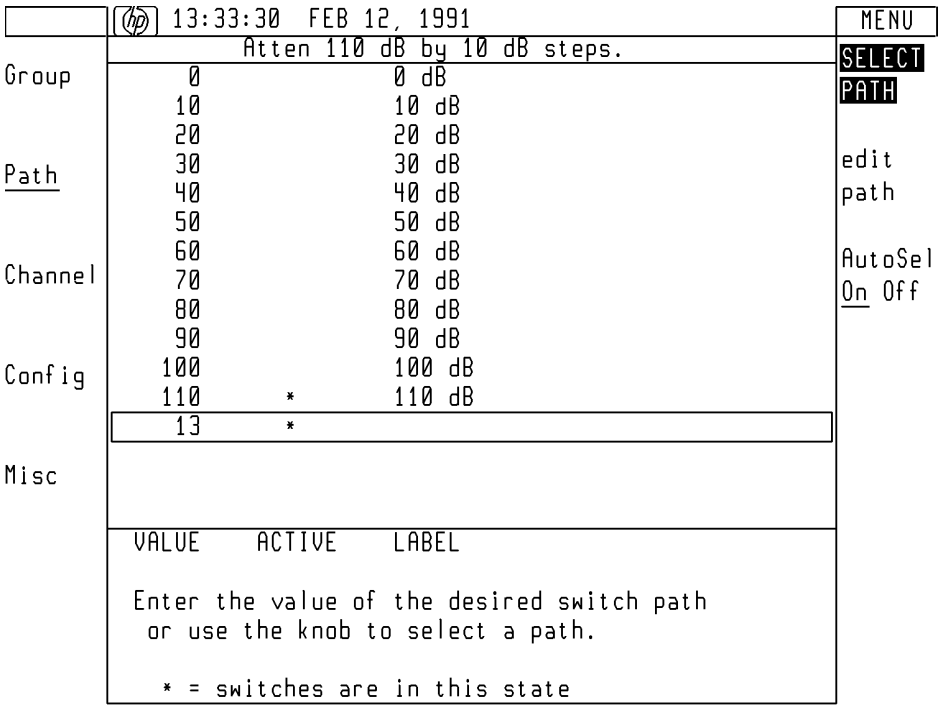


Figure 5-16 Double Asterisk Appears in Path Menu

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 drive data entry from the display.

GROUP MENU

{Group}
- *{SELECT PATH}*
- *{edit group}*
  - *{SELECT LOCK}*
  - *{REMOVE GROUP}*
  - *{NAME GROUP}*
  - *{LABEL GROUP}*
  - *{DELETE GROUP}*
  - *{add path}*
    - *{SELECT PATH}*
    - *{ADD TO GROUP}*
    - *{EXIT}*

PATH MENU

{Path}
- *{SELECT PATH}*
- *{edit path}*
  - *{SELECT PATH}*
  - *{path data}*
    - *{SELECT CHANNEL}*
    - *{ADD/REMOVE}*
    - *{EXIT}*
  - *{NEW PATH}*
  - *{NAME PATH}*
  - *{LABEL PATH}*
  - *{PATH VALUE}*
  - *{DELETE PATH}*
- *{Auto Sel On Off}*
  - *{SELECT}*

Channel Menu

{Channel}			
	{SELECT CHANNEL}		
	{TOGGLE}		

Config Menu

{Config}			
	{SELECT CHANNEL}		
	{ADD/REMOVE}		
	{DELAY}	Number keys 0.000 to 1.275	
			{s} (seconds)
			{ms} (milliseconds)
	{WIDTH}		
		Number keys 0.000 to 1.275	
			{s} (seconds)
			{ms} (milliseconds)
	{DRIVE}		
		{ADD/REMOVE}	
	{VERIFY}		
		{ADD/REMOVE}	
	{POWER FAIL}		
		{ADD/REMOVE}	

Misc Menu

{Misc}	
	{SAVE TO EEROM}
	{INIT RAM}
	{DELETE RAM}
	{SELF TEST}
	{POWER RECOVERY}

Display Command Reference

Channels, Paths, and Groups

70611A

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

70612A,C and 70613A,C

- The 70612A,C and 70613A,C can control up to seven external driver cards. The cards are numbered from 1 to 8.
- Each driver card can control up to 31 different relays. The relays on each card are numbered from 0 to 30.
- Each relay is referred to as a *channel* by the switch driver. 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, etc.) 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, refer to the “Save Memory” and “Restore Memory” programs in Chapter 6, “Remote Operation.”

Display (Front Panel) Command Sequences

The following pages list all of the display (front panel) command sequences for the 70611A, 70612A,C, and 70613A,C

{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

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

{ADD/REMOVE}

Key Sequence

{Group} {edit path} {path data} {ADD/REMOVE}

{Config) {ADD/REMOVE}

{Config) {DRIVE) {ADD/REMOVE}

{Config) (VERIFY} {ADD/REMOVE}

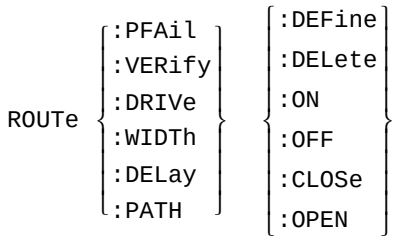
{Config) {POWER FAIL} {ADD/REMOVE}

Description

The ***{ADD/REMOVE}*** softkey actually functions as 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. Refer also to `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 Reference:



{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.
- 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 70611A) they must be added to the Drive List. Refer to **{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 Agilent relays are shown in Table 1-1 and Table 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, and 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, and 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 70611A RAM memory.

Refer to the “Save Memory” and “Restore Memory” example programs toward the end of Chapter 6, “Remote Operation”.

The preset state of the RAM is described in `MEMory:DELete` in 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 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. Refer to ***{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

```
                 ┌ :DEFine?  ┐
                 │ :CATalog? │
ROUTe:GROUP      { :LABel    }
                 │ :VALue    │
                 └ :DELete   ┘
```

{Group}

Key Sequence

{Group}

Description

The 70611A, 70612A,C, and 70613A,C power up in the Group Menu, which shows 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 the ***{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, 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 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:SEQuence: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 paths 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

```
                ┌:DEFine   ┐
                │:CATalog? │
ROUTe:PATH{     │: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 a 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 user 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:SEQuence: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 (refer to “Power Fail”). If the Power Fail List is empty, 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

{Group} {SELECT PATH}

Description

Pressing ***{SELECT PATH}*** 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.

{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 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.

- 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

```
            ┌ :VERify ┐
ROUTe:GROUP { :DRIVE  }
            └ :WIDth  ┘
```

Programming Internal Switches and Optional Step Attenuators

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

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

The interface module has the path definition, names and labels stored inside the EEROM.

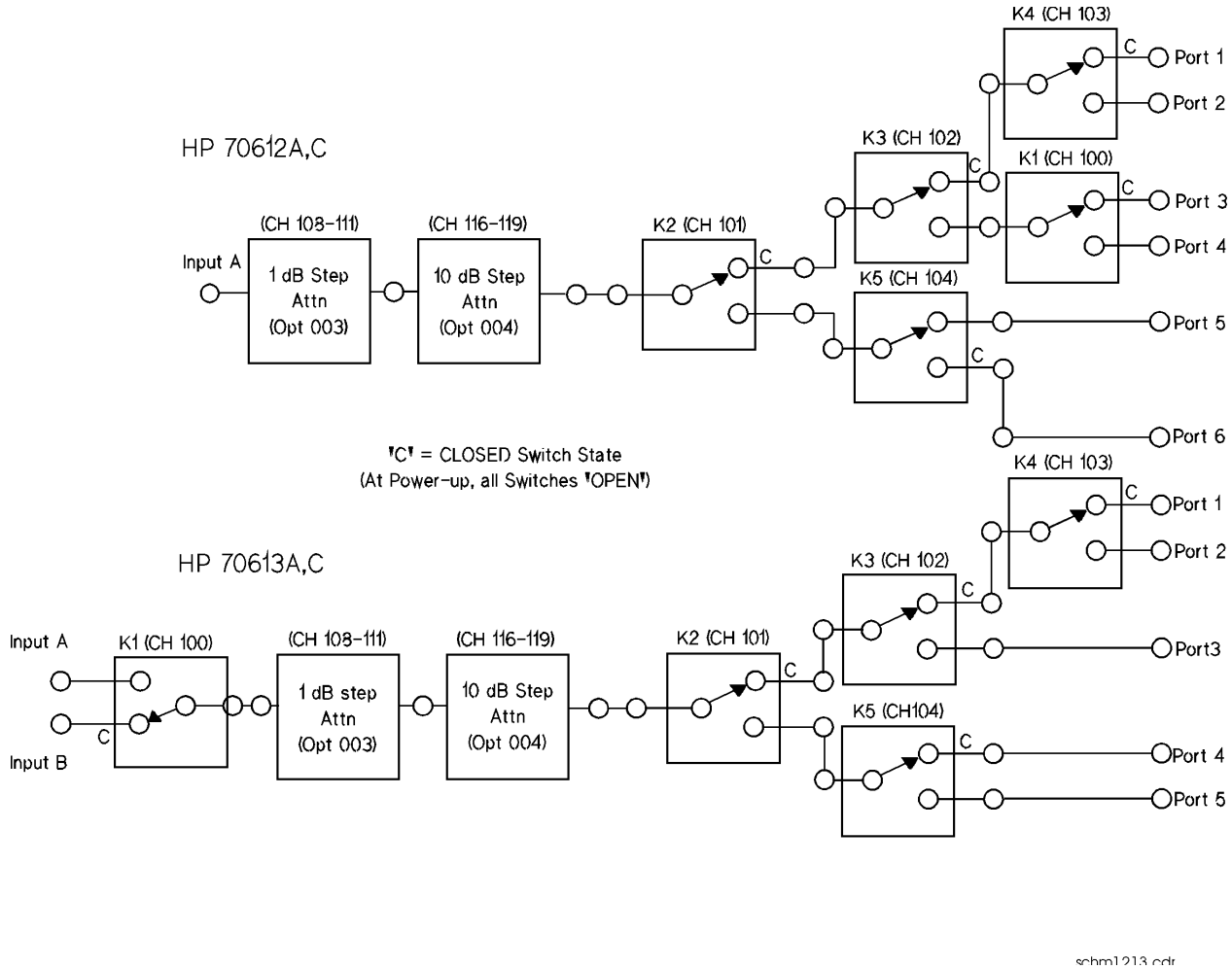


Figure 5-17 Schematics of 70612A,C and 70613A,C

Table 5-2 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 70613A,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, 129
2	A	P2TOA	Port 2 to A	101, 102, 120, 121, 122, 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	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, 122, 125, 126, 127, 129	101, 102, 103, 120, 124
5	B	P5TOB	Port 5 to B	100, 120, 122, 126, 127, 129	101, 102, 103, 104, 121, 124

Table 5-4 70612A,C and 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 70612A,C and 70613A,C Option 003 (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 70612A,C and 70613A,C 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

Overview

In this chapter you will learn about programming the 70611A, 70612A,C and 70613A,C modules using a controller. There are four operations that can be performed using a controller:

- Setting up the switch driver and start programming groups and paths for switches.
- Setting switch delay, pulse width, and sensing.
- Sensing switch status.
- Storing and retrieving switch parameters via remote interface.

Other more complicated tasks use a combination of these four basic functions.

To use this chapter

First perform the "Operating Example" on page 5-5 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 switching speed information. The alphabetical listing and command tree can be used for your own applications.

You will also find:

- 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

Tip

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}***

Programming

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. Commands are sent over an HP-IB bus which follows IEEE 488.1. Commands are also sent over the MSIB bus.

Language

The programming examples in this manual are written in BASIC 5.0 for a controller operating over HP-IB. 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, a 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 BASIC “OUTPUT” statement causes more than just the output of data to take place. For controllers other than HP/Agilent which are using a programming language other than HP BASIC, additional steps may have to be added to the program examples given in this manual.

For more information, refer to IEEE Standard 488.1 (HP-IB) and IEEE Standard 488.2-1987 Codes, Formats, Protocols and Common Commands.

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 9000 Series 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.

Example 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.

Programming Conventions

The programming examples in this manual are written in Basic 5.0 for an HP-IB controller compatible system. 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.
- On most 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 bus must have a unique instrument address between decimal 0 and 30. The address must not be the address of the controller. Refer to Chapter 2, “Installation”. The device address passed with the program message must include *both* the correct instrument address *and* the correct interface select code.

Example

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

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. *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 (a blank space which is required to separate the program mnemonic from the program data), headers, program data, and terminators. These elements are sent to the switch driver over the system interface as a sequence of ASCII data messages.

NOTE

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.

Example To execute a single function within a subsystem:

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

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

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

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

```
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.

Example 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, etc.). Their syntax is:

*<command header><terminator>

No space or separator is allowed between the asterisk and the command header.

Example *CLS is an example of a common command header.

```
*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” later in this chapter.

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. 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.

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

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

Character Program Data

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

Example

```
ROUTE:VERIFY:ON:ALL
```

The `:VERIFY` function is specified to be ON for *all* channels.

Numeric Program Data

Some command headers require program data to be a number.

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. 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. Query commands are used to find out how the switch driver is currently configured. 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).

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 also used to get results of switch status made by the switch driver, with the query actually activating the switch.

Example

```
ROUTe:CLOSE? <channel spec>
```

instructs the driver to sense the status of the switch and place the result in the output queue.

The output queue must be read before the next program message is sent.

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.

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.

The actual commands and syntax for initializing the switch driver are discussed in the section on "Common Commands." Refer to the controller 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 this command returns the switch driver to display operation; however, the switch driver still accepts remote commands.

```
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
80              !Switch driver will respond
```

Ordinarily, any command from the computer will place the switch driver into remote mode. However, if 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.

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$
```

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

Example All results for queries sent in a program message must be read before another program message is sent.

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$.

NOTE

- 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.

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.

Example This 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 query for command and execution errors. Refer to the `*ESR?` command for more information.

Common Commands Reference

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

- The common commands control some of the basic instrument functions, such as instrument identification, reset, and how status is read and cleared.
- The common commands are defined by the IEEE 488.2 standard and are common to all instruments that comply with this standard.

Table 6-1 IEEE 488.2 Command 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. This 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.

Table 6-2 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 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.

Refer to the command "*STB (Status Byte)" on page 6-20 to learn how the `ESR` is reported through the status byte.

Table 6-3 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 errors 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,US12345678,950713`

where US12345678 is a typical serial number and 950713 is a firmware version 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` is also used to signal the end of `MEM:SAVE` operation.
- `*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.

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:CLOS (@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` affects only the switches themselves and does not affect the configuration data stored in RAM (DRIVE and VERIFY lists, drive and delay times, etc).

The **[IP]** or [**Instr Preset]** key does a `*RST` operation, as does the `*TST?` command.

Example Command

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

*SRE (Request Enable)

Syntax

```
*SRE mask

*SRE?
```

Description

The *SRE command sets the Service Request Enable Register bits. 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.

Table 6-4 Service Request Enable Register

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

*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.

Table 6-5 Status Byte Bit Definitions

Bit	Weight	Name	Condition
7	128	OPER	0 = no operation status events have occurred 1 = an operation status events 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 events 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
```

Refer to 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), and then get placed in the appropriate power up positions. Refer to `*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 nor 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

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 6-6 Command Tree

```
ROUTE
            :CLOSe
            :OPEN
            :PATH
                        :DEFine
                        :CATalog?
                        :LABel
                        :VALue
                        :DELete       :ALL
            :GROUP
                        :NAME
                        :CATalog?
                        :ADD
                        :REMove
                        :DEFine?
                        :LABel
                        :AUTOselect
                                      :ON
                                      :OFF
                        :DELete
                        :DELete       :ALL
```

Command Tree (continued)

```
ROUTE
              :PFAil
                                  :CLOSe
                                  :OPEN
                                  :DELete
              :VERify
                                  :ON
                                  :OFF
                                                :ALL
              :DRIVe
                                  :ON
                                  :OFF
                                                :ALL
              :WIDth
              :DELay
```

Command Tree (continued)

```
MEMory
              :DELete
              :INITialize
              :SAVE
              :FREE?
STATus
              :OPERation
                                  :[EVENt]?
                                  :CONDition?
                                  :ENABle[?]
                                  :PTRansition[?]
                                  :NTRansition[?]
              :QUEStionable
                                  :[EVENt]?
                                  :CONDition?
                                  :ENABLe[?]
SYSTem
              :VERSion?
              :ERRor?
TRIGger
              :SEQuence
                                  :DELay[?]
```

NOTE

A colon (:) must be used in front of the `ROUTE`, `DIAGnostics`, `MEMory`, etc. commands if that command is not the first item in a command string. (The colon is optional if the command is the first in the string.)

SCPI Command Reference

Channel Lists

70611A

The 70611A can control up to seven different external 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.

70612A,C and 70613A,C

The 70612A,C and 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.

Example (@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.

SCPI Commands

The following pages list all of the SCPI compound command program mnemonics used to program this instrument.

: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`. Refer to 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.

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  } :CATALOG?
      {:GROUP }
```

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[?] {<path name>    }
               {<channel list>}

ROUTe:PFail:CLOSe[?] {<path name>    }
                     {<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 labeled 2 on the relay and the input terminal labeled C. It is recognized that CLOSE and OPEN are arbitrary 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.

- 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 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 (refer to 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.

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, and then switches 103 and 104 will be opened.

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.

NOTE

If you are configuring hardware for switching systems, keep in mind that CLOSE settings are executed before OPEN settings when a path is sent.

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 intermediate stage (after the CLOSEs and before the OPENs) is a stage representing higher attenuation and thus avoids signal spikes that could damage sensitive hardware.

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 a 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.

- 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.
- 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 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>  }
                         {<path name>}

ROUTe:DELay? <channel list>
```

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 (refer to ":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.

NOTE

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 list 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
```

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]      }
```

Description

This command sets memory to an initial state.

This command deletes the following:

- All data associated with the specified path or group and frees up the path storage register.
- All channels from the PFAIL list.

.

NOTE

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 (refer to `MEM:DELETE`).

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

This deletes all data associated with all the groups. The group names are set to the default (refer to `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 through 30 on card 1 used 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.

If you also wish to delete the EEROM data, this command should be followed by a `MEM:SAVE` command to copy this state to the EEROM.

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

Syntax

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

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

ROUTe:DRIVe { [:ON] | :OFF } <pathname>

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.

NOTE 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. Refer to 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.

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)
```

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.

If it is on for channels 101 and 105 and off for 103, the switch driver will return:

```
0,1,0
```

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. (Refer to “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”).

All possible error numbers with their descriptions are listed below.

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 significant (rightmost) two bits are channel 0, the most significant (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

Instability 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.

- 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 UNTERMINATD
-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 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

```
                    ┌ :NAME          ┐
                    │ :CATalog?      │
                    │ :ADD           │
ROUTE:GROUP         │ :REMove[?]     │
                    │ :DEFine[?]     │
                    │ :LABEL[?]      │
                    │ :AUTOselect[?] │
                    └ :DELete:ALL    ┘
```

Description

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

A “group” is an ordered collection of up to 256 paths. Paths can be collected into meaningful groups using the `GROUP` command. The 70611A can store up to 16 groups. Each group may be defined and labeled.

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. Refer to the `MEM:SAVE` command.

: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 70611A (or 70612A,C or 70613A,C as appropriate.) The serial number is initialized to USXXXXXXX.

   When equipment is manufactured by HP/Agilent, it is give a unique serial number. A serial number label is attached to the rear panel of the module. The first six entries are the same for all identical modules; they only change when a change in the electrical or physical functionality is made. The remaining digits are assigned sequentially and are different for each instrument.

If the EEROM tests is not defective, its data is downloaded into RAM, which cancels the effect of steps 1 and 2. If the EEROM is faulty, no download is performed.

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  }:LABEL {<path name> } “<label>”;
      {:GROUP }       {<group name>}
```

Description

This command specifies a label (32 characters max) to be used when labeling 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 characters.

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 already 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.

Refer to the `MEM:DELETE` command description for the default group names assigned when memory is initialized 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[?] {<path name>   }
              {<channel list>}

ROUTe:PFail:OPEN[?] {<path name>   }
                    {<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 labeled 1 on the relay and the input terminal labeled C. It is recognized that CLOSE and OPEN are arbitrary 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);
```

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 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 will be the state they were set to at power up if they haven't been switched since 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 through 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 and then switches 101 and 102 will be opened.

NOTE

If you are configuring hardware for switching systems, keep in mind that CLOSE settings are executed before OPEN settings when a path is sent.

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 intermediate stage (after the CLOSEs and before the OPENs) is a stage representing higher attenuation, and thus avoids 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 separated by commas.

- A 1 means the channel is in the PFA:OPEN list.
- A 0 means that it is not.

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.

If a relay is in neither the PFAil:OPEN or PFAil:CLOS lists, its power up state is determined by the last save stored to EEROM for that relay.

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.

: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 70611A.

- Paths are specified using CLOSE and OPEN channel lists. Each relay contains one CLOSE and one OPEN path. Refer to the :CLOSe and :OPEN command explanations 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 OPENs and CLOSEs in the path.
- The paths can be defined, labeled, 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.

NOTE

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. Refer to the MEM:SAVE command section.

:PFAil

Syntax

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

Description

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.
- 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. Refer to 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`. Refer to the query `:DEFine? <group name>` to list all paths in a group.

ROUTe

Syntax

Refer to the 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. (Refer to `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,
- what PATHs are in each group
- all PATH data, including path names, titles, and values
- 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

```
                    ┌ :[EVENt]?      ┐
                    │ :CONDition?    │
STATus:OPERation    { :ENABle[?]     }
                    │ :PTRansition[?]│
                    └ :NTRansition[?]┘

                      ┌ :[EVENt]?  ┐
STATus:QUEStionable   { :CONDition? }
                      └ :ENABle[?] ┘
```

Description

The STATus subsystem is fully specified by SCPI. 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 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:OPERation:PTRansition[?]`

- `STATus:QUEStionable`

The `QUEStionable` subsystem is required by SCPI but is not used by the 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 <number>
```

Description

This command allows the user to control the 24 V power supply recovery time. Input values are limited to between 0 and 200 ms. 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 supply and must be long enough for the specific application.

Example Command

```
TRIG:SEQ:DEL .15
```

This example assigns the value, 150 msec, to the `TRIGger` command.

Example Query

```
TRIG:SEQ:DEL?
```

The query form returns the assigned number. For the example, it would return

```
.15
```

:VALue [?]

Syntax

```
ROUTe:PATH:VALUE <path name>,<number>;
```

Description

This command specifies a number (integer in the range – 32768 to 32767) to be used when labeling 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]} {:ALL          }
             {:OFF } {<path name>   }
                     {<channel list>}

ROUTe:VERify {:[ON}} [?]<channel list>
             {:OFF }
```

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. Refer to the list of Hewlett-Packard compatible 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. Refer to the `MEM:SAVE` command.

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. Refer to the `:DELay` command 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) 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
```

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 with 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
```

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

The following programs written in Rocky Mountain Basic provide sample programs that may be helpful in programming the 70611A, 70612A,C and 70613A,C.

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 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$
870      ! HAVE TO OUTPUT THIS DATA ON THE FLY, AS 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 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},Paththitles$(255)[32],
          Pathval(255)
70    DIM Groupdata$(15,255)[12],Groupauto(15)
80    COM @File,@Sw
90    MAT Pathnames$= (“”)
100   MAT Gpnames$= (“”)    ! Group names
110   MAT Paththitles$= (“”)
120   MAT Gptitles$= (“”)   ! 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$(I,J)&””&”;”
520         J=J+1
530       END WHILE
540     END IF
550   NEXT I590     IF Pathnames$(I)<>”” THEN
560   ENTER @File;Pathtitles$(*)
570   ENTER @File;Pathval(*)
580   FOR I = 0 to 255
590    IF Pathnames$(I)<>”” THEN I=0 TO 255
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

Switching speed is a function of pulse widths, sensing delays, the state of the chosen channels, and the sequence of relays driven. A sample program and timing diagram are provided to help the user minimize switching time, since the user determines pulse widths, sensing delays and which channels are opened or closed.

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 you want 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 6-7 shows which connectors (J1 to J31) are on the same drive lines. Refer to the installation instructions to wire your relay into the arbitrary positions of OPEN and CLOSE.

Table 6-7 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	1 2, 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 following program along with Figure 6-1 on page 6-76 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 boards and the programmed variables of `:DELay` and `:WIDTh` can be calculated for a total switching time for any switching operation.

Recall that 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.

```
10 DIM Closl$[40]
20 OUTPUT 709:"*RST"
30 OUTPUT 709;"ROUT:DRIV:ON (@100:111);"
40  !
50  !     Drive is set to ON for channels 100 through 111 using
60  !    a range.
70 OUTPUT 709;"ROUT:DRIV:OFF (@112:130);"
80  !
90  !     Drive is set to OFF for remaining channels on driver
100 !     card 1.Unless channels are part of Drive list, no
110 !     pulse (:WIDTh) is sent.
120 OUTPUT 709;"ROUT:VER:ON (@100:111);"
130 !
140 !      Sensing is ON for channels 100 through 111.
150 !      VERify:ON works at switching time, and errors
160 !      (if they exists) are reported back immediately.
170 !
180 !      Unless channels are part of Verify list no sensing
190        (:DELay) can be valid.  In other words,
190 !      you can choose to sacrifice sensing for speed.
200 !
210 !
220 OUTPUT 709;"ROUT:CLOS (@100:111);"
230 !
240 !      This command ensures all channels start in the same
250 !      (CLOSE) state.
260 OUTPUT 709;"ROUT:CLOS? (@100:111);"
270 !
280 !      Queries CLOSe list.
290 !
300 ENTER 709;Closl$
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
350 !      CLOSE) state.
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 Openl$[40]
380 OUTPUT 709;”ROUT:WIDT .04,(@100,102,104,108);”
390 !
400 !      Pulse (:WIDTh) is set to 40 ms for channels 100,102,
410 !      104, and 108. When :OPEN is sent, 100 and 102
420 !      will OPEN at the same time.
430 !      Channels 104 and 108 will each OPEN at different
440 !      times, because they are connected to different
450 !      drive lines. See the Relay Drive Sequence table
460 !      and Figure 6-1, Timing Diagram.
470 !      In the absence of a pulse width declaration for
480 !      channels 101 and 103, of 30 ms seconds is applied.
490 OUTPUT 709;”ROUT:DEL .015,(@100:103);”
500 !
510 !      Sensing (:DELay) is set to 15 ms for channels 100 to
520 !     103.
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
690 !      open.
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
750 !      107 would still report back 1,1,1,1.
750 !      The query :OPEN? (or :CLOSe?) queries the channel
760 !      list, not the relay. The switch
770 !      driver reports the state the switch should be in.
780 !
790 ENTER 709;Openl$
800 PRINT Openl$
810 !
820 !      Switch driver should respond with: 1,1,1,1,1,1,1,1,1
830 !
840 END
```

.

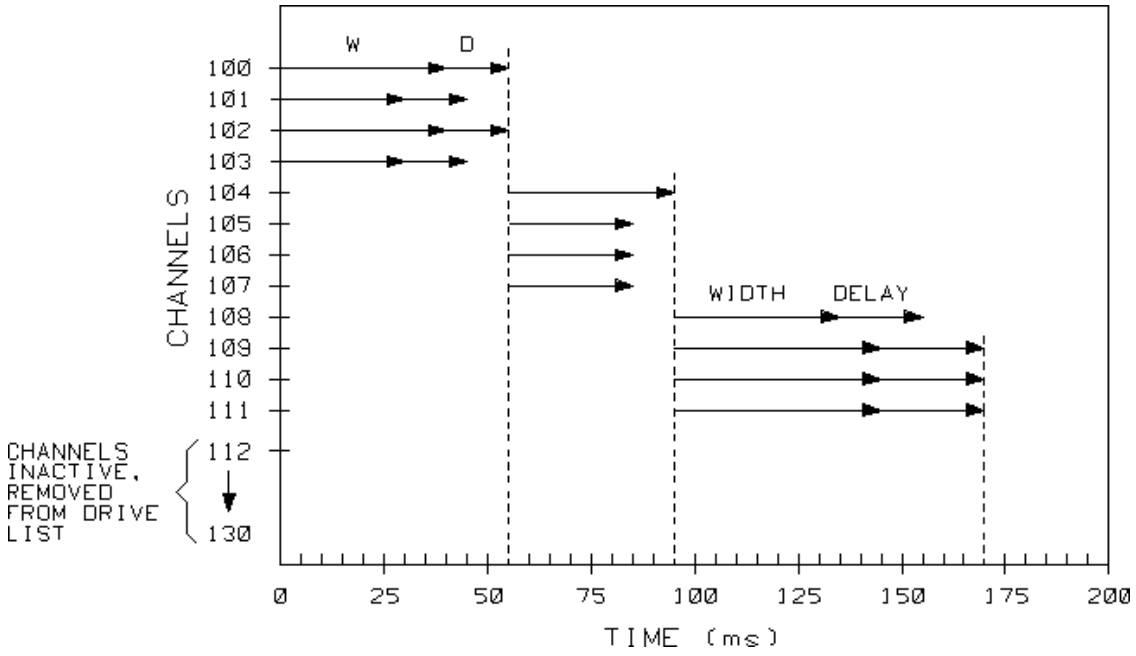


Figure 6-1 Timing Chart

Programming Internal Switches and Optional Step Attenuators

The switches inside the 70612A,C and 70613A,C interface modules have preprogrammed switch path definitions and front panel light controls.The path definition, names, and labels are stored inside the EEROM.

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

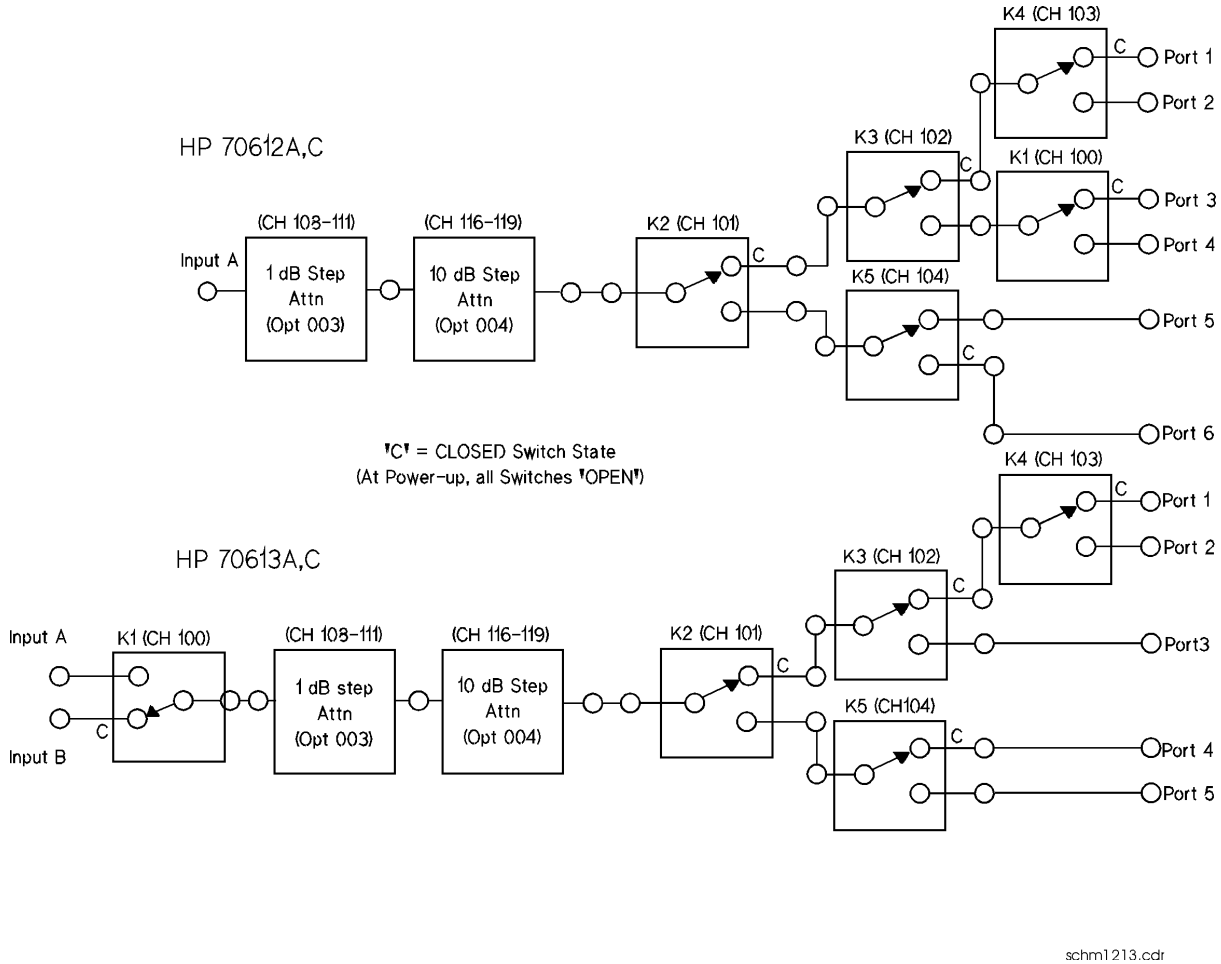


Figure 6-2 Schematics of 70612A,C and 70613A,C

Table 6-8 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 6-9 70613A,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, 129
2	A	P2TOA	Port 2 to A	101, 102, 120, 121, 122, 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, 122, 126, 127, 129	101, 102, 103, 104, 121, 124

Table 6-10 70612A,C and 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 6-11 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 6-12 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

Overview

In this chapter you will find:

- Accessories available for the switch driver by part number and description.
- All replaceable parts referenced in chassis and cable assemblies.

Accessory Boards and Cables

Additional driver boards, interconnect boards, and cables provide expanded capacity, remote switching and everything needed for device connection.

Table 7-1 Accessories

Agilent Part Number	Description
11764-60009	Cable (no sensing),10 pin DIP to 4-pin Berg connectors, 30 inches (used with 87222C,D,E transfer switch)
11764-60010	Cable (sensing), 10 pin DIP to 4-pin Berg connectors, 30 inches (used with 87222C,D,E transfer switch)
70611-60004	Cable, 68-pin to 68-pin SCSI II, 6 feet, 28 AWG
70611-60008	32 cables with connectors, 52 inches, 26 AWG (84940A to switches)
70611-60010	Cable, 36-pin SCSI II to 36 pin SCSI II, shielded, 5 feet, 28 AWG
70611-60011	Cable, ribbon, 36-pin SCSI II to 34-pin, 18 inches, 28 AWG
70611-60013	Cable kit, ribbon 36-pin SCSI to 34-pin
70611-60014	Service Aid. (For use in performance tests)
70612-60011	Cable, dual 36-pin SCSI II to 34-pin ribbon, 36 inches, 28 AWG
84940A	Driver board
84941A	Distribution board

Firmware Revisions

Firmware for the 70611A, 70612A,C, and 70613A,C is listed in the replaceable parts list. Older versions of this instrument may have firmware part numbers different from those listed in Table 7-7 and Table 7-8. 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.

Table 7-2 Replaceable Parts for 70611A, 70612A,C, 70613A,C Cover

Reference Designation	Agilent Part Number	Quantity	Description
70611A			
1	0515-2087	10	Screw, torx metric
2	0515-2087		Screw, torx metric
3	70611-00005	1	Cover
70612A,C and 70613A,C			
1	0515-2087	12	Screw, torx metric
2	0515-2087		Screw, torx metric
3	70612-00004	1	Cover

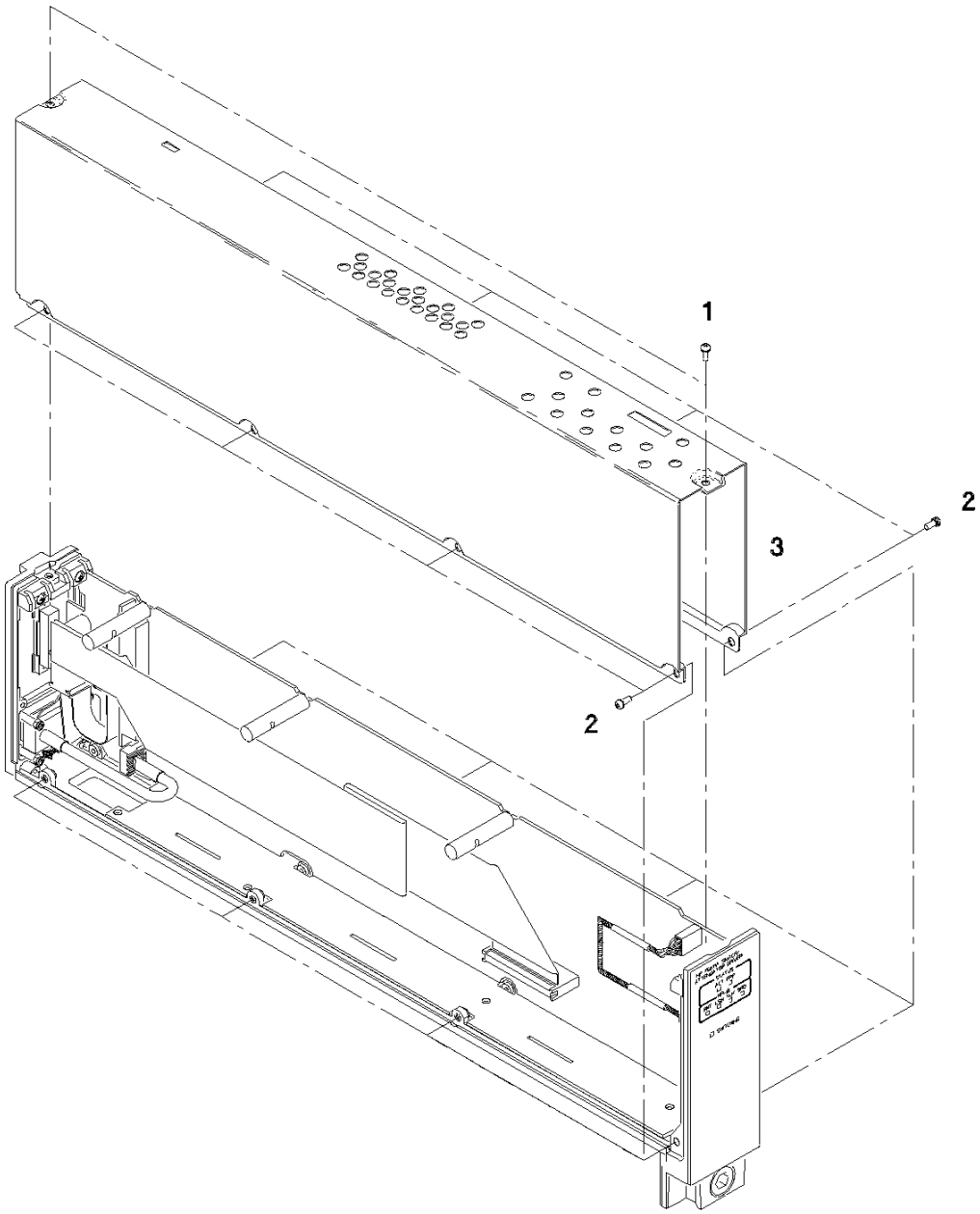


Figure 7-1 70611A, 70612A,C, 70613A,C Cover Removal

Table 7-3 Replaceable Parts for 70611A Front Panel

Reference Designation	Agilent Part Number	Quantity	Description
1	70611-60006	1	Display cable assembly
2	0515-0430	7	Screw, mach assembly M3 X 0.5 6MM-LG
3	0515-0430		Screw, mach assembly M3 X 0.5 6MM-LG
4	70700-40002	1	Guide PC board blk
5	70611-60003	1	Status PC board assembly
6	0515-1244	1	Rtnr push on
7	0900-0012	1	O ring
8	70611-20006	1	Front frame
9	0515-1851		Screw, torx metric
10	5180-2350	1	MMS serial tag and option
11	5022-0051	1	Latch front
12	70611-00008	1	Front panel

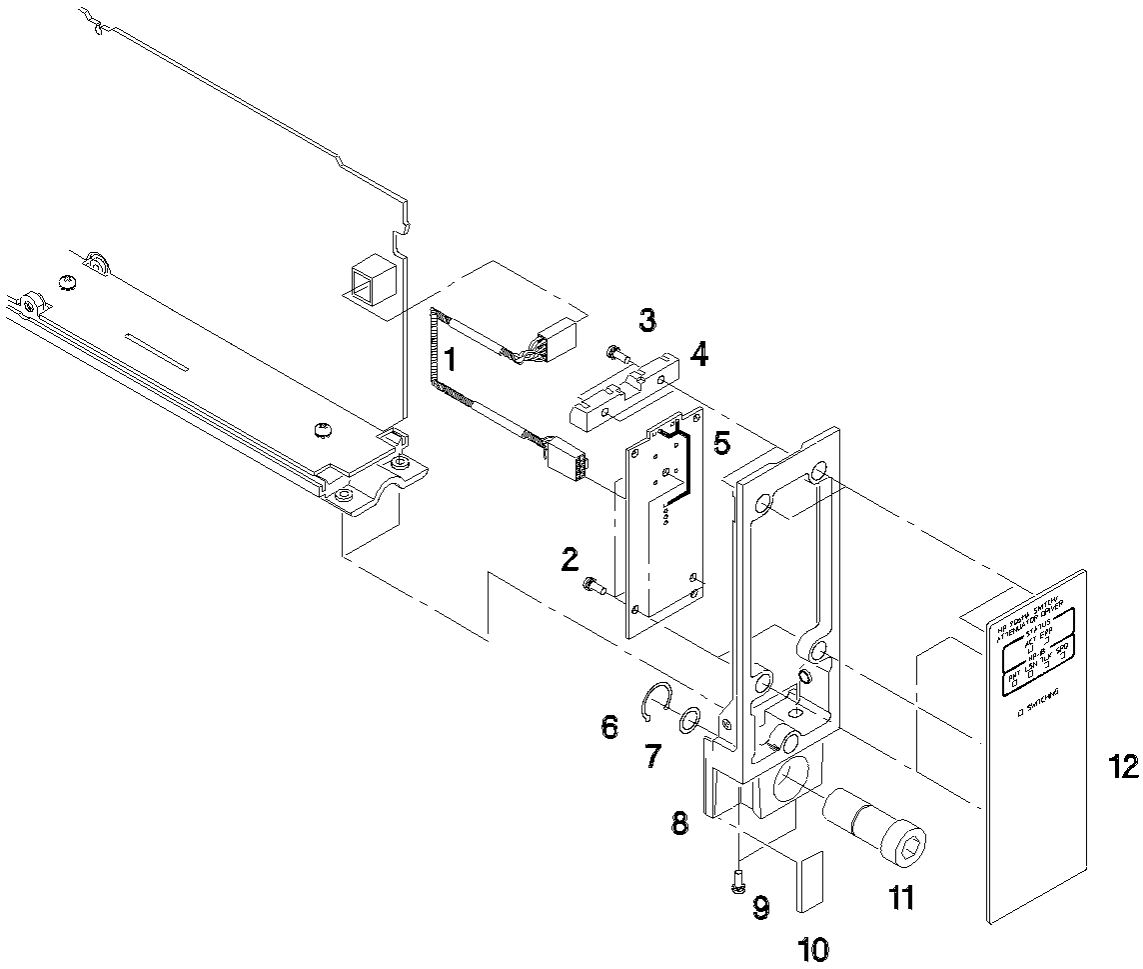


Figure 7-2 70611A Front Panel Removal

Table 7-4 Replaceable Parts for 70611A Rear Panel

Reference Designation	Agilent Part Number	Quantity	Description
1	0535-0042	2	Nut, hex plstc lkg M3 X0.54mm thk
2	1460-2095	2	Spring, compression, 5.49-mm-OD 16.8-mm-OA-LG
3	5001-5835	2	Bar connector
4	0535-0042		Nut, hex plstc llkg M3 X0.54mm thk
5	1460-2095		Spring, compression, 5.49-mm-OD 16.8-mm-OA-LG
6	5001-5835		Bar connector
7	0515-0430	8	Screw, mach assembly M3 X 0.5 6MM-LG
8	70700-40002	1	Guide PC board blk
9	70611-60011	1	Cable assembly 36/34 std
10	70700-20007	1	Rear frame
11	0515-1950		Screw, torx metric
12	70611-00006	1	Rear panel
13	0515-0430		Screw, mach assembly M3 X 0.5 6MM-LG
14	0515-2028	2	Screw, mach torx M2.5X0.45 6mm-lg

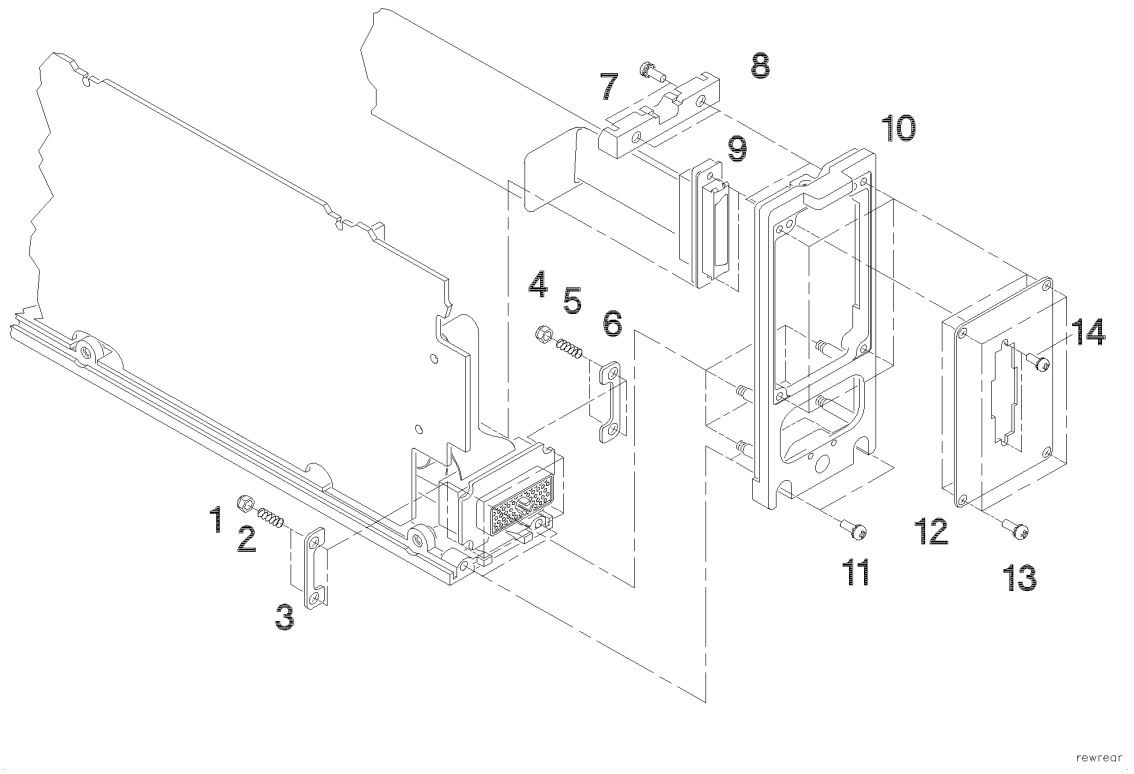


Figure 7-3 70611A Rear Panel Removal

Table 7-5 Replaceable Parts for 70611A Option 001 Rear Panel

Reference Designation	Agilent Part Number	Quantity	Description
1	0535-0042	2	Nut, hex plstc lkg M3 X0.54mm thk
2	1460-2095	2	Spring, compression, 5.49-mm-OD 16.8-mm-OA-LG
3	5001-5835	2	Bar connector
4	0535-0042		Nut, hex plstc llkg M3 X0.54mm thk
5	1460-2095		Spring, compression, 5.49-mm-OD 16.8-mm-OA-LG
6	5001-5835		Bar connector
7	0515-1950	6	Screw, torx metric
8	70700-40002	1	Guide PC board blk
9	70700-20007	1	Rear frame
10	0515-1950		Screw, torx metric
11	70611-00004	1	Rear panel
12	0515-0430		Screw, mach assembly M3 X 0.5 6MM-LG
13	0515-2028	2	Screw, mach torx M2.5X0.45 6mm-lg

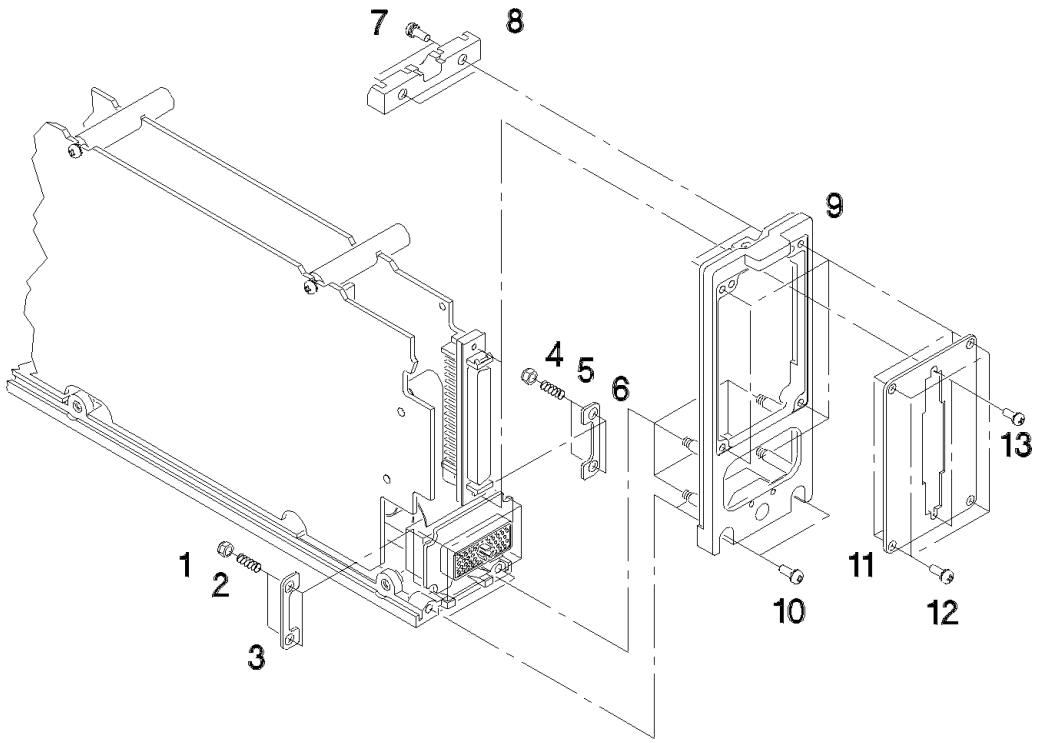


Figure 7-4 70611A Option 001 Rear Panel Removal

Table 7-6 Replaceable Parts for 70611A Controller Board

Reference Designation	Agilent Part Number	Quantity	Description
1	70700-0004-04	1	Bracket, ferrite
2	70700-60001	1	Flex assembly
3	70611-20008	1	Base mounting
4	70611-20004	3	Spacer cont board
5	70611-00007	1	Bottom panel
6	0515-0430	11	Screw, mach torx M2.5X0.45 6MM-LG
7	0515-0430		Screw, mach torx M2.5X0.45 6MM-LG
8	0515-0430		Screw, mach torx M2.5X0.45 6MM-LG
9	70611-20004		Spacer cont board
10	0515-0430		Screw, mach torx M2.5X0.45 6MM-LG
11	70611-20004		Spacer cont board
12	0515-0430		Screw, mach torx M2.5X0.45 6MM-LG
13	0515-0430		Screw, mach torx M2.5X0.45 6MM-LG
14	70611-60001	1	Controller board assembly

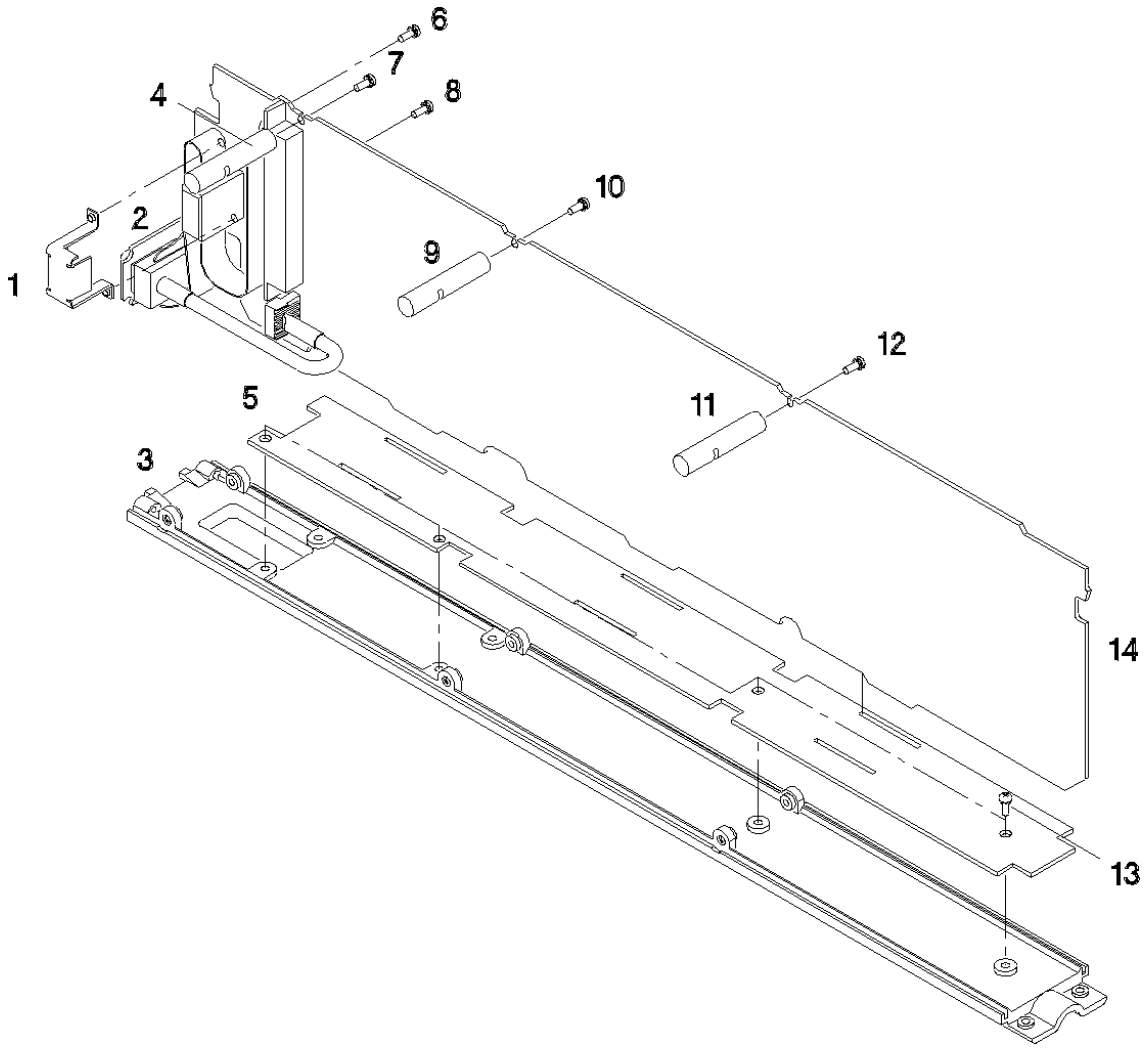


Figure 7-5 70611A Controller Board Removal

Table 7-7 Replaceable Parts for 70611A Option 001 PCA

Reference Designation	Agilent Part Number	Quantity	Description
1	70700-00004	1	Bracket, ferrite
2	70700-60001	1	Flex assembly
3	70611-20008	1	Base mounting
4	70611-20004	3	Spacer cont board
5	70611-00007	1	Bottom panel
6	0515-0430	11	Screw, mach torx M2.5X0.45 6MM-LG
7	0515-0430		Screw, mach torx M2.5X0.45 6MM-LG
8	0515-0430		Screw, mach torx M2.5X0.45 6MM-LG
9	70611-20004		Spacer cont board
10	0515-0430		Screw, mach torx M2.5X0.45 6MM-LG
11	70611-20004		Spacer cont board
12	0515-0430		Screw, mach torx M2.5X0.45 6MM-LG
13	0515-0430		Screw, mach torx M2.5X0.45 6MM-LG
14	70611-60001	1	Controller board assembly
	70611-80017	1	EPROM (version 950713)
	70611-80018	1	EPROM (version 950713)
15	70611-60005	1	Cable assembly 34/34
16	87130-62025	1	Driver select board assembly

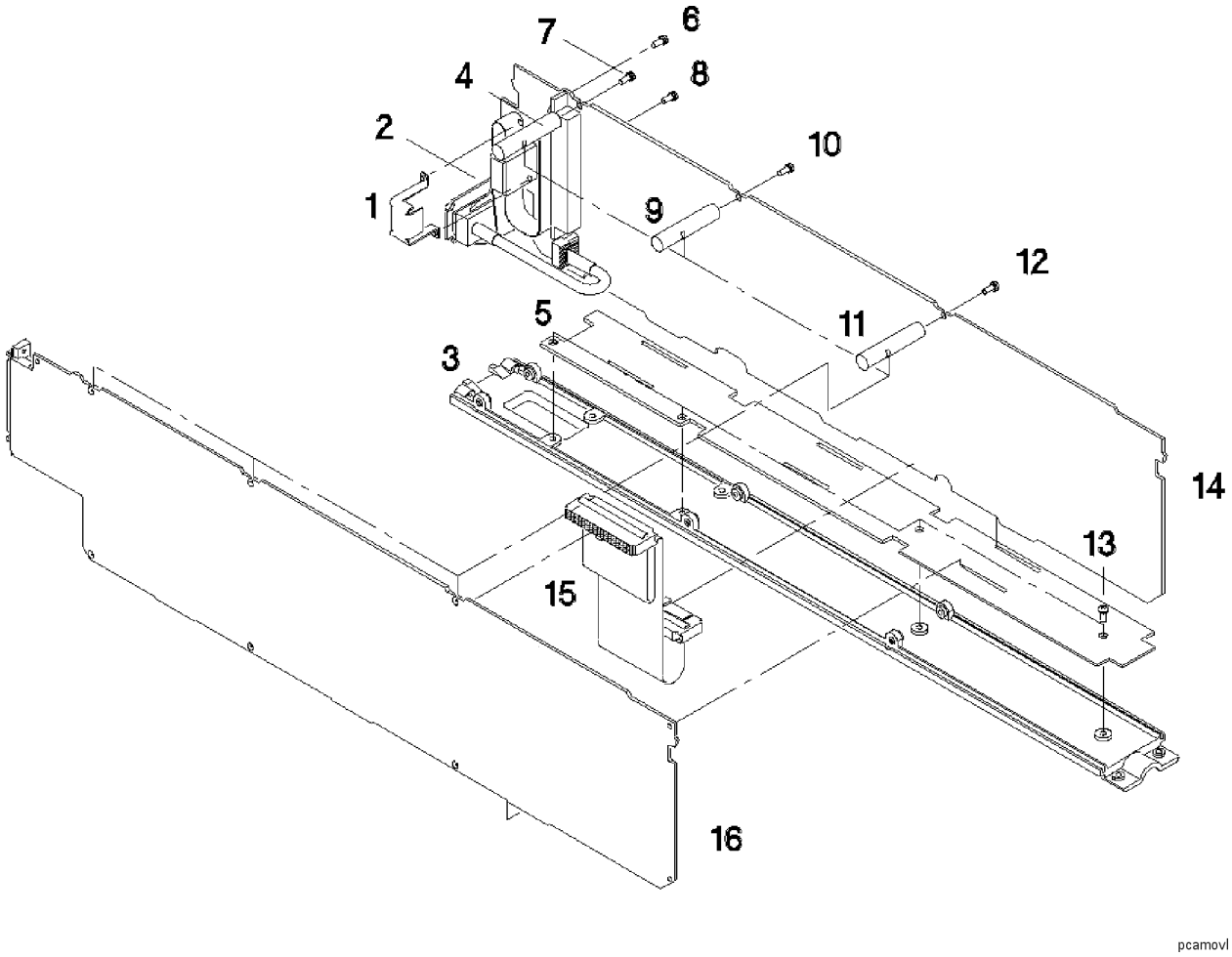


Figure 7-6 70611A Option 001 PCA Removal

Table 7-8 Replaceable Parts for 70612A,C and 70613A,C

Reference Designation	Agilent Part Number	Quantity	Description
1	70612-00026	1	70612A front panel
	70612-00030	1	Opt 005
	70612-00032	1	Opt 006
	70612-00028	1	Opt 011
	70612-00013	1	70612C front panel
	70612-00030	1	Opt 005
	70612-00032	1	Opt 006
	70612-00028	1	Opt 011
	70613-00013	1	70613A front panel
	70613-00017	1	Opt 005
	70613-00019	1	Opt 006
	70613-00015	1	Opt 011
	70613-00014	1	70613C front panel
	70613-00018	1	Opt 005
	70613-00020	1	Opt 006
	70613-00016	1	Opt 011
2	70612-00004	1	Top cover
3	70611-20009	2	Front frame
4	1250-2366	7	Adapter, coax str SMA f/f
5	70611-60003	1	Status board assembly (not used Opt 006 and 001)
6	70612-60010	1	Display board
7	70611-60001	1	Controller board assembly
	70611-80017	1	EPROM (not used Opt 006 and 011) version 950713
	70611-80018	1	EPROM (not used Opt 006 and 011) version 950713
8	70612-20038	3	Space cont board (not used Opt 006 and 011)
9	70612-20039	2	Guide, PC board
10	0515-2087	14	Screw, torx metric
		24	Opt 006 and 011
11	70700-60001	1	50-pin connector
12	70700-20007	2	Rear frame
13	0515-0430	2	Screw, mach torx M2.5X0.45 6MM-LG
		4	Opt 006 and 011

Reference Designation	Agilent Part Number	Quantity	Description
14			Rear panel
	70612-00018	1	70612A,C standard and Opt 005
	70612-00019	1	70612A,C standard and Opt 006 and 011
	70613-00011	1	70613A,C Opt 005
	70613-00012	1	70613A,C Opt 006 and 011
15	70612-60049	1	Driver board assembly
16	5001-5840	1	Spring, grounding
17	0515-1950	8	Screw, mach assembly M3 X 0.5 8MM-LG
18	0486-1476	A/R	Tape, elec 33 mm long
19	70700-00004	1	Bracket, ferrite (not used Opt 006 and 011)
20	5001-5385	2	Bar connector (not used Opt 006 and 011)
21	1460-2095	8	Spring, compression 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	Retainer-push on circular-ext
26	0900--0012	1	O ring .3634-IN-ID .07-IN-XSECT-DIA NTRL
27	5022-0051	1	Latch front
28	8160-0731	2	RFI gasket
29	8160-0687	3	O ring gasket mat
30	0515-1946	28	Screw, MACH M3X0.5 6MM-LG 90-DEG-FLH-HD
		30	Opt 003 and Opt 004
		30	Opt 007
32	5180-2350	1	MMS serial tag and option
33			Rear sub panel
	70612-00023	1	All modules except Opt 006 and 011
34	70612-00022	1	Opt 006 and 011
35	70612-00006	1	Connector cover
		2	Opt 006 and Opt 011
36	70612-00021	2	Bracket, right
		1	Opt 006 and Opt 011
37	70612-00020	2	Bracket, left

Reference Designation	Agilent Part Number	Quantity	Description
		1	Opt 006 and Opt 011
38	706112-00024	1	Bracket, attenuator (Opt 003, 004, and 007)
	70612-60007	1	Attenuator 110 dB assy (70612A, 70613A Opt 004 and 007)
	70612-60015	1	Attenuator 110 dB assy (70612A, 70613A Opt 003 and 007)
	70612-60008	1	Attenuator 11 dB assy (70612C, 70613C Opt 004 and 007)
	70612-60014	1	Attenuator 90 dB assy (70612C, 70613C Opt 003 and 007)
39	70612-00025	1	PC board guard
40	70612-00005	1	Board bracket
41	0515-0480	12	Screw, torx

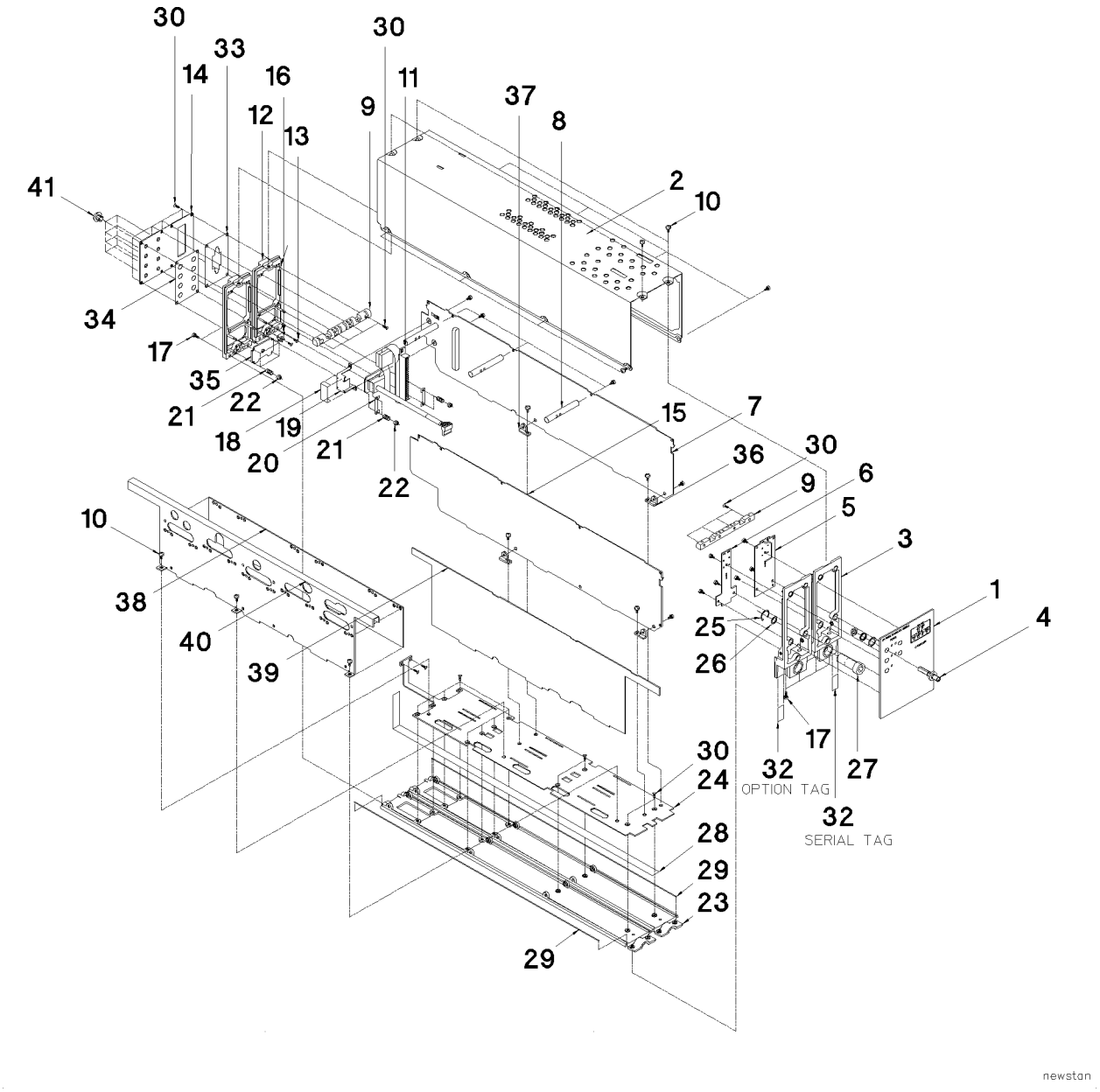


Figure 7-7 70612A,C and 70613A,C Standard

Table 7-9 Replaceable Parts for 70612A,C and 70613A,C Option 011

Reference Designation	Agilent Part Number	Quantity	Description
1	70612-00028	1	Front panel 70612A Opt 011
	70612-00029	1	70612C Opt 011
	70613-00015	1	70613A Opt 011
	70613-00016	1	70613C Opt 011
2	5022-0051	1	Latch front
3	70611-20009	2	Frame front
4	70612-20039	2	Guide, PC board
5	70612-60010	1	Display board assembly
6	70612-00021	1	Bracket, right
7	70612-00020	1	Bracket, left
8	1250-2366	7	Adapter, coax str SMA f/f
9	70612-00004	1	Top cover
10	0515-2087	12	Screw, torx metric
11	70612-00006	2	Connector cover
12	70700-20007	2	Rear frame
13	8160-0731	2	RFI gasket
14	70612-00019	1	Rear panel 70612A,C Opt 011
	70613-00012	1	70613A,C Opt 011
15	70612-60049	1	Driver board assembly
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 board guard
20	76312-00024	1	Attenuator bracket
21	1460-2095	8	Spring, compression 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	0515-1244	1	Retainer-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 Option
28	0515-2028	4	Screw, mach torx M2.5X0.45 6MM-LG
29	8160-0687	3	O ring gasket mat
30	0515-0430	42	Screw, mach assembly M3 X 0.5 6MM-LG
32	0515-1950	8	Screw, mach assembly M3 X 0.5 8MM-LG
33	70612-00005	1	Board bracket
34	0515-0430	8	Screw, mach assembly M3 X 0.5 6MM-LG

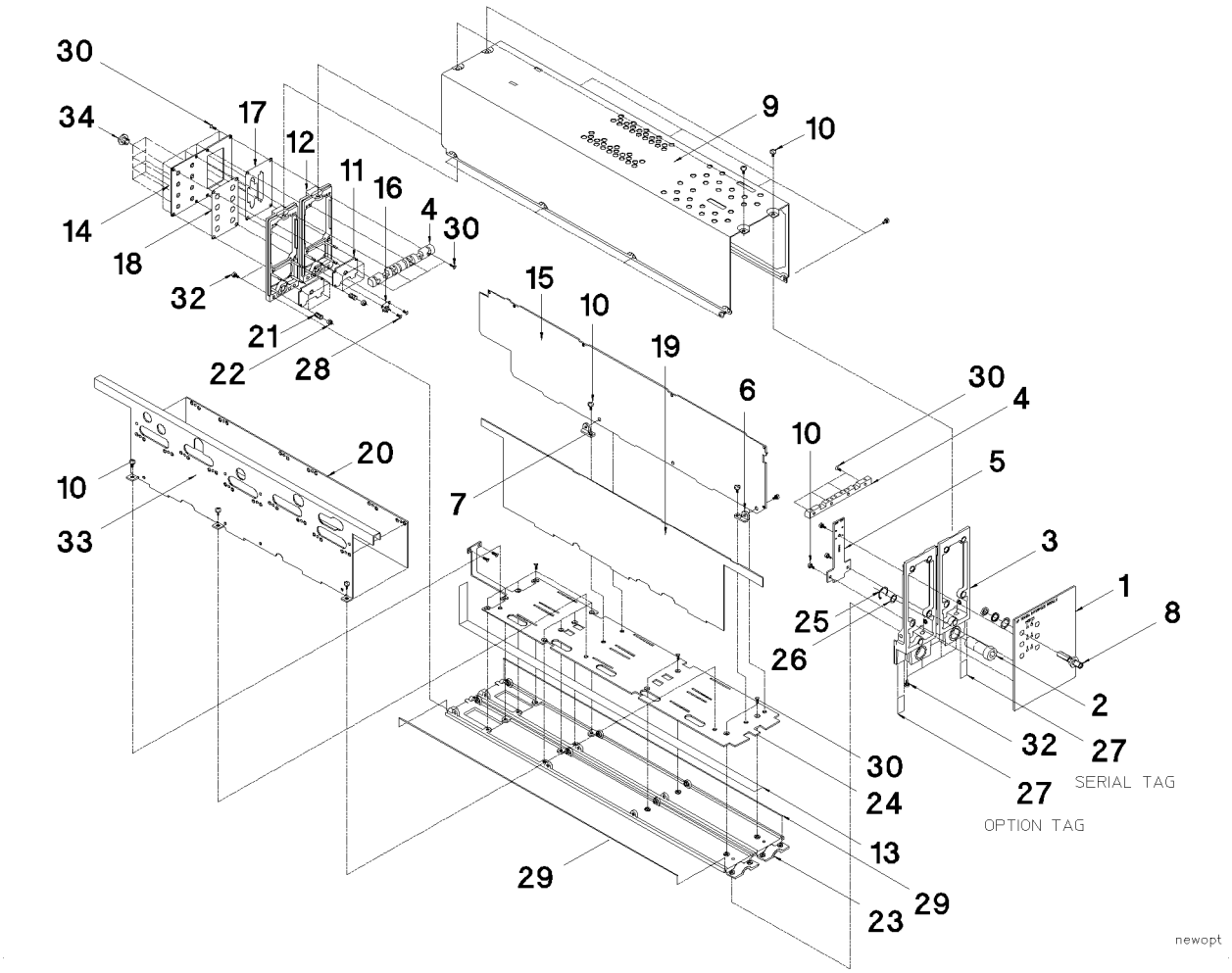


Figure 7-8 70612A,C and 70613A,C Option 011

Table 7-10 Replaceable Parts for 70612A,C and 70613A,C PCA Board Cables

Reference Designation	Agilent Part Number	Quantity	Description
1	70612-60002	1	Ribbon cable assembly
2	70612-60019	1	Ribbon cable assembly
3	70611-60006	1	Wire harness
4	70612-60018	1	Switch harness assembly
5	70612-60016	1	Attenuator cable assy 70612C, 70613C Opt 003, 007
6	70612-60017		Cable assembly/Viking connector attenuator
		1	70612A, 70613A Opt 003 and 004
		2	70612A, 70613A Opt 007
		1	70612C, 70613C Opt 004 and 007

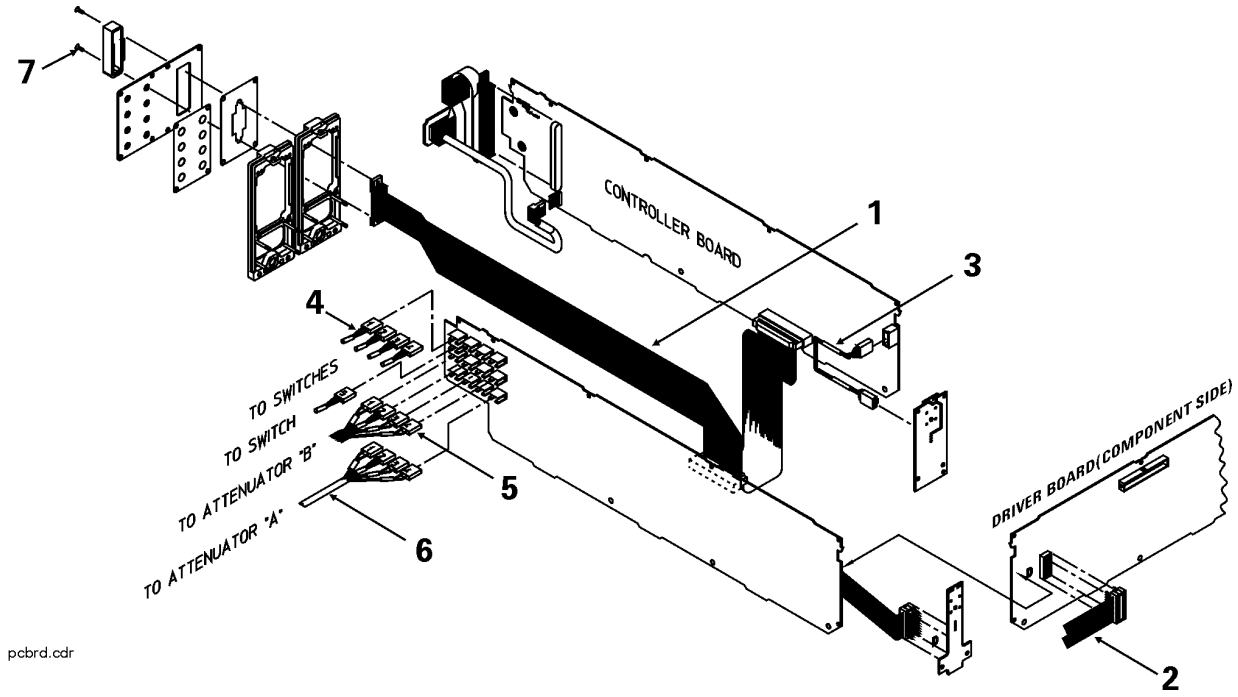


Figure 7-9 70612A,C and 70613A,C PC Board Cable Diagram

Table 7-11 Replaceable Parts for 70612A,C and 70613A,C Options

Reference Designation	Agilent Part Number	Quantity	Description
1	70612-60011	1	Ribbon cable assembly
2	70612-60019	1	Ribbon cable assembly
3	70612-60018	1	Switch harness assembly
4	70612-60016	1	Attenuator cable assy 70612C, 70613C Opt 003, 007
5	70612-60017		Cable assembly/Viking connector attenuator
			70612A, 70613A Opt 003 and 004
			70612A, 70613A Opt 007
			70612C, 70613C Opt 004 and 007

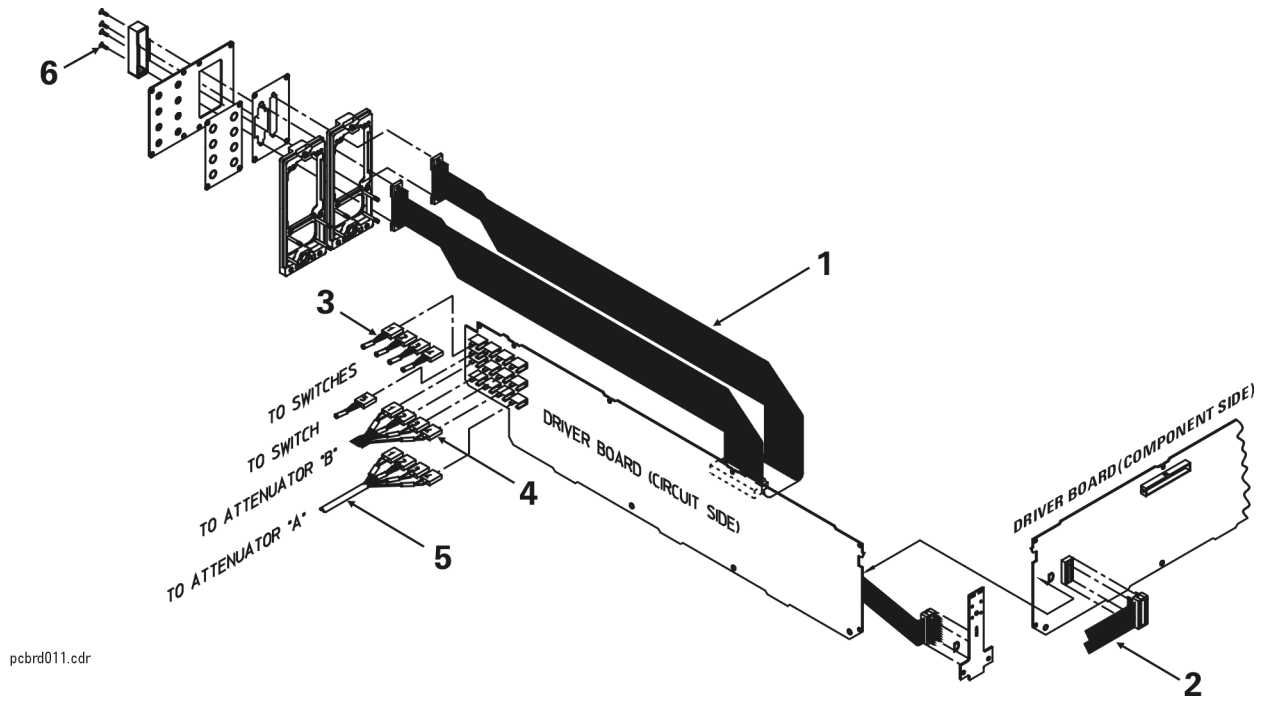


Figure 7-10 70612A,C and 70613A,C Option 011 Board Cable Diagram

Table 7-12 Switch and Attenuator Assembly Chart

Module	Switch Part Number	Attenuator Part Number	
		Position A	Position B
70612A	70612-60003		
Opt 002	70612-60005		
Opt 003		70612-60015	
Opt 004		70612-60007	
Opt 007		70612-60007	70612-60015
70613A	70612-60003		
Opt 002	70612-60005		
Opt 003		70612-60015	
Opt 004		70612-60007	
Opt 007		70612-60007	70612-60015
70612C	70612-60004		
Opt 002	70612-60006		
Opt 003		70612-60014	
Opt 004		70612-60008	
Opt 007		70612-60008	70612-60014
70613C	70612-60004		
Opt 002	70612-60006		
Opt 003		70612-60014	
Opt 004		70612-60008	
Opt 007		70612-60008	70612-60014

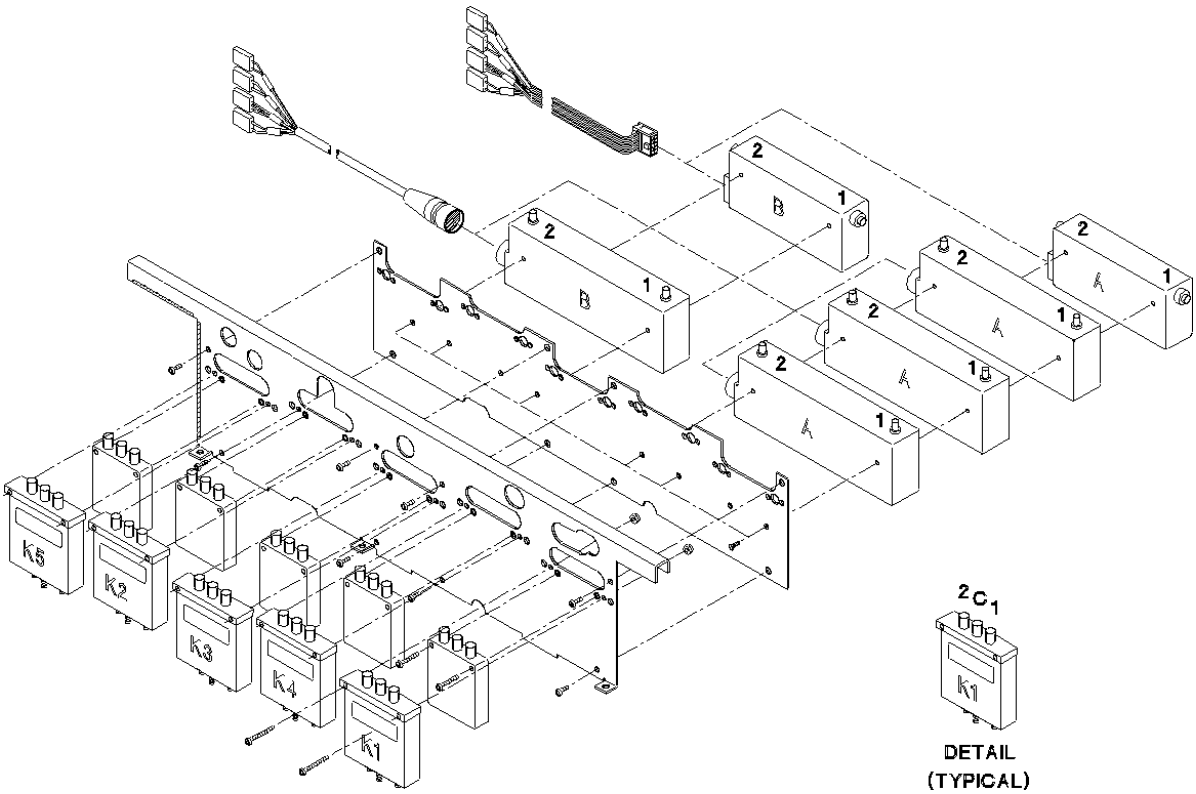


Figure 7-11 70612A,C and 70613A,C Attenuator/Switch Configuration

Table 7-13 70612A,C and 70613A,C Semi-Rigid Cable Chart (1)

Cable Part Number	From Component	To		Interface Modules
		Component	Port	
70612-20011	K1(C)	ATT 'A' LONG (1)		70613A Opt 003,004, & 007
				70613C Opt 004 & 007
			5	All modules
70612-20012	K5(2)			70612C Opt 007
70612-20013	ATT 'B' SHORT (2)	K2 (C)		70613C Opt 007
70612-20014	K4 (1)		1	All modules
70612-20015	K3 (2)		3	All 70613 modules
70612-20016	K5 (1)		4	All 70613 modules
70612-20017	K1 (1)		B (front)	All 70613 modules
70612-20018	K1 (2)		A (front)	All 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 70613A Opt 004 All modules except 70613C Opt 004
70612-20021	ATT 'A' LONG (2)	ATT 'B' SHORT (1)		70612A Opt 007 70612C Opt 007
70612-20022	K5 (1)		6	All 70612 modules
70612-20023	K1 (1)		3	All 70612 modules
70612-20024	K1 (2)		4	All 70612 modules
70612-20025	ATT 'A' LONG (2)	ATT 'B' LONG (1)		70612A Opt 007 70612C Opt 007
70612-20027	K1 (C)	ATT 'A' SHORT (1)		70613C Opt 003
70612-20028	ATT 'A' SHORT (1)		A (front)	70612C Opt 003
70612-20029	ATT 'A' LONG (1)		A (front)	70612A Opt 003, 004, 007 70612C Opt 004, 007
70612-20030	K2 (C)		A (front)	70612A, 70612C
70612-20031	K1 (C)	K2 (C)		70613A, 70613C
70612-20032	K1 (C))	K3 (2)		All 70612 modules
70612-20033	K1 (2)		A (rear)	70613A Opt 005 70613C Opt 005
70612-20034	K1 (1)		B (rear)	70613A Opt 005 70613C Opt 005
70612-20035	K2 (C)		A (rear)	70612A Opt 005 70612C Opt 005
70612-20036	ATT 'A' LONG (2)	K2 (C)		70612A Opt 003, 004 70612C Opt 004 70613A Opt 003, 004 70613C Opt 004
70612-20037	ATT 'A' SHORT (2)	K2 (C)		70612A Opt 003 70613C Opt 003
70612-20040	ATT 'B' LONG (2)	K2 (C)		70612A Opt 007 70613A Opt 007

Table 7-14 70612A,C and 70613A,C Semi-Rigid Cable Chart (2)

Cable Part Number	From Component	To		Cable I.D.
		Component	Port	
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
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
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
70612-20123	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 7-14 70612A,C and 70613A,C Semi-Rigid Cable Chart (2) (Continued)

Cable Part Number	From Component	To		Cable I.D.
		Component	Port	
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
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)		34	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
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
70612-20023	K3 (C)	K2 (1)		W8
70612-20024	K2 (2)	K5 (C)		W9
70612-20032	K4 (2)		2	W10
70612-20035	K1 (C)	ATT 'A' SHORT (1)		W11
70612-20037	ATT 'A' SHORT (2)	K2 (C)		W12

Table 7-14 70612A,C and 70613A,C Semi-Rigid Cable Chart (2) (Continued)

Cable Part Number	From Component	To		Cable I.D.
		Component	Port	
70612 A,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
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)	2	W10
70612-20036	ATT 'A' LONG (2)	K2 (C)		W11
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
70612-20123	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 7-14 70612A,C and 70613A,C Semi-Rigid Cable Chart (2) (Continued)

Cable Part Number	From Component	To		Cable I.D.
		Component	Port	
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
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
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)			W7
70612-20021	ATT '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 7-14 70612A,C and 70613A,C Semi-Rigid Cable Chart (2) (Continued)

Cable Part Number	From Component	To		Cable I.D.
		Component	Port	
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)			W11
70612-20025	ATT 'A' LONG (2)	ATT 'B' LONG (1)		W12
70612-20040	ATT 'B' LONG (2)	K2 (C)		W13
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	ATT 'A' LONG (2)	ATT 'B' SHORT (1)		W10

8 Troubleshooting

Overview

In this chapter you will find:

- Troubleshooting tests to help isolate possible failures
  - Fuse test
  - EEROM test
  - LED test
  - Channel test
  - Pulse parameter test
  - Reflection test
  - Insertion loss test
  - Isolation test
- Recommended test equipment
- Procedure for setting up the EPROM

Troubleshooting

Tests

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.

If the switch driver does not meet the parameters of the following tests, we strongly recommend that you send the entire unit back to Agilent Technologies for repair.

CAUTION

Opening the switch driver may void the warranty.

To isolate the possible failure, the following tests may be performed.

- Fuse test — Verifies condition of internal fuse.
- Power supply 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
- Insertion loss test — Isolates frequency related problems in the microwave performance of the switches
- Isolation test — Used to isolate faulty switches.

Conditions

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

- ❏ The 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 70611A, 70612A,C or 70613A,C must pass all self tests.
- ❏ During any performance test, all shields and connecting hardware must be in place. ESD precautions must be observed.
- ❏ Proper cables, adapters, and probes must be used for the test setups.
- ❏ The user must understand how to operate the specified test equipment needed for each test.

Recommended Test Equipment

Recommended test equipment for the verification tests is given in the tables below. Other equipment may be substituted if it meets or exceeds the critical specifications listed.

Table 8-1 Recommended Test Equipment for 70611A

Instrument	Critical Specifications	Recommended Model	Use[1]
External driver 70611A Standard	No substitute	84940A	O, P, T
Modular Measurement System	No substitute	70000 (with display)	O, P, T
Oscilloscope	Bandwidth: dc to 100 MHz Vertical sensitivity: 4 V/div Vertical input: 50 Ω impedance dc coupled Timebase: 5 ms/div	Various models	P, T
Multimeter	dc resistance: 0.1 ohms resistance	E2372A	
Test accessory	No substitute. Made specifically for MMS switch drivers.	70611-60014	
Cable	No substitute. Made specifically for MMS switch drivers.	70611-60010	P, T

[1]P = Performance tests, T = Troubleshooting, O = Operator's checks

Table 8-2 Recommended Test Equipment for 70612A,C and 70613A,C

Instrument	Critical Specifications	Recommended Model	Use[1]
External driver 70612A,C / 70613A,C Except Options 006 and 011	No substitute	84940A	O, P, T
External CPU 70612A,C / 70613A,C Options 006 and 011 only	No substitute.	70611A, 70612A,C or 70613A,C	O, P, T
Oscilloscope	Bandwidth: dc to 100 MHz Vertical sensitivity: 4 V/div Vertical input: 50 Ω impedance dc coupled Timebase: 5 ms/div	Various models	P, T
Multimeter	dc resistance: 0.1 ohms resistance	E2372A	
Test accessory	No substitute. Made specifically for MMS switch drivers.	70611-60014	
Cable	No substitute. Made specifically for MMS switch drivers.	70611-60010	P, T
Network analyzer 70612A, and 70613A, 70612C and 70613C	 dc to 6.5 GHz dc to 26.5 GHz	 8510B,C 8510B,C	O, P, T
Synthesized sweeper	dc to 26.5 GHz	83651A	O, P, T
Spectrum analyzer 70612A, and 70613A, 70612C and 70613C	 dc to 6.5 GHz dc to 26.5 GHz	 71209A 71209A	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 MSIB switch is set to 9. (Each instrument must have a unique MSIB address.)
3. Open the Modular Measurement System's door and slide the 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 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 up or down arrow keys 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 faulty.

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.
   - On the 70611A, the MSIB connector is centered on the bottom of the rear panel. On the 70612A,C and 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

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 (refer to Figure 7-1 on page 7-5). Make sure the RFI gasket remains in the groove in the bottom of the frame.
   - If the unit is a standard 70611A, the controller board is the only board installed in the instrument.
   - If the unit is an 70611A Option 001, 70612A,C or 70613A,C there will be two or more boards installed. The controller board, part number 70611-60001, is located on the right side when facing the front panel.
2. If the unit is a standard 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, part number 2110-0043.
5. After the fuse is replaced the boards 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 the Modular Measurement 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. Refer to "Saving to EEROM" in Chapter 5 for information on the correct procedure.
4. Press ***{Path}***.

   Examine the information displayed on the screen. If the information is incorrect reprogram the EEROM. Refer to 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}**.
4. Continue repeating steps 2 and 3 until all of the LEDs have been lit.

The following table lists the ports and the channel number 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. 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 you 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. Refer also to the `:ERRor?` query in Chapter 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 problem in the microwave path. Program the desired path to close. Use an ohmmeter 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.

1. Perform a continuity test between Input A and Port 1. If an open is detected, check the other output ports.
2. If continuity to Port 2 is detected the potential problem area is switch 103.
3. If continuity to Port 3 is detected the problem area is switch 102.
4. If continuity to Port 4 is detected the problem area is switch 101.
5. It may be necessary to perform continuity checks on additional paths in order to eliminate ambiguity. Refer to Table 8-3, Table 8-4 on page 8-12, and Figure 8-1 on page 8-13.

Table 8-3 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

1. If Option 003, 004, or 007 is included, the switch driver's attenuators should be set to 0 dB for the continuity tests.

Table 8-4 70613A,C Continuity Troubleshooting Chart

Input	Programmed Output Port	Measured Output Port	Problem Channel
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	
		—	
		5	104
	5	1, 2, 3	101
		4	104
	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
	5	1, 2, 3 then:	101
		4	104
B	1, 2, 3, 4, 5	—	100

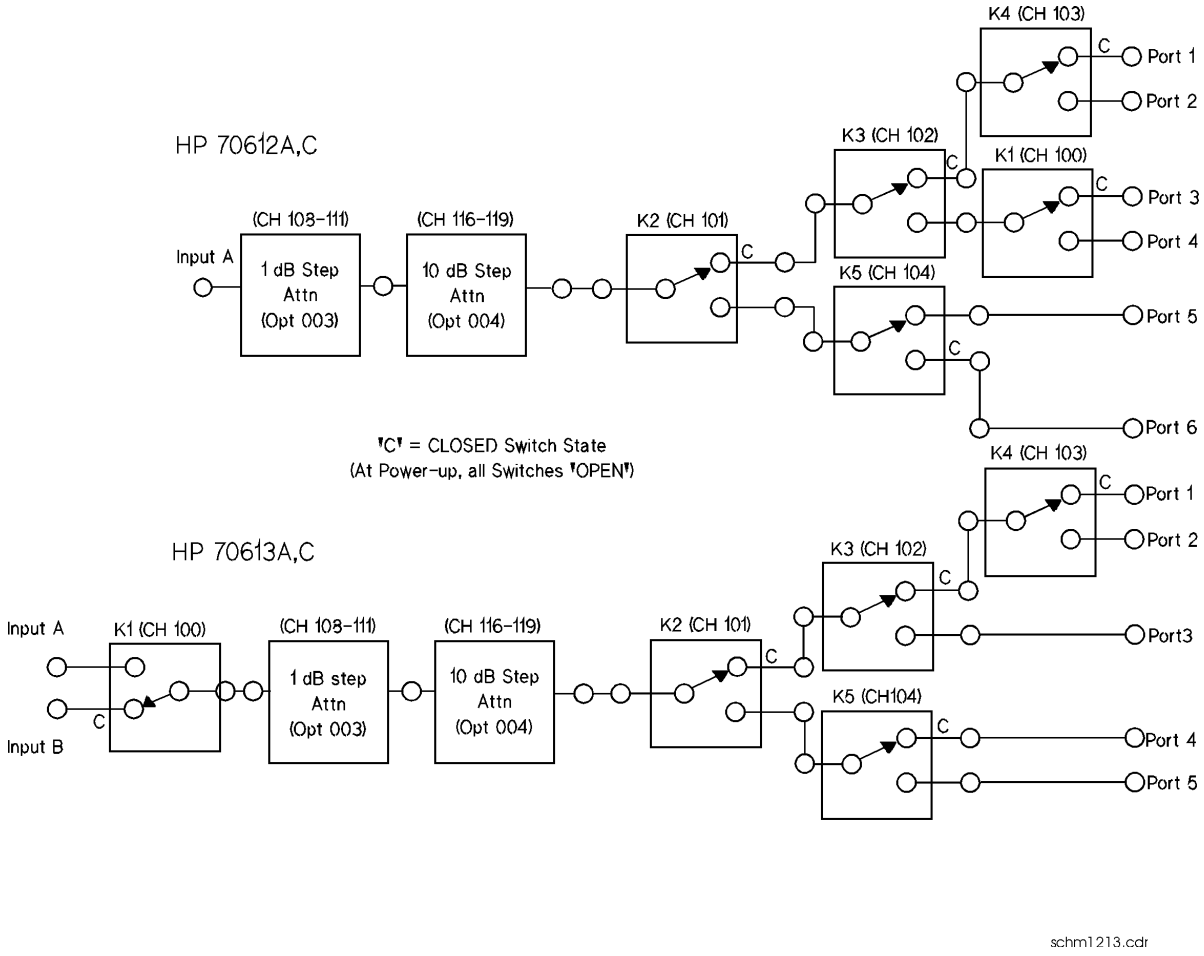


Figure 8-1 70612A,C and 70613A,C Schematic Diagrams

Pulse Parameters Test

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

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

Table 8-5 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

Hardware Limits

The +24 volt supply in the switch driver can supply sufficient current to drive up to four 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.

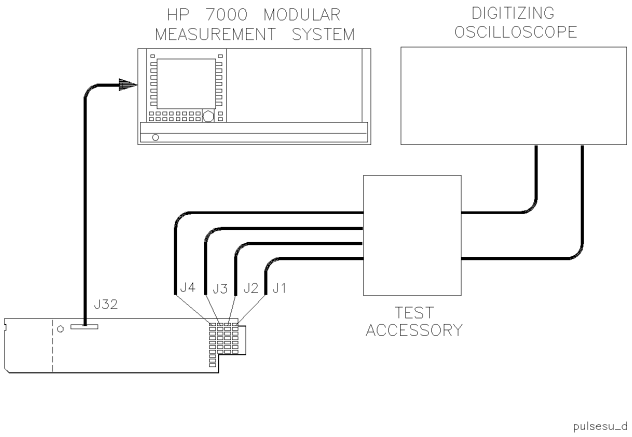


Figure 8-2 Pulse Parameters Test Setup

Equipment

Modular Measurement System . . . . . 7000 Series
Oscilloscope. . . . . Refer to Table 8-1.
Test accessory 70611-60014
Driver Board (70611A, 70612A,C, and 70613A,C) 84940A
Cable 70611-60004

1.This test accessory provides a 200 mA load for the driver.

Procedure

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

CAUTION

Do not connect or disconnect relays while the switch driver's 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 8-2.
   - Connect the test accessory to J1, J2, J3, J4 if you are using an external driver card.
   - Connect the test accessory to cable (70611-60004) if you are using an 70611A Option 001, 70612A,C or 70613A,C.
3. Set the oscilloscope as follows:
   - Volts/div . . . . . .5 V
   - Sweep speed . . . . . 10 ms per division
   - Trigger. . . . . .INTERNAL

4. Turn ON the MMS mainframe.
5. If necessary, bring the interface module's display onto the screen.
6. Toggle channels 100, 101, 102, 103 by pressing **[Channel]** and **[TOGGLE]**.

or

If you are using an 9000 Series 300 controller, you may 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
80   !  line 50 and leave line 100 in the program, as shown
90   !  here.
100  OUTPUT 709;"ROUT:VER:OFF (@100:103);"
110  !
120  !  For the Sensing (:VERify) Enabled test, comment out
130  !  line 100 and 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
230  !  not apply.
240  !  Switching speed is then the 30 ms pulse (:WIDTh).
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 the reading. +21 V < _____ < +27 V

Current

Divide the 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

70611A, 70612A,C or 70613A,C Range	Minimum	Actual Results	Maximum
Voltage	21 Vdc		27 Vdc
Current	175 mA		225 mA
Switching speed:			
Sensing disabled	25 ms		35 ms
Sensing enabled	45 ms		55 ms

Sensing Disabled

Each switch coil is internally connected to the +24 V bias. A power transistor on the driver board supplies the ground return that will activate the switch coil. The controller assembly actuates the transistor for a predetermined time. The default setting is 30 ms. Refer to ***{WIDTH}*** softkey command in Chapter 5 or the `Route:Width` remote command in Chapter 6.

Sensing Enabled

For switches that can be sensed, the switch coil is internally connected to the +24 V bias supply with a dc switch that removes the bias from the activated coil after the switch has changed position and applies the bias to the opposite coil. By monitoring the presence on this bias through the opposite coil, the switch controller can determine the switch position. After the initial 30 ms closure pulse, an additional 20 ms time is allowed for the sense lines to settle. At this time an error check and a programmed position check are performed. Therefore, the combined time for the switch drive and switch position verification is 50 ms.

Microwave Troubleshooting Tests 70612A,C and 70613A,C Only

Reflection and Insertion Loss Test

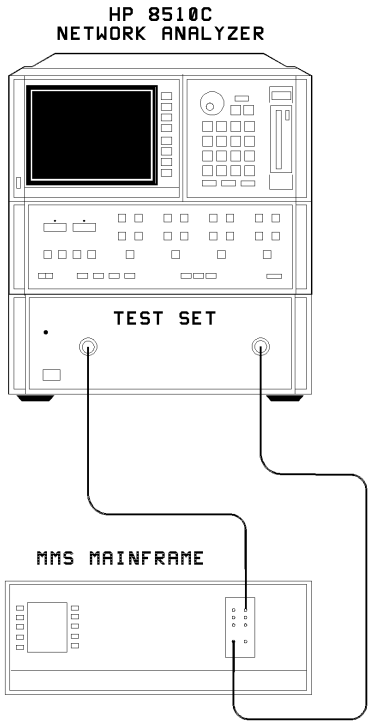


Figure 8-3 Reflection and Insertion Loss Test Setup

Equipment

Modular Measurement System Display/Mainframe. 70004
Network analyzer 8510B,C
Synthesized sweeper. 83651A
S-parameter test set. 8517A,B
3.5 mm calibration kit. 85052A

Measurement Calibration

1. Connect the equipment as shown in Figure 8-3.
2. Set the system's LINE switch to ON.
3. Press **[Local]**, **[Recall]**, ***{More}***, ***{Factory Preset}*** on the network analyzer to set the system to a known starting point.
4. Under the Stimulus block on the front panel, press **[Menu]**.
5. Press ***{Step}*** to set to step mode.

6. Press **[Cal]**.
7. Select ***{Cal 1 3.5 mm}***.
8. Press ***{Full 2 Port}***.
9. Press ***{REFLECT'N}***.
    a. Connect a short to Port 1 of the switch driver.
    b. Press ***{(S11): SHORT}***.
    c. Remove the short and connect an open to Port 1.
    d. Press ***{(S11): OPEN}***.
    e. Remove the open and connect a lowband load to Port 1.
    f. Press ***{(S11): LOADS}***.
    g. Remove the lowband load and connect a sliding load to Port 1.
    h. Press ***{SLIDING}***.
    i. Set the sliding load to the first mark. Press ***{SLIDE is SET}***.
    j. Repeat the steps above for all sliding load marks.
    k. Press ***{SLiDING LOAD DONE}***.
    l. Press ***{LOADS DONE}***.
    m. Repeat steps 9(a–l) above for Port 2 (S22).
    n. When the calibration of Port 2 is complete, press ***{REFLECT'N DONE}***.
10. Press ***{TRANSMISSION}***.
    a. Connect a THRU device
    b. Press ***{FWD TRANS THRU}***
    c. Press ***{FWD MATCH THRU}***.
    d. Press ***{REV TRANS THRU}***.
    e. Press ***{REV MATCH THRU}***.
    f. Press ***{TRANS DONE}***.
11. Press ***{ISOLATION}***.
    a. Connect a broadband load to Port 1 and Port 2.
    b. Press ***{FWD ISOL'N} {ISOL'N STD}***.
    c. Press ***{REV ISOL'N} {ISOL'N STD}***.
    d. Press ***{ISOLATION DONE}***.
12. Save the calibration in an empty Cal set (one without a star next to it).

To measure reflection

Measure the reflection for all desired paths. Refer to Chapters 5 or 6, "Programming Internal Switches and Optional Step Attenuators" for information on selecting paths or attenuators.

70612A and 70613A	Reflection (SWR) _____0.17 (<1.4:1) 6.5 GHz
70612C and 70613C	Reflection (SWR) _____ 0.26 (<1.7:1) 18 GHz
	Reflection (SWR) _____*0.46 (<2.7:1)*
	18 to 26.5 GHz typical

To measure insertion loss

1. Press **[S_{21}]** on the network analyzer.
2. Set the network analyzer as follows:
   - Insertion loss . . . . . 1 dB per division
   - Reference level . . . . . 0 dBm
   - Reference position 1

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

f = frequency in GHz

70612A/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
70612C/70613C	Insertion loss ____ <1.5 + 0.22f dB(18 GHz)
	Insertion loss_____<6.5 dB (18 to 26.5 GHz)
Option 003, 004	Insertion loss ____<1.5 + 0.28f dB (18 GHz)
	Insertion loss____ <8.0 dB (18 to 26.5 GHz)
Option 005, 006	Insertion loss ____<1.5 + 0.28f dB
	Insertion loss_____<8.0 dB (18 to 26.5 GHz)
Option 007	Insertion loss _____<2.0 + 0.35f dB(18 GHz)
	Insertion loss_____<10.0 dB (18 to 26.5GHz)

NOTE

- When measuring insertion loss > 80 dB on the 70612C and 70613C Options 003, 004 or 007 the isolation test setup should be used as shown in Figure 4-3. Measure the desired path by connecting the 83651A synthesized sweeper to the input port and the 71209A signal analyzer front end to the desired output.
- 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 70612A and 70613A Option 004 will be measured to 110 dB.
  - The 70612C and 70613C Option 004 range is 0 to 90 dB.
  - The 70612C and 70613C Option 004 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

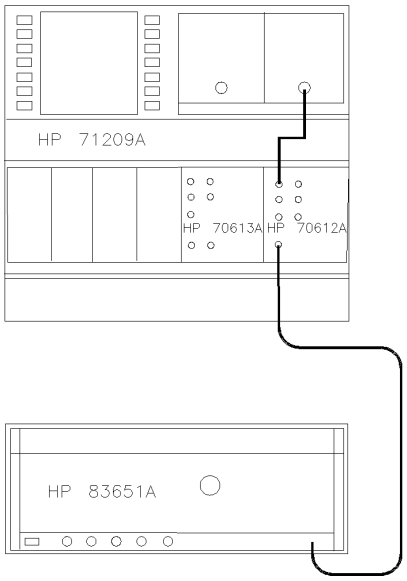


Figure 8-4 Isolation Test Setup

Equipment

Modular Measurement System Display/Mainframe. 70004
Spectrum analyzer 71209A
Synthesized sweeper. 83651A
50 ohm load, 3.5 mm (m) 909D

The 70612A,C or 70613A,C may be plugged into the 71209A spectrum analyzer if space is available. This eliminates the need for the 70004A MMS mainframe.

Procedure

1. Connect the equipment as shown in the test setup illustration for this procedure.
2. Set the system's LINE switch to ON.
3. Set the sweeper as follows:

   70612A/70613A (50 MHz to 6.5 GHz)

   70612C/70613C (50 MHz to 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 to 18 GHz)
     1 dBm (18 to 16.5 GHz)

4. Set the spectrum analyzer as follows:

   70612A/70613A (50 MHz to 6.5 GHz)

   70612C/70613C (50 MHz to 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 of 0 dB for the isolation tests.

5. Measure any 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
70612A / 70613A	Isolation_____<120 – 4.2f dB
Option 002	Isolation_____<100 dB
70612A / 70613A	Isolation_____<110 – 2.8f dB
Option 002	Isolation_____< 60 dB

Procedure for Setting Up the EPROM

Use the following procedure to set up the EPROM if the EPROM or the CPU board is replaced.

- To set up the EPROM from the controller, use the following commands:

`"MEM:DEL;"`	Deletes everything in CMOS RAM memory.
`"SYST:ERR?"`	
`READ HP-IB FOR ERROR`	Check error queue (this can be used at any point to read any error back).
`"DIAG:MOD ""70611A"","`	Writes model number of your instrument.
`"DIAG:SER ""US37349017"";"`	Writes unique serial number of your instrument (example is a typical serial number).
`"ROUTE:DRIVE:ON(@X00:X30)"`	Enables channels* to be engaged.
`"ROUTE:VERIFY:ON(@X00:X30)"`	Turns on sensing (can only be used with sensing switches. Do not turn on for non-sensing or non-switches.)
`"MEM:SAVE;"`	Saves above configuration to EPROM.

- Power cycle the 70611A and check the EPROM:

`"*IDN?"`	
`READ HP-IB`	Reads back the ID of the unit.

`"HEWLETT-PACKARD,70611A,US37349017,950713"` (typical readback)

`"ROUTE:DRIVE:ON?(@X00,X01,`
`X02,X03,X04,X05,X06,X07,`
`X08,X09,X10,X11,X12,X13,`
`X14,X15,X16,X17,X18,X19,`
`X20,X21,X22,X23,X24,X25,`
`X26,X27,X28,X29,X30)"`
	Queries X00 through X30

`READ HP-IB`	Reads back 1's and 0's for each channel. If VERIFY is ON, it will = 1; if OFF, it will = 0.

* Each channel has its own unique address. 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 and so forth up to card 800 to 830.

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